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Rev. 3

REDOX Facility Safety Analysis Report

Prepared for the U.S. Department of Energy, Richland Operations Office
Office of Environmental Restoration

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EXECUTIVE SUMMARY

E.1 FACILITY BACKGROUND AND MISSION

The Reduction-Oxidation (REDOX) Facility was the first large-scale, continuous-flow, solvent-extraction process plant built in the United States for the recovery of plutonium from irradiated uranium fuel. Operations began in 1952 and continued until the facility was shut down in 1967. Deactivation started in 1967 and was completed in 1969. Since deactivation, surveillance and maintenance (S&M) operations have been performed at the facility. The conduct of S&M activities constitutes the current facility mission.

This safety analysis report (SAR) documents the authorization basis for S&M activities at the REDOX Facility and supercedes the basis for interim operations, *Auditable Safety Analysis for the Surveillance and Maintenance of the REDOX Complex* (BHI 1997a). A graded approach was used in accordance with the guidance provided in DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports* (DOE 1994b).

E.2 FACILITY OVERVIEW

The REDOX Facility is located in the 200 West Area of the Hanford Site. The facility is composed of deactivated buildings and associated process equipment used for dissolution and separation of uranium, neptunium, and plutonium, as well as deactivated equipment formerly used for waste concentration, waste neutralization, and solvent recovery. In addition to the main processing building (i.e., the 202-S Canyon Building), the REDOX Facility includes buildings formerly used for the storage of chemicals and materials and for support systems (e.g., ventilation).

The 202-S Canyon Building is a reinforced-concrete structure that houses nine process cells and supporting operating, piping, and sample galleries, and a tower process area (referred to as the silo). The process cells (e.g., dissolver cell A and south extraction cell F) contain deactivated processing equipment. The silo contains deactivated solvent-extraction columns. The

202-S Canyon Building is serviced by the 291-S exhaust ventilation system. Exhaust air passes through a sand filter prior to discharge to the environment.

E.3 FACILITY HAZARD CLASSIFICATION

The REDOX Facility has been determined to be a hazard category 2 facility based on (1) the sum-of-ratios approach prescribed in DOE-STD-1027-92 (DOE 1997a), and (2) the radiological dose consequences of the bounding facility accident (i.e., a seismic event).

E.4 SAFETY ANALYSIS OVERVIEW

The S&M activities analyzed in this SAR include the following:

- S&M of barriers and postings
- Identification and removal of asbestos
- Container management
- Equipment calibration, testing, maintenance, and repair
- Repair and upgrades of confinement systems
- Repair and upgrades of structural components
- Inspection for and response to spills
- Hazardous substance removal and disposal
- Nondestructive assay waste characterization and sampling
- Removal of nonprocess equipment
- Radiological surveys
- General inspections and tours.

The principal significant hazards associated with these activities at the REDOX Facility (above and beyond standard industrial and occupational safety hazards) are related to the inventory of residual radioactive material. It is estimated that the 202-S Canyon Building contains 26.7 kg of plutonium-239, the majority of which is contained within former processing equipment (e.g., tanks and piping). Hazards related to this inventory include worker exposure and uptake, uncontrolled release to the environment, and nuclear criticality. The evaluation basis accident analyzed for the facility is a seismic event that results in the collapse of the facility roof. Because the majority of the inventory resides within the process cells and the cover blocks over the process cells survive intact, the radiological consequences of the seismic event are low at the site boundary (i.e., 0.023 rem) and relatively low at 100 m (i.e., 13 rem).

The following subsections describe the main preventive and mitigative features used for the protection of workers, the public, and the environment.

E.4.1 202-S Canyon Building Exhaust Ventilation Systems

The 202-S Canyon Building exhaust ventilation systems ensure that (1) the building is maintained at a negative air pressure relative to the environment, (2) the process cells and the silo tower shaft are maintained at a negative air pressure relative to adjacent operating areas, and (3) the exhaust air is filtered.

E.4.2 Process Cell Cover Blocks

By being in place, the process cell cover blocks protect the inventory of radioactive material within the process cells from release should the building roof collapse during a seismic event.

E.4.3 Review of Activities

All other activities (other than S&M activities) are evaluated to determine if they constitute an unreviewed safety question (USQ). This ensures that related hazards are identified, evaluated, and appropriately controlled prior to conduct of the activity.

E.5 ORGANIZATIONS

Bechtel Hanford, Inc. (BHI), under contract to the U.S. Department of Energy (DOE), is responsible for the conduct of REDOX Facility S&M activities. Eberline Services Hanford, Inc., under contract to BHI, provides radiological control support.

E.6 SAFETY ANALYSIS CONCLUSIONS

The following safety analysis conclusions are based on the results of the hazard and accident analyses and the establishment of associated technical safety requirements:

- Safety and environmental management programs acceptably manage the risk to the public, workers, and the environment from S&M activities.
- Engineered and administrative controls and safety management programs acceptably manage the risk to the public, workers, and the environment from potential hazardous conditions and postulated accidents.

BHI management has thoroughly analyzed the risks and concludes that, despite uncertain hazardous materials inventory, BHI can safely operate the REDOX Facility in the S&M mode.

E.7 SAFETY ANALYSIS REPORT ORGANIZATION

The main body of this SAR parallels the format delineated in DOE-STD-3009-94 (DOE 1994b). Applying a graded approach, Sections 6.0 through 17.0 are abbreviated because appendices to this document detail the standards and requirements applicable to the topical areas addressed by these sections.

The SAR is informational and establishes the basis for identifying USQs. This document is also intended for use by the following:

- By facility management to be knowledgeable of the safety issues and, as such, is a practical reference for day-to-day operations.
- As a basis for DOE to approve operations and activities related to S&M and other functions.
- As a BHI commitment to safe operations.
- As a living document (updated periodically) for other organizations with a need-to-know and for future management beyond the BHI Environmental Restoration Contract.

This revision is limited to include approved USQ safety evaluations and minor editorial changes as required for the annual update to the document. Items incorporated in this revision include the following:

- Deletion of the EF-8 exhaust system, system descriptions, and administrative technical safety requirement
- Incorporation of revised criticality safety evaluation
- Incorporation of the approved integrated environment and safety management system into Chapters 6.0 through 17.0
- Editorial changes for readability and consistency in the Technical Safety Requirements, Appendix E.

TABLE OF CONTENTS

Table of Contents

Table of Contents

APPENDICES

FIGURES

TABLES

ACRONYMS

ALARA	as low as reasonably achievable
amsl	above mean sea level
ARF	airborne release fraction
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ATS	automatic transfer switch
BHI	Bechtel Hanford, Inc.
BLAN	Bechtel local area network
BP	before present
CEDE	committed effective dose equivalent
CFR	*Code of Federal Regulations*
CONOPS	conduct of operations
D&D	decontamination and decommissioning
DCF	dose conversion factor
DF	decontamination factor
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
ER	environmental restoration
ERC	Environmental Restoration Contractor
ERCT	Environmental Restoration Contractor Training
ERO	emergency response organization
FHA	fire hazard analysis
HEPA	high efficiency particulate air
HMS	Hanford Meteorological Station
HSRCM	*Hanford Site Radiological Control Manual*
ISMS	Integrated Environment, Safety, and Health Management System
JHA	job hazard analysis
MAR	material at risk
MCC	motor control center
MMI	modified Mercalli intensity
NDA	nondestructive assay
ORPS	Occurrence Reporting and Processing System
PCB	polychlorinated biphenyl
PHMS	Project Hanford Management System
PMF	probable maximum flood
PMMA	polymethyl methacrylate
PR	product receiver
psf	pounds per square foot
QA	quality assurance
RCT	radiological control technician
REDOX	Reduction-Oxidation (Facility)
RF	respirable fraction
RL	U.S. Department of Energy, Richland Operations Office

RWP	radiological work permit
S/M&T	Surveillance/Maintenance and Transition (Project)
S&M	surveillance and maintenance
SAR	safety analysis report
SSCs	structures, systems, and components
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSR	technical safety requirement
USQ	unreviewed safety question
WAC	*Washington Administrative Code*
WDOH	Washington State Department of Health
wg	water gauge
X/Q	atmospheric dispersion coefficient

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If You Know	*Multiply By*	*To Get*	*If You Know*	*Multiply By*	*To Get*
Length			**Length**		
inches	25.4	millimeters	millimeters	0.039	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.621	miles
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.0836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
acres	0.405	hectares	hectares	2.47	acres
Mass (weight)			**Mass (weight)**		
ounces	28.35	grams	grams	0.035	ounces
pounds	0.454	kilograms	kilograms	2.205	pounds
ton	0.907	metric ton	metric ton	1.102	ton
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.033	fluid ounces
tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.057	quarts
cups	0.24	liters	liters	0.264	gallons
pints	0.47	liters	cubic meters	35.315	cubic feet
quarts	0.95	liters	cubic meters	1.308	cubic yards
gallons	3.8	liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
Temperature			**Temperature**		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity			**Radioactivity**		
picocuries	37	millibecquerel	millibecquerel	0.027	picocuries

1.0 SITE CHARACTERISTICS

1.1 INTRODUCTION

This section describes Hanford Site characteristics relevant to hazard and accident analysis of surveillance and maintenance (S&M) activities at the Reduction-Oxidation (REDOX) Facility. The Hanford Site is a 560-mi^2 area located in the southeast corner of Washington State (Figure 1-1). The REDOX Facility, shown in Figure 1-2, is located in the 200 West Area of the Hanford Site. The REDOX Facility consists of a former fuel processing facility (i.e., the 202-S Canyon Building) and ancillary support structures:

- 291-S Exhaust Fan Facility, Sand Filter, and Exhaust Stack (291-S-1)
- 276-S Solvent Handling Building
- 292-S Control and Jet Pit House
- 293-S Nitric Acid Recovery and Iodine Backup Building
- 2718-S Sand Filter Sample Building
- 211-S Liquid Chemical Storage Tank Farm
- 2711-S Stack Gas Monitoring Building
- 2715-S Storage Building
- 2904-SA Cooling Water Sampling Building
- 2710-S Nitrogen Storage Building
- 2706-S Storage Building (demolished).

This section uses the format delineated in DOE-STD-3009-94 (DOE 1994b), which represents acceptable U.S. Department of Energy (DOE) guidance for the preparation of comprehensive safety analysis reports (SARs) for complex hazard category 2, nonreactor nuclear facilities with long operational lives. The REDOX Facility is an inactive surplus facility that was deactivated in 1969. The majority of hazardous material consists of fairly adherent films and residues in deactivated equipment and systems. Using a graded approach, elements of this section are simplified, as appropriate. This SAR supercedes the basis for interim operations (BHI 1997a). This revision is limited to include approved unreviewed safety question (USQ) safety evaluations and minor editorial changes as required for the annual update to the document.

1.2 REQUIREMENTS

Applicable standards and requirements are derived from the approved Integrated Environment, Safety, and Health Management System (ISMS). Specific implementing procedures are required for the S&M activities and are defined in the approved conduct of operations (CONOPS) and associated project instructions. Descriptions of the applicable requirements are found in the detailed programmatic information in Sections 6.0 through 17.0 of this SAR.

1.3 SITE DESCRIPTION

The following subsections address the site characteristics of the area encompassed by and surrounding the Hanford Site.

1.3.1 Geography

The Columbia River enters the Hanford Site boundary at the northwest corner and crosses over to the eastern boundary as it flows southward. The section of the river on the Hanford Site is a free-flowing stretch commonly referred to as the Hanford Reach. The Yakima River flows from west to east, south of the Hanford Site, and empties into the Columbia River at the adjacent cities of Kennewick, Pasco, and Richland.

The topography of the Hanford Site is relatively flat, with the exception of several mountain ridges on the central 200 Area Plateau. The Site is bordered on the north by the Saddle Mountains and on the west by the Rattlesnake Hills. Elevations for the site range from 400 ft above mean sea level (amsl) along the Columbia River to greater than 3,600 ft amsl at Rattlesnake Mountain. The central 200 Area Plateau, located on a broad, flat, topographic high in the center of the Site, ranges in elevation from 620 to 800 ft amsl. Dominant natural features of the Hanford Site include the Columbia River, anticlinal ridges of basalt in and around the Hanford Site boundary, Gable Mountain and Gable Butte, and sand dunes near the Columbia River.

The Hanford Site extends into Benton, Franklin, Grant, and Adams Counties. State Highway 240 passes through the Site within 1 mi of the 200 West Area facilities and within 3.2 mi of the REDOX Facility boundary.

The majority of the land within the Hanford Site boundary is a limited-access area under DOE control for use in environmental restoration and remediation efforts. The DOE's nuclear facilities are located in what are called operational areas and make up approximately 6% of the total available Hanford Site land area. The remaining 94% of the Site land area is unoccupied and managed by DOE. Hanford Site operational areas are identified by area numbers and letters. Several other areas at the Hanford Site are managed under a multi-purpose concept and serve to isolate the areas of DOE nuclear activities. All industrial activities on the Hanford Site must be compatible with DOE activities and must be approved by DOE.

Public access to the Hanford Site is controlled by DOE at the Wye Barricade on Route 4 and the Yakima and Rattlesnake Barricades on State Highway 240. Traffic counts in 1996 indicated that an average of 61 vehicles per hour travel on State Highway 240, approximately 10% of which are driven by members of the general public. The Hanford Patrol, the Site security organization, is responsible for access control at the barricades. An additional access point to the 200 East and 200 West Areas from Highway 240, with limited hours of operation, is located near the southeast corner of the 200 West Area. Public access through the Hanford Site on Highways 24, 240, and 243 is not DOE-controlled under normal circumstances. Traffic on the Columbia River, in the airspace over the Hanford Site, and on the onsite access routes to areas used by non-DOE organizations (e.g., Washington State Department of Ecology [Ecology] and the Washington

Public Power Supply System) is also not subject to DOE controls under normal circumstances. Under emergency planning conditions, all access to the Site (with the exception of the Columbia River, which is jointly controlled by the Pacific Northwest National Laboratory, the Benton County Sheriff's department, and the United States Coast Guard) will be DOE-controlled and all Site routes to traffic not associated with official and approved activities may be closed.

1.3.2 Demography

The population density on the Hanford Site is very low as a result of the Federal ownership of the land, and the population distribution in the area surrounding the Hanford Site is not uniform. There is no residential or public occupancy on the Hanford Site. Most of the adjacent area located east, north, and west of the Site is used for farm land or range land and is populated with scattered farming communities.

Communities nearest the Site include Richland, Kennewick, Pasco, West Richland, Benton City, Prosser, Sunnyside, Grandview, and Mesa. The 2000 consensus data for these communities are presented in Table 1-1.

Individuals on the Columbia River or on Highways 24, 240, and 243 are considered transient. Access to the highways or the Columbia River is not controlled, except during emergency conditions.

Individuals from tribal organizations, universities, or other Federal, state, or local government agencies who have received approval from the U.S. Department of Energy, Richland Operations Office (RL) to access areas within the Hanford Site (e.g., Fitzner-Eberhardt Arid Lands Ecology Reserve) are also considered transient. In accordance with DOE RLID 1210.1, *Hanford Visitor Policies and Procedures*, RL may permit uncontrolled access to the Hanford Site; however, all unescorted individuals that are permitted either controlled or uncontrolled access are required to receive emergency preparedness training.

Approximately 15,000 persons were employed on the Hanford Site in late 1995. Some Hanford Site work assignments include shift and weekend coverage; therefore, the total number of persons on the Site at any one time varies with the time of day, the staffing requirements for active projects, and daily fluctuations in employee work attendance patterns. Worker population in the 200 West Area is 1,621; this number is distributed among the nearby structures, including those workers who are involved in the decontamination and decommissioning (D&D) of the 233-S and 233-SA Buildings (closest population), the 222-S Laboratory, the Plutonium Finishing Plant (largest population), Waste Management of Hanford, the 271-U Building, and numerous trailers.

No hospitals, nursing homes, or penal institutions operate within 12 mi of the REDOX Facility. The three closest schools, Edwin Markham Elementary School, Cypress Gardens School, and Country Christian School, are at least 13 mi southeast of the 200 West Area. The schools have a total population of less than 500.

1.4 ENVIRONMENTAL DESCRIPTION

1.4.1 Meteorology

The climate of the Hanford Site is a mid-latitude semi-arid or mid-latitude desert. The summers are warm and dry with abundant sunshine, and the winters are cool with occasional precipitation.

The mean surface air temperature at the Hanford Meteorological Station (HMS) averages about 53.3°F. Temperatures average 76°F in July and 30°F in January (PNL 1995). Mean average precipitation at the HMS averages 6.3 in. Prevailing near-surface wind around the HMS is primarily from the northwest with an average wind speed of 7.6 mph (Neitzel et al. 1996).

The Hanford Site is subject to frequent strong westerly winds. The all-time peak wind recorded at the HMS tower was a gust of 80 mph in 1972. A peak wind gust of 85 mph is expected to occur once every 100 years (Neitzel et al. 1996). The effects of high wind on the REDOX Facility are addressed in Section 3.0.

The Hanford Site is well outside of established tornado alleys. The probability of a tornado striking anywhere on the Hanford Site is 9.6E-6/year (Neitzel et al. 1996). The probability of occurrence of a tornado striking the REDOX Facility is much lower, as the target area is much smaller. There is no Hanford Site design criteria established for a tornado. Accordingly, evaluation of the effects of a tornado on the REDOX Facility is not warranted.

Thunderstorms occur with relative frequency on the Hanford Site, although severe thunderstorms are rare. The Hanford Site is vulnerable to lightening strikes, and lightning protection may be provided. Lightning strikes leading to a loss of production capability is no longer pertinent because the REDOX Facility is no longer operating. The probability of a lightning strike leading to sufficient structural damage to cause a contaminant release is of sufficiently low probability that further evaluation is not warranted. Lightning is also a potential fire initiator.

On average, the Hanford Site receives 15 in. of snowfall each year, with a range varying from 0.3 to 56 in. (PNL 1995). The Hanford Site design criteria for existing facilities specify a roof design load of 20 pounds per square foot (psf) for combined snow and ashfall.

Important historical ashfalls affecting this location were from eruptions of Glacier Peak (about 10,000 years before present [BP]), Mount Mazama (about 6,000 years BP), and Mount St. Helens (about 3,600 BP). The most recent ashfall resulted from the May 18, 1980, eruption of Mount St. Helens. Although the probability of volcanic activity and ashfall is fairly low (particularly in conjunction with snow), the Hanford Site criteria are for combined loads, as noted above.

1.4.2 Hydrology

The Columbia River and its tributary, the Yakima River, are the primary Hanford Site surface water features. West Lake, about 0.02 mi^2 in area and less than 3 ft deep, is the only natural lake on the Hanford Site. Artificial surface water bodies include ponds and ditches created and used for wastewater disposal.

Large floods of the Columbia River have occurred in the past, but the likelihood of recurrence of large-scale flooding has been reduced by the construction of several flood control and water storage dams upstream of the Site. Evaluation of flood potential is conducted in part through the concept of the probable maximum flood (PMF). Flooding associated with events such as surges, seiches, and tsunami effects are not credible and, therefore, are not considered.

The PMF for the Columbia River below Priest Rapids Dam is greater than the 500-year flood. The PMF is not expected to inundate the buildings in the 200 and 300 Areas but will flood part of the 100-N Area. The PMF may also flood access roads and temporarily cut off electrical power to the 100 and 300 Areas. Because the REDOX Facility is located in the 200 Areas, further consideration of PMF impact is not warranted.

A flood risk analysis of Cold Creek (along the western edge of the Hanford Site) was previously conducted. This analysis concluded that the maximum level that would be reached is the 645-ft elevation of certain areas within the western portion of the 200 West Area. The lowest elevation of the REDOX Facility is 700 ft amsl, which is well above the postulated flood levels. Accordingly, evaluation of the direct effects of the postulated Cold Creek flood is not warranted.

1.4.3 Geology

The Hanford Site lies in the Pasco Basin, one of the largest sub-basins of the Columbia Plateau in Washington State. The Columbia Plateau is a broad plain located between the Cascade Range to the west and the Rocky Mountains to the east. There are no nearby mountains to the north or south. The Columbia Plateau is often referred to as the Columbia Basin. In the central and western sections of the Columbia Basin, the Miocene epoch Columbia River Basalt Group is underlain predominantly by continental sedimentary rocks from the Tertiary period and overlain by fluvial and glaciofluvial deposits from the Tertiary and Quaternary periods.

1.5 NATURAL PHENOMENA THREATS

The probability of a lightning strike leading to a range fire is a credible event, as the Hanford Site is vulnerable to both lightning strikes and extremely dry conditions. Major range fires have occurred at least eight times in the last 35 years. The Hanford Fire Department provides response capability. The area surrounding the REDOX Facility is basically devoid of vegetation, and tumbleweed accumulations are periodically removed. The probability of a range fire leading to enough structural damage to cause a release of contaminants is of sufficiently low probability that further evaluation is not warranted.

The Hanford Site is in a region of low-to-moderate seismicity. The historic record of earthquakes in the Pacific Northwest dates from about 1840. The early part of this record is based on newspaper reports of structural damage and the human perception of the shaking, as classified by the modified Mercalli intensity (MMI) scale, and is probably incomplete because the region was sparsely populated. Seismograph networks did not start providing earthquake locations and magnitudes of earthquakes in the Pacific Northwest until about 1960.

Large earthquakes (i.e., magnitude greater than 7 on the Richter scale) in the Pacific Northwest have occurred in the vicinity of Puget Sound, Washington; the Rocky Mountains in eastern Idaho; and in western Montana. A large earthquake of uncertain location occurred in north-central Washington in 1872. This event had an estimated maximum MMI ranging from VII to IX and an estimated Richter scale magnitude of approximately 7.

The seismicity of the Columbia Plateau (as determined by the rate of earthquakes and the historical magnitude of these events) is low when compared to other regions of the Pacific Northwest. In the central portion of the Columbia Plateau, the largest earthquakes near the Hanford Site occurred in 1918 and 1973 north of the Site. These earthquakes had Richter scale magnitudes of 4.4 and MMIs of V. The ability of portions of the REDOX Facility to withstand the effects of an earthquake is evaluated in Section 3.0.

1.6 EXTERNAL MAN-MADE THREATS

External explosion potential is limited due to the relative isolation of the REDOX Facility and the level of activity in the general area. The transportation of flammable gases, combustible liquids, and explosives on the Hanford Site is limited and controlled by a permit system.

An external explosion that would cause sufficient structural damage and a significant release of contaminants is unlikely. Although it could be postulated that an explosion of some magnitude could cause localized damage, Hanford Site design criteria do not currently exist for this hazard. An explosion of sufficient magnitude to demolish the building is judged to be of sufficiently low probability that further evaluation is not warranted.

The likelihood of an aircraft crash on the Hanford Site is significantly reduced from past operations that involved frequent use of helicopters for security purposes. Hanford Site airspace is classified as uncontrolled airspace. Both commercial and private aircraft fly over the Site (the Federal Aviation Administration recommends that operators avoid flying below 2,400 ft amsl over the Site). Three airports are located within 25 mi of the Site, but none are located within 20 mi of the REDOX Facility.

A plane crash analysis was previously performed for another major processing plant (the Plutonium Finishing Plant) on the Hanford Site. This analysis indicated that the probability of an aircraft crash occurring at this major facility is less than 1.0 E-06 (WHC 1995). Based on this analysis, the probability of a plane crash at the REDOX Facility, which is comparable in target size, is considered an incredible event; therefore, no further evaluation is warranted.

An offsite transportation accident could occur near the Hanford Site. State Highway 240 is the closest public transportation route and is approximately 2.6 mi from the REDOX Facility. Although this public road is used for transportation of commercial fuels and hazardous materials, an offsite transportation accident is not considered credible to impact the facility due to distance and precautions imposed by the U.S. Department of Transportation for licensing of transporting hazardous materials. This conclusion is also consistent with other 200 West Area facility SARs.

An onsite transportation accident or vehicle crash could occur and, should the vehicle strike the building, some structural damage could occur. However, the probability of the impact leading to enough structural damage that a release of contaminants would occur is of sufficiently low probability that further evaluation is not warranted.

It is also possible that local evacuation could be required if the vehicle was carrying hazardous materials. Because the REDOX Facility is no longer operating, personnel evacuation would not result in unmonitored processes that could lead to a release of contaminants. Personnel evacuation would occur under the emergency preparedness program, and the facility could be vacated for extended periods of time without significant concern.

Potential dam failures on the Columbia River have been evaluated for the Hanford Site. A postulated 50% instantaneous breach of the Grand Coulee Dam as a result of sabotage has previously been evaluated (WHC 1996). This postulated event is not analyzed further in this document, because it is considered a "beyond-evaluation-basis event" that is adequately evaluated and addressed under the existing emergency preparedness program.

1.7 NEARBY FACILITIES

Given the upset conditions identified for the REDOX Facility in the hazards and accident analysis in Section 3.0, there are no nearby facilities, including the 233-S Building, that are directly impacted by S&M operations. Emergency preparedness procedures may require evacuation of facility or nearby area workers as a result of an accident. Emergency preparedness, as low as reasonably achievable (ALARA) principles, radiological controls, and other programmatic controls are in place to maintain worker exposure to hazards ALARA.

The 233-S Plutonium Concentration Facility is located to the north of the 202-S Canyon Building (see Figure 2-1). This structure and the 233-SA Building are undergoing D&D activities under the *Resource Conservation and Recovery Act of 1976*. The two buildings share a common pipe trench. The lines from 233-S to the 202-S Canyon Building have been capped.

The 202-S Canyon Building is unoccupied, except for periodic S&M. Other facilities within the proximity of the REDOX Facility are shown in Figure 1-2 and include the 222-S Laboratory, 200 West tank farm, Waste Management (solid waste), Plutonium Finishing Plant (Z Plant), U Plant, T Plant, and various environmental remediation projects. Population statistics of nearby facilities are provided in Section 1.3.2.

Accidents (uncontrolled releases) at nearby facilities could occur and may require evacuation of the REDOX Facility. Because the facility is no longer operating, personnel evacuation would not result in unmonitored processes that could lead to a release of contaminants. Personnel evacuation would occur under the emergency preparedness program, and the facility could be vacant for extended periods of time without significant concern.

1.8 VALIDITY OF EXISTING ENVIRONMENTAL ANALYSES

The Hanford Site is operating under a *National Environmental Policy Act of 1969* Site-wide categorical exclusion. The classes of activities that are excluded are contained in 10 *Code of Federal Regulations* (CFR) 1021, Subpart D, Appendices A and B.

Figure 1-1. Washington State.

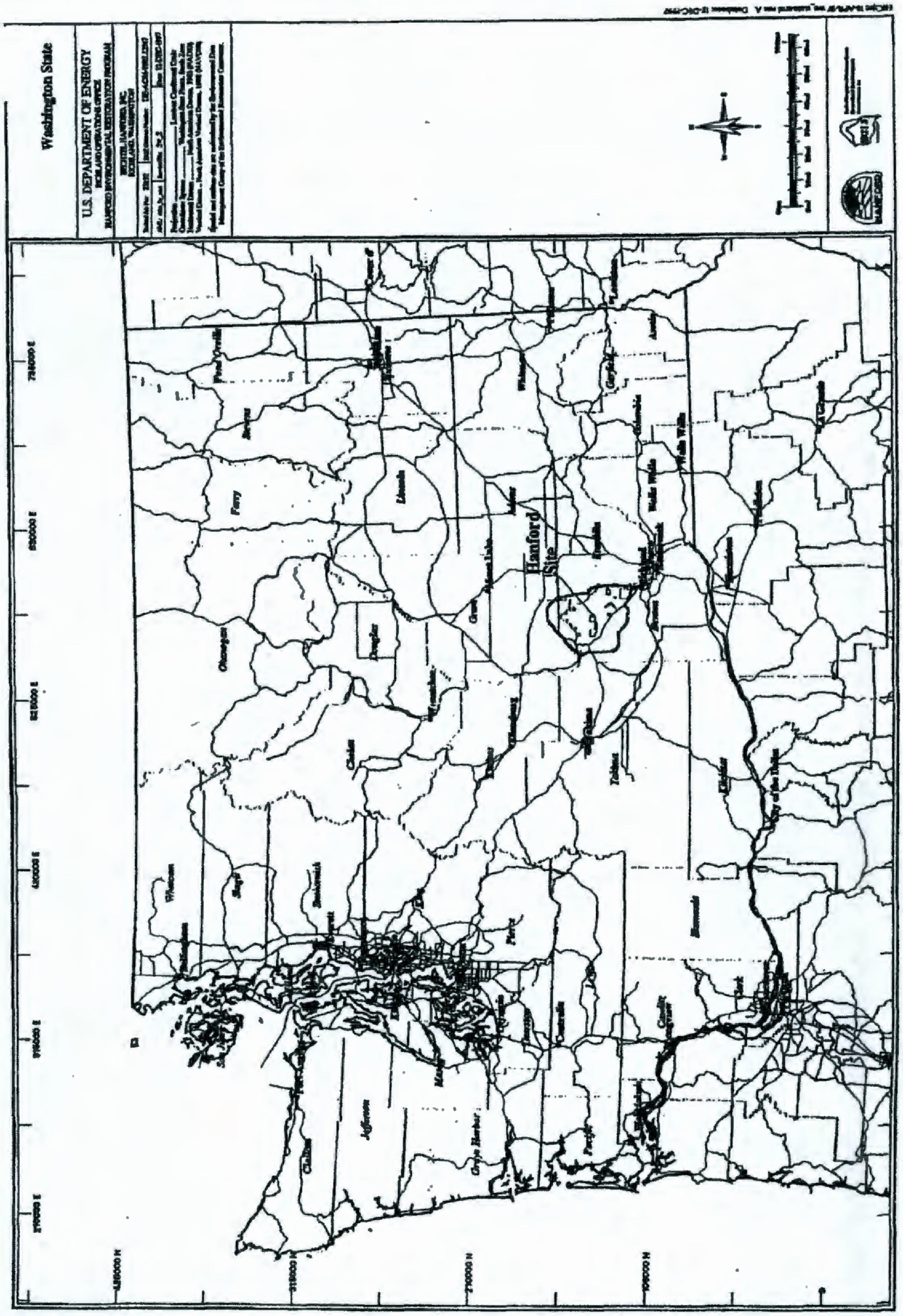

Figure 1-2. 200 West Area.

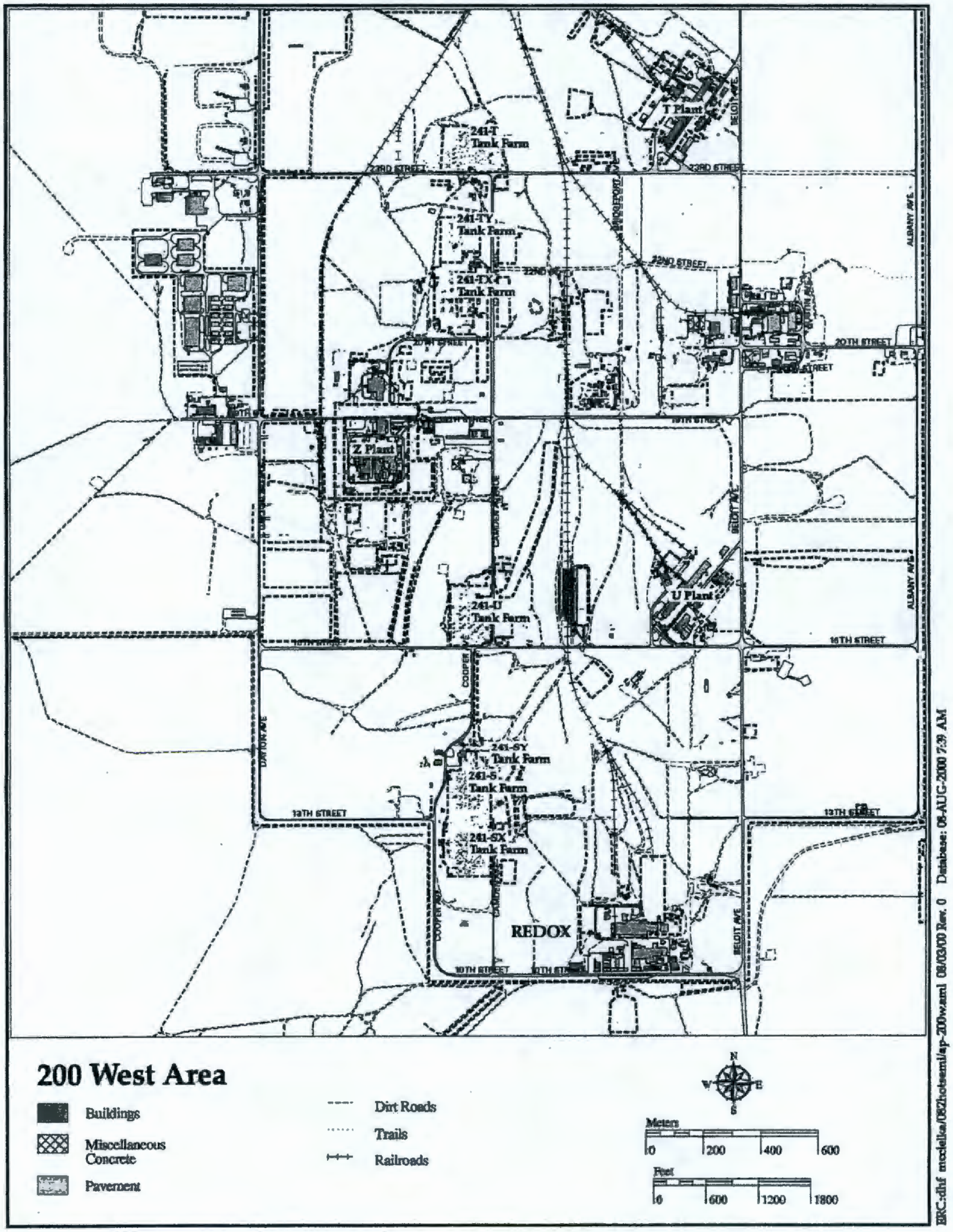

Table 1-1. Consensus Data for Nearby Communities.

Municipality	Population	Municipality	Population
Benton City	2,624	Richland	38,708
Connell	2,956	Royal City	1,823
George	528	Selah	6,310
Grandview	8,377	Sunnyside	13,905
Granger	2,530	Toppenish	8,946
Irrigon	1,702	Umatilla	4,978
Kennewick	54,693	Union Gap	5,621
Mabton	1,891	Wapato	4,582
Mattawa	2,609	Warden	2,544
Mesa	425	West Richland	8,385
Pasco	32,066	Yakima	71,845
Prosser	4,838	Zillah	2,198
Quincy	5,044		

Source: Internet, U. S. Census Bureau website http://factfinder.census.gov (2000)

2.0 FACILITY DESCRIPTION

This section provides a description of the REDOX Facility in accordance with DOE Order 5480.23, as described in DOE-STD-3009-94 (DOE 1994b). In addition to supplying an overall understanding of the facility, the facility description provides the basis for the assumptions made in the hazards and accident analysis (Section 3.0).

2.1 INTRODUCTION

The REDOX Facility, also known as S Plant and the 202 Facility, is located in the southwest portion of the 200 West Area of the Hanford Site. The physical layout is shown in Figure 2-1 and a list of the buildings included in the REDOX Facility is provided in Table 2-1. The 202-S Canyon Building is unoccupied, except for periodic S&M.

2.2 REQUIREMENTS

The REDOX Facility was constructed in accordance to the design codes, standards, and regulations in place at the time of construction. Requirements applicable to the S&M activities performed in the REDOX Facility are provided in Sections 6.0 through 17.0 of this SAR.

2.3 FACILITY OVERVIEW

The REDOX Facility, which was constructed between 1950 and 1952, became the first large-scale, continuous-flow, solvent-extraction process plant built in the United States for the recovery of plutonium from irradiated uranium fuel. The extraction process, which replaced the batch precipitation methods first used at the Hanford Site, was designed to separate uranium, plutonium, and neptunium as individual product streams from associated fission products in the irradiated fuel. Plant operations continued from 1952 until shutdown in 1967. Deactivation started in 1967 and was completed in 1969, when the REDOX Facility was transferred to S&M. The deactivation of the REDOX Facility is detailed in Foster (1977). Deactivation included multiple flushes of water, diluted hot nitric acid, permanganate, and oxalic acid. Regular flushings with water were conducted for nearly a year after the initial cleaning.

The deactivated REDOX Facility contains buildings and process equipment formerly used for dissolution and separation of uranium, neptunium, and plutonium, as well as deactivated equipment formerly used for waste concentration, waste neutralization, and solvent recovery. In addition to the main process areas, the REDOX Facility includes buildings that were formerly used to store chemicals and materials and support systems (e.g., ventilation, exhaust stacks, and environmental monitoring systems). Former offices located in the 202-S Canyon Building are not occupied, and the REDOX Facility will remain unoccupied for the duration of S&M activities. This SAR will not include the 233-S or 233-SA Buildings as part of the REDOX Facility, nor will it consider the D&D personnel trailers located nearby.

2.4 FACILITY STRUCTURE

2.4.1 202-S REDOX Building

The 202-S REDOX Canyon Building is a reinforced-concrete structure consisting of the canyon area, the galleries, the silo area, the east end, and the attached service areas. Figures 2-2 through 2-7 show general floor plans of the 202-S Canyon Building. An equipment arrangement is provided in Figure 2-6. Several elevation schematics of the 202-S Canyon Building are shown in Figures 2-8 through 2-16. The building is 468 ft long and 161 ft wide. The canyon area is 83 ft high, with 60 ft above grade. The silo area is 132 ft high, with 117 ft above grade.

A limited qualitative structural evaluation of the REDOX Facility was performed in 1990 (WHC 1991). The REDOX structures evaluated were the canyon building and the silo. The evaluation was performed to assess the structure's capability to withstand natural phenomena events (i.e., high winds and earthquake). The evaluation was based on the observations collected during walkdowns, design data, and limited failure modes analysis. It was noted during the walkdown of the canyon building that the roof and sidewall of the building are flexible and based on the type intersection used can move relative to each other. The intersection is a paper or "slip" joint that could allow the building to open up during high winds or fail during an earthquake. The silo was also evaluated. It was determined, based on the construction of the silo, that the silo would survive the anticipated lateral loads associated with high winds and earthquakes.

2.4.1.1 202-S Canyon Building. The canyon area of the building originally contained fuel processing areas. Today the canyon fuel processing areas contain deactivated equipment that was formerly used for dissolution, separation, and decontamination of uranium and plutonium, as well as waste concentration, waste neutralization, and solvent recovery (BHI 1994a). The canyon area, which will not be accessed under S&M, is defined as the process cells, cover blocks, deck, and the overhead space. The canyon area does not include the crane maintenance platform or the crane cab gallery. The canyon area operated at high levels of radioactivity and was separated from the canyon service areas by massive concrete shielding. The canyon area is arranged in two parallel rows of process cells, running east and west and separated by 2-ft-thick concrete walls for shielding. The nine cells of the canyon are designated by letters, as follows:

- Cell A – dissolver cell
- Cell B – dissolver cell
- Cell C – dissolver cell
- Cell D – waste cell (treatment)
- Cell E – north extraction cell
- Cell F – south extraction cell
- Cell G – organic cell (recovery)
- Cell H – metal solution preparation cell
- Cell J – filter cell.

A removable 4-ft-thick concrete process cell cover blocks form the canyon deck above the cells. The cell cover blocks are stepped and tapered to eliminate a path for direct radiation streaming and skyshine.

The canyon has two cranes. The largest is an electrically driven, overhead railway that operates on tracks running lengthwise on both sides of the canyon. This crane has a 60-ton-capacity main hoist, a 10-ton rotating auxiliary hook, and two dual-auxiliary hoists of 0.5- and 1-ton capacities, and was used for cover block removal. The second crane has a 2-ton capacity, is electrically operated, and is mounted on a monorail running cross-wise at the east end of the canyon. This crane is used for servicing the main crane. Current electrical diagrams show power supplied to the 60-ton canyon crane only.

2.4.1.2 Galleries. Piping, operating, and sample galleries exist on the north and south sides of the canyon. A storage gallery is located under the south sample gallery. The product receiver (PR) cage, which served as the plutonium loadout hood, is located in the north sample gallery. The PR cage (also known as PR cage, Pu loadout hood, and plutonium loadout hood) and selected areas of the north sample gallery were further stabilized with actions initiated in 1999 (BHI 1999a, 2000d). The stabilization activities are being performed to eliminate known and suspected sources of radiological contamination. Following stabilization activities, routine surveillance of the north sample gallery will be reduced or discontinued.

As discussed, the PR cage was stabilized and the EF-8 exhaust system was isolated as part of the stabilization activities initiated in 1999. As required by October 15, 2000, correspondence from K. A. Klein (RL) to M. C. Hughes (Bechtel Hanford, Inc. [BHI]) (Klein 2000), absorbent material has been placed in the sump of the PR hood, the PR hood has been sealed, and the sampler hoods in the north sample gallery have been isolated from the EF-8 exhaust system. These activities will prevent the inadvertent spread of contamination during S&M activities (e.g., surveillance).

2.4.1.3 202-S Silo. The silo area, located at the west end of the canyon, houses deactivated solvent-extraction columns and aqueous makeup vessels. The shaft, or tower process area, was specifically designed to house long extraction columns so column solutions cascaded from one column to the next. Figure 2-11 shows cross-section views of the silo, and Figures 2-17 through 2-25 show various plan views of the silo. The silo is 132 ft high, 84 ft long, and 41 ft wide, and consists of former process and operating areas.

The fuel processing side of the silo area was operated and maintained remotely and is separated from silo service areas by concrete shielding. Solvent-extraction columns were removed from and brought into the facility through the column removal tunnel, located on the north side of the silo near the column or tower shaft's floor. An electrically driven railway crane with a 10-ton capacity is located in the silo. The silo crane has two auxiliary hoists rated at 0.5- and 1-ton capacities. No power is provided to the silo crane.

The service/operating area of the silo has eight levels. The first five levels are aqueous makeup levels, the sixth level is occupied by the silo crane, and the silo operating gallery and sample gallery are on the seventh level. The eighth level houses blower room #4 and the feed tank area.

Of the two elevators located in the silo, one is a freight elevator that serves all levels of the silo and chemical storage room and is located on the west side of the building; the second elevator is on the north side of the building and is out of service.

The column laydown trench is located external to the 202-S Canyon Building and is connected to the silo via an underground tunnel. The trench is covered by diamond-plate steel with a six-layer asphalt pad beside it. The trench also has a weather cover. The columns were removed from the silo, placed in caissons, and loaded onto a mule (i.e., transportation cart). The columns were then rolled to the other side. During the movement of the columns, the caissons were bent in the middle, allowing liquid contaminants to leak out. There are currently no columns stored in the silo.

2.4.1.4 East End. The east-end segment contains the former hot shops for the facility and the railroad access tunnel to the canyon processing area.

2.4.1.5 Attached Service Areas.

2.4.1.5.1 North Service Area. The north service area contains a 2.4-kV switchgear room, a wet cell battery room, the north 480-V switchgear room, blower room #2, and the former electric shop and office. Blower room #2 contains a deactivated supply fan for the north pipe and operating galleries. The electrical shop contains the motor control center (MCC) and the lighting panel for the operating equipment in the REDOX Facility.

2.4.1.5.2 South and West Service Area. The south and west service areas contain blower room #1, a compressor room, the south 480-V switchgear room, and former chemical storage, equipment, shop, and office areas. Blower room #1 houses three deactivated supply fans for the REDOX Facility. The compressor room contains an air compressor and an instrument air dryer. The south 480-V switchgear room contains MCCs that have been deactivated.

2.5 OPERATIONS AND ACTIVITY DESCRIPTION

This section provides a description of the activities and operations envisioned for the REDOX Facility during this portion of its life cycle, prior to its ultimate disposition (i.e., D&D). The following subsections provide additional detail; however, the scope of work includes pre-planned surveillance and preventative maintenance that maintains confinement of hazardous substances and protects workers. This workscope includes activities that are anticipated but are not defined by pre-approved procedures. Examples of planned activities without pre-approved procedures include specific asbestos abatement actions; replacement or upgrades of postings and barriers; container management; demand repairs to structures, systems, and components (SSCs); spill response; characterization; and response or investigation of nontypical surveillance reports. Programmatic controls described in Sections 6.0 through 17.0 are in place to ensure that S&M activities are within the authorization basis and protect workers.

The USQ process is a programmatic control used to aid in change management. Pre-approved procedures, when revised, are screened and evaluated as required under USQ requirements. All original and revised demand work packages are screened and evaluated as required under the USQ process.

Nontypical surveillance reports, audits, and similar documents are reviewed to determine if they meet the entry criteria for safety evaluations under discovery requirements of the USQ process.

2.5.1 Definition of Routinely Surveyed Areas

Figures 2-2 to 2-7 and Figures 2-17 to 2-25 show the areas that are periodically surveyed.

2.5.2 Surveillance and Maintenance of Barriers and Postings

Barriers and postings are used to prevent unwarranted access to hazardous areas and to inform personnel of conditions that exist at the REDOX Facility. Examples include locks and tags, door locks, fencing, confined space postings, and radiological area postings. Installation and inspection of barriers and postings are conducted as part of the S&M activities, as specified in BHI Field Support work instructions. Any discrepant conditions regarding barriers or postings are identified on associated data/inspection sheets.

2.5.3 Identification and Removal of Asbestos

Asbestos-containing materials or presumed asbestos-containing materials are inspected prior to commencement of renovation or demolition activity. If damaged friable asbestos is present, the area is posted as a regulated area. Depending on the scope and severity of the damage, repair, encapsulation, or removal is performed through the asbestos abatement program and appropriate radiological and industrial hygiene requirements.

2.5.4 Container Management

Surveillance activities include inspecting existing containers and sampling, identifying, and labeling unlabeled containers. Containers are removed and transported to a permitted storage facility for treatment, storage, and/or disposal. Periodic container inspections are performed to identify container deterioration or signs of leakage. If a deteriorating or leaking container is found, the container is repackaged and moved to an appropriate disposal facility. Corrective action is then taken to prevent recurrence.

2.5.5 Equipment Calibration, Testing, Maintenance, and Repair

Calibration and testing are conducted as appropriate on equipment such as level monitoring systems, ventilation systems, and electrical components. Elements and schedules for these activities are included in the procedures and task instructions.

2.5.6 Repair and Upgrades of Confinement Systems

Repair of confinement systems is performed to confine hazardous substances within the REDOX Facility. Upgrades or physical changes to these systems may be performed if the changes provide equivalent or improved confinement. Maintenance and repair are also performed. Changes will be evaluated on a case-by-case basis to determine if these are within the bounds of the safety analysis.

2.5.7 Repair and Upgrades of Structural Components

Structural components necessary to ensure confinement will be repaired or upgraded to maintain control of hazardous substances. Work activities will be conducted in accordance with established procedures and programs.

2.5.8 Inspection for and Response to Spills

The REDOX Facility is routinely surveyed for indications of spills of hazardous substances. If a spill is discovered, the affected area will be isolated to prevent personnel exposure, corrective measures will be determined, and the spilled material will be packaged and shipped to an appropriate disposal facility.

2.5.9 Removal of Hazardous Substances

If required, hazardous substances within the REDOX Facility will be properly packaged and shipped to an appropriate disposal facility.

2.5.10 Hazardous Substance Disposal

Any hazardous substance removed from the REDOX Facility may, after proper waste designation, be disposed at the Environmental Restoration Disposal Facility or another disposal facility, as appropriate.

2.5.11 Nondestructive Assay Waste Characterization and Sampling

Nondestructive assay (NDA), waste characterization, and sampling may be performed in the REDOX Facility. The activities will be performed in accordance with established programs and procedures and shall comply with special controls (e.g., criticality reviews) as established in this SAR. These activities may be performed to better identify and characterize radioactive material inventory and location, determine quantity and makeup of newly discovered material, or support planning for eventual disposition.

2.5.12 Removal of Nonprocess Equipment

Removal of nonprocess equipment may be performed in the REDOX Facility to reduce the risks from known hazards (e.g., removing abandoned conduits and removing deactivated electrical equipment) and redeploy obsolete equipment as spare and replacement equipment (e.g., switchgear and MCCs). These SSCs may contain surface contaminants. The removal process shall not disrupt, intrude, or otherwise alter process vessels and piping or confinement structures. These activities will be performed in accordance with established programs and procedures.

2.5.13 Radiological Surveys

Radiological surveys are performed in support of S&M activities. These surveys are performed in accordance with established programs and procedures.

2.5.14 General Inspections and Tours

General inspections and tours may be performed separate from S&M activities. Inspections and tours will be conducted in accordance with appropriate programs and procedures.

2.6 CONFINEMENT SYSTEMS

The following subsections discuss the confinement systems within the REDOX Facility, excluding the structures themselves (which are described in Section 2.4). The discussion also excludes primary confinement systems such as process vessels and piping, gloveboxes, and hoods.

2.6.1 202-S Canyon Building Ventilation Arrangement

The 202-S Canyon Building ventilation system, depicted in Figure 2-26, is divided into six zones with two different exhaust paths. The ventilation system has been modified extensively over the last 30 years. The original ventilation system relied on a number of supply and exhaust fans, the majority of which have been deactivated. Figure 2-26 mainly shows the supply fans in blower room #1, the exhaust fans at the 291-S Building, and the other exhaust stacks.

The current ventilation system relies on the operation of one 20,000 ft^3/min exhaust fan (EF-1 or EF-2) to maintain appropriate negative differential pressures. All supply fans have been deactivated.

The maximum negative pressure that the 202-S Canyon Building can withstand is not known. However, the original ventilation design provided a steam-driven turbine backup exhaust fan of approximately 40,000-ft^3/min capacity to exhaust the building on a loss of normal power supply. Because no steam-driven or alternate power source was provided for any of the supply fans, the original design provided for exhausting the 202-S Canyon Building at 40,000 ft^3/min with no supply fans running. Accordingly, it is assumed that the operation of one exhaust fan (with no supply fans running) does not exceed the 202-S Canyon Building's maximum negative pressure.

In addition to local indication and control functions, remote equipment monitoring and control are provided. The remote monitoring system has an auto-dial system that contacts employees when abnormal conditions occur during off-hours. The following remote monitoring and control capability is provided:

- Exhaust fan EF-1 and EF-2
  - Remote start/stop/indication
  - Remote vibration and temperature indication/alarm
- Remote differential pressure indication for the following:
  - Sand filter
  - Canyon to atmosphere
  - Canyon to sample gallery
  - Sample gallery to atmosphere
  - Wind tunnel to atmosphere
- Remote indication of 291-S-1 stack pack alarm.

2.6.2 202-S Canyon Building Ventilation Normal Operations

Blower room #1 contains three supply fans that originally provided fresh air for the canyon, silo, sample galleries, and other areas. All three supply fans have been deactivated. The supply fan to the canyon craneway has also been deactivated.

The air-operated outlet dampers for all supply fans have been isolated from the plant air supply. Two supply fan outlet dampers are blocked to increase negative differential pressures in the building and canyon. To provide an infiltration flow path into the 202-S canyon, silo, and sample galleries, the outlet damper of one fan is partially blocked. Supply air is also provided through various infiltration pathways such as gaps around exterior doors in the service areas, the barn doors on the silo tower area, the railroad tunnel door, structural expansion joints, and other exterior penetrations.

One filtered exhaust flow path, the 291-S-1 flow, is normally in operation. The 291-S-1 flow path provides the majority of ventilation for the 202-S Canyon Building and maintains the canyon at approximately -0.35 to -0.45 in. water gauge (wg) pressure with respect to the atmosphere. The galleries and other areas are typically maintained at a slight negative pressure with respect to the atmosphere, thereby controlling the spread of contamination.

Air exhausted from the 202-S Canyon Building is filtered by the 291-S sand filter prior to discharge through the exhaust fans and 291-S-1 stack. Exhaust fan EF-1 is designated as the primary exhaust fan and EF-2 is designated as the standby exhaust fan. The fans discharge into a common plenum prior to discharge through the 291-S-1 stack. A wind tunnel controller modulates the EF-1 inlet damper to maintain the wind tunnel differential pressure at a constant static pressure (approximately -0.5 in. wg) with respect to the atmosphere. The dampers of EF-2 are held closed to prevent "windmilling" of EF-2 as a result of discharge plenum velocity.

The 291-S-1 stack is provided with a "stack pack" of generic Hanford Site design for effluent sampling and monitoring. The stack pack contains a modified beta-gamma monitor and record sampler/totalizer assembly, associated local alarms, and a timer. Because the Washington State Department of Health (WDOH) has determined that the effluent represents a very low risk to the environment, the stack pack is normally operated only 1 week each quarter to obtain record samples required for the stack air permit. This monitoring frequency requirement is currently under review by WDOH and any change will be documented in the annual review and update of this SAR.

2.6.3 202-S Canyon Building Ventilation Abnormal Operations

2.6.3.1 291-S Flow Path Abnormal Operations. Exhaust fans EF-1 and EF-2 are not rotated to equalize wear because automatic start logic is not provided to start EF-1 (if EF-2 was operating and failed) and the wind tunnel controller does not modulate EF-2 dampers. Exhaust fan EF-2 is operated when EF-1 requires maintenance or under certain abnormal conditions, as discussed in the following paragraphs.

2.6.3.1.1 Degrading Wind Tunnel to Atmosphere Differential Pressure. Control for the EF-1 is provided by the wind tunnel (brown) controller that is located in the south sample gallery. Upon decreasing the wind tunnel to atmosphere differential pressure, the controller will initiate a trip of EF-1, and EF-2 will start. When in normal lineup with EF-1 operating and the wind tunnel to atmosphere differential pressure degrades to approximately -0.25 in wg, the controller initiates the following actions:

- Trip of EF-1
- Closure of EF-1 dampers and opening of EF-2 dampers
- Time-delayed start of EF-2 (timer located on the MCC in the 291-S Building).

When in maintenance lineup with EF-2 operating, and the wind tunnel to atmosphere differential pressure degrades to approximately -0.25 in. wg, and EF-2 will continue to operate.

2.6.3.1.2 Loss of Air Supply. When in normal lineup with EF-1 operating, a loss of air supply initiates the following actions:

- Trip of EF-1
- Closure of EF-1 dampers and opening of EF-2 dampers
- Time-delayed start of EF-2.

When in maintenance lineup with EF-2 operating and a loss of air supply occurs, and EF-2 will continue to operate.

2.6.3.1.3 Loss of Power. When in normal lineup with EF-1 operating, on loss of the normal power supply, an automatic transfer switch (ATS) senses the power loss and initiates a start of the diesel generator as EF-1 coasts down. When the diesel generator is up to speed, it re-energizes the MCC in the 291-S Building. The MCC initiates a time-delayed start of EF-2 and EF-2 automatically starts (after the time-delay times out) with power provided by the diesel generator.

When in maintenance lineup with EF-2 operating, upon loss of the normal power supply, the ATS detects the power loss and initiates a start of the diesel generator as EF-2 coasts down. When the diesel generator is up to speed, it re-energizes the MCC in the 291-S Building. The MCC initiates a time-delayed start of EF-2, and EF-2 automatically starts (after the time-delay times out) with power provided by the diesel generator.

2.6.3.1.4 Stack Pack Abnormal Operations. When the stack pack is in service and an exhaust fan is operating, any of the following conditions may occur:

- Low-flow condition in record sampler assembly
- Low-flow condition in the beta gamma monitor
- Beta-gamma monitor failure
- High/low cabinet temperature.

Any of these will cause a local alarm at the stack pack enclosure and the initiation of a trouble alarm (system fail) at the 271-U Building. If a high beta airborne condition occurs when the stack pack is in service, a local alarm is initiated and transmitted to the 271-U Building.

Should the operating exhaust fan shut down when the stack pack is in service (e.g., due to mechanical failure), the beta-gamma monitor assembly will continue to function (alarming on low flow) and the record sampler and totalizer will shut down (alarming on low record sample flow). A trouble alarm will be sent to the 271-U Building. The shutdown of the record sampler and totalizer will preserve the integrity of the sample.

2.6.4 Equipment and Floor Drains

The REDOX Facility sumps and internal drains are inactive (i.e., plugged) and are not currently used. All process operations at the 202-S Canyon Building have been shut down for many years, and accumulations of liquids in equipment and floor drains are not subject to significant change. No significant accumulations of liquids exist in the equipment and floor drains of the 202-S Canyon Building. Connections to the sanitary sewer have been plugged.

At the 202-S Canyon Building, a number of process cell sumps and several deactivated process tanks have air-bubbler (weight-factor) level instruments provided. It is believed that these level instruments are functional; however, because the instruments are located in process cells, this condition cannot be verified. Level indication for these sump and tank levels is provided both locally in the 202-S Canyon Building's operating galleries and remotely in the 271-U Building. According to plant personnel, no significant changes in level have occurred in the last 10 years.

Condensate forming in the 291-S-1 stack drains to the 292-S drain seal tank (191-S) (see Section 2.9.4). Other liquid wastes are disposed in accordance with established procedures.

2.7 SAFETY SUPPORT SYSTEMS

2.7.1 Fire Protection Systems

A description of fire protection systems is provided in the fire hazard analysis (FHA) in Appendix D.

2.7.2 Radiation Detection Systems

Portal monitors are placed at select entry and exit locations. The portal monitors are equipped with gas proportional detectors that use P-10 (90% argon, 10% methane) gas.

2.8 UTILITY DISTRIBUTION SYSTEMS

Active utility distribution systems include electrical power, lighting, communication, and compressed air. There is no breathing air supply at the REDOX Facility, and steam supplies to the REDOX Facility have been disconnected.

2.8.1 Electrical Power, Lighting, and Communications

Electrical power is supplied to the REDOX Facility by two 13.8-kV lines, one of which supplies a 13.8-kV/480-V transformer that carries the majority of loads in the REDOX Facility. The second 13.8-kV line supplies a 13.8-kV/208/120-V transformer that supplies various lighting panels in the 202-S Canyon Building.

A simplified one-line diagram of the electrical supply system and major loads is provided in Figure 2-27. Power at the 202-S Canyon Building is fed from a 480-V MCC and various 208/120-V lighting panels. The 202-S Canyon Building provides power for the exhaust fan MCC, which is located in the 291-S Building.

In the event of a loss of normal power, a standby diesel generator will start and power the exhaust fan MCC in the 291-S Building, providing power to exhaust fan EF-2, the 291-S stack pack, the remote monitoring and control system at the 202-S and 291-S Buildings, and lighting in the 291-S Building. The diesel generator has remote indication, alarm, and operating status. Backup power is not provided for other equipment or systems of the REDOX Facility. Current electrical diagrams show power to the 60-ton canyon crane only. Remote elevator/crane breaker operation is provided for REDOX Facility. No power is provided to the silo crane.

Communications for surveillance personnel are provided by an active telephone system at the 202-S Canyon Building, radios, and cellular telephones.

2.8.2 Compressed Air Systems

2.8.2.1 Normal Operations. Compressed air is provided for control air functions in the REDOX Facility. A single compressor, air receiver, and air dryer are skid-mounted in the 202-S compressor room. All air is dried and supplied to one of two main branches.

One of the branch lines supplies air to the 291-S Building where it is reduced in pressure and used for control of the EF-1 and EF-2 fan dampers. This line also supplies the bubbler level instrumentation in the 292-S Building. A second branch line supplies various monitoring instruments located in the 202-S Canyon Building.

As of the end of 1997, the REDOX Facility has the following remote instrument air monitoring and control capability:

- Air compressor operating status (feeder breaker position; local start/stop control only)
- Air compressor/dryer alarms
- Header blowdown features
- Remote indication of 292-S Building bubbler cabinet pressure.

2.8.2.2 Abnormal Operations. A loss of air could be initiated through compressor failure or loss of electrical supply. In addition to the impacts on the ventilation system described in Sections 2.6.3.1 and 2.6.3.2, a loss of air would also result in the loss of level instrumentation in the 202-S and 292-S Buildings.

2.8.3 Water Systems

An existing 20-in. raw water main and a parallel 12-in. sanitary water main are located on the west side of the REDOX Facility. From these mains, a 12-in. raw water line and a 6-in. sanitary line are extended to the REDOX Facility north of the 202-S Canyon Building. The 6-in. sanitary line is terminated in the yard; the 12-in. raw water line is terminated at the exterior of the 202-S Canyon Building. In addition, a 12-in. raw water line and a 12- to 6-in. sanitary water line are extended down the west and south side of the facility, also terminating at the exterior of the 202-S Canyon Building. The sanitary water main and branch line supply hydrants in the yard that can be used for manual fire fighting.

2.9 AUXILIARY SYSTEMS AND SUPPORT FACILITIES

A variety of facilities that were involved in waste generation, transfer, treatment, storage, or disposal are described in the following subsections.

2.9.1 291-S Exhaust Fan Building and Sand Filter

Exhaust fans EF-1 and EF-2 for the 202-S Canyon Building are located outside of the 291-S Building. Two identical, stainless-steel, direct-driven blowers are installed in parallel and are powered by 60-horsepower electric motors. The westernmost fan (EF-1) is referred to as the primary exhaust fan, and the other fan (EF-2) is referred to as the standby exhaust fan. The 291-S Building is not occupied but is routinely entered for surveillance. Heavy weather damage to asbestos insulation in and around the building has occurred.

The 291-S sand filter removes radioactive particles from exhaust air before discharge to the atmosphere. The sand filter is a below-grade structure, approximately 85 ft by 85 ft by 20 ft, consisting of approximately 12 ft of sand and 8 ft of air space in a concrete shell. The filter media decreases in particle size from coarse gravel at the bottom to 30-mesh sand at the top. The roof over the sand filter was recently repaired and is in good condition.

2.9.2 291-S-1 Operating Stack

The 291-S-1 stack is the elevated effluent release point that ensures personnel exposure to radioactivity is minimized. The stack is 14 ft in diameter at the base and 200 ft tall.
The 291-S-1 stack is currently included in the WDOH radioactive air emissions permit (Permit No. FF01). Because normal operating emissions do not exceed 0.1 mrem/yr in accordance with 40 CFR 61, this stack is not classified as a "designated" or "major" stack.

The 291-S-1 stack has been included in the 1997 initial issuance of Hanford Site air operating permit for 40 CFR 70 and *Washington Administrative Code* (WAC) 173-401. Under the proposed Hanford Site air operating permit, Ecology and WDOH share responsibilities for oversight and compliance, with Ecology responsible for nonradioactive airborne emissions and WDOH responsible for radioactive airborne emissions.

2.9.3 276-S Solvent Handling Facility

The 276-S Solvent Handling Facility was formerly used for bulk storage of pure hexone and for chemical treatment of new and recycled hexone. Hexone was used in the extraction of plutonium and uranium from dissolved fuel elements (WHC 1992). The building is located north and west of the 202-S silo. This aboveground concrete building is 43 ft 2 in. wide by 58 ft long. The building was built in two sections: the process section and service/operating section.

The process section is 26 ft wide by 58 ft long, with 2-ft-thick concrete walls on the south, east, and west sides. The north wall is constructed of a steel frame with corrugated asbestos siding. The process section housed three aluminum storage tanks used for treatment and storage of hexone. Since deactivation and cleanup of the building in 1967, the hexone storage tanks within the 276-S Building process section have not been used and were confirmed to be empty and clean in 1989.

The service/operating section is 15 ft wide by 58 ft long and has a steel framework with asbestos siding on all four walls and the roof. A 2-ft-thick concrete wall separates the process and operating sections with no interconnecting doors. All doors from both sections open to the outside. Valves required for operation have extension handles that pass through the center concrete wall that separates the two sections.

Hexone storage tanks 276-S-141 and 276-S-142 are buried north of the 276-S Building. These single-shelled, carbon-steel storage tanks each have a capacity of 24,000 gal and were formerly used to store makeup solvent for the REDOX Facility during operations. From 1990 through 1992, 35,000 gal of the solvent remaining in the tanks were recovered from the tank, distilled, and incinerated. The process used to drain and flush the waste solvent is discussed in WHC (1992).

Sample verification in 1999 found that concentrations of hexone are likely to exceed lower flammability limits in the underground tanks (BHI 1999d). The nitrogen system is maintained to ensure that oxygen levels remain below combustion potential. The process for closure of the tank previously recommended in the facility closure plan included tank removal and sandblasting the interior of tanks (DOE 1992). However, because of corrosion issues discovered in 1999, the selected closure alternative should be reconsidered. An in situ closure alternative should be re-evaluated.

2.9.4 292-S Control and Jet Pit House

The 292-S Building was built as part of the original REDOX Facility and formerly provided the control point of discharge jets on dissolver vessels within cells A, B, and C of the 202-S Canyon Building. The jets have been deactivated. An exhaust jet pit (located directly beneath the building) housed jets and actuators that formerly controlled discharges from dissolver vessels and from the 291-S Building.

A second pit (located adjacent to the exhaust jet pit) is covered by exterior cover blocks. This 35-ft-deep pit contains the drain-seal tank (191-S) for vent lines from the 202-S Canyon Building and a sump that collects liquid from all vents and trenches in the 291-S, 292-S, and 293-S Buildings. Approximately 7 ft of water remains in the pit. Prior to cessation of REDOX Facility operations, this liquid condensate remaining in the sump was air-jetted into the drain-seal tank and then jetted to D cell (waste cell) in the 202-S Canyon Building. Adequate liquid level exists in the drain-seal vessel to ensure isolation of each contributing drain and vent line. Two liquid-level monitors are located in the 292-S Building to provide information on the status of the liquid in the sump and drain-seal tank. Because of the sources of this liquid, the liquid is assumed have radioactive contaminants and characterization is required before this liquid can be removed. S&M activities do not encompass liquid condensate removal; therefore, work packages reviewed by the USQ process must be prepared to drain this pit.

2.9.5 293-S Nitric Acid Recovery and Iodine Backup Facility

The 293-S Nitric Acid Recovery and Iodine Backup Building formerly provided filter backup capabilities for radioactive iodine removal in combination with recovery of nitric acid vapors that developed when irradiated uranium rods were dissolved. This building was not constructed as part of the original REDOX Facility; it was added in 1957 and deactivated in 1969. The radioactive iodine was removed using a caustic scrubber system, and the acid fumes were captured in a nitric acid absorber. The recovered nitric acid was stored in an underground, cylindrical, stainless-steel, nitric acid storage tank (10 ft high by 10 ft in diameter), located directly west of the 293-S Building. The tank is currently empty.

2.9.6 2708-S Lagger Storage Building

The 2708-S Lagger Storage Building had provided storage for lagging operations at the REDOX Facility. Inspection in 1999 found fluorescent light fixtures, loose metal shelving, and other small items remaining in the building. No significant sources of hazardous material are known or suspected. The building may have been mildly contaminated in the past from events at the REDOX Facility. No additional safety analysis is required.

2.9.7 2718-S Sand Filter Sample Building

The 2718-S Sand Filter Sample Building is a wooden structure with sampling ports that were used to monitor performance of the exhaust air from the 291-S sand filter. The sand filter differential pressure gauge, which measured the pressure differential across the sand filter, is adjacent to this building.

2.9.8 211-S Liquid Chemical Storage Tank Farm

Liquid chemicals used in the REDOX process were received and stored in the 211-S tank farm. The tank farm contains eight above-grade storage tanks of various sizes ranging from 4,300 to 149,000 gal. The tanks were constructed of mild-steel, stainless-steel, and aluminum, depending on the contents of the tank. The chemicals stored at the 211-S tank farm were nitric acid, sodium hydroxide, sodium dichromate, and aluminum nitrate nonahydrate. All tanks are currently empty.

2.9.9 2711-S Stack Gas Monitoring Building

The 2711-S Stack Gas Monitoring Building is a small wooden structure, 12 ft by 14 ft by 8 ft in dimension, with a sloping roof. The building was originally used for gas monitoring and storing samples from the 291-S-1 stack. The building is currently being used for equipment storage. The interior, exterior, and roof of the building are in poor condition.

2.9.10 2715-S Storage Building

The 2715-S Building is a steel-frame structure with metal walls and roof that was used to store miscellaneous materials. The building is currently empty and contains no hazardous materials or energies.

2.9.11 2904-SA Cooling Water Sampling Building

The 2904-SA Cooling Water Sampling Building was built in 1956 to provide sampling of process waste flowing from the 202-S Canyon Building, through the 2904-S-170 weir, to liquid waste disposal sites. The 2904-SA Building is an 8 ft by 8 ft by 8 ft-high prefabricated metal building that rests on a concrete foundation. The sampling equipment inside consists of a below-grade, 2-ft by 3-ft stainless-steel tank, with a sample riser coming up through the building floor and associated piping. The sample building extends 3 ft over the southern end of the 2904-S-170 weir. The building is no longer active.

2.9.12 2710-S Nitrogen Storage Building

The wooden frame 2710-S Nitrogen Storage Building was originally used to generate nitrogen gas for the REDOX canyon vessels and is presently not in use. The building is deteriorating due to a lack of maintenance.

Figure 2-1. REDOX Complex.

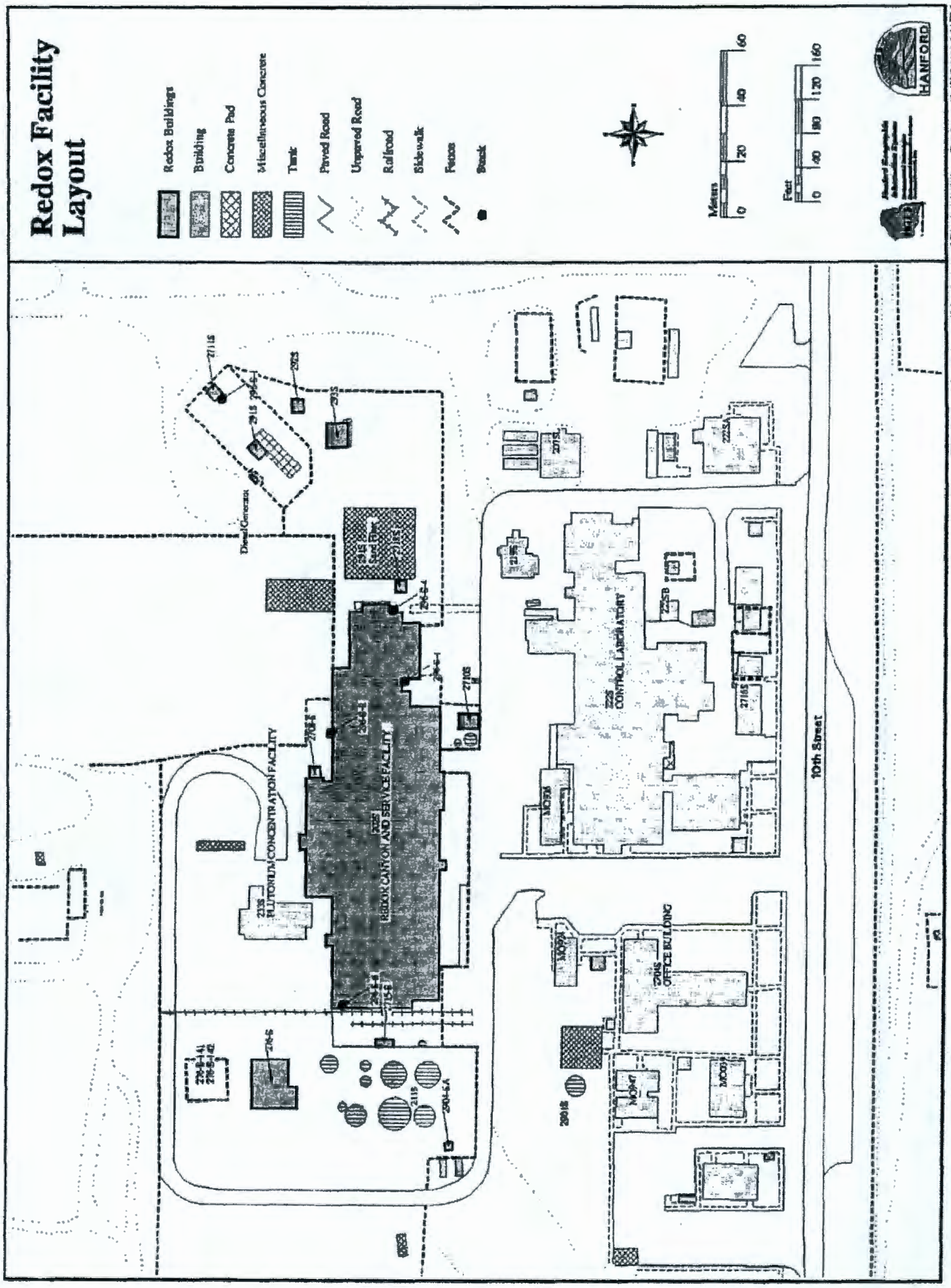

Figure 2-2. Plan View Cell Floor Level.

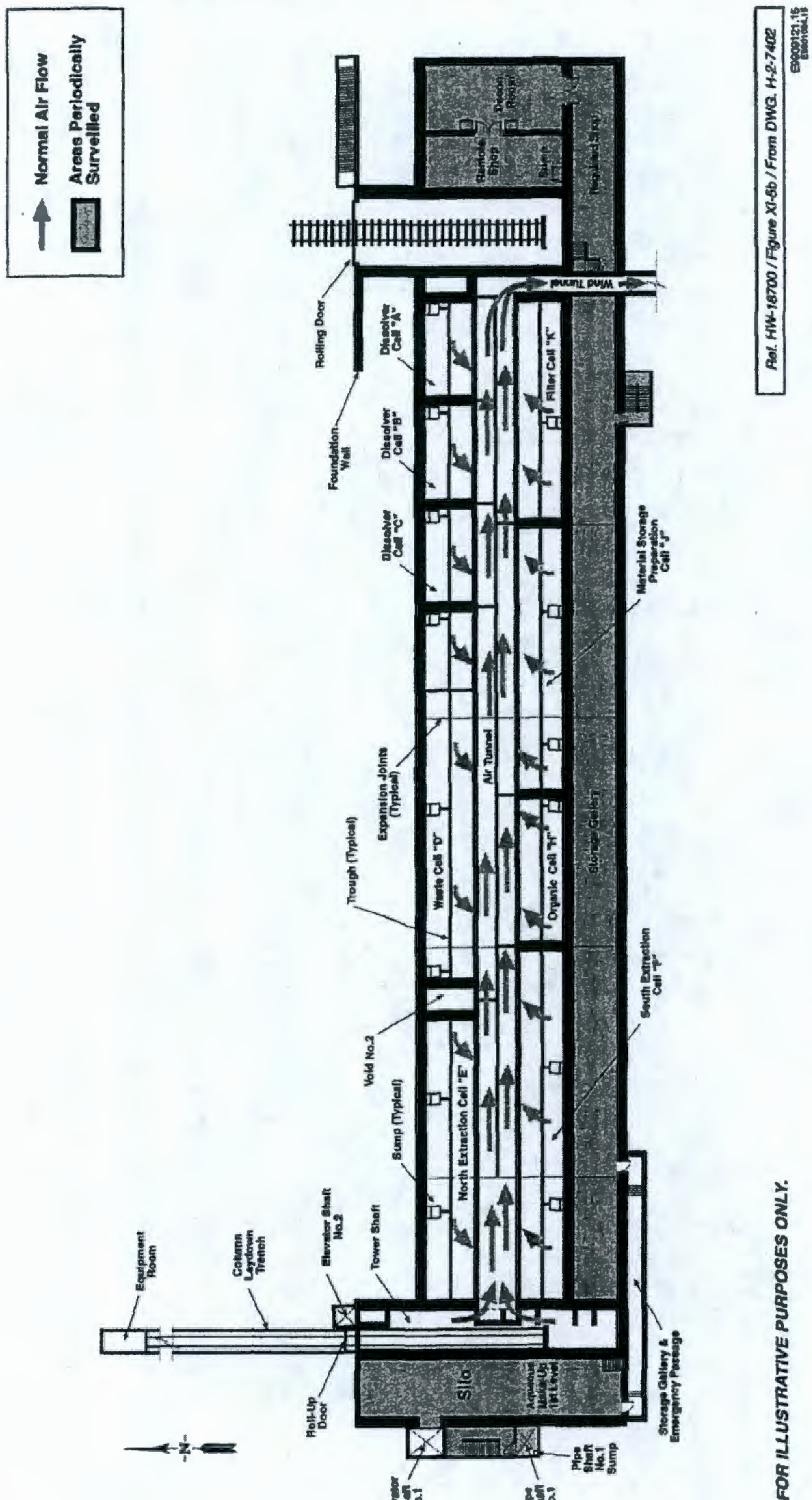

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Figure 2-3. Plan View Sample Gallery Level.

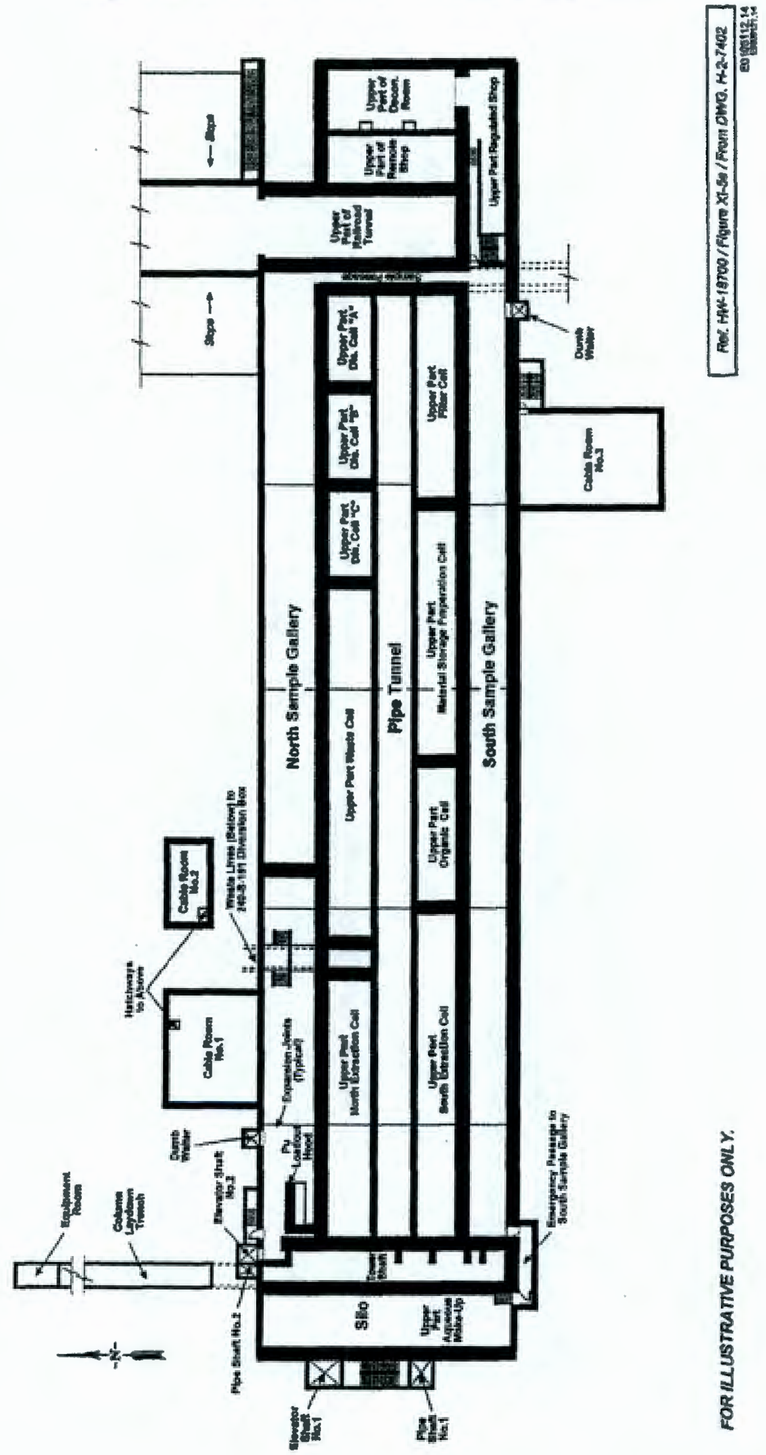


Figure 2-4. Plan View Pipe Gallery Level.

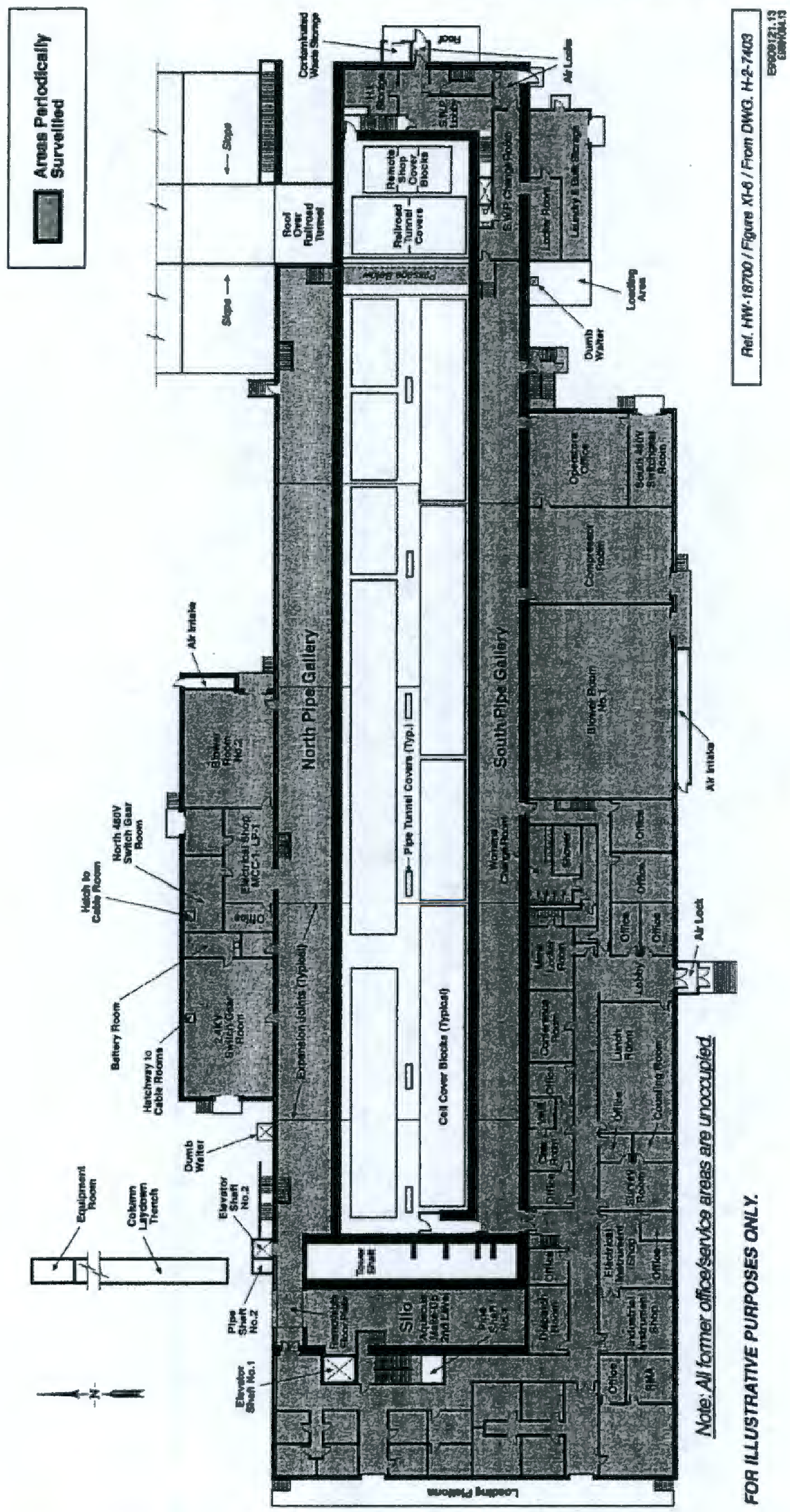


Figure 2-5. Plan View Operating Gallery Level.

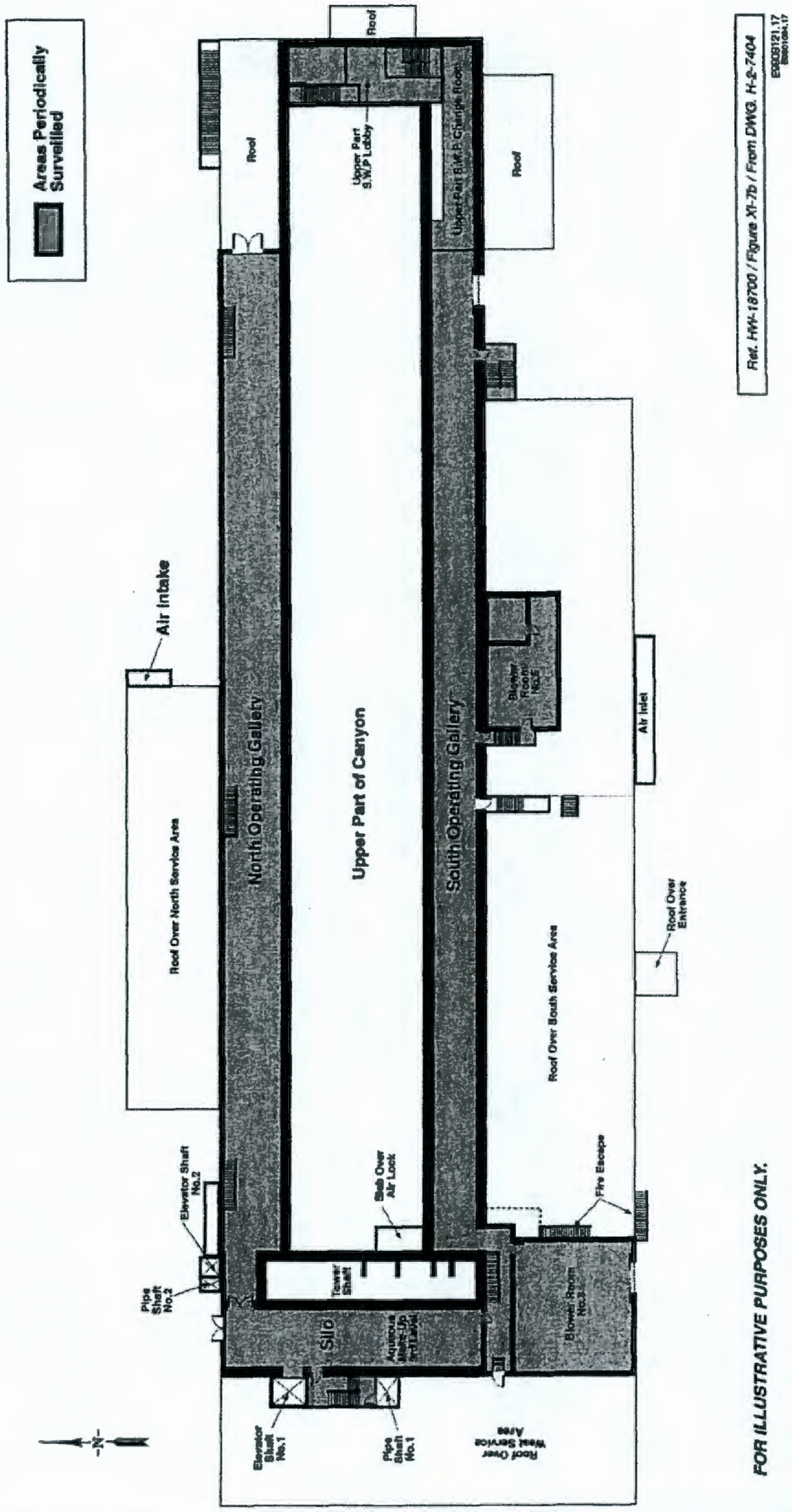
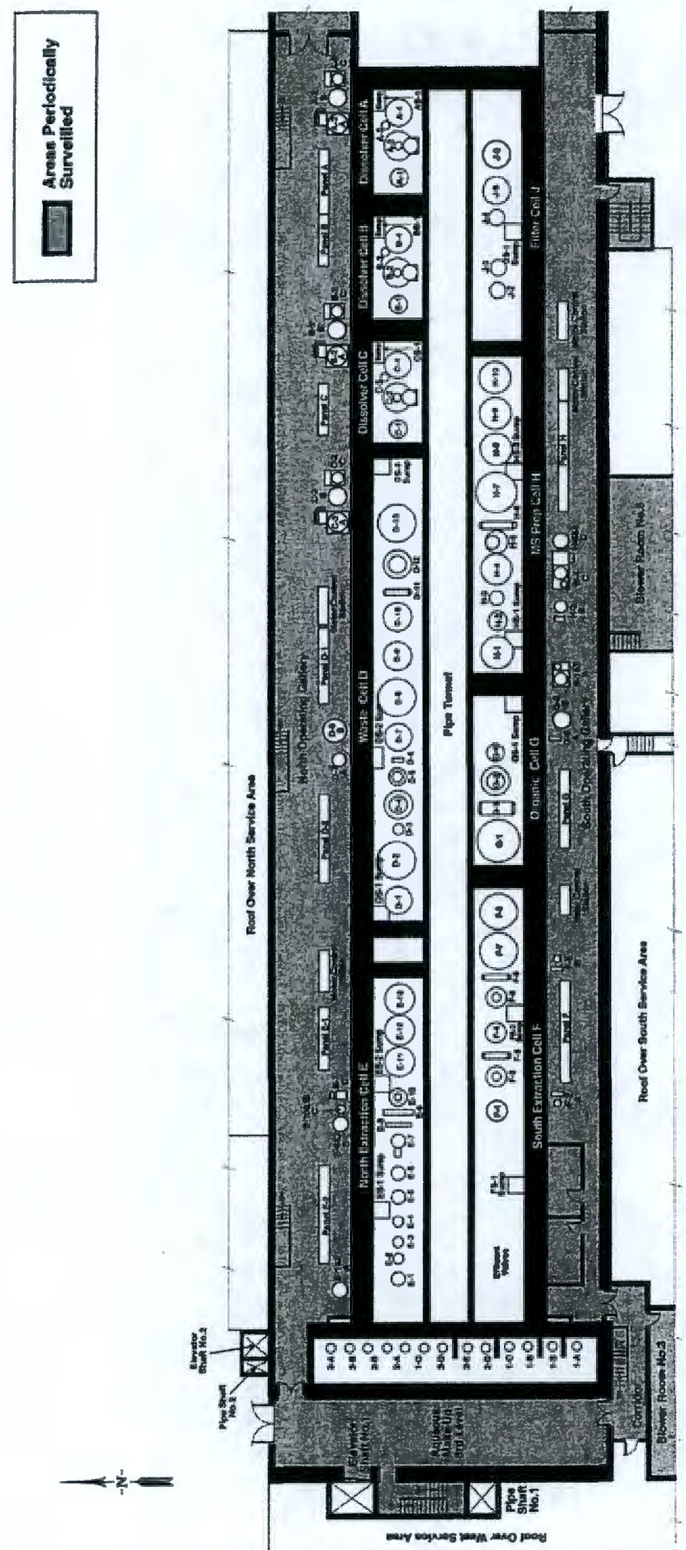


Figure 2-6. Plan View Canyon, North and South Operating Gallery Process Equipment Arrangement.



Ref. HW-18700 / Figure XI-9 / From DWG. H-2-8010, and DWGS. H-2-9441 Thru H-2-9472

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Figure 2-7. Plan View Above Crane Cab Gallery Level.

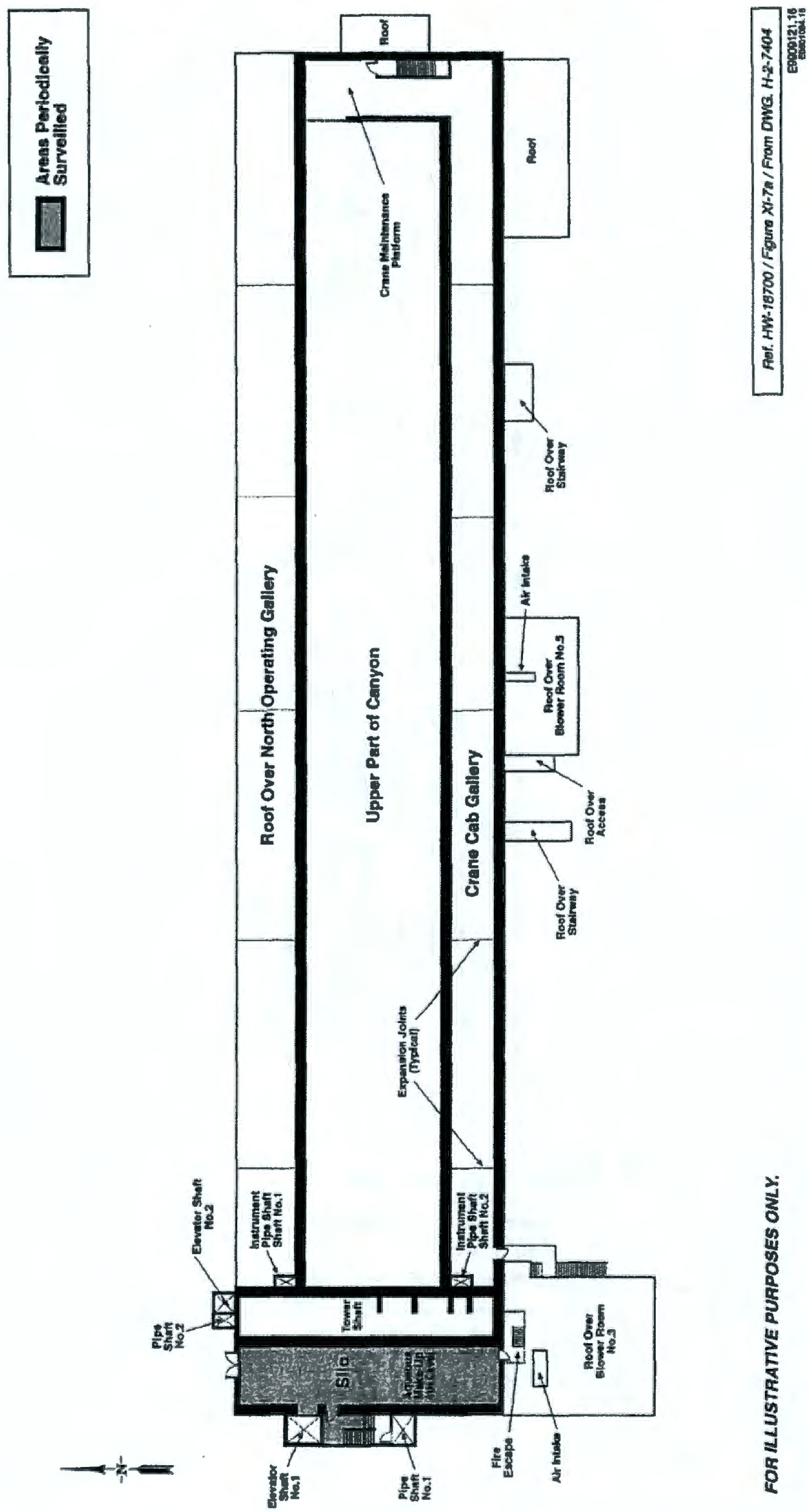
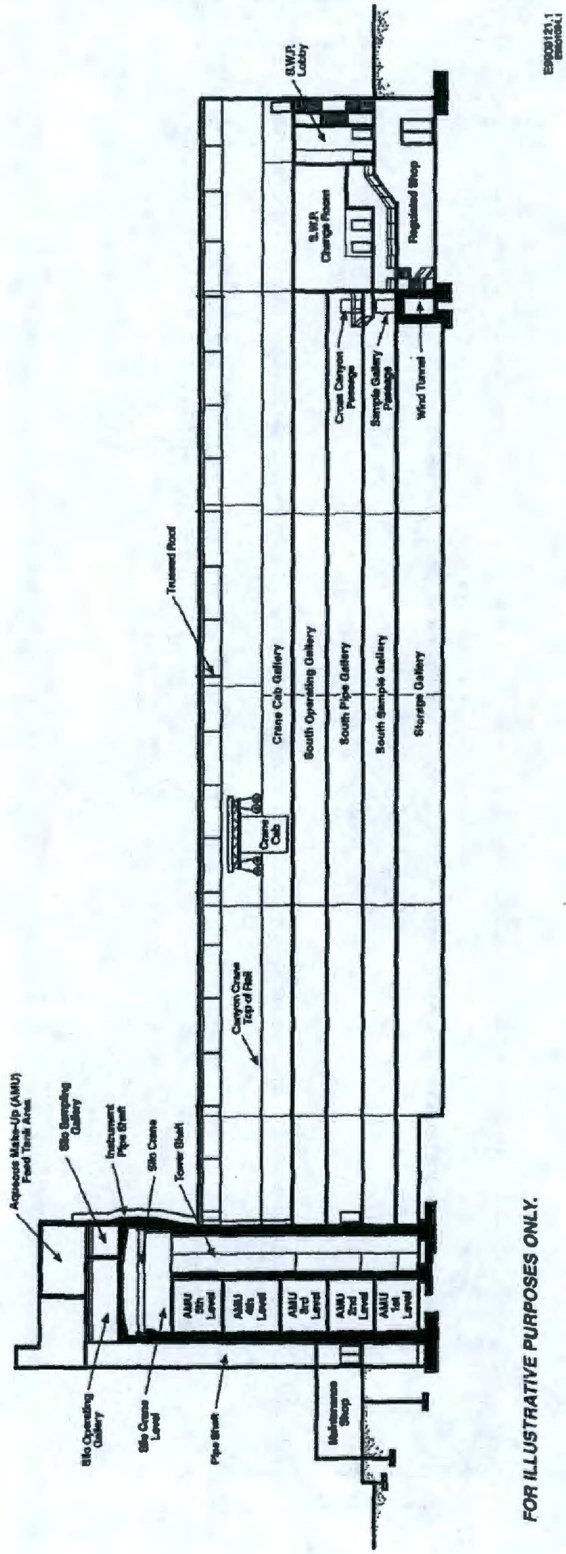


Figure 2-8. Longitudinal Section A-A.



FOR ILLUSTRATIVE PURPOSES ONLY.

Figure 2-9. Longitudinal Section B-B.

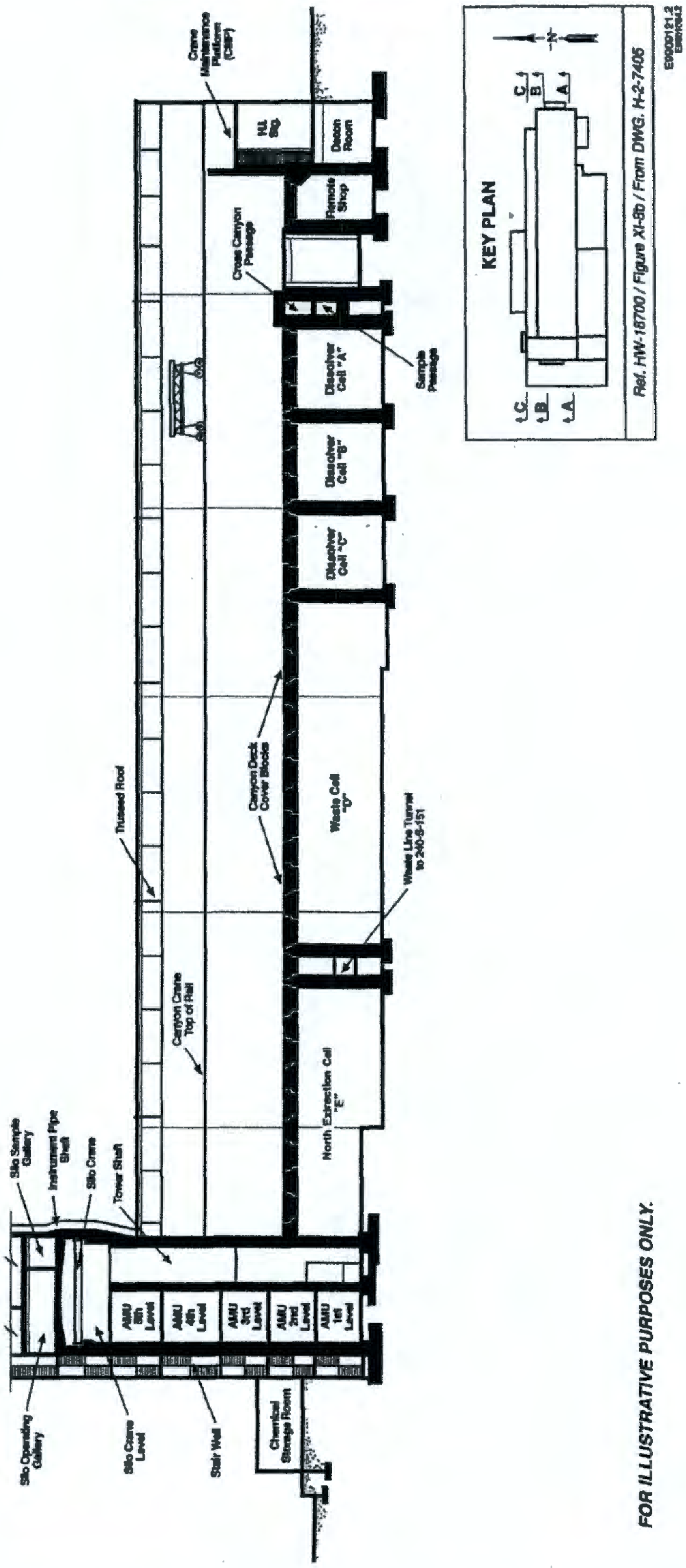
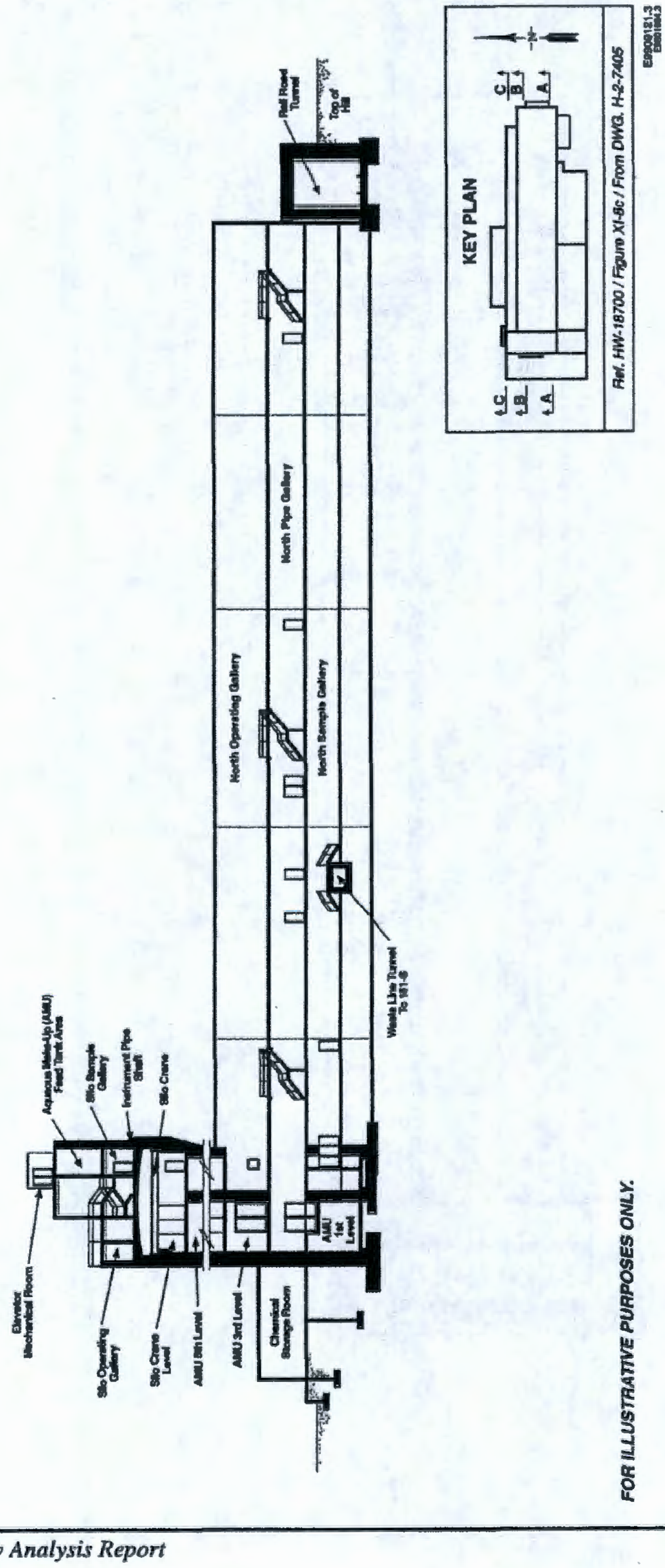


Figure 2-10. Longitudinal Section C-C.



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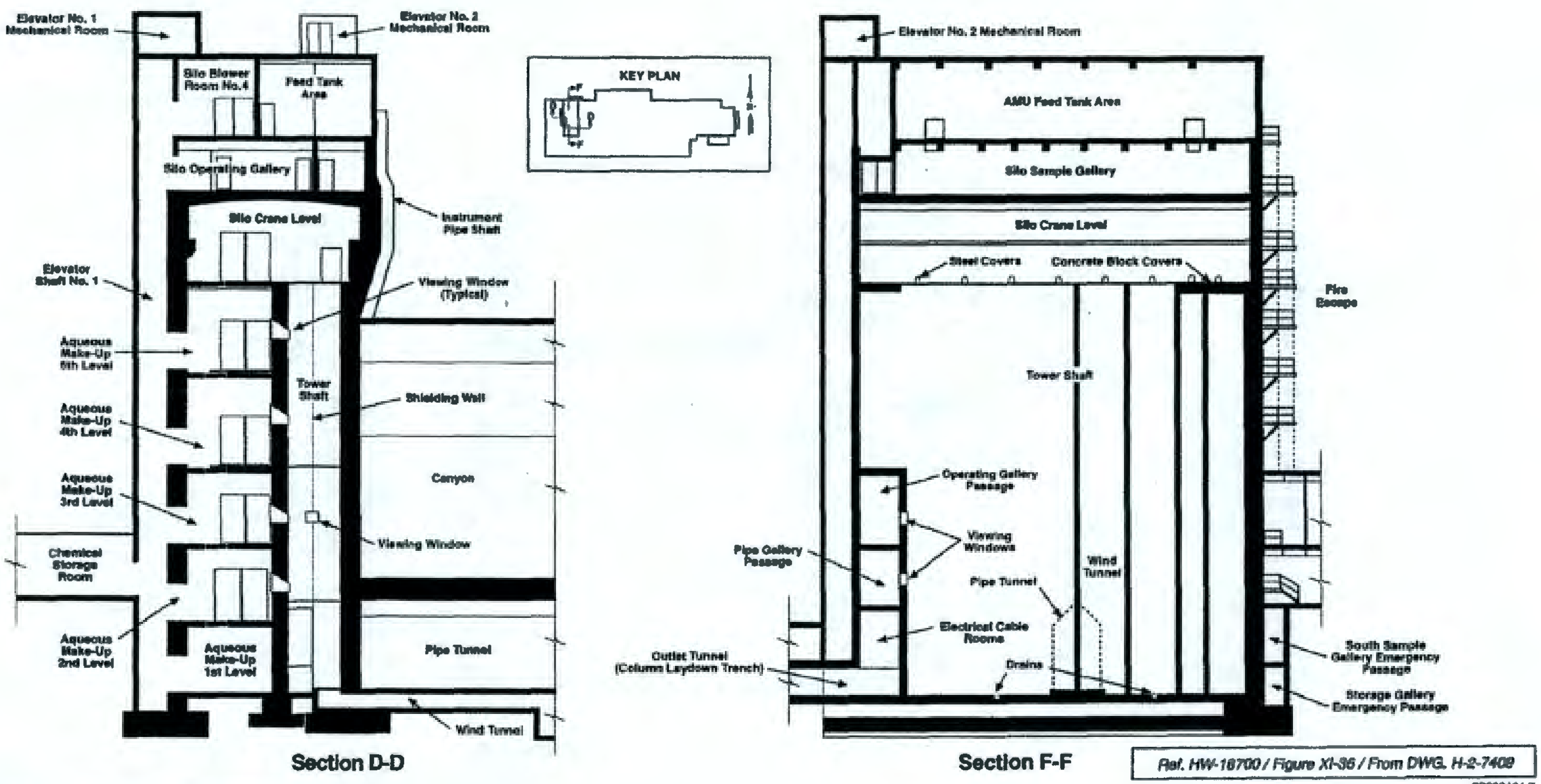

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Figure 2-11. Silo Cross-Sections D-D and F-F.

Figure 2-12. Canyon Emergency Exit.

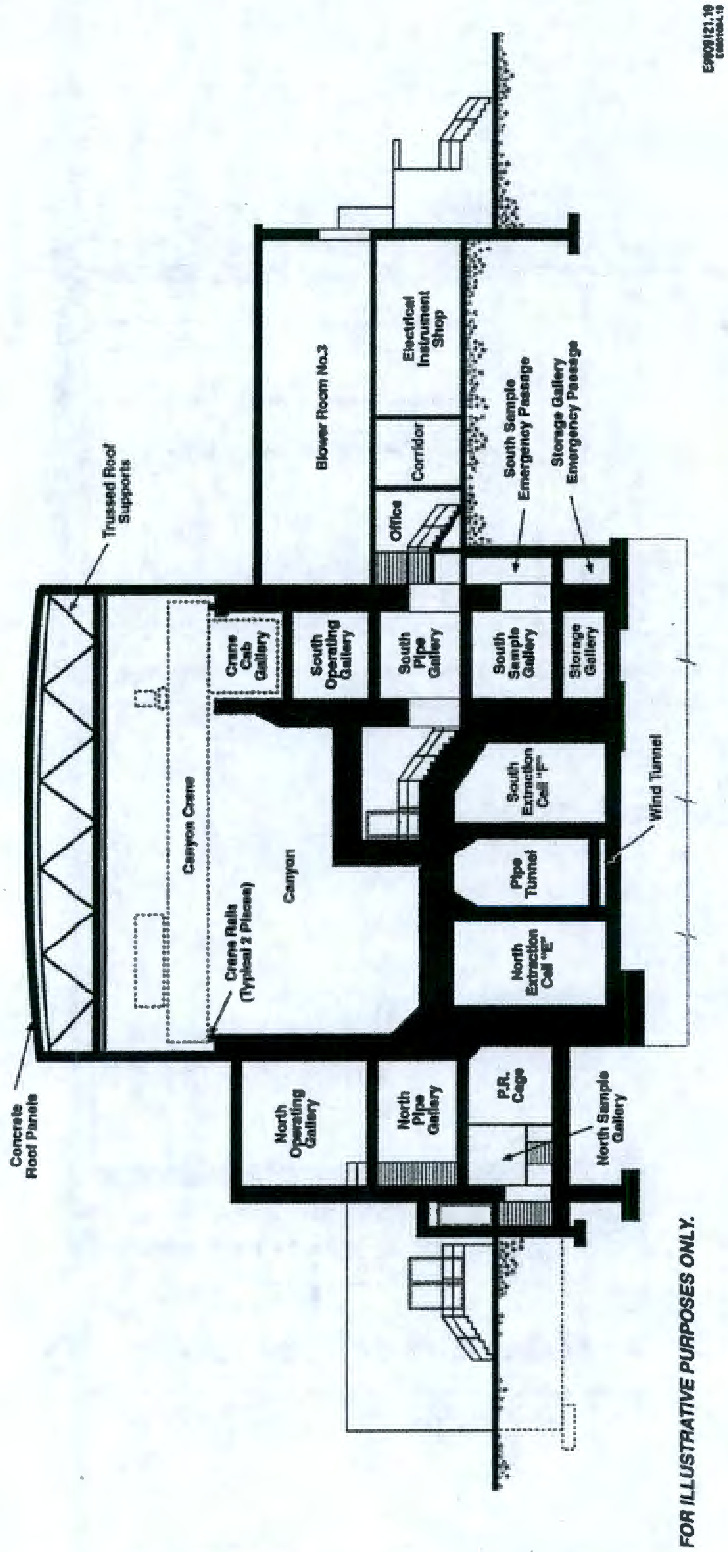

Figure 2-13. Waste Line Tunnel.

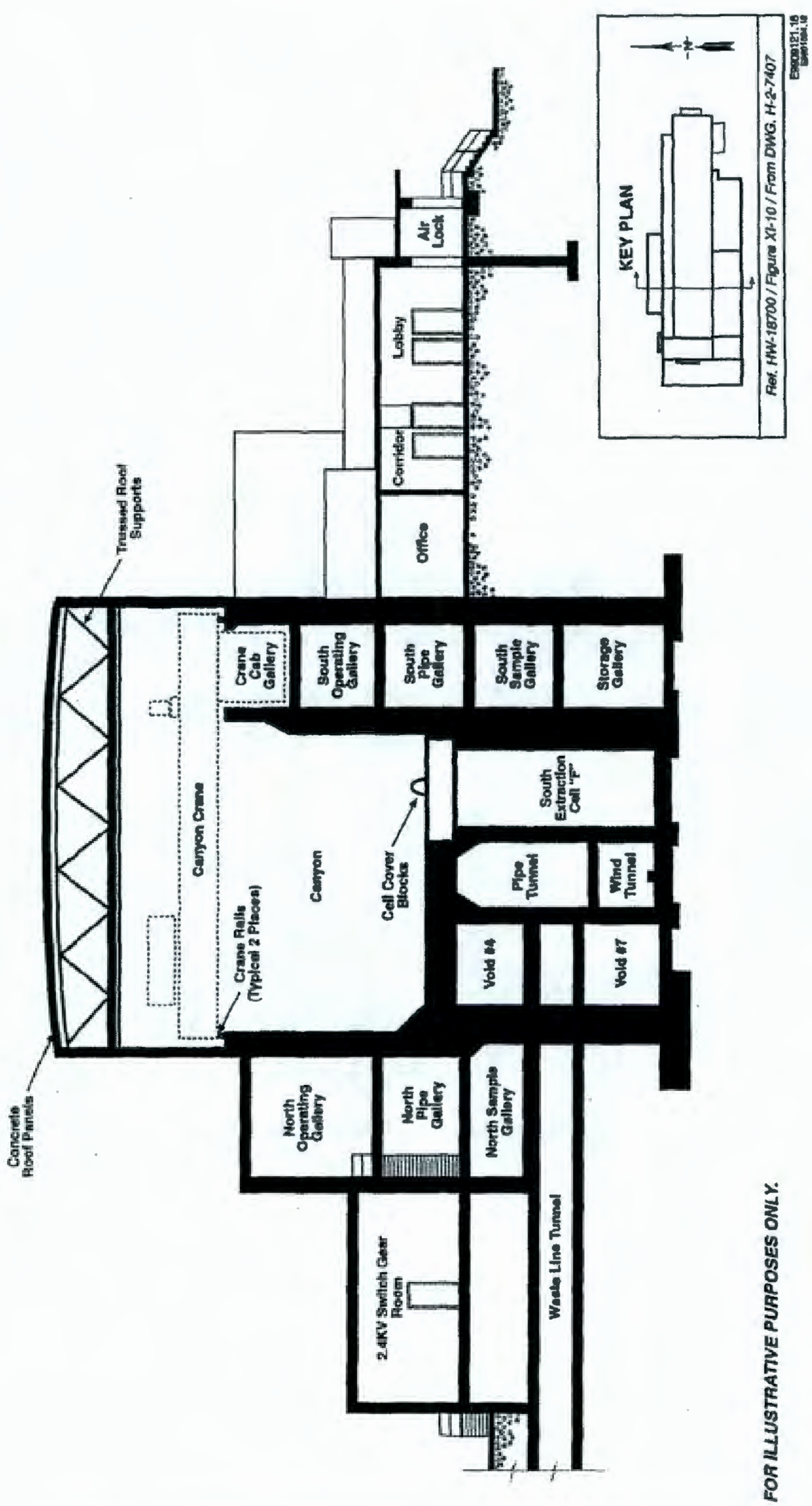

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Figure 2-14. Canyon Cross Passages.

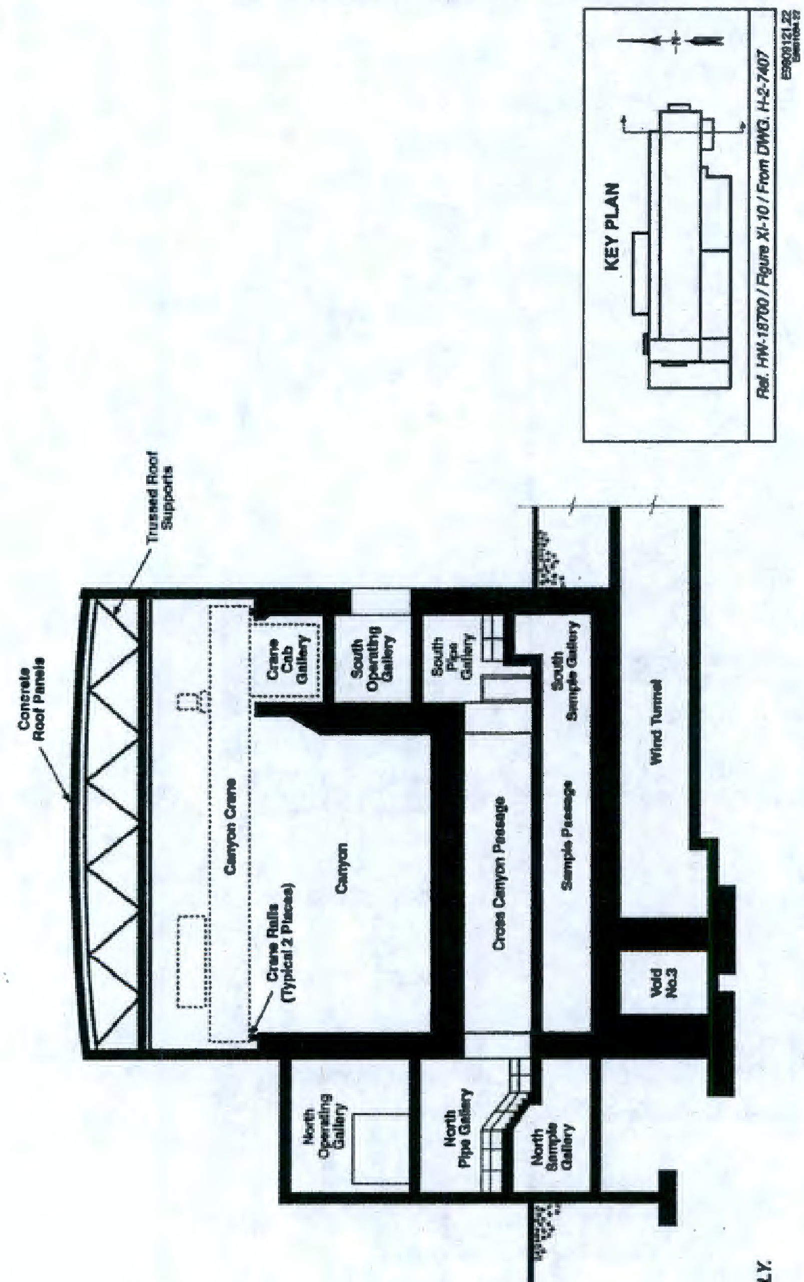

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Figure 2-15. Railroad Tunnel.

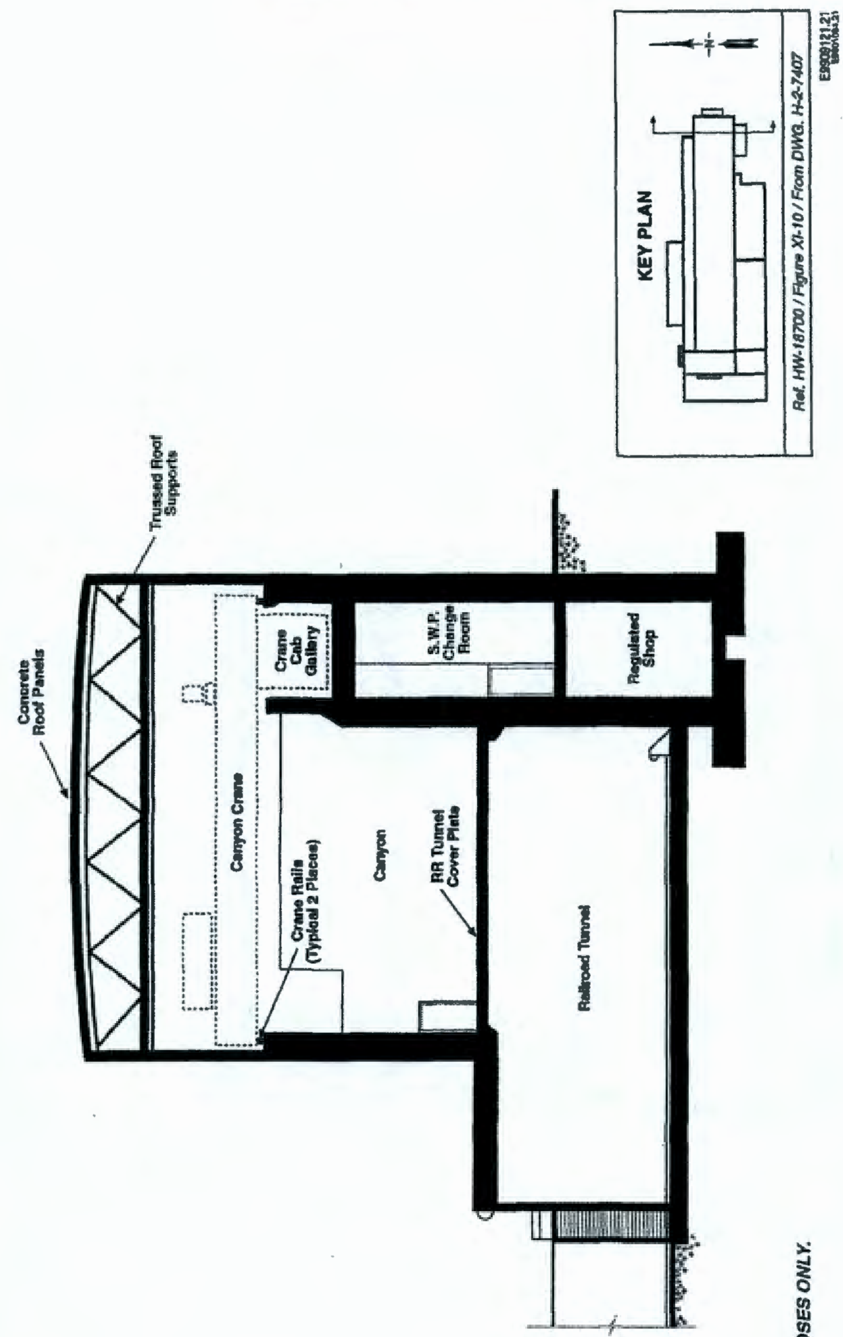

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Figure 2-16. Crane Maintenance Platform.

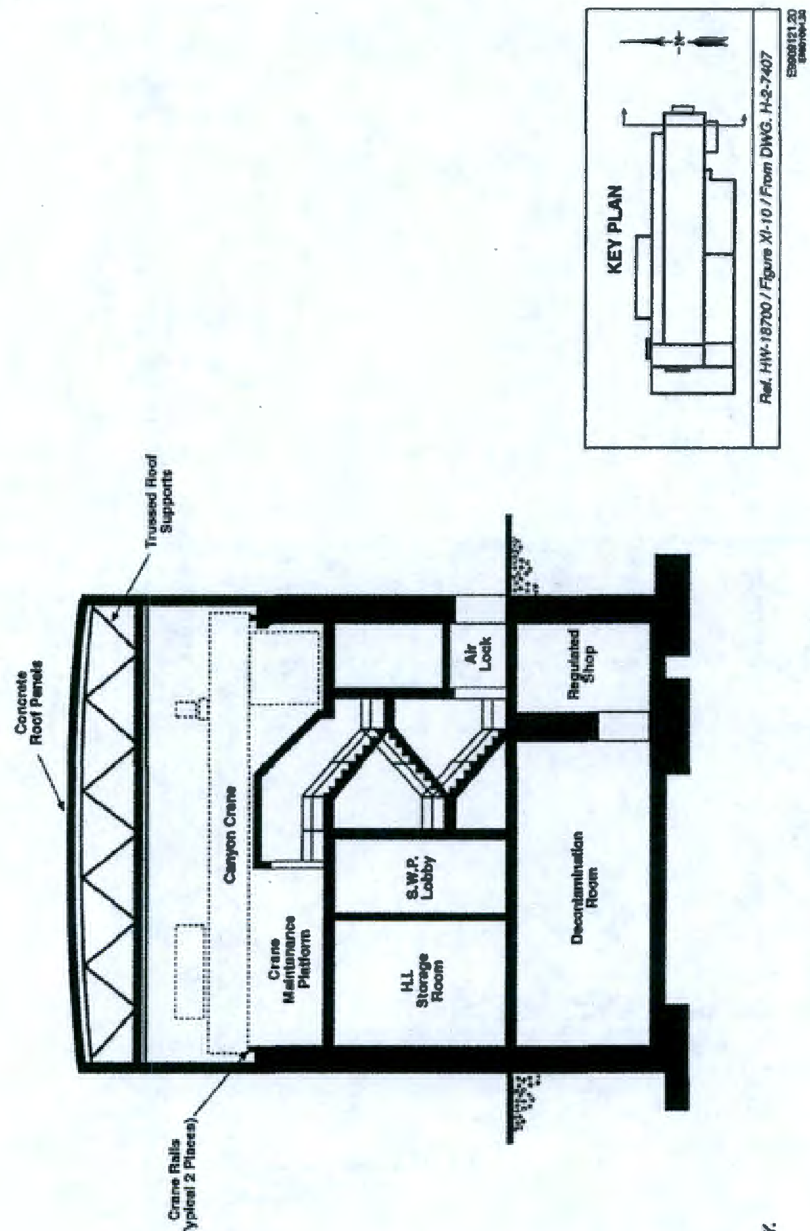

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Figure 2-17. Plan View Product Receiver Cage in North Sample Gallery.

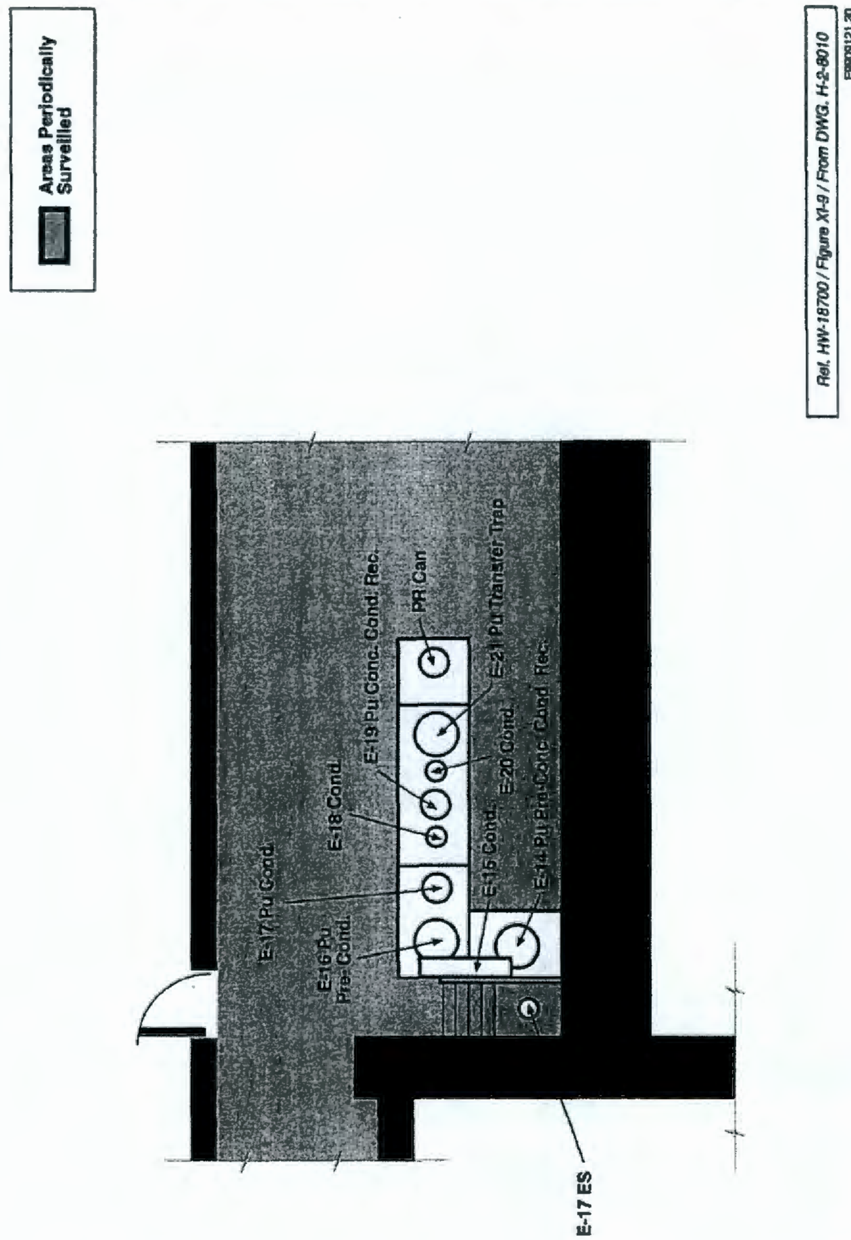

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Figure 2-18. Plan View Silo Processing Aqueous Makeup, Second Level.

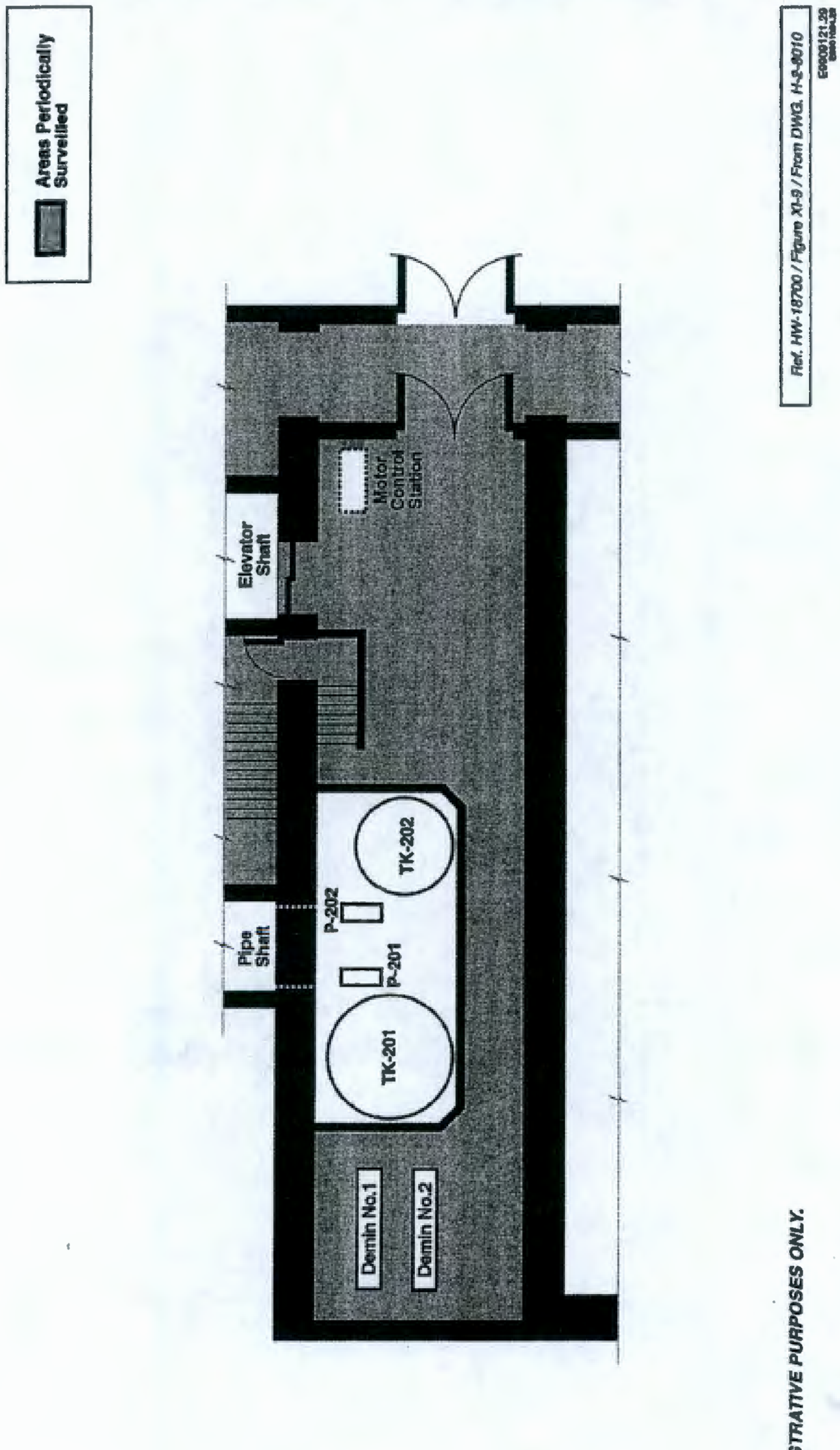
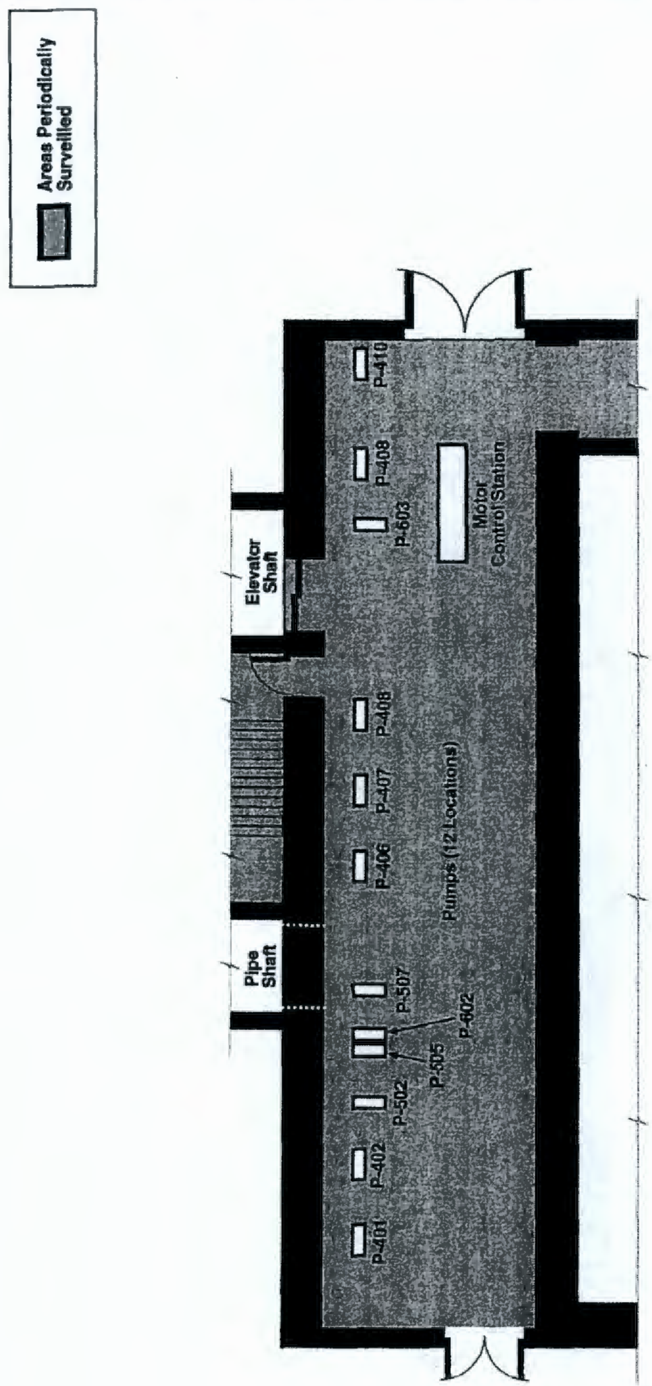


Figure 2-19. Plan View Silo Processing Aqueous Makeup, Third Level.



Ref. HW-18700 / Figure XI-9 / From DWG. H-2-8010

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Figure 2-20. Plan View Silo Processing Aqueous Makeup, Fourth Level.

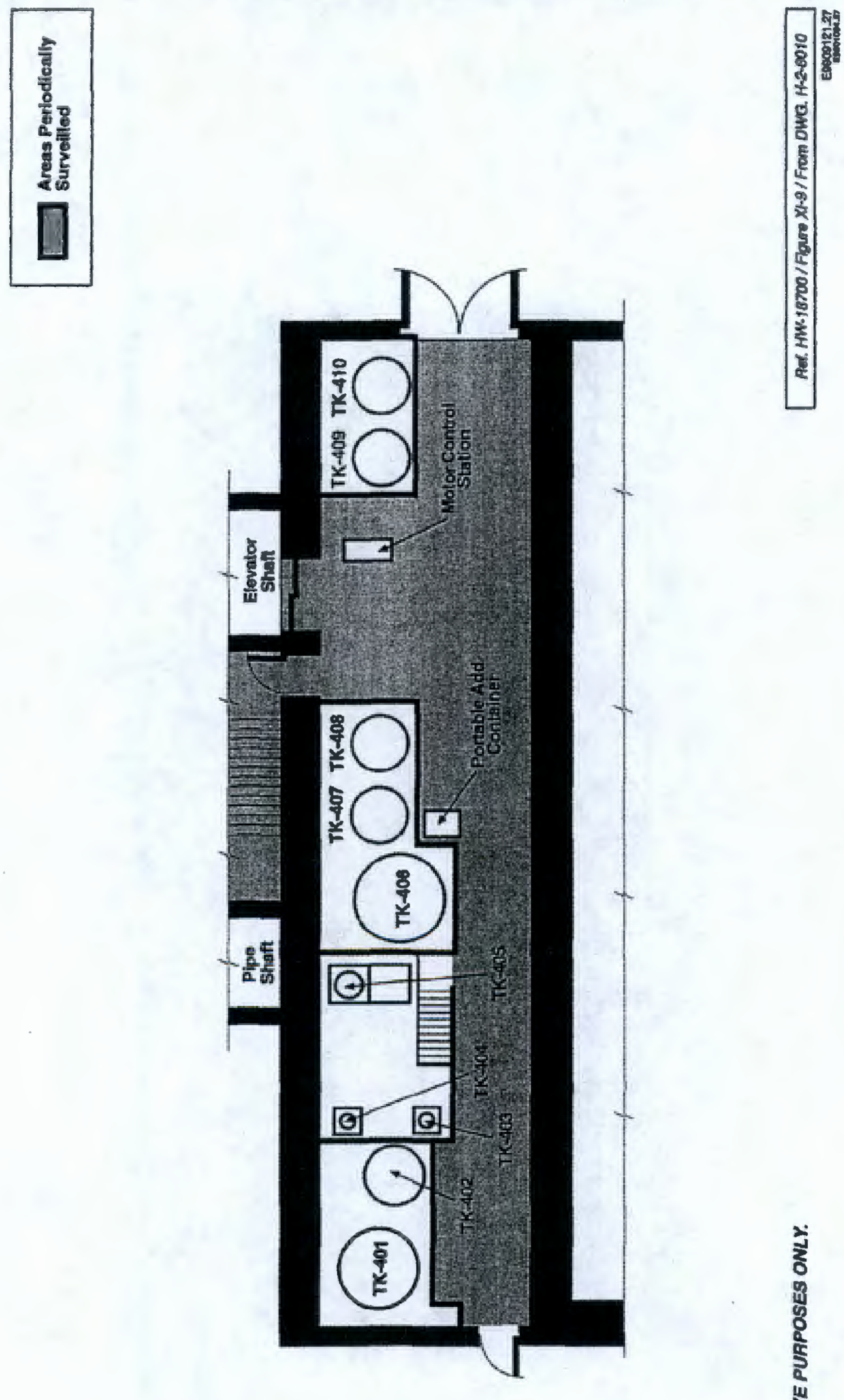

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Figure 2-21. Plan View Silo Processing Aqueous Makeup, Fifth Level (Lower Part).

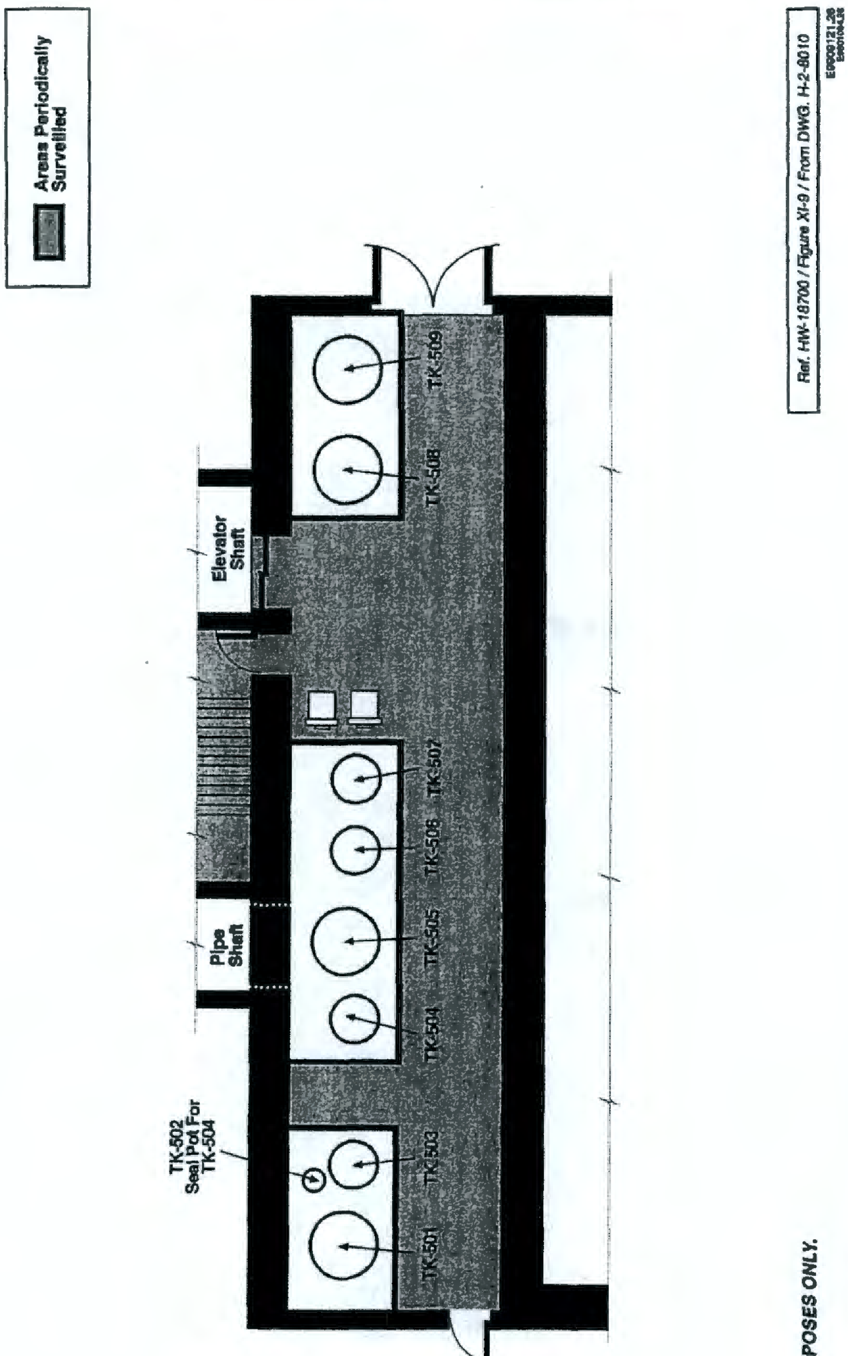

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Figure 2-22. Plan View Silo Processing Aqueous Makeup, Fifth Level (Upper Part).

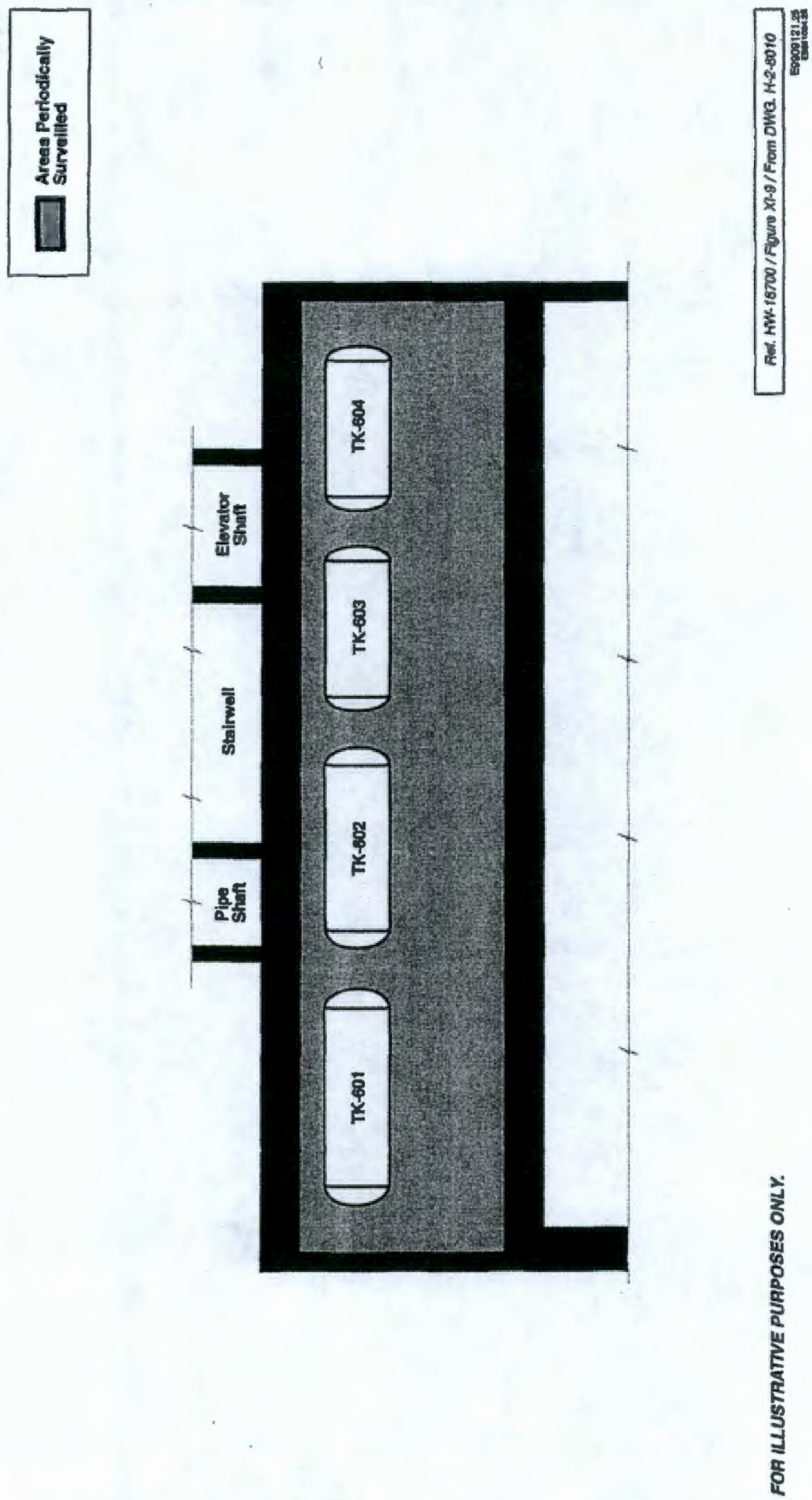
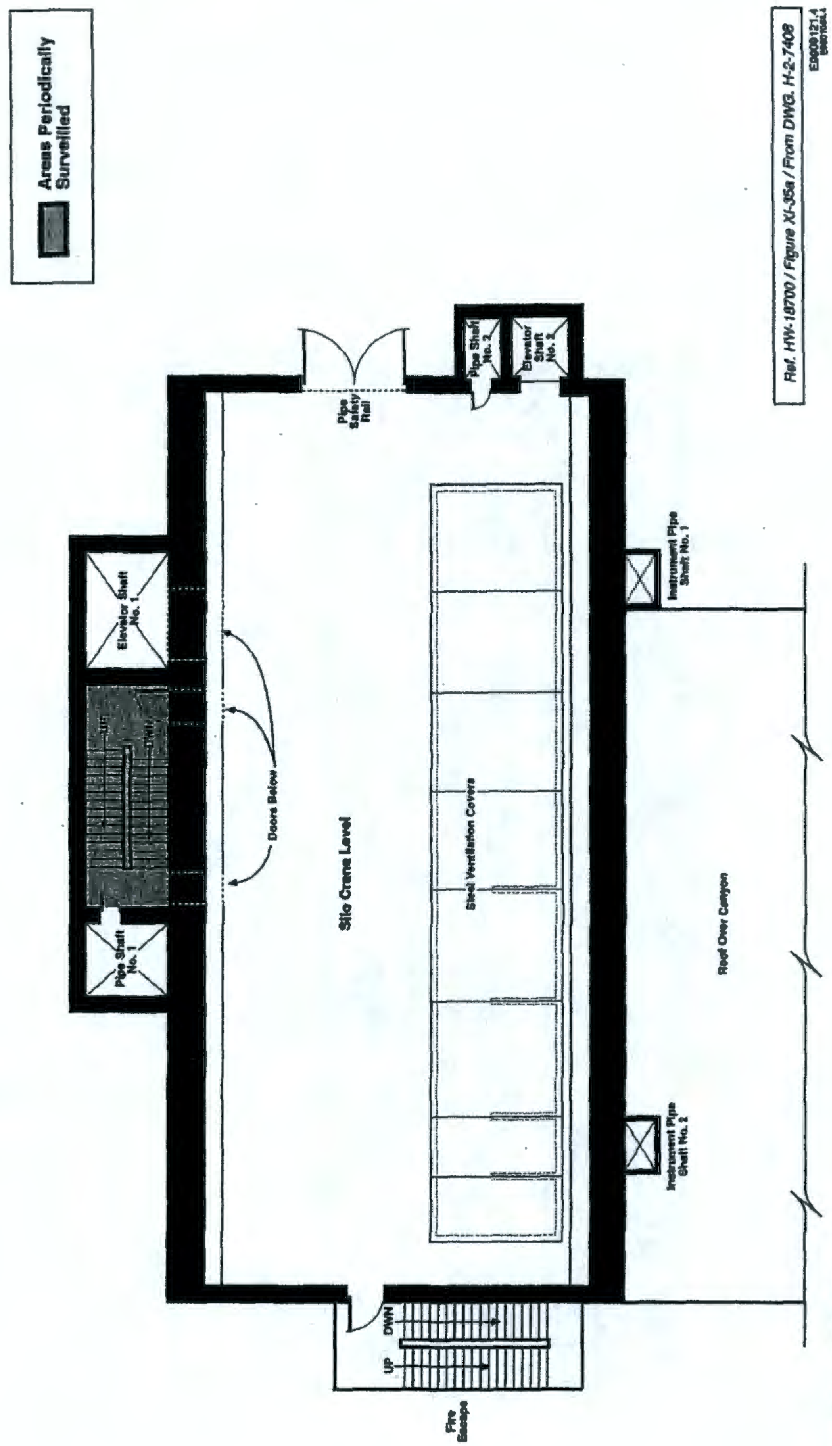


Figure 2-23. Plan View Silo Crane Level, Sixth Level.



FOR ILLUSTRATIVE PURPOSES ONLY.

Figure 2-24. Plan View Silo Processing Operating and Sample Galleries, Seventh Level.

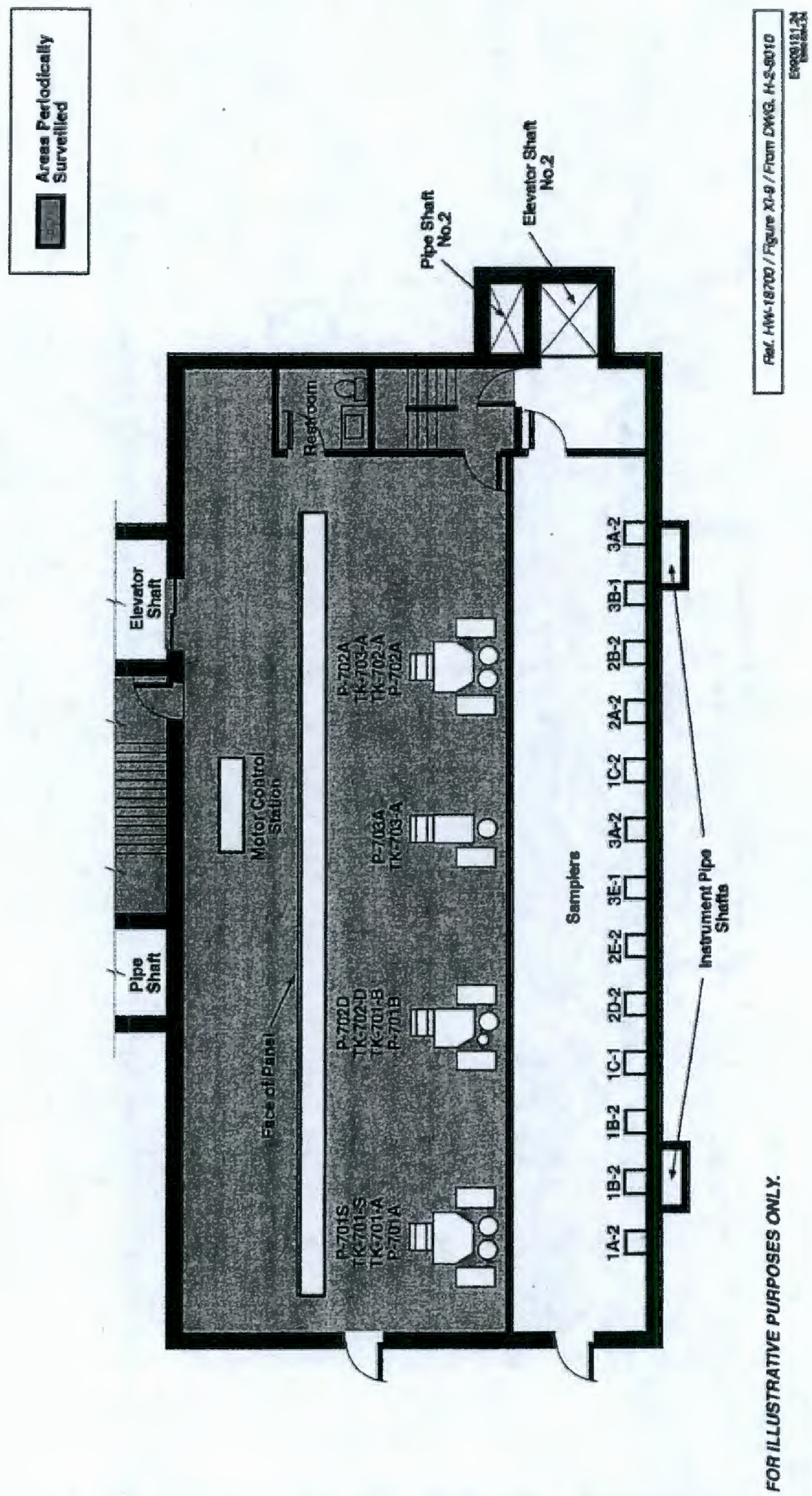


Figure 2-25. Plan View Silo Processing Operating and Sample Galleries, Eighth Level.

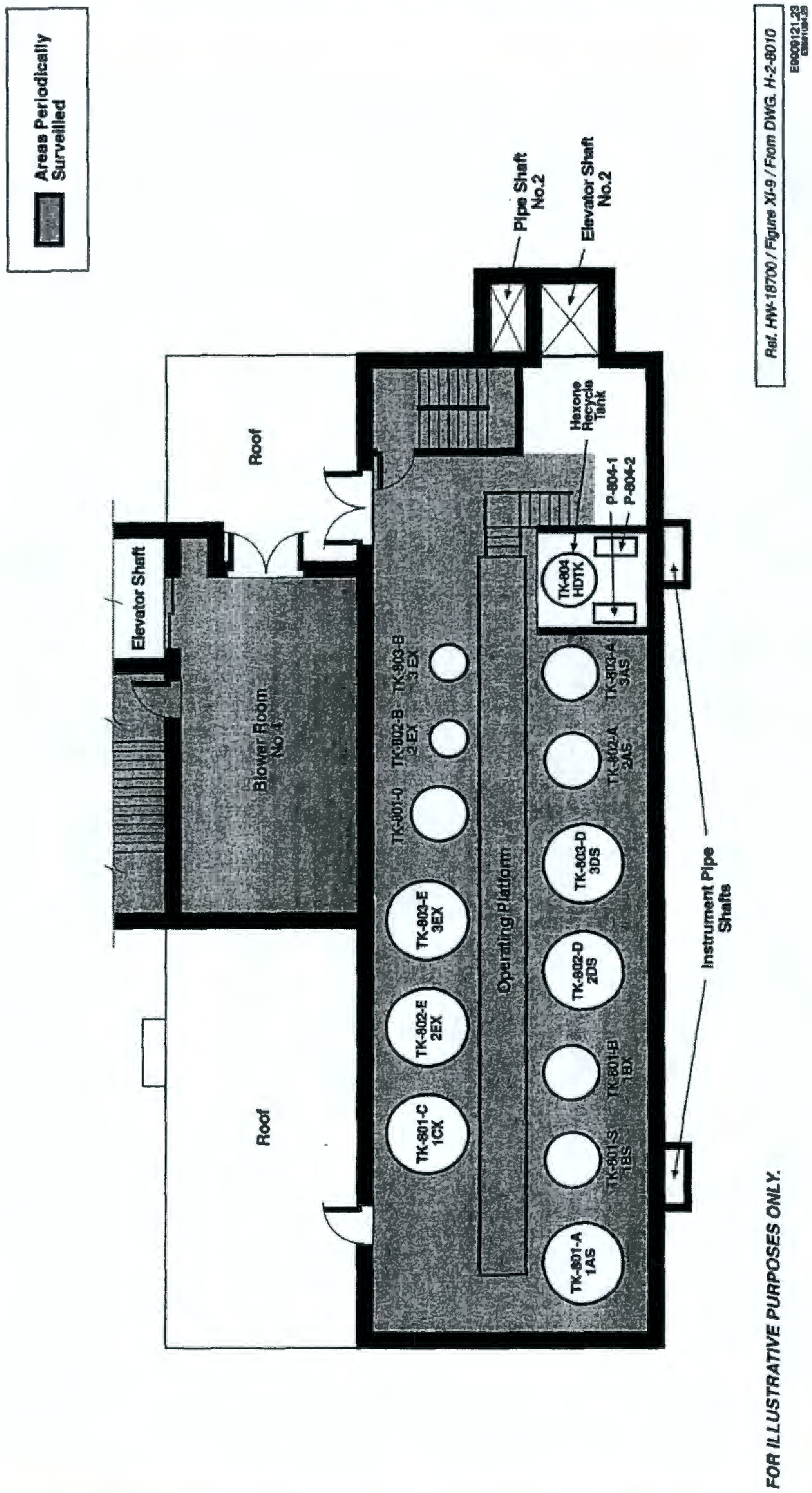


Figure 2-26. REDOX Air Flow Diagram.

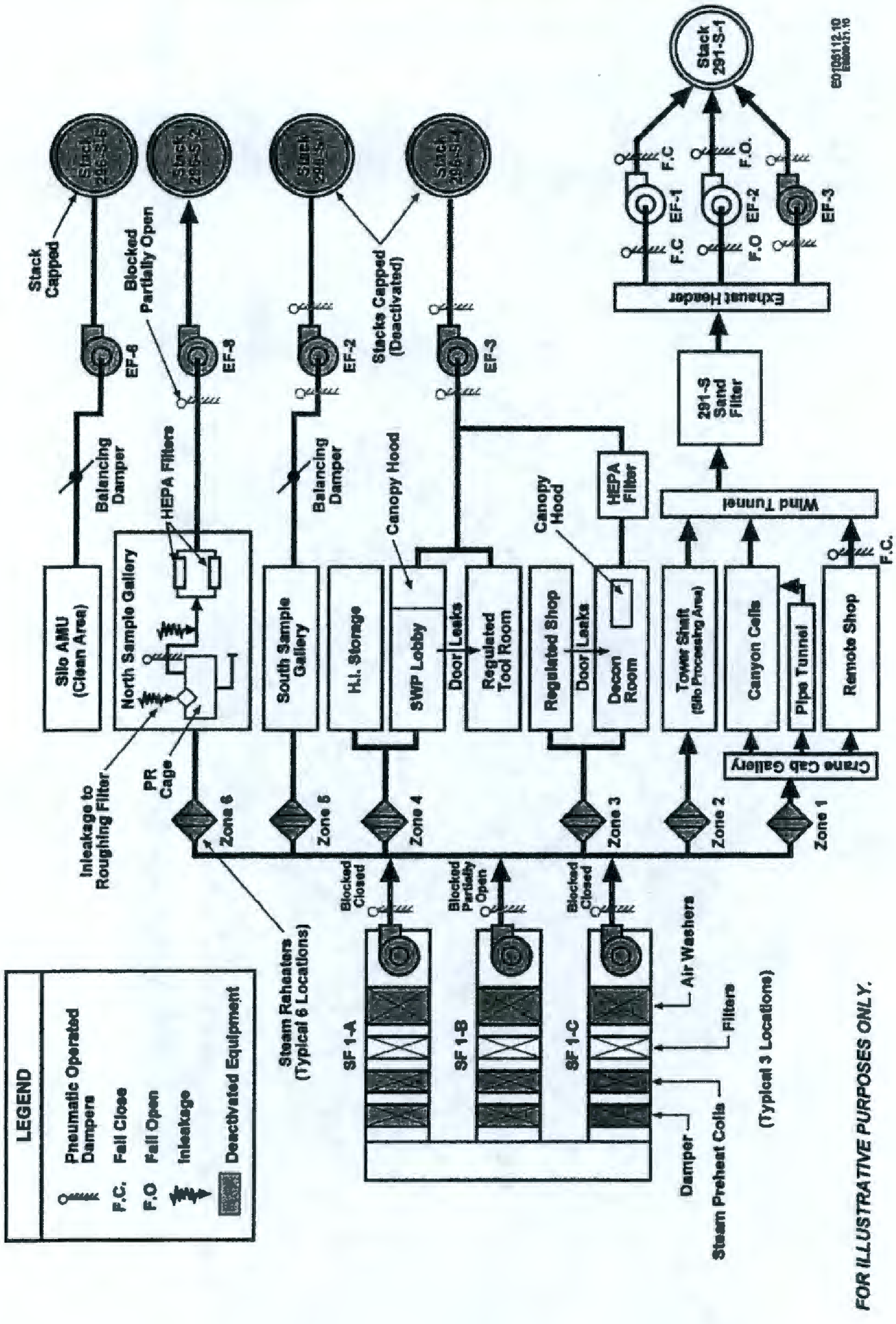


Figure 2-27. One-Line Electrical Schematic of REDOX Facility.

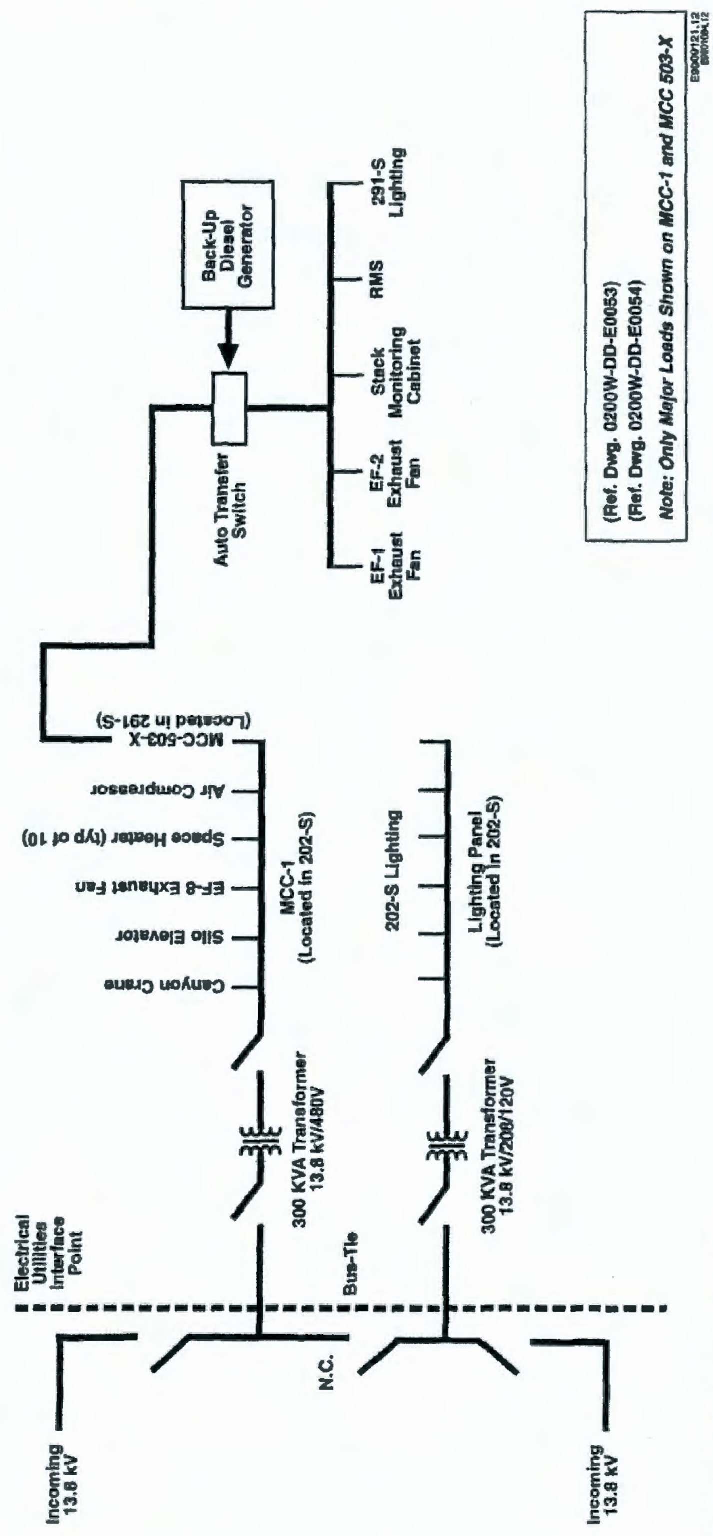


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Table 2-1. REDOX Facility.

Building Number	Building Name
202-S	Canyon Building
291-S	Exhaust Fan Building, Sand Filter, and Exhaust Stack (291-S-1)
276-S	Solvent Handling Building
292-S	Control and Jet Pit House
293-S	Nitric Acid Recovery and Iodine Backup Building
2708-S	Lagger Storage Building
2718-S	Sand Filter Sample Building
211-S	Liquid Chemical Storage Tank Farm
2711-S	Stack Gas Monitoring Building
2715-S	Storage Building
2904-SA	Cooling Water Sampling Building
2710-S	Nitrogen Storage Building
2706-S	Storage Building (demolished)

3.0 HAZARD AND ACCIDENT ANALYSES

3.1 INTRODUCTION

This section describes the methodology and presents the results of the hazard and accident analyses performed for REDOX Facility S&M activities. The hazard analysis consists of hazard identification, classification, and evaluation. The accident analysis consists of a detailed consequence analysis of the bounding accident for the facility. These analyses provide the basis for the controls required for protection of workers, the public, and the environment. The following subsections contain a brief summary of this section's contents.

3.1.1 Hazard Identification

The methodology used to identify hazards is described in Section 3.3.1.1. The results of the hazard identification are presented in Section 3.3.2.1. The hazards identification table, Table A-1, is found in Appendix A. Table A-1 presents the hazard type, location, form, quantity, remarks, and reference to where the information was found. The following types of hazards were investigated:

- Radioactive material
- Hazardous material
- Flammable/combustible material
- Electrical energy
- High pressure
- Direct radiation
- Biohazards
- Reactive material
- Thermal energy
- Fissionable material
- Asphyxiants
- Explosive material
- Kinetic energy.

3.1.2 Hazard Evaluation

The methodology used to evaluate hazards is described in Section 3.3.1.2. The results of the hazard evaluation are presented in Section 3.3.2.3. The preliminary hazards evaluation table, Table A-2, is found in Appendix A. Table A-2 presents the potential event, location, hazard type, impact of the event and possible cause, SSCs and administrative features that may serve a preventive or mitigative function, consequence ranking, and likelihood ranking and identifies if the event was selected for a detailed evaluation. Events selected for detailed evaluation are found in Section 3.3.2.3. These events include fire in the PR cage, loss of ventilation, criticality, and a seismic event.

3.1.3 Hazard Classification

The REDOX Facility is considered a hazard category 2 facility based on the quantity, form, and location of the radioactive material. The detailed discussion of hazard category is found in Section 3.3.2.2.

3.1.4 Accident Analysis

The bounding accident for the REDOX Facility is a seismic event. Based on engineering evaluations in WHC (1991), a 0.03g seismic event could collapse the roof of the 202-S Canyon Building. BHI prepared a separate assessment of the resistance of the canyon structure to seismic loading. The failure point was found to be 0.054g, which confirmed that the canyon roof structure is likely to fail (Carrato 1997). A separate analysis demonstrates that the process cell and cell cover blocks would survive a design basis earthquake in addition of the collapsing roof, thus protecting the majority of the facility inventory from potential release (BHI 1997a). BHI prepared an additional evaluation (BHI 1999b) of the structural adequacy of the north gallery walls and slabs against seismic forces and potential load drop effects (i.e., collapse of the canyon roof and upper canyon walls). This analysis concluded that the PR cage in the north sample gallery is protected from the effects of a seismic event with peak ground accelerations of 0.188g (horizontal) and 0.122g (vertical). Additionally, the PR cage is protected from load-drop effects resulting from the collapse of other structural elements during a seismic event. The surface contamination in other areas of the facility would be at risk, and a fraction of the contamination would become airborne and be transported downwind. The radiological consequences are 13 rem at 100 m, 2.2 rem at 300 m, and 0.023 rem at the site boundary.

3.2 REQUIREMENTS

DOE orders and standards that provide requirements and guidance for performing hazard and accident analyses to establish the safety basis of nuclear facilities are as follows:

- DOE Order 5480.23, *Nuclear Safety Analysis Reports*
- DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (DOE 1997a)
- DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports* (DOE 1994b).

Requirements applicable to the S&M activities performed in the REDOX Facility are discussed in Sections 6.0 through 17.0 of this SAR.

3.3 HAZARD ANALYSIS

The methodology and results of the REDOX Facility hazard analysis are presented in this section. The analysis is a structured, systematic examination of the facilities and operations (described in Section 2.0). The hazard analysis consisted of a hazard identification, classification, and evaluation.

3.3.1 Methodology

3.3.1.1 Hazard Identification. The hazard identification methodology consisted of determining the presence of hazardous materials and energy sources. To prepare this document, several sources of data were researched to obtain background/facility history information, inventory data, current facility status information, and past occurrence information. The following sources were researched:

- Records Management Information System
- Fluor Hanford, Inc. central files
- Facility personnel and files
- RL Reading Room
- Related projects, activities, and facilities
- Former REDOX operating and management personnel
- Facility walkdown
- Hanford Site drawing database (maintained in Soft Reporting[1])
- Occurrence Reporting and Processing System (ORPS) database
- Event fact sheets.

The first five sources were used primarily to search for documents and reports related to the REDOX Facility. The Records Management Information System is a database of Site-wide documents, and several useful documents were located that provided inventory data and facility background information. The central files document database (maintained by Fluor Hanford, Inc.) was also useful for locating documents related to the REDOX Facility. Facility files were searched for documentation not found in the document databases, such as radiological survey reports and event fact sheets. An example of a document that provided useful insight into the history of the REDOX Facility is *Synopsis of REDOX Plant Operations* (RHO 1978). This document contains information on REDOX Facility operations, including plant capacity and products, process development, major historical events, and significant events for each year of operation.

A workshop composed of former REDOX Facility operating and management personnel, Assistant Manager for Environmental Restoration/RL, BHI personnel, and H&R Technical Associates personnel was held to identify and discuss hazards. Former REDOX Facility personnel provided valuable historical information, shared experiences, and process knowledge. These individuals identified additional documentation that would potentially be useful in identifying historic events and described undocumented events with which they were familiar.

The facility walkdown was crucial in understanding the current status of the facility. The facility walkdown was performed with knowledgeable facility personnel. All noncontaminated accessible areas of the facility and those areas not requiring special access were visited.

[1] Soft Reporting is database located on the Hanford local area network, owned and operated by Fluor Hanford, Inc.

The Hanford Site drawing database, maintained on Soft Reporting and in the various drawing release stations, was also a useful source of information. Many drawings were outdated, but several were useful references for developing the figures presented in this document.

The final two sources of information, the ORPS database and event fact sheets, were used to identify and understand prior upsets that had occurred at the facility. The ORPS, maintained by Idaho National Environmental Engineering Laboratory for all DOE facilities, contained some information on the REDOX Facility. The Hanford Site occurrence reporting database had several references to the REDOX Facility.

3.3.1.2 Hazard Evaluation. The REDOX Facility hazard evaluation was conducted using a graded approach consisting of three steps: (1) an initial screening, (2) a preliminary hazard evaluation, and (3) a detailed hazards evaluation.

3.3.1.2.1 Initial Screening. The initial screening was based on the results of the hazard identification process. The hazard identification considered all of the buildings and structures that comprise the REDOX Facility. Buildings and structures identified as containing little or no radioactive/hazardous material and/or judged to present only standard industrial or occupational hazards were screened from further evaluation. Standard industrial and occupational hazards were considered to the extent that they could initiate an accident or impact a nonstandard industrial hazard.

The screening was originally performed by safety analysts and was subsequently reviewed and finalized at a hazard evaluation workshop. Representatives from the following groups participated in the workshop:

- Engineering
- Operations
- Radiological control
- Fire protection
- Nuclear safety
- Training
- Industrial hygiene/occupational safety
- DOE Assistant Manager for Environmental Restoration.

3.3.1.2.2 Preliminary Hazard Evaluation. A preliminary hazard evaluation was performed for the buildings and structures that had passed through the initial screening. The evaluation was performed by first postulating an event involving a specific hazard (e.g., fissionable material) at a specific location (e.g., PR cage). Evaluated events fall into one of three general categories: natural phenomenon (e.g., seismic or high wind), external events (e.g., aircraft impact or water intrusion), and internal/operational events (e.g., fire or criticality).

The SSCs and administrative controls that would serve to prevent or mitigate the event were then identified. The identification of controls was based primarily on a review of available facility and operations documentation and by consulting experienced facility personnel during the hazard evaluation workshop. An initial condition of the preliminary hazard evaluation assumed that operations are conducted by trained personnel and in accordance with approved procedures.

Following the identification of SSCs and administrative controls, qualitative consequence and likelihood rankings were assigned to each event. The four consequence ranks are as follows:

- Rank I – catastrophic
- Rank II – severe
- Rank III – unplanned releases
- Rank IV – minor.

The five likelihood ranks are as follows:

- Rank A – frequent
- Rank B – probable
- Rank C – occasional
- Rank D – remote
- Rank E – improbable.

The consequence and likelihood rankings are further defined in Appendix A. The methodology used to assign likelihood and consequence rankings is based upon the methodology developed in the *Risk Management Study for the Hanford Site Facilities* (WHC 1994b) and applied in *Qualitative Risk Evaluation Update for the Retired Hanford Site Facilities* (BHI 1994b).

The results of the preliminary hazard evaluation were reviewed to determine which, if any, of the hazards warranted further evaluation. In making this determination, consideration was given to the following factors:

- Consequence ranking. High consequence events (i.e., I, II, or III-1) were considered for further evaluation. Low consequence events (i.e., V) were not considered for further evaluation unless the corresponding likelihood ranking was high (i.e., A or B).

- Likelihood ranking. High frequency events (i.e., A or B) were considered for further evaluation. Low frequency events (i.e., E) were not considered for further evaluation unless the corresponding consequence ranking was high (i.e., I).

The events remaining after this screening were further reviewed to reduce the hazards that required additional evaluation:

- Bounding events. Events judged to be bounding from a radiological dose consequence perspective (e.g., fire in the PR cage) for a given subcategory of events (e.g., fire) were considered for further evaluation.

- Control suite. Consideration was given to the degree to which a hazard was controlled by existing institutional and programmatic controls.

The above factors were not applied as stringent criteria but were qualitatively weighted by participants at the hazard evaluation workshop, and a consensus was reached as to those hazards warranting further evaluation.

3.3.1.2.3 Detailed Hazard Evaluation. Detailed hazard evaluations were performed by further evaluating, as appropriate, the location, form, and quantity of the hazard; potential initiating events; accident progression radiological consequences; and available engineered and/or administrative controls.

3.3.2 Hazard Analysis Results

3.3.2.1 Hazard Identification Results. The results of the hazard identification process are documented in Appendix A, Table A-1. The following subsections summarize (1) available information regarding the location and quantity of radioactive and hazardous materials at the REDOX Facility and (2) historic events that have occurred during the conduct of S&M activities.

3.3.2.1.1 Inventory of Radioactive Materials. The majority of the radiological inventory at the REDOX Facility is located in the 202-S Building and the 291-S exhaust system sand filter. Relatively minor quantities exist in other buildings, typically as residues or surface contamination. Table 3-1 presents the inventories for the 202-S Canyon Building and sand filter. The values in Table 3-1 are based on the best available data. For radiological consequence calculation purposes, the alpha activity is assumed to be plutonium-239 (Pu-239) and the beta activity is assumed to be strontium-90 (Sr-90). These assumptions are conservative in that Pu-239 and Sr-90 have the largest dose conversion factors (DCFs) of those radionuclides potentially present in significant quantities.

Within the EF-4 tank and the E4-L2 transfer line, a higher concentration of neptunuim-237 (Np-237) may exist because a special Np-237 recovery campaign was performed. The actual concentration of Np-237 is unknown; however, isotopic analyses for the 233-S Building process vessels show Np-237 to be approximately 4%, which may be taken as the upper concentration limit. In addition, D cell was used as late as 1982 for transferring radioactive liquid waste from the 222-S Laboratory to the tank farms. This transfer operation would tend to dilute residuals within the process vessels. For the Np-237 to be a bioassay concern, the Pu-239 to Np-237 ratio must be greater than 6 to 1; therefore, the Np-237 is assumed to be Pu-239.

In general, detailed radionuclide characterization data (i.e., form, quantity, and location) for the 202-S Building do not exist. The values listed in Table 3-1 are based on best available information. Recent surveys (BHI 1997d) have identified significant accumulations of residual materials in the north sample gallery, located primarily in PR cage processing equipment (see Table 3-2). Evaluation (BHI 2000d) of characterization (BHI 1999c) of the PR cage confirmed the plutonium inventory estimates presented in BHI (1997d) and showed that nearly all of the inventory is contained within the processing equipment. BHI (1999c) also confirmed earlier indications (BHI 1997d) that Am-241 and Np-237 are present in the PR cage. Evaluation of the sample data and other technical references (BHI 2000d) indicated that the residual waste in the vessels and piping of the PR cage is likely to have an activity ratio of approximately 3 to 1 for Pu-239/240 to Am-241. The summary of fissionable material listed in Table 3-3 is based upon limited features of the PR cage; however, the likelihood that other vessels and piping associated with the PR cage contain significant fissionable inventories is low. Because of the extensive chemical cleaning of the process vessels and piping followed by weekly flushing with water (Foster 1977), the radioactive materials remaining in these confinement systems are likely encrusted and fixed to the internal surfaces and are not easily dislodged. The balance of the radioactive material is assumed to be loose surface contamination distributed throughout the structure in a manner represented in Appendix B.

Appendix B documents radiological conditions inside the 202-S Canyon Building at the time that this SAR was prepared. These figures are provided for information purposes only and should not be used for work planning purposes, as radiological conditions within the building can change over time. In addition, because the figures are provided to be "indicative" and not "definitive," they do not need to be updated for the sole purpose of maintaining currency of the SAR.

The inventory of radioactive material in the 202-S Canyon Building presents both an external exposure and internal deposition hazard to facility workers. Dose rate surveys, surface contamination surveys, and air sampling are routinely performed.

The inventory of radioactive materials has a very high degree of uncertainty including form, quantity, and distribution. Because of this uncertainty, highly conservative assumptions are used when applying the limited inventory data. In any undertaking that involves intrusive activities within the REDOX Facility, caution must be exercised, recognizing that higher levels of contamination or materials may be encountered.

3.3.2.1.2 Hazardous Chemical and Toxic Material Inventories. Exposure to hazardous chemicals at the REDOX Facility was rated as "low to negligible" in a risk management study of Hanford Site surplus facilities (WHC 1994b). The study identified loose containerized chemicals, lead shielding and counter-weights, deteriorating and flaking lead-based paints, mercury switches, and fluid-filled manometers present inside facility buildings and surrounding grounds.

The REDOX Facility formerly used large amounts of the following hazardous chemicals:

- Acetylene tetrabromide
- Hexone
- Nitric acid
- Sodium nitrate
- Sodium hydroxide
- Coating and caulking compounds
- Zirconium cladding material
- Ammonium fluoride/ammonium nitrate
- Tributyl phosphate
- Normal paraffin hydrocarbon (kerosene).

While deactivation activities removed a vast majority of these chemicals, minor quantities of residual chemicals are expected to be found in the process vessels and piping located in the various buildings throughout the facility. Deactivation procedures specified the use of nitric acid, permanganate, and oxalic acid that are also likely to be present in residual quantities.

In addition to residual quantities of process and deactivation chemicals, polychlorinated biphenyl (PCB) light ballasts, lead paint, lead material used for shielding, mercury in switches and lights, and used oils may be encountered during the conduct of S&M activities.

Asbestos-insulated steam lines run throughout the REDOX Facility. Asbestos was also used as a building material in the walls in the operating area of the 276-S Solvent Handling Building. The pre-existing condition surveys (BHI 1994a) noted several instances of friable asbestos in the various facility buildings, predominately in piping insulation.

3.3.2.1.3 Occurrence Reporting and Processing System Results. The ORPS database was reviewed for events that had occurred at the REDOX Facility. The results of the database review are summarized in Table 3-3.

3.3.2.2 Hazard Classification Results. This section presents the results of the final hazard categorization performed as required by DOE Order 5480.23 and in accordance with the guidance provided in DOE (1997).

The REDOX Facility is treated as a single segment for hazard classification purposes. The principal buildings that comprise the REDOX Facility are 202-S, 291-S, 292-S, 2904-SA, 293-S, 2711-S, 2715-S, 2718-S, 2706-S (demolished), 276-S, 211-S, and 2710-S. Table 3-1 presents the radiological inventories within the REDOX Facility. For the sum-of-the-ratios calculation, only the 202-S Canyon Building inventory was considered, as the inventory in other buildings is small by comparison.

The sum of the ratios for the 202-S Canyon Building was found using the following equation:

$$Sum\ of\ Ratios = \sum_{i=1}^{j} \frac{Inventory\ at\ Risk\ of\ Isotope}{Category\ 2\ Threshold\ Quantity\ of\ Isotope}$$

Applying this equation, the sum of ratios is:

$$Sum\ of\ Ratios = \frac{1{,}500\ Ci\ Pu-239}{56\ Ci\ Pu-239} + \frac{9{,}000\ Ci\ Sr-90}{2.2e+4\ Ci\ Sr-90} + \frac{140\ Ci\ Pu-239}{56\ Ci\ Pu-239} + \frac{840\ Ci\ Sr-90}{2.2e+4\ Ci\ Sr-90}$$

$$Sum\ of\ Ratios = 29.7$$

Because the sum of the ratios is greater than one, the REDOX Facility is classified as nuclear category 2.

The bounding accident for hazard classification purposes at the REDOX Facility is a seismic event (see Section 3.4.2). Consistent with the sum-of-the-ratios approach, the radiological consequences of a seismic event dictate the REDOX Facility be classified as nuclear category 2.

3.3.2.3 Hazard Evaluation Results. As discussed in Section 3.3.1.2, the REDOX Facility hazard evaluation was conducted using a graded approach, consisting of three steps: (1) an initial screening, (2) a preliminary hazards evaluation, and (3) a detailed hazards evaluation. The results for the three steps are presented below.

3.3.2.3.1 Initial Screening. Table 3-4 presents the results of the initial facility screening. All former processing buildings and principal support buildings were retained for further evaluation. The following building were screened from further analysis based on the absence of significant quantities of radioactive and/or hazardous materials:

- 2904-SA Cooling Water Sampling Building
- 2718-S Sand Filter Sample Building
- 2711-S Stack Gas Monitoring Building
- 2706-S Storage Building (demolished)
- 211-S Liquid Chemical Storage Tank Farms
- 2715-S Storage Building
- 276-S Solvent Handling Building
- 2710-S Nitrogen Storage Building.

3.3.2.3.2 Preliminary Hazard Evaluation. The preliminary hazard evaluation is documented in Appendix A, Table A-2. Three general categories of hazards were evaluated:

- Natural phenomena
- External events
- Operational events.

The results of the preliminary hazard evaluation are summarized below:

- Natural phenomena events
  - Seismic event – Selected as the bounding representative event requiring detailed evaluation.
  - High wind – Represented/bounded by the seismic analysis for the 202-S Canyon Building.
  - Ash and/or snow loading – Represented/bounded by the seismic analysis for the 202-S Canyon Building.
- External events (caused by man-made initiators external to the facility)
  - Aircraft impact – Improbable.
  - Vehicle impact – Low consequence.

- Inadvertent transfer – Low consequence.
- Water intrusion – Low consequence.
- Loss of offsite power – Evaluated as an initiator for loss of confinement.
- Spread of external surface contaminants – Relatively high frequency but low consequence.

- Operational accidents (caused by initiators internal to the facility)
  - Fire – Fire in PR cage selected as bounding representative event requiring detailed evaluation.
  - Loss of confinement – Loss of 202-S Canyon Building exhaust ventilation selected for detailed evaluation based on high frequency.
  - Criticality – Selected for detailed evaluation based on high consequence.
  - Liquid spray release – Activity will require USQ evaluation.
  - Liquid spill to ground – Activity will require USQ evaluation.
  - Container spill – Low consequence.
  - Flammable gas explosion – Improbable.
  - Facility worker exposure to external radiation – Low consequence based on known/suspected dose rates (i.e., would not constitute an immediate casualty).
  - Facility worker uptake of radioactive material – Low consequence based on known/suspected airborne concentrations (i.e., would not constitute an immediate casualty).
  - Facility worker exposure to toxic materials – Low consequences based on known/suspected airborne concentrations (i.e., would not constitute an immediate casualty).

3.3.2.3.3 Detailed Hazard Evaluation. Based on the results of the preliminary hazard evaluation, four hazards were selected for more detailed evaluation: seismic event, loss of ventilation, PR cage fire, and nuclear criticality.

Seismic Event. A seismic event impacting the 202-S Canyon Building was evaluated in the preliminary hazard evaluation tables in Appendix A. The assigned consequence rank is "I" (catastrophic, potentially lethal consequences) and the likelihood rank is "C" (occasional, 10^{-2} per year). Based on the consequence rank and frequency of occurrence, the event was selected for detailed evaluation. Upon further evaluation, including a review of previously performed seismic event analyses, the event was selected for a full accident analysis.

Loss of Ventilation. A loss of 202-S Canyon Building ventilation was evaluated in the preliminary hazard evaluation tables in Appendix A. The assigned consequence rank is "III-3" (unplanned release, releases resulting in insignificant environmental contamination) and the likelihood rank is "A" (frequent, could occur on an annual basis). Based on likelihood rank, the event was selected for detailed evaluation.

The 202-S Canyon Building is the only building in the REDOX Facility with operating ventilation systems. The function of the ventilation systems is to maintain contamination control within the building via air pressure differentials and to filter exhaust air prior to release to the environment.

The principal ventilation system is the 291-S system. This system is normally operated with one of two exhaust fans (i.e., the primary fan, EF-1) on at all times. The primary fan is operated from electrical utility service. The standby fan (EF-2) can be operated either from the electrical utility service or from electrical power supplied by a standby diesel generator. The standby fan is designed to start automatically upon drop of pressure differential in the wind tunnel. The diesel generator starts automatically upon a loss of electric power. The primary fan normally provides 20,000 ft^3/min airflow through the building, and the standby fan is also capable of providing 20,000 ft^3/min airflow through the building. Exhaust air from the 202-S Canyon Building system passes through a sand filter prior to discharge through the fans and out stack 291-S-1. A more detailed description of the 291-S ventilation system is provided in Section 2.0.

A loss of electrical power to the REDOX Facility either from a general Hanford Site-wide or local failure would result in loss of the electrically driven primary exhaust fan. If electrical power is lost, the backup diesel generator automatically starts and supplies power to the standby exhaust fan. The standby exhaust fan is then automatically started to supply exhaust airflow. The diesel generator has a capacity of 180 gal of diesel fuel and can run for approximately 32 hours.

A mechanical failure in one or more ventilation system components could also result in a loss of ventilation. A mechanical failure in the primary fan coupled with a mechanical failure of the control system, diesel generator, or the standby exhaust fan would result in a loss of ventilation. However, multiple independent mechanical failures are less likely than a single failure.

The least likely cause for a loss of ventilation is a loss of institutional control. If the building were abandoned (i.e., lack of maintenance and monitoring), the ventilation system would eventually fail.

Performance Capability. As stated in Section 2.0, the 291-S-1 flow path provides the majority of ventilation for the 202-S Canyon Building and maintains the canyon at approximately -0.35 to -0.45 in. wg pressure with respect to the atmosphere. The galleries and other areas are typically maintained at a slight negative pressure with respect to the atmosphere, thereby controlling the spread of contamination. The wind tunnel differential pressure with respect to the atmosphere is approximately -0.5 in. wg.

These pressure differentials do not meet the standards for confinement established by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE). The ASHRAE standards for confinement systems are provided in the *Heating, Ventilating, and Air Conditioning Design Guide for Department of Energy Nuclear Facilities* (ASHRAE 1993). The ASHRAE recommended differential pressures for secondary confinement areas for canyons and process cells is a minimum of -1.04 in. wg with respect to the environment. It is assumed that the silo falls into the same functional category as the canyon and cells. Although the air enters the canyon via the galleries, no pressure differential monitoring is performed for the galleries and the performance of the system with respect to these areas is unknown.

Operating at a normal airflow rate of 20,000 ft^3/min, the building air is exchanged approximately once per hour (ventilated volume is approximately 1E+06 ft^3). The ASHRAE standard for confinement systems in nuclear facilities (ASHRAE 1993) indicates that a minimum of four air exchanges per hour should be maintained in secondary confinement zones. The air exchange rate maintained by the 291-S ventilation system, in its normal operating condition, does not meet the ASHRAE standard.

While the ventilation system does not provide the differential pressure or air exchange rates indicated by the ASHRAE standard in the canyon and cells, the standard does indicate that this is only a recommended value. The REDOX Facility is no longer an operating facility, and spills and releases into the canyon and cell confinement spaces as a result of process operations no longer occur. During S&M activities, the likelihood of disturbing radiological material in the canyon or cells is minimal, resulting in reduced challenges to the confinement function and differential pressure requirements. In addition, the canyon and cells have been maintained at these differential pressures for roughly 30 years without significant migration of contamination. On this basis, the normal operation of the 291-S ventilation system provides adequate radioactive material confinement.

Hazards. Three concerns are associated with a loss of ventilation in the 202-S Canyon Building: (1) the potential release of contamination from the building, (2) the potential migration of contamination within the building, and (3) the accumulation of radon gas.

To examine the loss of ventilation, a model is required to determine the degree of contaminated air that could be released to the environment. With no ventilation, the contaminated air is unfiltered. A bounding, hypothetical release from the 202-S Canyon Building given a loss of ventilation can be estimated using stack emissions data and adjusting this data for the decontamination factor (DF) of the exhaust filters. Such data have been documented in various reports since 1980 and have been compiled by Adam (1995). To ensure that the estimate is bounding, emission data for two currently inactive stacks (i.e., 296-S-4 and 296-S-6) are included. The data are shown in Table 3-5. The DFs used in Table 3-5 are a direct reflection of the filter efficiency. For high-efficiency particulate air (HEPA) filters, the efficiency is 99.97%, which equates to a DF of 3,000. For the sand filter, the efficiency is 99.95%, which equates to

DF of 2,000. For conservative purposes, a sand filter DF is nominally set at 500 when the concern is emissions; therefore, the DF of 500 for the sand filter is also used in Table 3-5.

The total alpha radiation released for the 291-S-1 stack in 1980 was a factor of 20 greater than the total release for any subsequent year. The total alpha released is likely to have included large contributions from short-lived radon daughters. The bounding doses reported in Table 3-5 for each of the stacks are likely to be a factor of 10 to 1,000 larger than what would be estimated from more recent emissions data.

For the purpose of calculating radiological dose consequences, it is conservative to model the alpha activity as Pu-239 and the beta activity as Sr-90. These isotopes are both present in the building and have the greatest inhalation DCF for those types of radiation. The inhalation DCF for Pu-239 is 330 rem/μCi, and for Sr-90 is 0.23 rem/μCi to prolonged exposure to air. The DCF for Pu-239 is more than three orders of magnitude greater than for Sr-90. Thus, 1.12 Ci of Sr-90 does not significantly contribute to the dose when compared to 0.069 Ci of Pu-239. On this basis, Sr-90 is not considered further.

The calculation uses the inhalation DCF for plutonium oxide rather than plutonium nitrate. Bulk material, which may still be present in nitrate form, is present in equipment, piping, and possibly the PR cage sump; however, none of this bulk material is impacted by this event. The material impacted is surface contamination present in the PR cage and on other surfaces throughout the facility. Because of the length of time that the facility has been in a quiescent state, the surface contamination would have already converted to oxide form due to prolonged exposure to air.

Under loss of ventilation conditions, the motive force for suspension and transport of contamination would be drastically reduced compared to that caused by mechanical ventilation of the building. Even if the motive forces were assumed to remain the same, the release of 0.069 Ci of Pu-239 (0.039 Ci with the lower DF for the sand filter) over the course of a year does not represent the potential for a significant dose consequence. The average release per day would be 1.9E-04 Ci (1.1E-04 Ci for the lower DF).

Based on a conservative analysis (BHI 1998b), a release of 1.9E-04 Ci over a 24-hour period results in a bounding dose consequence of 0.051 rem at 100 m (0.029 rem for the lower DF), and 0.0012 rem at Highway 240 (6.7E-04 rem for the lower DF). These doses are far below any accidental release criteria, including those for the declaration of a SITE AREA Emergency (1 rem at 100 m) and GENERAL Emergency (1 rem at the site boundary).

The value of the atmospheric dispersion coefficient (X/Q) used for the 24-hour-release calculations is conservative because of the length of the release. The value used is applicable to short-duration releases, on the order of 2 hours, and a 24-hour X/Q value would be roughly one-third of the 2-hour X/Q. However, no credit is taken for the smaller X/Q.

An annual release of 0.069 Ci results in a bounding dose consequence of 4.6E-04 rem at the Hanford Site boundary (2.6E-04 rem for the lower DF [BHI 1998b]). These doses are far below the applicable criteria, GENERAL Emergency (1 rem at the site boundary).

The greater dose consequence for the 24-hour release is due to the greater value of X/Q associated with the shorter release duration. The larger X/Q value for the short release is obtained because of the possibility of short-term atmospheric conditions that result in very little mixing of the plume and relatively high concentrations of hazardous materials at receptor locations. Over the course of an entire year, such "spikes" are averaged with very turbulent atmospheric conditions, resulting in the "annual average" X/Q, which is much smaller than the peak, short-term X/Q.

Therefore, the potential releases from the 202-S Canyon Building (given a loss of ventilation) are not significant even for a protracted (greater than 1 year) event. This conclusion is based upon highly conservative assumptions and worst-case scenarios and does not represent a predicted consequence. The standby exhaust fans and backup power supply (diesel generator) are good engineering practices and are prudent to ensure that environmental consequences are maintained ALARA, but are not required from a defensive in-depth or worker-safety perspective. If an exhaust fan is not operating, workers are prohibited from entering the 202-S Canyon Building until appropriate assessment is completed.

The second hazard associated with a loss of ventilation is the migration of contamination within the building. As indicated in the performance capability discussion in this evaluation, the ventilation system in the 202-S Canyon Building does not meet the current ASHRAE standards for nuclear confinement systems for the canyon and cells during normal operations. However, the existing ventilation system and radiological control program ensure worker safety. The radiation control program is relied upon to monitor and evaluate the changing radiological conditions within the building and provide appropriate measures for reducing worker exposures and controlling contamination with the ventilation system, providing a defense-in-depth function.

If a facility worker were allowed to enter and work in the building after an extended ventilation outage without protective equipment, the worker could be exposed to radioactive contamination. The vast majority of the contamination in the building is present in process equipment and piping, as was found to be the case for the contamination in the PR cage. In the PR cage, greater than 99% of the contamination was in piping and equipment and was not subject to migration, regardless of the status of the ventilation system. In the remainder of the 202-S Canyon Building, the same fraction (or greater) of the contamination would be expected to be in piping and process cell equipment.

Although the potential consequences of a loss of ventilation are relatively minor, two differential pressure monitors in the building would detect a loss of ventilation condition. Upon loss of differential pressures, the monitors would automatically initiate an alarm in a central office in the 271-U Building. Radios, telephones, and physical messages could be used to alert any workers in or near the building to the loss-of-ventilation condition.

When the loss of ventilation in the system has been detected, the access control program restricts entry to the building until the specific situation has been evaluated and appropriate compensating measures have been taken. The radiation control program requirements ensure that personnel exposures are maintained ALARA by specifying personal protective equipment requirements and engineered measures (e.g., reactivation of the ventilation system). When ventilation is restored, the radiation control program requires that initial re-entry into the building is monitored by radiation control technicians to identify any changes in the radiological conditions. The radiation control program is sufficient to control worker exposures in the event of a loss of ventilation.

The third hazard associated with a loss of ventilation is the accumulation of naturally occurring radioactive radon gas. Natural ventilation of the building is probably insufficient to prevent an accumulation of radon gas; however, worker exposure to the accumulated radon would fall under the same radiation control program requirements that are applied to prevent worker exposure to a spread of contamination. The radiation control program is sufficient to control worker exposures to radon gas in the event of a loss of ventilation.

The hazards resulting from a loss of ventilation are relatively minor and are adequately controlled by the radiation control program, so no further analysis of this event is necessary.

Product Receiver Cage Fire. A fire involving the combustible loading of the PR cage was evaluated in the preliminary hazard evaluation (Appendix A). The potential fire event assigned consequence rank is "III-2" (unplanned release, releases resulting in minor environmental contamination) and the likelihood rank is "D" (remote, 10^{-4} per year).

A fire involving all combustible loading of the PR cage was postulated to determine if a significant release of radioactive contaminants would occur as a result of vessel or piping damage or HEPA filter failure. Appendix C describes the propagation of the unmitigated postulated fire and concludes that the HEPA filters would not fail as a result of the postulated fire, nor would vessel or piping damage occur. Accordingly, the amount of contaminants that would be subject to release as a result of the postulated fire is limited to the surface contaminants present on the vessels, piping, and polymethyl methacrylate (PMMA) panels of the PR cage.

As shown in Table 3-2, greater than 99% (i.e., 2,149.1 g out of 2,155 g) of the plutonium is confined in lines and vessels. The Sr-90 in the PR cage is assumed to be similarly distributed. This activity is not subject to release because the fire does not compromise the integrity of the lines and vessels.

The remaining inventory, 5.9 g of plutonium and 2.5 Ci of Sr-90, is located within the PR cage sump. The sump inventory is also not subject to release during the fire. The temperature near the floor of the PR cage is 200°F (see Appendix C). Such temperatures are well below the range of temperatures found to cause significant suspension of particles from a heated, noncombustible surface (DOE 1994a). Thus, the sump inventory would not be subject to release during the fire.

The only inventory subject to release during a fire in the PR cage is surface contamination present on the PMMA panels and equipment. Characterization data for the PR cage reported in BHI (1999c) were evaluated in 0200W-US-N0156-02 (BHI 2000d). The data indicate that the alpha activity is not comprised of Pu-239 only. A laboratory analysis of smear sample data for PR cage interior surfaces showed that the highest concentration of Pu-239/240 is 1.62 μCi/100 cm^2, while the concentrations of other isotopes (e.g., Am-241) are, at most, about an order of magnitude less than this value. BHI (2000f) determined that the maximum surface contamination inventory of Pu-239/240 based on the BHI (1999c) data is approximately 0.025 Ci (0.4 g), while the inventories of other isotopes are, at most, about an order of magnitude less than this value. The evaluation in BHI (2000d) indicates that Pu-239, Pu-238, and Am-241 are the only isotopes that could significantly contributed to the dose consequences of a fire involving the PR cage.

For the purposes of this evaluation, it is conservatively assumed that an amount of Pu-239 (oxide) equal to the amount of plutonium in the PR cage sump is present as surface contamination inside the cage and is equally split between the equipment and PMMA panels. The equal split is conservative because the panels are a vertical surface for collection of contamination, while equipment and piping have significant horizontal surface areas. The horizontal surface areas would be expected to collect and retain more contamination than the vertical surfaces, so the bulk of the surface contamination would be expected to be present on equipment and piping.

To better understand the conservatism of the surface contamination inventory assumption, the characterization data and inhalation DCFs of the identified isotopes were evaluated in BHI (2000d). The consequences of the PR cage fire event are dependent on the product of the appropriate DCF and the isotopic inventory. While no isotopes of plutonium, including Pu-238, have a larger inhalation DCF than Pu-239, the inhalation DCF for Am-241 is about 1.6 times larger than the inhalation DCF for the oxide form of Pu-239 (520 rem/μCi versus 330 rem/μCi). Therefore, assuming that all of the surface contamination is Pu-239 (oxide) under-estimates the consequences of the event for that fraction of the material that is Am-241. However, the assumed inventory (5.9 g of Pu-239) is more than an order of magnitude larger than the calculated amount of surface contamination based on the data evaluated in BHI (2000d). Considering the inventory and DCF information qualitatively, it is apparent that it is conservative to use a surface contamination inventory of 5.9 g (0.36 Ci) of Pu-239 (oxide) to determine the consequences of a fire involving the PR cage.

Bulk material, which may still be present in nitrate form, is present in equipment, piping, and possibly the PR cage sump. However, none of the bulk material is impacted by this event. The material impacted is surface contamination present in the PR cage and on other surfaces throughout the facility. Because of the length of time that the facility has been in a quiescent state, the surface contamination would have already converted to oxide form due to prolonged exposure to air.

The inhalation DCF for Sr-90 (0.23 rem/μCi) is approximately three orders of magnitude less than the release mechanism for Pu-239 (330 rem/μCi). Thus, the 2.5 Ci of Sr-90 are negligible compared to the 0.36 Ci of Pu-239 and are neglected for the remainder of this evaluation. Thus, the surface contamination inventory subject to release during the fire is 0.36 Ci of Pu-239, with one-half of the contamination (0.18 Ci) on the PMMA panels and one-half on the equipment and piping.

The release mechanism for the contamination assumed to be present on the PMMA panels is different than the release mechanism for the surface contamination on equipment and piping. The contamination on the panels would become airborne as the fire consumes the panels. DOE

(1994a) indicates that the bounding release fraction combined with the bounding respirable fraction (RF) for this type of release is 5E-02; thus, 9.0E-03 Ci of Pu-239 would be released from the PMMA panels.

The contamination present on equipment and piping would be subject to release due to heating of contaminated, noncombustible, unyielding surfaces in a cross-wind. The upper portions of the PR cage are calculated to reach temperatures for which DOE (1994a) indicates that a bounding release fraction combined with a bounding RF for nonreactive compounds is 6E-05. If the plutonium were assumed to be a reactive compound (e.g., as a nitrate) that oxidizes, the fraction would drop to 1E-05. Applying the higher fraction, 6E-05, to the assumed inventory of contamination on equipment and piping results in a release of 1.1E-05 Ci Pu-239. This result is nearly three orders of magnitude less than the release assumed from the PMMA panels and is neglected for the remainder of this evaluation.

Although fire modeling (Appendix C) concludes that the majority of combustion products would plate-out on the cooler internal surfaces of the sample gallery, the dose consequence calculation assumes that all airborne contamination would be released from the REDOX Facility to the atmosphere. This results in a bounding consequence of 2.4 rem at 100 m and 5.4E-2 rem at Highway 240.

Inside the building, the 9.0 E-03 Ci of Pu-239 would create an airborne radiation hazard in addition to the spread of nonrespirable contamination. The potential doses to facility workers, however, would be low for the following reasons:

- The initial contamination spread would likely be contained within the PR cage and, after burn-through occurs, the combustion products would plate-out on the cooler surfaces of the north sample gallery, with lesser spread down the sample passage and even less contamination reaching the regulated shop, decontamination room, and remote shop.

- The 291-S ventilation system would continue to ventilate the north sample gallery, reducing the airborne concentration over time.

- Re-entry to the building following the fire would fall under the radiation control program that would specify personal protection requirements for workers entering suspected contamination areas.

As noted in the REDOX FHA (Appendix D), heat detectors are located in portions of the 202-S Canyon Building; however, these sensors would not detect the presence of the postulated fire because of the distances involved. It is extremely unlikely that personnel entry would be planned for the north sample gallery, decontamination room, remote shop, or the canyon during or shortly after the fire. The active ventilation systems would continue to operate, reducing the airborne concentrations of the contamination. Although extremely unlikely, if the fire were not detected and a facility worker did enter the north sample gallery without proper protective equipment, 9.0E-03 Ci of Pu-239 spread out over the north sample gallery does not represent the threat of serious injury or death.

Because the release from the facility is minor and the potential consequences to a facility worker are small, no additional analysis of this event is warranted. The programmatic controls relied upon to provide radiation protection for facility workers are adequate to control this hazard.

Deflagration. A test and safety evaluation (BHI 1999d) verified the presence of hexone vapors in the 276-S-141 and 126-S-142 tanks. The residuals from the deactivation (WHC 1992) were found to have the potential for a deflagration event should a spark or static discharge occur in either of the tanks. The worst-case postulated consequences are summarized in Table 3-6 (see BHI 2000e for additional detail).

The nitrogen purge system (with minimal upgrades [BHI 2000e]), administrative procedures, and an administrative technical safety requirements (TSRs) ensure that a deflagration event is precluded until the tanks are eventually decontaminated and closed.

Nuclear Criticality. An accidental nuclear criticality in the 202-S Canyon Building, 291-S Exhaust Building sand filter, and 292-S Control and Jet Pit House Building was evaluated in the preliminary hazard evaluation tables in Appendix A. The assigned consequence rank is "I" (catastrophic, potentially lethal consequences) and the likelihood rank is "E" (improbable, 10^{-6} per year). Based on the consequence rank and the fact that the likelihood rank is contingent upon administrative controls, the event was selected for detailed evaluation. The double contingency requires that process design incorporates sufficient safety factors to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible. This normally keeps the probability of occurrence not credible, regardless of the fissionable material form, quantity, or distribution particularly when placed in context of S&M activities. Even though engineering judgment deems the event to be improbable, precautions are instituted to protect these judgments. To preserve/validate the assumptions regarding the estimated inventory in the PR cage, limits controlling moderation/reflection/ relocation are provided. Access control, engineering procedures, and USQ process are used to control the remaining areas of concern.

The 202-S Canyon Building was shut down and decontaminated in 1967. In 1969, the building was placed in surplus status. No further analysis or characterization of the inventory of fissionable material was conducted until 1996. During this time period, facility classification and activity planning were based on assumptions for residual fissionable material that ranged from something greater than 177 g (Oberg 1979) to 24.5 kg of Pu-239 (1,500 Ci). In 1996/1997, a detailed fissionable material characterization was conducted of selected systems and components in the north and south sample galleries. The results of the 1996/1997 characterization are summarized in Table 3-2. No estimate of fissionable material holdup was made for systems or components inside the 202-S canyon and silo or 292-S.

202-S Canyon and Silo

The 202-S canyon and silo are addressed in *REDOX Plant and Exhaust System – S&M*, 0200W-CE-N0011 (BHI 2001a). No information is available at this time regarding the form, quantity, or distribution of potential fissionable material accumulations in these areas. Hence, radiological measurements and characterization of the fissionable material present is the first priority but must be performed in ways that do not compromise criticality safety. If at any time the quantity present in a single cell or neutronically separate area appears that it may exceed the subcritical mass limit thresholds in BHI-DE-01, *Design Engineering Procedures Manual*, EDPI 4.35-01, Exhibit D, the evaluation must be revised before the following actions can be initiated or continued:

1. Changing quantity or distribution of fissionable material

2. Changing moderation (e.g., by adding or removing liquids such as water)

3. Adding significant amounts of neutron reflectors (e.g., heavy metals, concrete, or hydrogenous materials).

Activities such as personnel entry into a canyon cell or silo processing area (including unlimited work around or in contact with vessels or equipment), obtaining smears (including smears from external surfaces of vessels or equipment) and samples, or similar activities are not restricted by criticality safety concerns. Field verification consists of neutron and/or gamma NDA measurements that are sufficient to estimate quantities and distributions of fissionable materials. Such NDA is permitted if shielding and support materials, which can provide significant neutron reflection, are kept at least 10 cm from vessels and components potentially containing fissionable material. This paragraph also applies to the 291-S exhaust system and sand filter and the 292-S Control and Jet Pit House Building (discussed in this section).

PR Cage and Sample Galleries

The PR cage and the transfer and drain lines in the sample galleries are addressed in BHI 2000e and BHI (2001a), respectively. With the exception of the PR cage (containing the E-16 pre-concentrator and tower, and the E-17 concentrator and tower), the fissionable material quantities and distributions in the north and south sample galleries are below levels that require controls for criticality safety. The S&M activities associated with, or in proximity to, components containing insignificant quantities of plutonium may be conducted with no criticality restrictions. Personnel entry into the PR cage is permitted to perform NDA measurements and obtain smear samples. Direct NDA neutron and gamma measurements are permitted. Heavy metal reflectors beyond those needed to support the NDA equipment are not permitted within 10 cm of the exterior surfaces of the E-16 pre-concentrator and its tower, the E-17 concentrator and its tower, or the sump. It has been determined based on measurements completed on vessels and piping inside the PR cage, that the PR cage should be posted with a category "C" fire-fighting symbol (BHI 2001a).

291-S Exhaust System and Sand Filter

The 291-S sand filter, wind tunnel, and 291-S stack are addressed in BHI (2001a), which presents the initial field verification requirements. Table 3-1 lists an estimate of 340 Ci alpha (5,600 g of Pu-239) in the 291-S sand filter. Although this value was not known when the criticality evaluation (BHI 2001a) was prepared, the field verification requirements in BHI (2001a) still remain the same. Any proposed activity potentially involving the sand filter, wind tunnel, or stack duct shall be based on a plan that includes a requirement for preliminary radiological field verification measurements and further criticality safety evaluation in accordance with BHI (2001a).

292-S Control and Jet Pit House Building

There have been no criticality assessments of the 292-S Control and Jet Pit House Building and no preliminary criticality evaluation because nothing of significance is anticipated. Because the drain-seal tank and sump collect liquids from areas where fissionable material is known or is suspect to be present (e.g., the sand filter), the potential occurrence of a criticality cannot be ruled out. Currently there are no fissionable material inventory data for the drain-seal tank or sump. Based on operational knowledge, the quantity of fissionable material is anticipated to be relatively small (e.g., on the order of grams). Conditions within the pit are subcritical, but water in the pit provides neutron moderation and the concrete pit walls provide reflection.

The S&M activities do not have the potential to increase the fissionable material inventory in the drain-seal tank or the sump or to alter the geometry of fissionable material currently present. Any proposed intrusive activity involving materials inside the drain-seal tank or sump must be based on a plan that includes a requirement for preliminary radiological field verification measurements and criticality safety evaluation.

3.3.2.3.4 Planned Design and Operational Safety Improvements. Certain operational and administrative safety improvements have been identified for S&M activities. The improvements include the following:

- Control of transient combustibles with 202-S Canyon Building
- Structural inspection procedures following notification of seismic event.

These improvements will be reflected and implemented in S&M activity procedures with 60 days of approval of this SAR.

3.3.2.3.5 Defense-in-Depth. This subsection discusses the role of defense-in-depth in the REDOX Facility as identified by the hazard evaluation.

The first line of defense-in-depth for the confinement of radioactive materials in the 202-S Canyon Building is the process piping and vessels (primary confinement) in which the majority of radioactive materials reside. Piping and vessels have been left intact after deactivation activities (draining and flushing). As a result, these systems protect the worker from direct contact with the residual contamination. Although process vessels and piping are not assumed to survive a seismic event, these systems would provide some limited containment function in the event of earthquake damage to the facility.

The shielded silos, sample galleries, and canyon cells provide another layer of defense-in-depth against the release of radioactive materials and protect workers from contact with radioactive materials and direct radiation exposure. The canyon cells and cover blocks are designed to survive the evaluation basis seismic event and will remain intact to provide a containment function during this event. These structures also work in combination with the 202-S ventilation system to prevent the spread of airborne radioactivity within the building, protecting workers in occupied areas.

The final layer of defense-in-depth against the release of radioactive materials is the 202-S Canyon Building itself. The sealed building design (with airlock doors) in combination with the 202-S ventilation system maintains a negative pressure differential between the building and the environment. This prevents the release of airborne radioactive materials outside the 202-S Canyon Building. The building structure also provides a final barrier against direct radiation exposure outside the building. If an earthquake occurs, building emergency evacuation plans are in place to minimize worker exposure to any radioactive materials released.

Defense-in-depth for an internal spread of contamination within the 202-S Canyon Building resulting from a ventilation outage is provided by standby exhaust fan that can be automatically supplied with power from a diesel generator upon loss of normal power.

The defense-in-depth barriers against fire hazards are described in detail in the FHA (Appendix D). These barriers include automatic fire alarms, fire evacuation procedures, and a fire suppression system. The fire suppression system consists of raw water sources from fire hydrants outside the building and hand-held fire extinguishers at various locations inside the building. The primary barrier against flooding of the sand filter and a resulting spread of radioactive material is the water-proof weather cover over the sand filter.

The 276-S-141 and 276-S-142 hexone tanks contain residual hexone products that are determined to be potentially flammable. Defense-in-depth protection required for the tanks includes (1) controlling access to minimize inadvertent entry, (2) implementing work controls for a flammable environment (including hot work permits, as necessary), and (3) limiting oxygen concentrations in the tanks.

3.3.2.3.6 Worker Safety. This subsection identifies the controls that are in place to protect workers from hazards identified during the hazard evaluation. Many of the worker safety protection measures have previously been discussed and are repeated here for convenience.

As previously discussed, the piping and vessels containing radioactive materials, the canyon cells, cover blocks, and ventilation system act to protect facility workers from both direct radiation exposure and airborne radioactive contamination. In addition, radiation protection procedures limit worker access and activities on the canyon floor. Ventilation systems must be operable to access any portion of the 202-S Canyon Building.

In the event of an earthquake, building emergency evacuation plans are in place to minimize worker exposure to any radioactive materials released.

Workers are protected against an internal spread of contamination within the 202-S Canyon Building resulting from a ventilation outage by a standby exhaust fan, which is supplied power by a diesel generator equipped with auto-start for a normal power outage.

Workers are protected from the asbestos hazard in the 202-S Canyon Building galleries by stabilization measures that were carried out during the asbestos abatement program. Other programmatic protection is afforded by limiting worker activities in areas posted as potential asbestos hazards.

Workers are protected from fire hazards by automatic fire alarms, fire evacuation procedures, and a fire suppression system. Other programmatic controls for worker safety are discussed in Sections 6.0 through 17.0.

3.3.2.4 Environmental Protection. This subsection discusses the controls that are in place to protect the environment from contamination by toxic materials or radioactive materials.

As previously discussed, the sealed building design (with airlock doors) in combination with the 202-S ventilation system prevents the release of airborne radioactive materials outside the 202-S Canyon Building.

3.3.2.4.1 Accident Selection. Events selected for detailed hazard evaluation were further reviewed to determine which, if any, warranted detailed accident analysis. A qualitative ranking process was used that factored in both the consequence and likelihood ranking, consistent with the example provided in Table 3-5 of DOE (1994b). Consideration was given to the performance of accident analyses for both nuclear criticality and a seismic event based on their assigned consequence ranking (i.e., "I", catastrophic). Criticality was not selected for accident analysis because of its extremely low probability of occurrence (i.e., a likelihood ranking of "E," remote). A seismic event was selected based on its potential high severity and probability of occurrence (i.e., a likelihood ranking of "C," occasional).

3.4 ACCIDENT ANALYSIS

3.4.1 Methodology

The radiological consequences of an accident to receptors located downwind from a facility are a function of the source term, the DCF, and the X/Q.

The source term is a function of the inventory of radioactive material within the facility. Not all hazards will involve the total inventory of a facility. The source term is the product of the material at risk (MAR), the airborne release fraction (ARF), and the RF:

Source term = MAR x ARF x RF.

The MAR is the amount of material available to be acted on by accident-induced physical stresses such as temperature and pressure. The ARF is the coefficient used to estimate the amount of material suspended in air as an aerosol (thus, available for transport) by the physical stresses of a specific accident. The RF is the fraction of the airborne particles that can be transported through air and inhaled into the pulmonary region of the respiratory system and includes particles having a 10-micron aerodynamic equivalent diameter or less (DOE 1994a).

The GENII computer code (Napier et al. 1988) was used to calculate the DCFs. The source term for a given accident was entered into the code. This analysis assumes that the beta inventory consists entirely of Sr-90 and that the alpha inventory consists entirely of Pu-239. This assumption maximizes the consequences of airborne releases from the REDOX Facility. Two exposure pathways, inhalation and submersion in a semi-infinite cloud, were included in the calculation. The acute release option was selected, forcing the code to use a breathing rate of 3.3E-4 m^3/sec. A value of 1 was entered for the X/Q. The result from the GENII computer code is the committed effective dose equivalent (CEDE) per X/Q in units of rem/(sec/m^3).

The X/Q is a function of the atmospheric conditions assumed to exist at the time of the accident. It represents the dilution of an airborne contaminant caused by atmospheric turbulence resulting from wind speed and atmospheric stability conditions. The computer code GXQ (WHC 1994a) was used to calculate X/Q values at distances of 30 m, 100 m, 300 m, and at the site boundary (5.2 km west of the facility). Both 99.5% sector-dependent and 95% sector-independent X/Qs were calculated and the largest was selected in accordance with guidance contained in *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants* (NRC 1982). The MACCS virtual-source building wake model was also applied. Using this model with a release height of zero allows the use of an area-source release rather than a point-source release. The X/Q values are presented in Table 3-7.

Multiplying the DCF by a given X/Q yields the CEDE to a given receptor (in units of rem). Dose calculations for REDOX Facility accident analyses are documented in calculations 0200W-CA-N0002 (BHI 1998b) and 0200W-CA-N0015 (BHI 2000b).

3.4.2 Evaluation Basis Accidents

3.4.2.1 Seismic Event. A structural study of the 202-S Canyon Building concluded that the building could withstand seismic events up to a peak ground acceleration of 0.03g (WHC 1991). As discussed in Section 2.4.1, the likely failure mode of the building would be a collapse of the roof onto the canyon structures. BHI prepared a separate assessment of the resistance of the canyon structure to seismic loading. The failure point was found to be 0.054g, which confirmed that the canyon roof structure is likely to fail (Carrato 1997). A release of hazardous materials is expected to occur as a result of this failure.

3.4.2.1.1 Scenario Development. Based on the probabilistic seismic hazard analysis for the Hanford Site (WHC 1993), the 200 West Area has seismic loading criteria for a PC3 structure (e.g., the REDOX Facility) of 0.188g (horizontal) and 0.122g (vertical). Because the failure point for the canyon roof structure has been determined to be 0.054g (Carrato 1997), it is postulated that the canyon roof collapses as a result of a seismic event. A structural analysis of the concrete process cell cover blocks (BHI 1996) determined that the blocks could withstand the impact of roof debris without failure. A subsequent analysis showed that the cover blocks would withstand the impact of roof debris even under seismic loading conditions (BHI 1997f). An additional analysis (BHI 1999b) showed that the north gallery structure would survive a seismic event with peak ground accelerations of 0.188g (horizontal) and 0.122g (vertical).

The PR cage is adequately protected against the combined effects of seismic forces and potential load drops resulting from seismic forces. Consequently, as a result of the seismic event, only a fraction of the contamination present on facility and equipment surfaces will become airborne.

3.4.2.1.2 Source Term Analysis. For a seismic event, the entire 202-S Canyon Building inventory is potentially available for suspension and release. The building inventory, exclusive of the sample galleries, is 1,500 Ci of plutonium and 9,000 Ci of beta emitters (see Table 3-1).

The distribution of this activity inside the building has not been characterized. Based on the discussion in Section 2.4.1 of this SAR (i.e., likely failure of the canyon roof), for conservatism it is assumed that all the inventory is located in the Canyon Building, railroad tunnel, and process cells, piping, and equipment. Further based on engineering judgment, existing radiation surveys, and discussions with the REDOX Facility operating personnel, the vast majority of the source is thought to be present inside process equipment and piping located within the process cells. This material is not available for suspension and release, given the fact that the process cell cover blocks remain in place. Thus, the material that is available for suspension and release is that present as contamination on surfaces external to the process cells. It is estimated that the MAR is 0.1% of the total building inventory (Smith 1996).

In addition to the 202-S Canyon Building, proper consideration was given to the inventory that is potentially present as surface contamination in the railroad tunnel. It is estimated that the MAR is also 0.1% of the total building inventory.

Based on characterization data, 140 Ci of Pu and 840 Ci of beta emitters are present in the sample galleries, primarily within the PR cage located in the north sample gallery (see Section 3.3.2.1.1). Equipment and piping in the sample galleries are protected from damage (BHI 1999b). The sample gallery inventory is, therefore, not considered to be at risk (BHI 2000e). Table 3-8 summarizes the MAR.

The releasable respirable inventory is determined by multiplying the MAR by the appropriate ARF and RF. These values were determined from the DOE-HDBK-0013-93 (DOE 1993). For walls, surfaces, and the railroad tunnel, the collapse of the roof would cause suspension of surface contamination by free-fall and direct impact. For this case, the DOE handbook (DOE 1993) states that the release of surface contamination is bounded by the material impact and shock vibration case. The DOE handbook (DOE 1993) provides the following bounding values for impact/shock vibration for noncombustible materials that do not undergo brittle fraction:

$$ARF = 0.001$$

$$RF = 1.0$$

The releasable respirable inventory for the seismic event is summarized in Table 3-9. The values in Table 3-9 are judged to be conservative for the following reasons:

- Because of the massive amounts of debris from the fallen roof, it would be expected that there would be significant plate-out of airborne material. In addition, the debris itself will provide some confinement of the disturbed activity.
- The ARF and RF values used above are bounding; mean values could be an order of magnitude or more lower.
- The analysis examples in Section 7.3.10.3 of DOE (1994a) determine that tightly bound surface contamination is unlikely to be released by seismic forces.

These conservatisms are not readily quantified; however, it is evident that there is a substantial level of conservatism in this assessment. Therefore, it is reasonable to conclude that the evaluation of the scenario is truly bounding.

3.4.2.1.3 Consequence Analysis. The radiological consequences of a seismic event were calculated in accordance with the methodology described in Section 3.4.1. The CEDE calculated in BHI (1998b) at the distances of interest are as follows:

CEDE at 30 m	=	74 rem
CEDE at 100 m	=	13 rem
CEDE at 300 m	=	2.2 rem
CEDE at site boundary	=	0.023 rem.

3.4.2.1.4 Summary of Safety-Class Structures, Systems, and Components and Technical Safety Requirements Controls. There are no safety-class SSCs. The process cell walls and cover blocks significantly protect onsite workers from the consequences of a seismic event. If the cell covers were removed, the MAR would increase from 3 Ci to an upper bound of 1,503 Ci of Pu-239. This would result in potential doses in excess of 1,000 rem at 100 m.

Table 3-1. REDOX Facility Radiological Inventory.

Facility/Areas	Inventory	Source Document	Remarks
202-S Canyon Building, silo, railroad tunnel, and process cells, piping, and equipment	1,500 Ci alpha (24,500 g of Pu-239) 9,000 Ci beta (64 g of Sr-90) Assumed distributed about the facility	RHO (1982)	Based on historical published data, the basis of which is unknown. Estimated that greater than 99% of the inventory is located in the process cells, piping, and equipment (see Section 3.4.2.1.2). Assumption is that all alpha is Pu-239/240 and all beta is Sr-90.
202-S north sample gallery	140 Ci of Pu-239 (2,155 g of Pu-239) 840 Ci of Sr-90 (6.0 g of Sr-90)	BHI (1997d)	See Table 3-2.
291-S sand filter	340 Ci alpha (5,600 g of Pu-239) 8,000 Ci beta (57 g of Sr-90)	BHI (1998a)	Estimated inventory based on stack emission data and an assumed sand filter efficiency of 99.95%.

Table 3-2. Fissionable Material in the 202-S Canyon Building Sample Galleries.

Component	Plutonium Inventory (g)	Pu-239 Inventory (Ci)
H-4 transfer line (488 ft)	45.4	0.049
E-3 to L-12 transfer line (29 ft)	0.8	0.05
233-S floor drain line (26 ft)	2.0	0.12
233-S pipe trench line (10 ft)	0.6	0.04
PR cage sump (6 in. by 6 in. by 6 in.)	5.9	0.36
E-16 pre-concentrator	1,450	88.9
E-17 concentrator	650	40
Total	2,155	132.1[a]

Source: BHI 1997d; uncertainty is approximately ±10% (one sigma).
[a] Assumed to be 140 Ci of Pu-239 in this SAR (for the sake of conservatism).

Table 3-3. Occurrence Reporting and Processing System Database Results.[a] (2 Pages)

Location	Discovery Date	Description
202-S Canyon Building	07/13/92	RL-WHC-WHC200ERD-1992-0006 An over-current fault on B and C phases that resulted in a loss of power to the 202-S Building for 11 hours. Although ventilation was lost during this period, there was no loss of contamination control. The event was attributed to defective equipment and inadequate maintenance of the breakers and protective relays.
	03/11/96	RL-BHI-DND-1996-0006 During decontamination, material was found on a flange in the sample hood area of the REDOX Facility. Smear surveys indicated 10 million dpm alpha, and the potential for criticality and leakage of material from the flange into a sample box was identified. Subsequently, the facility was placed in lock-down status and an unusual occurrence was declared. DOE, WHC, and BHI criticality staff were consulted and additional investigative activities were defined and performed. The activities included (1) visual observation that liquids were not accumulating; (2) high-efficiency gamma-ray measurements using robotics (that concluded less than one-third of a critical mass was present); (3) visual inspection of the interior of the sample box confirming that leakage was not occurring; and (4) thermal imaging and ultrasonic transducer examinations that confirmed that no liquid material was present in the line. The direct, root, and contributing causes were attributed to legacy contamination resulting from inadequate 1967 deactivation flushing.
	05/07/96	RL-BHI-GENEREAS-1996-0003 The installation of remote monitoring and control equipment at the REDOX Facility was temporarily suspended based on discussions with DOE concerning the BHI approach to hazard classification. DOE provided subsequent written guidance on hazard classification and follow-up actions for BHI, and installation of the remote monitoring equipment was resumed.
291-S Exhaust Fan Building	05/20/96	RL-BHI-DND-1996-0014 A mechanical failure of exhaust fan EF-1 resulted in the auto-start of EF-2 powered by the backup diesel generator. Twenty-nine hours later, the backup diesel generator ran out of fuel, which resulted in shutdown of EF-2 and loss of the main exhaust ventilation system for the REDOX Facility for approximately 2 days. Operations were suspended until ventilation was restored. No spread of contamination resulted from the loss of ventilation. The event was attributed to mechanical failure of equipment and failure to provide adequate fuel supply or surveillance for weekend operation.
202-S Canyon Building	9/25/96	RL-BHI-DND-1996-0020 Portions of the REDOX Facility lost negative differential pressure when a supply fan was started with the dampers full open. There was no spread of contamination. The event was attributed to personnel error resulting from lack of safety basis documentation for the ventilation system. The supply fan capacity exceeds the exhaust fan capacity.

Table 3-3. Occurrence Reporting and Processing System Database Results.[a] (2 Pages)

Location	Discovery Date	Description
202-S Canyon Building	09/27/96	RL-DND-1996-0022 The REDOX Facility was not designed nor analyzed to current seismic criteria. Seismic studies have concluded that the roof would collapse during a seismic event with a ground acceleration of >0.054g but that the process cell cover blocks would protect the deactivated process equipment. The cause is attributed to inadequate design criteria during construction in the 1950s. Because some cell cover blocks are off, the cover blocks will be placed back on appropriate cells.
276-S-141 and 276-S-142	10/14/97	RL-BHI-DND-1997-0022 Sample results of the hexone tanks confirmed the presence of acetone, which was not identified in earlier records. Although the sample concentrations were well below the lower flammability limit, the potential exists for previously unidentified gases in the tanks and uncertainties regarding the distribution of gases in the vapor space. It is believed that the nitrogen purge can be removed. Additional samples are to be taken.
202-S D cell	1982	NON-ORPS REPORT Low-level RLW was to be transferred from the 222-S Building to the tank farm via D cell. Because of personnel error, the jumpers were not properly aligned, the RLW overflowed tanks D-10 and D-13, and about 900 gal of fission product waste were discharged into D cell. This RLW overflow has been removed from the floor of the cell, however, RLW still remains in the tanks (D-10 = 1,420 gal and D-13 = 5,560 gal). The liquid levels of these tanks are routinely monitored.

[a] This table contains a summary of significant occurrences affecting the REDOX Facility. Minor occurrences, such as clothing contamination, are not included.
dpm = disintegrations per minute
RLW = radioactive liquid waste
WHC = Westinghouse Hanford Company

Table 3-4. REDOX Facility Hazards Summary. (2 Pages)

Facility[a]	Representative Hazards	Included in Hazards Evaluation Tables?	Basis for Yes/No for Inclusion in Hazards Evaluation Tables
202-S Canyon Building (all areas [e.g., process cells, galleries, and column laydown trench])	Radioactive material, direct radiation, fissionable material, flammable material, explosive material, reactive material, kinetic material	Yes	Building contains significant inventories of radioactive materials.
291-S Exhaust Fan Building (including sand filter and 291-S-1 stack)	Radioactive material, fissionable material, hazardous material (asbestos), flammable material, reactive material	Yes	Contaminants are present in small amounts (minor contamination inside fans). Potential significant quantities of radioactive materials present in sand filter.

Table 3-4. REDOX Facility Hazards Summary. (2 Pages)

Facility[a]	Representative Hazards	Included in Hazards Evaluation Tables?	Basis for Yes/No for Inclusion in Hazards Evaluation Tables
292-S Control and Jet Pit House	Radioactive material, hazardous material (asbestos), reactive material	Yes	Liquid wastes drawn from highly contaminated areas: wind tunnel and sand filter condensate.
2904-SA Cooling Water Sample Building (including below-grade weir)	Radioactive material	No	Very small quantities of radioactive/hazardous material.
293-S Nitric Acid Recovery and Iodine Backup Building	Radioactive, toxic material	Yes	Radioactive material inventory present in scrubber/absorption column and piping.
2711-S Stack Gas Monitoring Building	Radioactive material	No	Very small quantities of material present.
2715-S Storage Building	None	No	Contains only industrial hazards.
2718-S Sand Filter Sample Building	Radioactive material	No	Very small quantities of material present.
2706-S Storage Building (demolished)	Hazardous material, reactive material	No	Industrial type hazards.
276-S Solvent Handling Building	Radioactive material	No	Contaminants are present in small amounts (chemical residuals and minor surface contamination).
276-S hexone tanks	Residual encrusted radioactive material, toxic material, flammable material	Yes	Tanks drained and flushed. Very small quantities of radioactive material (BHI 1999d).
211-S liquid chemical storage tank farm	Radioactive material, reactive material, flammable material	No	Contaminants are present in small amounts (chemical residuals and minor surface contamination).
2710-S Nitrogen Gas Preparation Building	None	No	Contains only industrial hazards.

[a] All facilities have the potential for the following hazards: carcinogen, biohazard, and kinetic energy.

Table 3-5. Summation of Stack Releases.

Stack 296-S-2, HEPA Filter Year of the Largest Release: 1981					
Original Annual Release			**Decontamination Factor of 3,000**		
Alpha (Ci)		**Beta (Ci)**	**Alpha (Ci)**		**Beta (Ci)**
5 E-07		5 E-06	1.5 E-03		1.5 E-02
Stack 296-S-4 (Deactivated), HEPA Filter Year of the Largest Release: 1980					
2 E-06		2 E-05	6 E-03		6 E-02
Stack 296-S-6 (Deactivated), HEPA Filter Year of the Largest Release: 1980					
7 E-06		8 E-05	2.1 E-02		2.4 E-01
Stack 291-S-1, Sand Filter Year of the Largest Release: 1980					
Original Annual Release		**Decontamination Factor of 500**		**Decontamination Factor of 2,000**	
Alpha (Ci)	**Beta (Ci)**	**Alpha (Ci)**	**Beta (Ci)**	**Alpha (Ci)**	**Beta (Ci)**
2 E-05	4 E-04	0.01	0.2	0.04	0.8
Total Release					
Decontamination Factor of 500			**Decontamination Factor of 2,000**		
Alpha (Ci)		**Beta (Ci)**	**Alpha (Ci)**		**Beta (Ci)**
0.039		0.52	0.069		1.12

Source: Adam (1995)

Table 3-6. Hexone Tank Deflagration Consequences.

Distance (m)	Wind Speed (m/sec)	Continuous χ/Q (sec/m^3)	Puff χ/Q (sec/m^3)	Dose (rem)	Peak Concentration (ppm)
30	8.90E-01	2.69E-01	2.31E-01	2.8E+00	7.8E-01
100	8.90E-01	3.41E-02	9.85E-03	3.5E-01	3.3E-02
5,200 Highway 240	8.90E-01	6.07E-05	5.00E-07	6.3E-04	1.7E-06

ppm = parts per million

Table 3-7. Maximum Atmospheric Dispersion Coefficients.

Receptor Location	Atmospheric Dispersion Coefficient, X/Q (sec/m^3)
30 m, east	1.6E-1
100 m, east	2.8E-2
300 m, east	4.8E-3
5.2 km, west (site boundary)	5.0E-5

Table 3-8. Material in 202-S Canyon Building at Risk for a Seismic Event.

REDOX Area	% of Total Inventory[a]	Comments	Isotope	Curies
Walls and surfaces	0.1%	Surfaces have all been flushed and decontaminated	Sr-90	9
			Pu-239	1.5
Railroad tunnel	0.1%	High plutonium solutions not normally handled in the railroad tunnel	Sr-90	9
			Pu-239	1.5
		Total	Sr-90	18
			Pu-239	3

[a] Percentage of total excluding sample gallery inventory.

Table 3-9. Respirable Inventory Released from the 202-S Canyon Building During a Seismic Event.

Isotope	Walls and Surfaces, Ci (g)	Railroad Tunnel, Ci (g)	Total, Ci (g)
Sr-90	0.009	0.009	0.018
Pu-239	0.0015 (0.025)	0.0015 (0.025)	0.003 0.050

Figure 3-1. REDOX Hazard Evaluation Screening Matrix.a

Likelihood	CONSEQUENCE					
	Catastrophic I	Severe II	Unplanned Release III			Minor IV
			1	2	3	
A - Frequent						
B - Probable						
C - Occasional						
D - Remote						
E - Improbable						

[a] Shaded cells denote level at which further screening is performed.

4.0 SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS

4.1 INTRODUCTION

The REDOX Facility uses a graded approach to identify SSCs that maintain or perform safety functions. This graded approach results in selected applications of functional requirements to engineered features.

Safety SSCs are divided into two categories: safety-class SSCs and safety-significant SSCs. Safety-class SSCs prevent or mitigate releases that would otherwise result in a dose of 25 rem to a member of the public. The designation of safety-significant SSCs is based on worker safety and is limited to those SSCs whose failure is estimated to result in worker fatality or serious injuries to workers.

4.2 REQUIREMENTS

The design codes, standards, and regulations for REDOX Facility safety SSCs are those that existed at the time that the individual safety SSCs were designed, fabricated, and installed and reflect the prevailing health, safety, and environmental requirements of that time. Most of these design requirements were not documented. Requirements applicable to the S&M activities performed in the REDOX Facility are discussed in Sections 6.0 through 17.0 of this SAR.

4.3 SAFETY-CLASS STRUCTURES, SYSTEMS, AND COMPONENTS

Based on the results of the hazard and accident analyses presented in Section 3.0, there are no safety-class SSCs associated with the REDOX Facility.

4.4 SAFETY-SIGNIFICANT STRUCTURES, SYSTEMS, AND COMPONENTS

Based on the radiological consequences of a seismic event (see Section 3.0, Section 3.4.2.1.3), the north gallery structure, process cell walls, and cover blocks are designated as safety-significant structures.

4.4.1 Process Cell Walls and Cover Blocks

4.4.1.1 Safety Function. The process cell walls and cover blocks serve to protect the inventory of radioactive material contained within the process cells in the event of a seismic event.

4.4.1.2 System Description. The nine process cells arranged in two parallel rows (see Section 2.0, Figure 2-6). The walls of the cells are constructed of 2-ft-thick concrete. These walls are an integral part of the 202-S Canyon Building structure.

Removable cover blocks cover each process cell. The cover blocks are constructed of reinforced concrete. The cover blocks' design allowed for remote removal and repair or replacement of failed process equipment during former REDOX Facility operations. An electrically driven, 60-ton-capacity overhead railway crane located in the canyon was used to lift and replace the cover blocks.

Currently all cover blocks are in place over their respective process cells. The S&M activities do not require the removal of cover blocks or provide for maintenance of the 60-ton crane. Electrical power is isolated at MCC-1.

4.4.1.3 Functional Requirements. The process cell cover blocks shall remain in place.

4.4.1.4 System Evaluation. Seismic analysis (WHC 1991, Carrato 1997) has concluded that the thin wall sections below the canyon roof structures and adjacent to the crane rails are a weak design. The analysis concluded that the walls may be below standard building codes that were applicable during the facility design, as well as current commercial (Uniform Building Code) and DOE standards. Though detailed analysis does not exist, professional judgment indicates that the roof structures could collapse from a relatively low-energy earthquake. The likely structural consequences would be limited to the canyon roof and related structures falling onto the canyon deck. It is not likely that the canyon walls, north silo, or north and south galleries would respond in catastrophic collapse.

Load-drop analysis has concluded that the cover blocks would survive the falling roof panels, thereby protecting the suspected inventory of radiological contamination below the cell covers. Consequently, the accident analysis presented in Section 3.0 concludes that the cell cover blocks provide a significantly passive barrier for the suspected inventories. Adequate protection is provided through the USQ process for facility modifications because the cover blocks cannot be removed without extraordinary measures, including reactivating the crane (in accordance with the *Hanford Site Hoisting and Rigging Manual* [DOE-RL 1996a]) and hiring and training certified crane operators, and because the crane is expressly excluded from the current authorization scope.

However, from a defense-in-depth perspective, it is important to note the administrative commitments made by BHI staff related to the canyon roof structure. BHI committed to perform inspections of the canyon roof should potentially damaging earthquakes occur. RL has committed to notify BHI when such an event requires inspection. This defense-in-depth commitment is summarized in Section 5.0 and detailed in Appendix E.

4.4.1.5 Controls. The seismic event accident analysis assumes that the cover blocks are in place. The controls for protecting this assumption are developed in Section 5.0 and Appendix E.

4.4.2 North Gallery Structure

The north gallery structures protect residual contaminant in the north sample gallery (i.e., PR cage and process piping) from the impacts of the evaluation basis earthquake. As a passive barrier, the structures require no specific controls (BHI 2000a). Integrity of the north gallery structure is adequately protected by the programmatic commitments for S&M operations, as defined in Section 2.5. Evaluation of the north gallery structure is consistent with a graded approach. No further evaluation is necessary.

4.5 OTHER EQUIPMENT

4.5.1 Systems, Structures, and Components Important to Safety

Based upon defense-in-depth concerns and worker safety issues, additional SSCs are deemed by BHI management to be important to safety. Equipment important to safety is a graded approach to classifying SSCs and is used to designate SSCs that do not meet the criteria to be classified as safety-significant. However, these SSCs are still relied upon to provide an additional margin of safety to workers or defense-in-depth for hazardous material confinement that affords additional protection to the environment and the public. Changes and modifications to these SSCs shall be afforded a USQ evaluation to ensure that the safety basis is not compromised.

- 202-S Canyon Building, 291-Exhaust Fan Building (sand filter), 292-S Control and Jet Pit House, and 291-S-1 stack
- 202-S Canyon Building structure including primary (e.g., process cells and piping, silo core) and secondary confinement systems
- 202-S heating, ventilation, and air conditioning system, including exhaust fans, sand filter, and instrumentation and controls (which includes monitors, alarms, and two differential pressure alarms)
- Standby diesel generator, ATS, battery starter, and instrumentation and controls (which includes monitors and alarms)
- Fire detection system
- Stack effluent monitoring equipment
- Electrical power distribution system
- Standby air compressor
- 60-ton overhead crane (prior to use)
- Nitrogen purge for the 276-S-141 and 276-S-142 hexone tanks.

4.5.2 Industrial Structures

The remaining structures within the REDOX Facility (i.e., those not cited in Section 4.5.1) are considered industrial structures because they do not contain hazardous material or amounts of hazardous material below reportable quantities, as defined in 40 CFR 302. These structures, listed below, are exempt from USQ evaluation unless the change involves increases in inventory of hazardous materials.

- 2904-SA Cooling Water Sampling Building
- 2711-S Stack Gas Monitoring Building
- 2715-S Storage Building
- 2718-S Sand Filter Sample Building
- 2706-S Storage Building (demolished)
- 2708-S Lagger Storage Building
- 276-S Solvent Handling Building
- 211-S Liquid Chemical Storage Tank Farm
- 2710-S Nitrogen Gas Preparation Building.

5.0 DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

5.1 INTRODUCTION

The TSRs define acceptable conditions, safe boundaries, and management or administrative controls that ensure safe operation of a nuclear facility and reduce the potential risk to the public and onsite workers from uncontrolled releases of radioactive or toxicological material or from radiation exposures caused by inadvertent criticality.

This section provides information sufficient to support the derivation of TSRs and identifies safety-significant passive design features. The REDOX Facility TSRs are documented in Appendix E.

5.2 REQUIREMENTS

The primary requirements specific for this section are included in DOE Orders 5480.22 and 5480.23. Requirements applicable to the S&M activities performed in the REDOX Facility are discussed in Sections 6.0 through 17.0 of this SAR.

5.3 TECHNICAL SAFETY REQUIREMENT COVERAGE

The REDOX Facility TSRs were selected based on information contained in Sections 3.0 and 4.0, which discusses the evaluation process for selecting TSRs based on the magnitude of the uncontrolled release.

1. Release greater than/equal to safety class.

   As stated in Section 4.0, there are no safety-class SSCs at the REDOX Facility.

2. Release greater than/equal to safety significant.

   As stated in Section 4.0, the 202-S Canyon Building process cell walls and cover blocks have been designated as safety significant. The cover blocks in place is an assumed initial condition of the safety analysis. Because the cover blocks are passive components and because there are no equipment failures or operator errors associated with S&M activities that could result in inadvertent removal, the cover blocks are more appropriately addressed as a design feature (see Section 5.6). Removal of the cover blocks would require a USQ evaluation.

3. Defense-in-depth (i.e., release less than safety significant).

   Bauer (1998) requires an evaluation of the hazard and accident analyses to define any release that requires or has preventive or mitigative SSCs not already identified as either safety class or safety significant. These important-to-safety SSCs have been discussed in detail in Section 4.5.

Bauer (1998) also defines two conditions under which an inventory control TSR is required. These conditions relate to the following: (1) verification of assumptions regarding contaminant characteristics as related to worker protection programs, and (2) hazards and accident analyses based on limited inventory of hazardous materials. As the REDOX Facility meets neither of these conditions, an inventory control TSR is not required.

DOE Order 5480.22, Section 9.e(5), states that administrative controls shall be established for reporting deviations from TSRs, staffing requirements for positions important to safety, and criticality safety. For the REDOX Facility, administrative controls have been developed for reporting deviations and criticality safety (see Section 5.5). An administrative control has not been developed for staffing requirements, as no positions important to safety have been identified. Although failure to perform S&M activities due to inadequate staffing would result in a gradual degradation of radiological conditions inside (and potentially outside) the REDOX Facility, no operational events have been identified that would result in safety-significant consequences.

5.4 DERIVATION OF FACILITY MODES

Based on the scope of activities authorized by this SAR (see Section 2.5), there is one facility mode (i.e., normal operations), defined as follows:

Normal Operations: S&M activities, as defined in Section 2.5, are being performed. The radioactive material inventory meets or exceeds the hazard category 3 threshold, as defined in DOE-STD-1027-92 (DOE 1997a).

5.5 TECHNICAL SAFETY REQUIREMENT DERIVATION

There are no safety limits, limiting control settings, or limiting conditions of operation TSRs for the REDOX Facility. The following sections provide the basis and necessary information for the derivation of administrative control TSRs.

5.5.1 202-S Canyon Building Exhaust Ventilation System

The 202-S Canyon Building exhaust ventilation system is a defense-in-depth system credited in the hazard evaluation. Refer to Sections 2.6 and 2.9 for a description of the ventilation system and Section 3.3.2.3 for a detailed hazard evaluation of the system.

Establishing an administrative TSR for the exhaust ventilation system protects the following four key hazard evaluation assumptions.

1. The building is maintained at a negative air pressure relative to the environment.

2. The process cells are maintained at a negative air pressure relative to the galleries.
3. Exhaust air is filtered.
4. Protect workers from potential radiological exposures when the exhaust fans are not operating.

The hazards evaluation credits operation of one 291-S exhauster with maintaining the negative air pressure differential. A second 291-S exhaust fan is credited as a backup. The 291-S sand filter is credited with filtering exhaust air prior to release to the environment.

5.5.2 Nuclear Criticality Safety

A nuclear criticality is considered to be an improbable event given S&M activities. However, due to the potential consequences of a criticality, a detailed hazard evaluation was performed (see Section 3.3.2.3).

Establishing an administrative control for criticality safety protects the hazard evaluation assumption that other than S&M activities at locations of concern (e.g., the PR cage) are not performed prior to fissionable material characterization, the performance of criticality evaluations (as required based on the characterization), and the establishment of controls.

5.5.3 Control of Transient Fire Loading

The fire hazard evaluation of the fire in the PR cage takes credit for limited combustibles to support a fire. In addition, the fire detection system is limited and the ability to suppress a large conflagration is also limited. Although the FHA does not identify any adverse impact to other important safety SSCs, BHI management has committed to maintaining the amount of transient combustibles within the 202-S Canyon Building ALARA.

5.5.4 Seismic Evaluation

Seismic analyses have predicted the potential structural degradation of the roof to the 202-S Canyon Building from an earthquake measuring as low as 0.03g. BHI management has made a commitment to RL to conduct a structural inspection and produce an inspection report within 30 days from notification by RL that such an event has occurred.

5.5.5 Stack Monitor

Activities that increase the potential for elevated radioactive releases to the environment require the stack record sampler to be operating. Work plans that involve evolutions within the pipe and air tunnels, process cells, process piping and vessels, silo, sand filter, exhaust duct, and stack have a increased potential for disturbing the radioactive contaminants and creating a release to the environment. The hazard evaluation predicts these potential releases to be well below any environmental reporting requirements; however, BHI management has made a commitment to monitor any such release and, therefore, requires the stack record sampler to be operating during activities that create a potential for elevated releases.

5.5.6 Cell Cover Block

The accident analysis assumes that the cell cover blocks are in place during a seismic event and, as a result, this condition limits the consequences of the postulated accident. For this assumption to remain valid, removal of the cell cover blocks is prohibited.

5.5.7 Nitrogen Purge System

Analysis has concluded that a nitrogen purge system is required to ensure that the 276-S-141 and 276-S-142 hexone storage tanks and associated charcoal absorption canisters are provided with an inert atmosphere. A nitrogen supply with monitoring capabilities is provided to ensure tank safety.

5.6 DESIGN FEATURES

The process cell walls and cover blocks are safety-significant components credited in the seismic event accident analysis. Refer to Section 4.4 for a description of the cover blocks.

Based on the passive nature of the process cell walls and cover blocks, they are designated as design features. Design features are passive facility features that, if altered or modified, would have a significant effect on safe operation. Designation of the cover blocks as design features protects the accident analysis assumption that the cover blocks are in place. The absence of the cover blocks would significantly increase the quantity of radioactive material released given the occurrence of a seismic event.

Design features are best managed by standard engineering and configuration control practices. Changes to design features are considered significant modifications. The USQ process ensures that changes to design features are appropriately analyzed and controlled so the changes do not adversely affect safe operation of the facility.

5.7 INTERFACE WITH TECHNICAL SAFETY REQUIREMENTS FROM OTHER FACILITIES

The REDOX Facility interfaces physically and administratively with other Hanford facilities/programs. The interfaces include utilities (i.e., water and electrical power), fire protection (i.e., the Hanford Fire Department), emergency preparedness (i.e., DOE-RL 1999), and waste material transfers (e.g., shipment of waste to the Environmental Restoration Disposal Facility and/or the Central Waste Complex). There are no utility, fire protection, or emergency preparedness interface requirements that affect the REDOX Facility safety basis. There are no TSRs at Hanford Site waste management facilities that affect the REDOX Facility safety basis.

6.0 PREVENTION OF INADVERTENT CRITICALITY

This section provides the graded summary for criticality safety that is applicable to the REDOX Facility under the S&M mission.

6.1 INTRODUCTION

Fissile material in the REDOX Facility is limited in the form of residual contamination in the deactivated process components. As indicated in the safety analysis and reference criticality evaluation (Section 3.0), the potential for criticality is improbable. While there are criticality safety precautions related to future characterization and potentially for decommissioning, there are no criticality safety controls and/or safety systems applicable to the REDOX Facility under the S&M program.

6.2 REQUIREMENTS

Criticality safety is an integral part of the BHI nuclear safety program and approved ISMS. A DOE-approved criticality program is documented in *Bechtel Hanford, Inc. Criticality Safety Program* (BHI 2000a) defines the approved process for the implementation of the contractual requirements of DOE O 420.1, *Facility Safety*. The BHI nuclear safety program approves applicable criticality precautions and specific requirements as applicable to work activities. Policies and procedures governing this subject are maintained in controlled procedure manual and are available on the Bechtel local area network (BLAN). The Surveillance/Maintenance and Transition (S/M&T) Project administrates health and safety programs in accordance with the BHI and facility programs and procedures.

Qualified USQ evaluators screen work packages for potential impacts of planned changes and potential discoveries. As applicable these changes and discoveries are evaluated against the criticality safety analysis and specific criticality safety evaluation that are applicable to the facility (see Section 3.0 for details). Should change conditions have the potential to impact the assumption basis of the criticality evaluation or require potentially intrusive action in restricted areas the criticality safety specialist will evaluate the change condition. Changes will be approved and implemented as required by the approved criticality safety program and approved USQ process.

7.0 RADIATION PROTECTION

This section provides a graded outline of the radiation protection program administered by the S/M&T Project.

7.1 INTRODUCTION

The DOE-approved radiation protection program provides essential services and expertise necessary to ensure the radiological safety of personnel who work in the facility. The technical content of this section provides an overview of the radiation protection program, the requirements that apply to the program, and the minimum program elements necessary to maintain a safe radiological work environment by S&M personnel.

7.2 REQUIREMENTS

All activities performed at REDOX Facility are subject to the requirements of 10 CFR 835, "Occupational Radiation Protection." Approved changes to 10 CFR 835, as published in the *Federal Register*, are applicable to REDOX Facility in accordance with the implementation processes and implementation schedules allowed by DOE and as specified in 10 CFR 835. The approved radiation protection program is provided by controlled manual BHI-RC-01, *Radiation Protection Program Manual*. Procedures that implement specific requirements are also documented in controlled manual are implemented by the radiological protection staff that are assigned to the project as required by work control processes that are defined in the approved ISMS process (BHI 2000c). The controlled manuals are maintained and are available on the BLAN. The Project line management administrates health and safety programs in accordance with the Project Hanford Management System (PHMS) and facility programs and procedures. The controlled manuals that implement the requirements of the approved radiation protection program are maintained by the BHI radiation protection function, including the following:

- BHI-RC-02, *Radiation Protection Procedures*
- BHI-RC-03, *Radiological Control Procedures*
- BHI-RC-04, *Radiological Control Work Instructions*
- BHI-RC-05, *Radiological Instrumentation Instructions*
- BHI-RC-06, *Environmental Radiological Instructions.*

7.3 RADIATION PROTECTION PROGRAM AND ORGANIZATION

Services provided by the approved radiological protection program included, but are not limited to, the following:

- Radiological surveillance
- Radiological work monitoring

- Work place air monitoring
- Radiological access control
- Field dosimetry administration
- Radiological work permit (RWP) preparation
- Radiological work planning reviews.

The radiation protection manager administrates the radiation protection program that may serve several facilities simultaneously. The radiation protection manager is responsible for ensuring that the radiation protection program meets the required technical criteria. The radiological protection manager has direct access to the senior facility manager.

Radiation protection supervisors provide direction and guidance to radiological control technicians (RCTs). Supervisors are primarily responsible for enforcing radiological requirements/procedures, reviewing radiological survey data, and maintaining radiation protection logs/records. The number of radiological control supervisors allocated to the facility is subject to facility needs, as determined by the radiological control manager and facility line management.

The RCTs perform radiological surveillance activities, provide radiological access control, and provide radiological work monitoring. In addition, RCTs provide work practice guidance to field crews. The RCTs have direct access to the radiation protection manager and are responsible for exercising immediate stop-work authority as necessary to enforce requirements and/or ensure personnel safety. The number of radiological control supervisors allocated to the facility is subject to facility needs, as determined by the radiological control manager and facility line management.

Qualification criteria for the radiological control manager, radiological control supervisors, and RCTs are specified within the radiological protection program. Qualification programs for RCTs include classroom and applied training commensurate with 10 CFR 835.

7.4 AS LOW AS REASONABLY ACHIEVABLE POLICY AND PROGRAM

The ALARA policy for BHI is as follows:

> *There should not be any occupational exposure of workers to ionizing radiation without the expectation of an overall benefit from the activity causing the exposure.*

The ALARA program and procedures implement the mechanisms required by 10 CFR 835 and are documented in program manuals. The Radiological Control organization screens radiological work for ALARA purposes and contributes technical support to the work planning process.

7.5 RADIOLOGICAL PROTECTION TRAINING

Training programs for general employees, radiological workers, and RCTs are governed by 10 CFR 835 that are defined in applicable program manuals.

All general employees with access to controlled areas are trained in radiation safety prior to receiving occupational exposure. Knowledge of radiation safety by general employees is verified by examination. Retraining is provided when there is a significant change to radiation protection policies and procedures that affect general employees and is conducted at intervals not to exceed 2 years.

Radiological worker training programs and retraining are established and conducted at intervals not to exceed 2 years to familiarize the worker with the fundamentals of radiation protection and the ALARA process. Training includes both classroom and applied training. Knowledge of radiation safety possessed by radiological workers is verified by examination prior to assigning workers to perform radiological work.

Training for RCTs is established and conducted to familiarize the technicians with the fundamentals of radiation protection and the proper procedures for maintaining exposures ALARA. The training program includes both classroom and applied training and precedes performance of tasks assigned to RCTs. The required level of knowledge of radiation safety possessed by RCTs is verified by examination to include demonstration prior to unsupervised work assignments. Training documentation clearly identifies the individual's name, date of training, and topics covered.

7.6 RADIATION EXPOSURE CONTROL

Occupational exposures are maintained ALARA by limiting access to the major radiological source terms at the facility. The major source term is comprised of radioactive materials/systems located that is confined in the deactivated process components. Entries into the cells, if required, and adjacent surveillance areas are evaluated in advance for ALARA considerations, and exposure control measures are incorporated into job-specific work instructions.

Removable contamination is controlled in accordance applicable requirements that include, but are not limited to, the following:

- Decontamination efforts (where/when practical)
- Radiological posting and clearly designated physical boundaries surrounding contamination areas and high contamination areas
- Radiological work instructions designed to prevent the spread of contamination
- Radiological surveillance of work areas.

Minimization and control of internal exposure is achieved through the following:

- Engineering controls, including control of radioactive material at the source (wherever practical)
- Administrative controls, including access restrictions and the use of specific work practices designed to minimize exposures.

When engineering and administrative controls have been applied and the potential for airborne radioactivity still exists, respiratory protection is used to limit internal exposures.

7.7 ADMINISTRATIVE LIMITS

The objective of applicable administrative limits is to maintain personnel radiation exposure well below regulatory dose limits. This objective is facilitated by administrative control levels that are established below the regulatory limits. The control levels are multi-tiered, with increasing levels of authority required to approve higher administrative control levels. Administrative control levels are established separately for total effective dose equivalents, skin and extremity, lens of the eye, organs other than the lens of the eye, and gestation periods. Numerical values for each administrative control level and specific requirements for the application of administrative control levels are specified in applicable program manuals.

7.8 RADIOLOGICAL PRACTICES

Maintenance and modification plans and procedures are reviewed to identify and incorporate radiological requirements such as engineering controls, dose reduction considerations, and contamination reduction considerations. The review of radiological work is performed by line management, with support and concurrence from the Radiological Control organization. Work procedures and/or RWPs specify the types and amount of respiratory protection equipment, protective clothing, and shielding necessary to complete activities in accordance with ALARA practices.

Radiological posting, labeling, and radiological boundary control criteria are specified in the controlled manuals of the radiological protection program. In general, radiological areas are classified according to the degree and nature of the radiological hazards present. Entry and exit control are established in accordance with applicable requirements and are commensurate with the degree of risk associated with the area(s) to be entered.

The RWP is an administrative mechanism used to establish radiological controls for work activities. The RWP informs the workers of area radiological conditions and entry requirements and provides a mechanism to relate work exposure to specific work activities. Specific criteria for RWP content, including stay times and access control requirements, are specified in applicable radiological protection program manuals.

7.9 DOSIMETRY

Dosimetry is required for personnel when one or more of the following conditions apply:

- An expected annual external whole body dose greater than 100 mrem
- An expected annual dose to the extremities, organs and other tissues greater than 10% of the corresponding administrative control limits specified by the *Hanford Site Radiological Control Manual* (HSRCM) (DOE-RL 1996b)
- Declaration of pregnancy and an expected external dose equivalent of 50 mrem or more during the gestation period.

The types of dosimetry that may be used at the REDOX Facility, depending upon specific radiological conditions, include the following:

- Hanford standard dosimeters
- Pocket and electronic dosimeters
- Extremity dosimeters, including finger rings and/or thermoluminescent dosimeters.

Job-specific dosimetry is issued by the Radiological Control organization as part of the access control process. Job-specific dosimetry requirements are documented on the applicable RWPs and are based on the radiological hazards associated with planned work. Upon completion of work activities, personnel return job-specific dosimetry to the Radiological Control organization. The Radiological Control organization reads the dosimetry and enters the dosimetry readings into approved access control data management systems.

7.10 RESPIRATORY PROTECTION

Respiratory protection equipment includes respirators with particulate or gas-filtering cartridges, supplied-air respirators, self-contained breathing apparatus and air line supplied-air suits and hoods. The most common type of respirators used are air-purifying respirators. Other types of respirators may be issued as conditions dictate.

Respirators are issued only to personnel who are trained, fitted, and medically qualified to wear the specific type of respirator. Positive controls are maintained for the issue, use, and return of respirators to ensure that only qualified personnel wear respirators. Documentation of the positive controls is specified by procedures that are written in compliance with applicable requirements.

Training and qualification testing for personnel who wear respirators is performed annually. The training is contracted to site service organizations that have obtained DOE approval to conduct these training programs.

7.11 RADIATION MONITORING

Radiological monitoring of dose rates, contamination levels, and airborne radioactivity levels is performed by RCTs in accordance with program requirement that are applicable to facility, area, and specific work. Areas of the REDOX Facility that are not routinely occupied may be surveyed upon entry if routine radiological surveillance is not practical or ALARA.

Radiological Control maintains records of radiological monitoring results and affiliated trend analysis. Radiological anomalies identified by the Radiological Control organization are reported to line management for resolution. The Radiological Control organization provides recommendations for the resolution of radiological anomalies and performs radiation surveys to verify the effectiveness of corrective actions.

7.12 RADIOLOGICAL INSTRUMENTATION

Radiological instrumentation includes a variety of portable and semi-portable instruments designed to detect the types and energies of radiation present. The instrument descriptions provided in this section are intended to provide an overview of the radiological instrumentation typically available to RCTs. These descriptions are not intended to restrict the number or types of instruments selected by the Radiological Control organization or to necessarily imply that the instruments described below are required for all activities performed at the facility.

Portable radiological instrumentation includes, but is not limited to, the following:

- RO-20 rate meters
- Micro-rem meters
- Geiger-Muller counters
- Portable alpha meters.

The REDOX Facility is deactivated and is not normally occupied; therefore, there are no fixed-building occupational radiation protection instruments (i.e., area monitors or air monitors) in service. Should specific tasks require, air monitoring instrumentation will be provided as dictated by requirements and ALARA practices.

Maintenance and calibration of radiological instrumentation are compliant with DOE-approved maintenance/calibration programs. Field source checks and function checks (performed by RCTs and instrument technicians) are performed and documented in accordance with approved procedures.

7.13 RADIOLOGICAL PROTECTION RECORDKEEPING

Radiological control records are maintained as necessary to document compliance with the requirements of 10 CFR 835. Recordkeeping standards are specified and administrated in accordance with the records retention criteria of DOE Order 1324.2A, *Records Disposition*. The

Radiological Control organization provides records management services for records directly applicable to occupational radiation protection.

7.14 OCCUPATIONAL RADIATION EXPOSURES

The REDOX Facility is a deactivated facility that is rarely occupied. Most entries into the REDOX Facility are restricted to surveillance activities where dose rates average less than 0.5 mrem/hr. Annual collective exposure for personnel performing S&M activities is expected to be at or below 50 mrem.

8.0 HAZARDOUS MATERIAL PROTECTION

This section provides a graded description the essential requirements of the hazardous material protection program as it relates to the S&M of the REDOX Facility.

8.1 INTRODUCTION

In the operational mode of long-term S&M, the REDOX Facility is a deactivated facility with limited potential for hazardous material exposure to workers. There is no active hazardous material storage, process utilization, or disposal activities under long-term S&M. Anticipated discharges to the environment are limited in scope to radiological discharge for the canyon exhaust system. Hazardous substance of an incidental nature may be used in decontamination and maintenance activities.

8.2 REQUIREMENTS

Requirements for worker protection from hazardous material are provisions within the BHI safety and health program. Regulatory requirements of 10 CFR 29, "Occupational Safety and Heath Standards," and contractual order requirements of DOE Order 5483.1A, *OSHA for DOE Contractor Employees at GOCO Facilities*, and DOE Order 5480. 4, *Environmental Protection, Safety, and Health Protection Standards*, are defined in controlled manuals and are implemented consistent with the approved ISMS process (BHI 2000c).

Policies and procedures that govern this subject are maintained on the BLAN and include the following:

- BHI-SH-01, *ERC Safety and Health Program*
- BHI-SH-02, *Safety and Health Procedures*.

8.3 HAZARDOUS MATERIAL PROTECTION AND ORGANIZATION

Chemical processing does not occur during the S&M phase of the facility's mission. Known chemicals have been removed or stabilized. If unexpected chemicals are found during the S&M phase, removal, stabilization, or treatment may be performed.

Industrial hygienist support is provided by staffing on the project and through functional support. The Industrial Hygiene staff are responsible for evaluating potential hygiene hazards, identifying appropriate monitoring procedures to ensure compliance with all pertinent exposure limits, and ensuring that areas with such hazards are properly posted and access is appropriately controlled.

The S/M&T personnel are responsible for safe facility operation. The project organization fulfills its responsibilities by applying ALARA and safety awareness programs to minimize hazards exposure, increase health and safety awareness, alert personnel to known hazards, and recognize positive safety performance. The project organizational structure is described in Section 17.0.

8.4 AS LOW AS REASONABLY ACHIEVABLE POLICY AND PROGRAM

The radiological ALARA program principles (see Section 7.4) are applied to hazardous material activities.

8.5 HAZARDOUS MATERIAL TRAINING

The safety training program consists of courses in general safety awareness, radiological safety, and hazardous materials and waste. Employees who routinely work with hazardous chemicals or materials and/or who may come into contact with hazardous material during a foreseeable emergency receive general classroom training (i.e., hazard communication and waste management awareness training), as well as facility and job-specific hazard training.

9.0 RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

This section provides a graded outline of the radioactive and hazardous waste management program administered by the S/M&T Project. Waste management requirements during S&M activities at the REDOX Facility relate to management and disposal of the multiple types and small quantities of materials generated from routine S&M activities. These activities involve handling and dispositioning waste generated from small-scale cleanup, spill cleanup, and housekeeping activities (i.e., there are no routine waste streams).

9.1 INTRODUCTION

Waste management requirements directly related to the S&M scope of work are limited. The scope of waste management activities is generally limited to maintenance of the confinement system and housekeeping activities. Consequently, generation of waste streams from areas of significant radiation is outside the routine S&M scope of work.

9.2 REQUIREMENTS

Waste management requirements for hazardous (classified by Washington State as "dangerous") and radioactive mixed waste are primarily derived from the WAC, which is generally more stringent than the comparable Federal standards. DOE O 435.1, *Radioactive Waste Management*, is used as the applicable standard for radioactive and mixed waste under the provisions of the *Atomic Energy Act of 1954*. Federal standards are used for PCBs and asbestos waste.

Applicable BHI policies and procedures that govern this subject are listed below and are maintained on the BLAN.

- BHI-EE-02, *Environmental Requirements*
- BHI-EE-10, *Waste Management Plan*
- BHI-SH-01, *ERC Safety and Health Program*
- BHI-MA-02, *ERC Project Procedures*.

9.3 RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT PROGRAM AND ORGANIZATION

Field personnel conduct waste management activities in accordance with the following:

- BHI-MA-02 defines the responsibilities for waste management personnel.

- BHI-EE-10, *Waste Management Plan*, discusses designation, packaging, labeling, transporting, and disposition of wastes.

- BHI-MA-02, *ERC Project Procedures*, contains the detailed steps to be used in the waste management process.

The S/M&T personnel are responsible for safe facility operations. The REDOX Facility organization fulfills its responsibility by applying the requirements (as presented above) to day-to-day operations that includes routine S&M. The REDOX Facility organization is described in Section 17.0.

9.4 RADIOACTIVE AND HAZARDOUS WASTE STREAMS AND SOURCES

The REDOX Facility is a deactivated surplus facility with the majority of hazardous materials consisting of fairly adherent films and residues in deactivated equipment and systems. Consequently, activities involve handling and dispositioning waste generated from small-scale cleanup, spill cleanup, and housekeeping activities. Various NDA and sampling techniques may be used to characterize potential hazardous substances encountered or anticipated during S&M activities. Materials and determination methods are handled on a job-specific basis. The potential regulated wastes include the following:

- Heavy metals (e.g., lead and mercury)
- Light bulbs
- Radioactively contaminated rainwater
- Contaminated oils
- Fuels
- Miscellaneous chemicals
- Miscellaneous liquids
- Asbestos
- PCBs.

10.0 IN-SERVICE SURVEILLANCE AND MAINTENANCE

This section provides a graded summary of the testing, and in-service S&M programs and procedures designed and implemented to support defense-in-depth protection of the workers, onsite personnel, the public, and the environment.

10.1 INTRODUCTION

The in-service S&M program is required to ensure that any unfavorable conditions or trends are promptly recognized and evaluated so appropriate action can be taken. The S&M program provides preventative maintenance and demand maintenance to ensure that the hazardous substances that remain in the building are confined by the building and retired process components. This work is accomplished by the implementation of procedural requirements that are maintained in controlled manuals.

Procedures are used to control the methods for performing and documenting applicable S&M activities. Maintenance activities focus on confining contamination to minimize release and exposure potential.

10.2 REQUIREMENTS

The requirements that are implemented and define the S&M program include the following:

- DOE Order 4330.4B, *Maintenance Management Program*
- *Hanford Site Hoisting and Rigging Manual* (DOE-RL 1996a).

Applicable BHI policies and procedures that govern this subject are listed below and are maintained on the BLAN.

- BHI-FS-01, Vol. 1, *Field Support Administration*
- BHI-FS-02, *Field Support Work Instructions*
- BHI-MA-01, *ERC Policies, Organization, and Responsibilities*
- BHI-MA-02, *ERC Project Procedures*
- BHI-SH-01, *ERC Safety and Health Program*
- DOE-approved *ERC Maintenance Implementation Plan* (BHI 1997c)
- *Program Plan for Surveillance and Maintenance* (BHI 1998c).

10.3 INITIAL TESTING PROGRAM

Because the facility was deactivated prior the assumption of S&M and because no facility modifications are planned for the REDOX Facility, initial testing is not applicable to the REDOX Facility.

10.4 IN-SERVICE SURVEILLANCE AND MAINTENANCE PROGRAMS

All activities conducted at the REDOX Facility are part of the facility's S&M activities. This SAR is the key documentation of all S&M activities conducted within the facility. The S&M project manager and line staff are responsible for ensuring that S&M activities conducted within the REDOX Facility follow BHI procedures and the commitments made in this SAR.

Procedures are used to control the methods for performing and documenting S&M. Maintenance activities focus on maintaining the confinement of contamination so a release of contaminants will not reasonably occur. Maintenance activities are tailored to building age, condition, remaining useful life, and environmental and safety factors.

The in-service surveillance program is required to ensure that any unfavorable conditions or trends are promptly recognized and evaluated so appropriate action can be taken. The maintenance program is to perform preventative maintenance and accomplish work tasks identified during the surveillance activities that are within the bounds of the safety basis. The S&M program requirements are specified in BHI-FS-01 (Vol. 1) and BHI-FS-02. Programmatic safety and health requirements that are to be implemented as applicable by specific tasks and work packages. These requirements are found in BHI-SH-01. A requirement for line implementation, which includes ISMS integration, is found in BHI-MA-01. The work is performed using approved work plans and procedures, as directed in BHI-MA-02. A DOE-approved maintenance implementation plan is provided in BHI (1997c). Typical changes to the maintenance implementation plan and programmatic procedures will occur and do not require USQ evaluation. Specific work packages are reviewed as required by USQ requirements.

11.0 OPERATIONAL SAFETY

This section presents a graded summary of the aspects of CONOPS and fire safety by the use of programmatic controls associated with the REDOX Facility's S&M activities. Programmatic controls are designed to ensure worker safety and to protect workers from hazardous substances. Programmatic controls also govern S&M activities necessary to maintain confinement of contaminants and prevent releases to the environment. Implementation of the applicable requirements is consistent with the commitments provided in the approved *Integrated Environment Safety and Health Management System Description* (BHI 2000c).

11.1 INTRODUCTION

BHI conducts all operations, including S&M activities, by integrating environment, safety, and health system into procedures and specific work packages. Integrating and implementing ISMS is the responsibility of all functional managers and project line management. The functions primarily establish programs and procedures that define applicable requirements of the regulations and other contract requirements. The project manager and line staff implement the policies and procedures that are applicable to the facility and specific work task.

The conduct of S&M activities is also guided by a specific CONOPS agreement that was approved by DOE. This agreement, in conjunction with the ISMS, serves the purpose of ensuring a high level of performance with no significant environmental, safety, or health impact to facility activities.

11.2 REQUIREMENTS

Applicable regulatory and contractual requirements pertaining to operational safety include the following:

- 29 CFR 1910, "Occupational Safety and Health Standards"
- 29 CFR 1926, "Safety and Health Regulations for Construction"
- NFPA 101, *Life Safety Code*
- NFPA 1, *National Fire Code*
- DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*
- DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards*
- DOE O 420.1, *Facility Safety*
- RLID 420.1, *Fire Protection.*

Specific requirements for CONOPS and fire protection are discussed in the respective sections below. Policies and procedures that govern these subjects are maintained on the BLAN and include the following:

- BHI-FS-01, Vol. 1, *Field Support Administration*
- BHI-MA-01, *ERC Policies, Organization, and Responsibilities*
- BHI-SH-01, *ERC Safety and Health Program*
- BHI-SH-02, *Safety and Health Procedures*
- 000X-PMII-G0001, *Surveillance/Maintenance and Transition Project, Project Manager's Implementing Instructions* (BHI 2000g).

11.3 CONDUCT OF OPERATIONS

The CONOPS graded approach applicability matrix (DOE-RL 1997b) serves the purpose of ensuring a high level of performance with no significant environmental, safety, and/or health impact from facility S&M activities. The matrix identifies and implements DOE Order 5480.19, *Conduct of Operations for DOE Facilities*, which contains guidelines applicable during S&M until final disposition of the REDOX Facility. The document was prepared by BHI for submittal to DOE for review and approval.

The CONOPS for S&M activities is documented in 000X-PMII-G0001 (BHI 2000g). DOE provided approval of the applicable CONOPS requirements (BHI 1997). A graded approach to CONOPS and was approved by RL in 1997 (DOE-RL 1997). The matrices integrate a graded approach into the S&M matrix and identify both the applicable elements of DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*, for S&M activities and the implementing documents for these activities. Review and approval of changes to the Environmental Restoration Contractor (ERC) CONOPS program and matrix do not require a USQ evaluation.

11.4 FIRE PROTECTION

The REDOX Facility is a deactivated building that is occupied only during periodic surveillance and for maintenance needs. Fire loading is minimal and few ignition sources exist. There are no active building fire alarms or suppression systems, and a pre-fire plan has been prepared. Table D-3 identifies the location and the fire detection/alarm capabilities (e.g., heat detectors and pull boxes) within the facility. The FHA in Appendix B provides an evaluation of fire hazards, combustible loading, ignition sources, and fire analysis for the building. Project-specific commitments for fire protection are described in the FHA in Appendix B of this SAR.

12.0 PROCEDURES AND TRAINING

This section presents a graded summary of the programs related to development, verification, and validation of procedures and training associated with the deactivated REDOX Facility S&M activities. These programs ensure that procedures are adequate for application and that personnel are trained appropriate to the required work.

12.1 WORK CONTROL PROCESS

The S&M activities are controlled by approved work packages and procedures consistent with the approved *Integrated Environmental, Safety, and Health Management System Description* (BHI 2000c). Activity-specific work packages implement applicable regulatory and contractual requirements that are defined in BHI program policy and procedure manuals.

The work control process is organized into three types of jobs: (1) routine work, (2) scheduled maintenance work request, and (3) demand work request. Facility-specific task instructions are used, as appropriate, to accomplish each task. Routine work is repetitive, familiar, has a low potential risk of exposing workers to unusual hazards, and does not require a work package or specific procedures. Work packages, when required, identify the scope of work and safety and radiological requirements for the work to be performed. The need for a job hazard analysis (JHA) is considered in the planning of each work package. The packages are reviewed by project functional representatives (e.g., Design Engineering, Field Engineering, Safety and Health, Radiological Controls, and qualified USQ evaluators) to ensure that requirements and documentation are appropriate for the work to be performed.

A scheduled maintenance work request is generated for each scheduled or preventive activity. The scheduled maintenance work request process uses task instructions to direct fixed-cycle activities. The task instructions are reviewed to ensure that safety and health hazards and appropriate controls are addressed.

A demand work request is generated for a non-routine activity. Non-routine activities include, for example, new designs, design changes, corrective maintenance actions, deactivation actions, and system isolations. A JHA is considered in the planning of each work package.

Training requirements specific to the REDOX Facility are specified in controlled documents. The requirements are based on (1) the employee's position, (2) the hazards to which the employee will be exposed, and (3) project-specific training that is identified by the project manager (or designee).

12.2 REQUIREMENTS

Contractual requirements pertaining to procedures and training include the following DOE requirements:

- DOE Order 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*
- DEAR 970.5204-02, "Integration of Environment, Safety, and Health into Work Planning and Execution" (DOE 1997b).

Applicable BHI policies and procedures that guide the implementation of the various requirements that apply to BHI S&M activities are listed below and are maintained on the BLAN.

- BHI-HR-02, *ERC Training Procedures*
- BHI-MA-02, *ERC Project Procedures*
- BHI-SH-01, *ERC Safety and Health Program*
- *Training Implementation Matrix for Environmental Restoration Contract Managed Nuclear Facilities* (BHI 2001b).

The controlled manual BHI-HR-02, *ERC Training Procedures*, describes the necessary processes involved in conducting required training and BHI (2001c) covers the facility-specific training for the REDOX Facility that is required for nuclear facilities.

BHI-HR-02 defines a suggested matrix for training courses to be taken in accordance with job descriptions (e.g., Rad Worker II training for personnel working in a radiation/contamination zone). ERC Training (ERCT) provides projects with the flexibility to develop all necessary training that may arise due to site-specific needs. Specific training matrixes are maintained by BHI Human Resources and are disseminated by controlled distribution.

12.3 PROCEDURE PROGRAM

The project management manual, BHI-MA-02, describes the major sections of the workflow processes, defines the responsible party for its execution, references the appropriate ERC procedure(s) that initiate the work, and identifies applicable requirements with the specific tasks. These initiating referenced documents pertain to the specific scope of work being addressed; however, other procedures are developed and employed by the supporting organizations (e.g., S/M&T). These procedures and their interrelation to the ERC workflow process and the ISMS program are presented in BHI-MA-02.

The process required to identify safety hazards and specific work controls is documented in BHI-SH-01. BHI safety and health objectives that are defined in BHI-SH-01 ensure the following:

- Thorough analysis of the work environment to anticipate, recognize, evaluate, and control situations, stressors, or other conditions in the work environment that may impair the health, well being, or efficiency of the ERC workforce.

- Safety- and health-related exposures to ERC workers and the public are compliant with regulatory and DOE requirements.

The ERC's programmatic controls are based on BHI guidance documents, including the BHI-MA manuals (Project Management), BHI-FS manuals (Field Support), BHI-SH manuals (Safety and Health), BHI-DE (Design Engineering) manuals, BHI-QA (Quality Assurance) manuals, and BHI-EE (Environmental Engineering) manuals. Programmatic controls define the general requirements under the ERC (i.e., radiological protection, hoisting and rigging, and lock and tag) that are implemented project instructions and specific work packages.

The programmatic controls that apply to this SAR include the following:

- CONOPS
- Work controls
- Radiological controls
- Worker health and safety controls
- Training requirements
- Maintenance requirements
- Configuration controls
- Quality assurance (QA)
- Emergency preparedness
- Criticality safety
- Hazardous material protection
- Radioactive and hazardous waste management
- USQ program.

Changes to these controls and the related procedures are evaluated, reviewed, and approved under the cognizance of the appropriate functional manager without need to revise this document.

The USQ process is a programmatic control that is used to aid in change management. Pre-approved procedures, when revised, are screened and evaluated as required under USQ requirements. All original and revised demand work packages are screened and evaluated as required under the USQ process. Commitments related to the USQ process are presented in Section 17.0.

12.4 TRAINING PROGRAM

A program is in place by ERCT that provides consistent, effective, and efficient training for ERC personnel. A systematic, performance-based, graded approach is used by ERCT to ensure on-time, as-needed training that is based on the requirements of the projects. ERCT is responsible for managing and administering all training categories and subjects, records, any necessary accreditation, and key interfaces.

Personnel are trained and qualified based on job-specific requirements. Personnel performing special processes must be qualified according to specific codes and standards. Qualification includes demonstrated proficiency of each candidate for a job or task. Facility-specific training on hazards associated with the facility is provided for S&M workers. Special briefings are conducted when new or changing hazards are encountered.

Training requirements for ERC personnel performing activities in nuclear facilities are documented in BHI (2001b). All procedures found to apply to or developed for the REDOX Facility will be part of required reading for personnel. ERCT will provide training using procedures that are based on the standards/requirements.

13.0 HUMAN FACTORS

The purpose of this section is to define the human-machine interfaces required for the functionality of SSCs that are important to safety, as applied in DOE-STD-3009-94 (DOE 1994b). The REDOX Facility has no active systems that provide prevention or mitigative capacity. Instrumentation is limited to pressure monitoring for trending information on the vessel vent header. Consequently, human factors design or interface requirements are not required in this SAR.

The primary focus of human interaction with the REDOX Facility is provided under the BHI Safety and Health, Radiological Protection, and Field Support programs. These programmatic commitments are addressed in other programmatic sections of this SAR (e.g., Sections 7.0, 8.0, 10.0, 11.0, 12.0, 13.0, 15.0, and 17.0).

14.0 QUALITY ASSURANCE

This section addresses the QA program associated with the REDOX Facility S&M activities. Applicable regulations and requirements that are applicable to this subject area include the following:

- 10 CFR 830, Subpart A, "Quality Assurance Requirements"
- DOE O 414.1A, *Quality Assurance*.

The ERC quality program is described in BHI-QA-01, *ERC Quality Program*, Parts I through III. Part I consolidates the quality program requirements of the BHI-DOE prime contract, applicable regulations, and DOE orders. Part II describes how the quality program requirements are implemented through a system of manuals and procedures. Part III describes how the ERC quality program will be implemented for the nuclear scope of work. BHI-QA-01 has been reviewed and approved by DOE as meeting the requirements of 10 CFR 830.120.

When a facility is classified as nuclear, a QA plan is prepared to provide additional assurance that work is planned and performed in a safe and compliant manner. The QA plan is based on the technical scope of work to be performed and associated hazards analysis. The plan is approved by project management and the BHI quality program manager and issued as a controlled document in accordance with BHI-QA-03, *ERC Quality Assurance Program Plans*. Changes to the QA program do not require USQ evaluation.

15.0 EMERGENCY PREPAREDNESS PROGRAM

This section provides a graded summary regarding the emergency preparedness program associated with S&M activities at the REDOX Facility. Additional requirements may be imposed on facility modifications if they are required at a future date.

Primary requirements that define the program include the following:

- 29 CFR 1910.38(a), "Emergency Action Plan"
- DOE O 151.1, *Comprehensive Emergency Management System.*

BHI-SH-03, *Emergency Management Program,* complies with and implements the requirements of the *Hanford Emergency Management Plan* (DOE-RL 1999) and applicable DOE orders. BHI-SH-03 establishes a coordinated emergency response organization (ERO) capable of planning for, responding to, and recovering from industrial, security, or hazardous materials incidents.

BHI-SH-03 ensures that these activities are integrated with similar activities of other Hanford Site contractors, RL, and relevant local, tribal, state, and Federal agencies. Emergencies at nearby facilities such as 222-S Laboratory, 242-S Evaporator, or the 241-SY tank farm may impact the REDOX Facility. Notification of emergencies/abnormal events at nearby facilities that warrant protective actions of BHI workers will be made through audible alarms, and BHI management will be notified by the Hanford Site emergency crash phone system. BHI managers will then notify workers of the appropriate protective actions. BHI-SH-03 provides for organizational control of emergencies; training; emergency preparedness drills, screenings, assessments, and classifications; preparation of emergency procedures, plans, and guides; and post-accident re-entry and recovery.

BHI-SH-03 defines the ERO, which is responsible for managing emergency incidents affecting environmental restoration facilities and providing as-needed emergency response assistance elsewhere on the Hanford Site. The ERC-ERO provides representatives and support to the Hanford Site ERO and emergency operation centers. Changes to the emergency preparedness program do not require USQ evaluation.

16.0 PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

This section addresses the provisions for D&D applicable to REDOX Facility S&M activities. Requirements applicable to the S&M activities performed in the REDOX Facility are provided in the other programmatic sections of this SAR, as applicable. Additional requirements may be imposed on facility modifications in order to meet DOE safety requirements.

Because the REDOX Facility was built in the late 1940s and deactivated in 1969, provisions for D&D are not within the scope of this SAR. The majority of hazardous materials remaining in the facility consist of fairly adherent films and residues in deactivated equipment and systems. The S&M activities will, by definition, ensure confinement of existing material or will dispose some portion of the material inventory through cleanup or relocation.

17.0 MANAGEMENT, ORGANIZATIONAL, AND INSTITUTIONAL SAFETY PROVISIONS

This section presents information on management, technical, and other organizations that support safe S&M operations. This overview provides a basic outline of the organization structures, responsibilities, and interfaces between the contractor's functional and project organizations related to S&M activities. Safety management policies and programs in place for (1) assessing and controlling safety performance and (2) for integrating safety consciousness. This presentation is tailored to overall implementation of the safety culture applicable to the long-term S&M requirements, including the scope for the REDOX Facility.

17.1 INTRODUCTION

The structure of the BHI safety culture is described in the *Integrated Environment, Safety and Health Management System Description* (BHI 2000c). BHI functional organizations maintain the safety management policies and procedures that implement the commitments that are required by regulations and the ERC and described in the DOE-approved ISMS. The functional organizations that are responsible for defining the requirements to be implemented include project management, Safety and Health (e.g., Radiological Protection, Industrial and Occupational Safety, Industrial Hygiene, Fire Protection, Hazardous Waste Operation Safety, and Health and Emergency Management), Design Engineering, Environmental Engineering, Field Support, and Assessment and Quality Programs. The S/M&T Project is the line organization that is directly responsible for the implementation of the functional requirements into the specific activities for long-term S&M.

17.2 REQUIREMENTS

Specific requirements, inclusive of the safety basis requirements of this section, are maintained by the BHI Legal and Contracts organizations. The contract-specific requirement can be found on the BLAN. These include, but are not limited to, the following:

- 10 CFR 830, "Nuclear Safety Management"
- 10 CFR 835, "Occupational Radiation Protection"
- DOE O 151.1C, *Comprehensive Emergency Management System*
- DOE O 232.1, *Occurrence Reporting and Processing of Operations Information*
- DOE O 414.1A, *Quality Assurance*
- DOE 470.1C, *Safeguards and Security Program*

- DOE Order 1324.5B, *Records Management Program*
- DOE Order 5400.5, *Radiation Protection of the Public and the Environment*
- DOE Order 5480.3, *Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Waste*
- DOE Order 5480.4, *Environmental Protection, Safety, and Health Standards*
- RLID 420.1, *Fire Protection*
- DOE Order 5480.9A, *Construction Safety and Health Program*
- DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*
- DOE Order 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*
- DOE Order 5480.21, *Unreviewed Safety Questions*
- DOE Order 5480.22, *Technical Safety Requirements*
- DOE Order 5480.23, *Nuclear Safety Analysis Reports*
- DOE Order 5480.26, *Trending and Analysis of Operations Information Using Performance Indicators*
- DOE Order 5480.2A, *Radioactive Waste Management.*

The Richland Environmental Restoration (ER) Project's scope and requirements are defined, first and foremost, by contractual agreements with DOE. These contractual agreements state that the ERC will comply with all applicable laws and regulations regarding its work, including Federal, state, and local regulations, as well as DOE orders and stipulations in the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1998). To manage its work, the ERC has developed a program of controlled procedures, plans, and workflow processes. The management authority, approval, and design of these documents (and processes) and specific sponsors are presented in the ERC document hierarchy depicted in Figure 17-1.

17.3 ORGANIZATIONAL STRUCTURE, RESPONSIBILITIES, AND INTERFACES

BHI is responsible for planning, integrating, and managing the S&M of the REDOX Facility. Implementing ISMS is the responsibility of all functional and project managers, which is in line with the concept that ER Project functional groups primarily establish programs and project managers implement programs. The ISMS demonstrates this concept by placing the responsibility for the ISMS with the Manager of Quality, Safety, and Health. Developing and implementing environmental protection within the scope of the ISMS is the responsibility of the Manager of Environmental Technologies. The ISMS program traverses all elements of the ERC Project and is integrated with other safety components (including nuclear safety, chemical safety, industrial safety), as well as other safety programs. Each of these programs is governed by DOE orders, Federal and state regulations, local regulations, or industry standards designed to establish an effective environment, safety, and health program.

Project management and Field Support work to integrate the applicable protective requirements into specific project and work instructions. Project staff implement measurement and feedback requirements to ensure that requirements are not only meet, but can be used for continuous improvement of the safety culture. Functional groups also provide assessment to measure performance and compliance that may lead to corrective actions and continuous improvement in the work process and safety culture.

17.3.1 Organizational Structure

BHI manages S&M operations at various Hanford Site facilities. The S/M&T Project manages S&M activities for all facilities under the long-term S&M that are awaiting D&D. Each employee must understand his/her roles and responsibilities relative to the work performed. Managers must ensure that staff understand their roles and responsibilities, and identify training necessary to perform the job duties. BHI-MA-01 provides the description of the ERC organization and responsibilities.

17.3.2 Organizational Responsibilities

In a matrix organization described in BHI (2000c), the project manager is responsible for the overall project objectives and uses the task lead and project engineer for ensuring execution of the work. Functional managers provide technical expertise and subject matter experts, as necessary, to support the projects. The field engineer, field superintendent, and the subcontract technical representative(s) are the day-to-day interfaces in the field and provide line management in the field that reports directly to the project manager for the S/M&T Project. Line management at the executive level includes the BHI President and Vice President. BHI-MA-01 documents the ERC management organization, which is referred to as the ERC management team.

The S/M&T Project has engineers and support staff to support work control and the safety programs, including application of the institutional safety programs and radiation protection, fire protection, industrial hygiene, and industrial safety. Engineers and management ensure that engineering is conducted in accordance with program requirements and the safety authorization basis.

Other site services are used to implement Site-wide safety standards. These organizations include the following:

- Hanford Fire Department
- Safeguards and Security

- Transportation and Packaging Services
- Waste Management Services.

17.3.3 Staffing and Qualifications

To perform work safety, employees must have the necessary skills, knowledge, and ability to perform the work. Systems that are used include the hiring process, the ERC training program, procedure reviews, pre-job briefings, plan-of-the-day meetings, and other activities for identifying clear roles and responsibilities, ensuring proper management and supervision, and following prescribed procedures or work directions. Further descriptions that are related to staffing qualification and requirements are described in BHI-DE-01, BHI-HR-01, BHI-HR-02 and BHI-MA-02.

17.4 SAFETY MANAGEMENT POLICIES AND PROGRAMS

This section identifies safety programs and procedures implemented by BHI to enhance safe operations. BHI provides management and operating plans, policies, and procedures for conducting safe operations.

17.4.1 Safety Review and Performance Assessment

Procedures and other mechanisms are in place and used by personnel to detect and prevent quality problems. The corrective action system is used by managers to identify improvement opportunities and to consider and resolve recommendations for improvement, including worker suggestions.

The ERC's assessments of project and functional group activities (e.g., surveillance, self-assessments, operation readiness reviews and readiness assessments, and independent assessments) are conducted to evaluate the effectiveness of compliance with procedural and contractual requirements; to confirm that safety is integrated into the workplace; and to initiate corrective actions. Assessments identify strengths and weaknesses and bring attention to good practices, positive events, and accomplishments.

Corrective actions identified during assessments are tracked in the ERC Corrective Action Tracking System, as defined in BHI-MA-02.

The procedures and mechanisms that provide the framework to ensure continuous improvement are implemented through an assessment and feedback process, which functions at each level of work and at every stage in the work process.

17.4.2 Configuration and Document Control

Configuration and document control are specifically addressed in BHI policies and procedures. The interrelated programs are addressed in the policies and procedures so all associated safety and technical basis programs work together to provide quality CONOPS. Facility drawing and control requirements are prepared in accordance with engineering procedures in BHI-DE-01. Drawings of active systems project (e.g., electrical and mechanical) are maintained by the S/M&T Project. Nuclear safety requirements (e.g., documented safety analysis, the USQ process, and criticality safety), are defined in BHI-DE-01.

17.4.3 Occurrence Reporting

Occurrence reporting requirements are specifically addressed in BHI policies and procedures. The procedures address reporting occurrences and processing operations information, reporting and investigating accidents, corrective action management, conducting event critiques, and managing lessons learned.

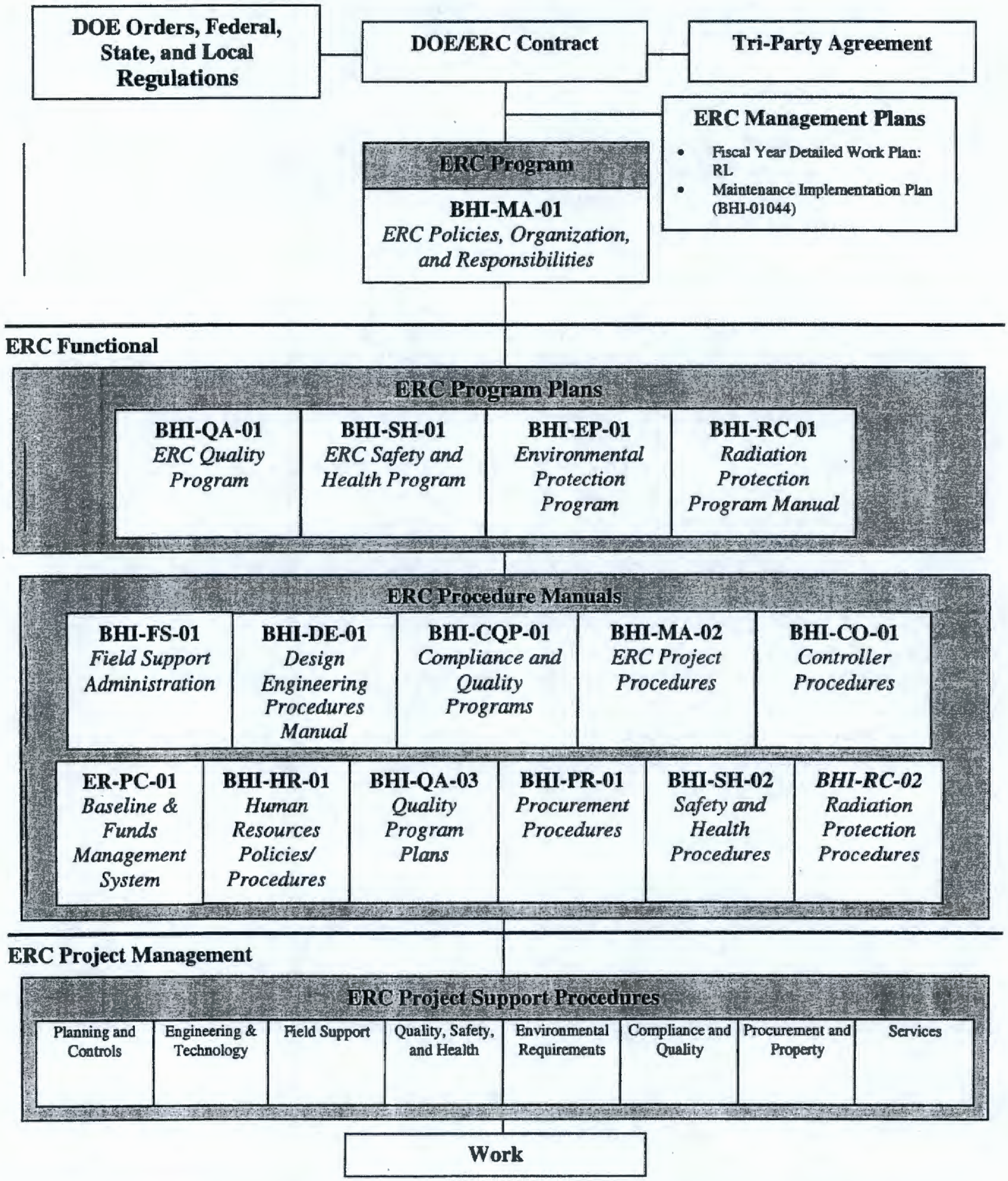
17.4.4 Safety Culture

BHI regards safety as the highest priority concern for conducting all activities at work. BHI strives to maintain a management staff and workforce that voluntarily believe that it is their responsibility and best interest to adapt to a "ZERO ACCIDENT" safety culture at Hanford and at home.

BHI management and staff work to improve the health and safety of employees and visitors by demonstrating commitment to provide the leadership to influence positive behavior and continual improvement toward the achievement of zero accidents.

Additional procedures and mechanisms used to implement continuous improvement include lessons learned, occurrence reporting, critiques, issue evaluation reports, management walkthroughs, safety statistics, trends, contractual performance objectives, technical competency, *ERC Team Safely Speaking* newsletter, employee surveys, the Voluntary Protection Program, and monthly functional meetings. Continuous improvements are also encouraged as an integral element of day-to-day activities for identifying unsafe practices and stopping work, as well as daily communications at job briefings, plan-of-the-day meetings, staff meetings, project meetings, and management meetings.

Figure 17-1. The ERC Hierarchy of Documents.



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APPENDIX A

REDOX FACILITY HAZARDS IDENTIFICATION AND EVALUATION

TABLE OF CONTENTS

TABLES

APPENDIX A

REDOX FACILITY HAZARDS IDENTIFICATION AND EVALUATION

A.1 HAZARDS IDENTIFICATION

The methodology used to identify hazards at the Reduction-Oxidation (REDOX) Facility is described in Section 3.3.1.1, "Hazard Identification." The results of this methodology are presented in Table A-1.

Table A-1 has six columns. The column headings and the content of each are described in the following paragraphs.

Column 1. Hazard Type

This column identifies the type of hazard investigated. Hazard types investigated included the following: radioactive material, direct radiation, fissionable material, hazardous material (i.e., toxic, carcinogenic), biohazards, asphyxiant, flammable/combustible material, reactive material, explosive material, electrical energy, thermal energy, kinetic energy, and high pressure.

Column 2. Location

This column identifies the location investigated for the presence of the hazard type. Because the 202-S Canyon Building is relatively large, it was subdivided into specific process and operating areas (e.g., canyon, operating gallery, and silo) for hazards identification purposes. Refer to Section 2.0, "Facility Description" for detailed information.

Column 3. Form

This column specifies the form of the hazard type. For example, the hazard type "hazardous material" is present in the 202-S Canyon Building silo in the form of sodium hydroxide. Note that this column is not intended to provide a detailed identification of the chemical (e.g., oxide) or physical (e.g., crystalline) form of the hazard type. Such detail is not considered at the hazard identification stage of a safety analysis.

Column 4. Quantity

This column quantifies the form of the hazard type. Measured values are presented when relevant and available.

Column 5. Remarks

This column presents information that provides for a better understanding of the hazard type, location, form, and quantity.

Column 6. References

This column lists the information sources used to identify the location, form, and quantity of a given hazard type.

A.2 PRELIMINARY HAZARDS EVALUATION

The methodology used to perform a preliminary evaluation of identified hazards is described in Section 3.3.1.2, "Hazard Evaluation." The results of this methodology are presented in Table A-2.

Table A-2 has ten columns. The column headings and the content of each are described in the following paragraphs.

Column 1. Item

This column sequentially numbers the table rows for ease of reference.

Column 2. Potential Event

This column identifies an event (e.g., fire) that, if it were to occur, could result in negative consequences to workers, the public, or the environment.

Column 3. Location

This column identifies the building (e.g., 202-S Canyon Building), or a specific location within a building (e.g., product receiver [PR] cage) impacted by the potential event. Refer to Section 2.0, "Facility Description" for detailed information.

Column 4. Hazard Type

This column identifies the type of hazard (e.g., radioactive material) that could negatively impact workers, the public, or the environment. Column entries are selected from Table A-1, as appropriate.

Column 5. Event and Possible Causes

This column describes the impact of the event at the location being evaluated and identifies possible causes. For example, a loss of electrical power caused by equipment failure can result in a loss of negative pressure differential lead to the migration of contamination.

Column 6. Structures, Systems, and Components

This column identifies structures, systems, and components (SSCs) (e.g., sand filter) that potentially serve a preventive or mitigative function.

Column 7. Administrative

This column identifies administrative features (e.g., emergency procedures) that potentially serve a preventive or mitigative function.

Column 8. "C"

This column identifies the consequence ranking assigned to the event (see following discussion).

Column 9. "L"

This column identifies the likelihood ranking assigned to the event (see following discussion).

Column 10. Detailed Hazards Evaluation

This column identifies (e.g., yes/no) if the event has been selected for detailed evaluation. If an event is not selected, the rationale is provided.

Columns 8 and 9 present the consequence and likelihood rankings for a given event. There are four consequence ranks, as defined below:

Consequence Rank I – Catastrophic

This is the highest consequence rank assigned in the hazards analysis. Included are events that can cause death to individuals from any means, including exposure to radioactive or hazardous materials. No differentiation is made between onsite and offsite individuals.

Consequence Rank II – Severe

This consequence rank encompasses events that could produce severe injury, significant lost work time, or long-term disability. This rank refers to acute consequences, implying radioactive or toxic material exposure must be severe and occur in a relatively short time. For example, radiation doses on the order of 200 rem result in severe debilitating effects that would be considered acute as well as severe. Similarly, contact with hazardous materials (e.g., acids and bases) could produce severe, acute injury. As was the case for rank I, no differentiation is made between onsite and offsite individuals.

Consequence Rank III – Unplanned Releases

This consequence rank is assigned to events that could release radioactive or hazardous material outside the REDOX Facility but would not result in catastrophic or severe impacts. This rank encompasses impacts to onsite and offsite individuals as well as insults to the environment. Consequence rank III is further divided into three sub-ranks: (1) releases resulting in significant environmental contamination, (2) releases resulting in minor environmental contamination, and (3) releases resulting in insignificant environmental contamination that may or may not exceed regulatory guidelines.

Consequence Rank IV – Minor

This consequence rank is assigned to events that result in minor injury but no release outside the facility. While many events that would receive this designation are screened out of the hazardous analysis, some may be included to provide documentation they were considered as potential event initiators.

There are also five likelihood ranks defined as follows.

Likelihood Rank A – Frequent

Judged to be likely to occur frequently. Such an event could occur on an annual basis.

Likelihood Rank B – Probable

Likely to occur several times in the life of an item. Such an event could occur at a frequency of once in 10 years ($1x10^{-1}$/yr).

Likelihood Rank C – Occasional

Likely to occur sometime in the life of an item. Such an event could occur at a frequency of once in 100 years ($1x10^{-2}$/yr).

Likelihood Rank D – Remote

Unlikely but possible to occur in the life of an item. Such an event could occur at a frequency of once in 10,000 years ($1x10^{-4}$/yr).

Likelihood Rank E – Improbable

So unlikely that it can be assumed that it will not occur. Such an event could occur at a frequency of once in 1 million years ($1x10^{-6}$/yr).

The methodology used to assign likelihood and consequence rankings is based upon the methodology developed in *Risk Management Study for the Hanford Site Facilities* (WHC 1994) and is applied in *Qualitative Risk Evaluation Update for the Retired Hanford Site Facilities* (BHI 1994). Note that in BHI (1994), the consequence and likelihood rankings were combined to derive the overall risk associated with a given facility, thus allowing the risk associated with different facilities to be compared and factored into resource allocation decisions. Risk estimates for the REDOX Facility were not developed because the goal of the safety analysis is to identify and analyze hazards to ensure that all authorized activities are accounted for and adequately controlled.

Table A.2-1. REDOX Facility Hazards Identification. (10 Pages)

Hazard Type	Location	Form	Quantity	Remarks	References
Radioactive material	202-S Canyon Building: Canyon (including process cells, equipment and piping, and deck)	Mixed fission products, plutonium and americium in vessels and piping; also present as surface contamination; tank D-10 contains 968 gal and tank D-13 contains 2,530 gal of contaminated liquid waste (water).	9,000 Ci beta activity. 1,500 Ci alpha activity (equivalent to 24.5 kg Pu-239).	Attempts were made during deactivation to flush systems with nitric acid and water to remove residual contamination. Liquid level in tanks D-10 and D-13 dropping over time due to evaporation.	Historic assumption from RHO-SD-DD-FL-001 (RHO 1982), deactivation report; hazards identification workshop.
	202-S Canyon Building: PR cage (including sample hoods, equipment and piping)	Mixed fission products, plutonium and americium present within equipment and piping, also present as surface contamination.	840 Ci beta activity. 140 Ci alpha activity (equivalent to 2.15 kg Pu-239).	Of known quantities, majority of activity (i.e., 97%) present in E-16 and E-17 concentrators.	BHI (1997), facility staff interviews, hazards identification workshop.
	202-S Canyon Building: North sample gallery (excluding PR cage) and south sample gallery	Mixed fission products, plutonium and americium in hoods, ducting, and piping; also present as surface contamination.	Minor amounts, included in inventory estimates for canyon.	Some contamination and airborne radiation areas.	Facility staff interviews, hazards identification workshop.
	202-S Canyon Building: North and South Operating, Pipe, and Storage Galleries	Mixed fission products, plutonium and americium in equipment and piping; also present as surface contamination.	Minor amounts, included in inventory estimates for canyon.	Some contamination and radiological buffer areas.	Facility staff interviews, hazards identification workshop.
	202-S Canyon Building: Silo (processing side only)	Mixed fission products, plutonium and americium present as surface contamination and inside equipment and piping.	Included in inventory estimates for canyon.	The silo contained solvent extraction columns used in plutonium separations processes; all columns remain in the silo.	Facility staff interviews.

Table A.2-1. REDOX Facility Hazards Identification. (10 Pages)

Hazard Type	Location	Form	Quantity	Remarks	References
Radioactive material (cont.)	202-S Canyon Building: Remote shop (east end of the canyon at the cell floor level)	Mixed fission products, plutonium and americium present as surface contamination.	Minor amounts, included in inventory estimates for canyon.	Area is designated as a surface contamination and airborne radiation area. Radiation area adjacent to sump in southwest corner. Significant contamination potentially present in decon hood (located in the outer decon room) and wind tunnel.	Facility staff interviews.
	202-S, D cell	Low-level radioactive liquid waste.	Tank D-10 approximately 1,420 gal, tank D-13 approximately 5,560 gal	Waste transferred from 222-S and is uncharacterized.	Facility staff.
	291-S Exhaust Fan Building (including sand filter)	Mixed fission products; fissionable material.	Estimated 8,000 Ci beta activity. Estimated 340 Ci alpha activity (equivalent to 5.6 kg Pu-239). Minor surface contamination in the soil around the filter building. Some contamination internal to the exhaust fans.	No data could be found to indicate the inventory of radioactive material in the sand filter. Estimates calculated used historic stack emission data and a filter efficiency of 99.95% (as a reference point, the T Plant sand filters contain 50 Ci alpha); building is designated as a radiological buffer area and the fans are posted as contamination areas.	Facility walkdown, hazards identification workshop, and BHI (1995), and (1998a). See Section 3.3.2.3.
	291-S-1 stack	Mixed fission products, plutonium and americium present as surface contamination.	Minor levels of fixed contamination.	Stack routinely washed during operations, top 100 ft of stack lined with stainless steel, stack equipped with a record sampler and beta/gamma monitors.	Hazards evaluation workshop.

Table A.2-1. REDOX Facility Hazards Identification. (10 Pages)

Hazard Type	Location	Form	Quantity	Remarks	References
Radioactive material (cont.)	292-S Control and Jet Pit House Building	Mixed fission products, plutonium and americium present as surface contamination and contaminated liquid waste (water).	4 Ci beta activity.	Seal pot is used for condensate collection from concrete encased lines, sand filter, and 291-S-1 stack; building lower level is posted as a contamination area and upper level is a radiological buffer area.	Historic assumption from (RHO 1982), staff interviews.
	2904-SA Cooling Water Sampling Building	Mixed fission products, plutonium and americium present as surface contamination, and contamination in equipment.	Minor levels.	Below-grade weir previously used for sampling/diversion of liquid waste. Currently posted as a contamination area.	Hazard evaluation workshop, facility interviews.
	293-S Nitric Acid Recovery and Iodine Backup Building	Mixed fission products, plutonium and americium present as surface contamination, and contamination in equipment.	4 Ci beta activity, 1 Ci Pu.	Upper level of building contains fiber filter media (which is contaminated from operational use) and is designated as a radiological buffer area; lower area contains exchange columns and is designated as a contamination area.	Historical assumption from (RHO 1982), staff interviews.
	2711-S Stack Gas Monitoring Building	Mixed fission products, and plutonium and americium present within equipment.	Minor amounts from air sample collection.	Some areas of building are designated as contamination areas, other portions are radiological buffer areas.	Facility staff interviews, survey data.
	2715-S Storage Building	None.	None.	Facility cleaned in 1993; currently used for storage of clean drums.	Hazards evaluation workshop, facility interviews.
	2718-S Sand Filter Sample Building	Mixed fission products, plutonium and americium present as surface contamination, and contamination in piping.	Minor spots of contamination only.	Building is posted as a contamination and radiation area.	Facility staff interviews.

Table A.2-1. REDOX Facility Hazards Identification. (10 Pages)

Hazard Type	Location	Form	Quantity	Remarks	References
Radioactive material (cont.)	2706-S Storage Building (demolished)	Mixed fission products, plutonium and americium present as surface contamination on equipment.	Minor quantities.	Contamination is present on remote crane tools used in the canyon; building is locked, posted as a radiation areas, located within a contamination area.	Facility staff interviews, hazards evaluation workshop.
	276-S Solvent Handling Building	Mixed fission products, plutonium and americium; material is present in the form of surface contamination in the building, tanks, and piping.	Minor quantities.	Of the three tanks, most of the contamination is present in tank 276-S-0-2; surface contamination in the building is minimal; building is designated as a radiological buffer area.	Internal WHC memorandum from Decommissioning Engineering to hexone file (WHC 1989). Facility walkdown.
	276-S hexone tanks	Mixed fission products, plutonium and americium; contamination is present in fixed and hardened residue.	Assumed to be 250 gal of distillation sludge and 30 gal of hexone-contaminated liquid.	Testing indicates residual hazard remains.	WHC (1992), sample data, BHI (2000).
	211-S liquid chemical storage tank farm	Mixed fission products present as surface contamination on surrounding soils.	Minor quantities.	Tanks were emptied and flushed during deactivation; no known internal contamination; contaminated soils believed to have migrated into the tank farm from other surface contamination areas, two storage pits in tank farm used for radiation instrument calibration surveyed and no sources present.	Facility walkdown; facility staff interviews.

Table A.2-1. REDOX Facility Hazards Identification. (10 Pages)

Hazard Type	Location	Form	Quantity	Remarks	References
Radioactive material (cont.)	202-S column laydown trench	Mixed fission products, plutonium and americium.	Minor quantities present as surface contamination within the trench.	There are currently no columns in the trench. Leaks from columns during former transport and storage activities resulted in contamination of the trench; posted as a radiation area. Lead shielding installed in first portion of trench in 1990 to reduce exposures.	Facility staff interviews.
Direct radiation	202-S Canyon Building: Canyon (including process cells, equipment and piping, deck)	Mixed fission products present as surface contamination on/above above deck, and in/on cells, vessels, and piping.	9,000 Ci beta activity. 1,500 Ci alpha activity (equivalent to 24.5 kg Pu-239).	Interior of process cells likely in high radiation area; however, the Canyon is not accessed during routine S&M activities. Canyon deck is posted as an airborne radiation area.	WHC (1994), facility staff interviews.
	202-S Canyon Building: Remote shop (east end, cell floor level)	Mixed fission products present as surface contamination and contamination within equipment.	Minor amounts, included in inventory estimates for Canyon.	Area is designated as a radiation area based on dose rate measurements adjacent to sump in SW corner.	Facility staff interviews.
	202-S column laydown trench	Mixed fission products, plutonium and americium.	Minor quantities present as surface contamination within the trench.	Area is designated as a radiation area; dose rate could be due to shine from roll-up door at based of silo or from contamination within trench. Lead shielding installed in first portion of trench in 1990 to reduce exposures.	Facility staff interviews.
Fissionable material	202-S Canyon Building Canyon: Canyon (including process cells, equipment and piping, deck)	Pu-239 present in process cell equipment and piping and present as surface contamination.	1,500 Ci alpha activity (equivalent to 24.5 kg Pu-239).	Attempts were made during deactivation to flush systems with nitric acid and water to remove residual contamination.	Historic assumption from RHO (1982), deactivation report, hazards identification workshop.

Table A.2-1. REDOX Facility Hazards Identification. (10 Pages)

Hazard Type	Location	Form	Quantity	Remarks	References
Fissionable material (cont.)	202-S Canyon Building: PR cage (including sample hoods, equipment and piping)	Pu-239 present in equipment and piping.	140 Ci alpha activity (equivalent to 2.15 kg Pu-239).	Majority of activity (i.e., 97%) present in E-16 and E-17 concentrators.	BHI (1997), facility staff interviews, hazards identification workshop.
	291-S Exhaust Fan Building (including sand filter)	Pu-239 in sand filter.	Estimated inventory of 340 Ci alpha activity (equivalent to 5.6 kg Pu-239).	Material dispersed within sand filter matrix. Estimated inventory calculated using historic stack emission data and a filter efficiency of 99.95% (as a reference point, the T Plant sand filters contain 50 Ci alpha).	Facility walkdown, hazards identification workshop, BHI (1995).
Hazardous material (e.g., toxic, carcinogenic)	202-S Canyon Building: Canyon (including process cells, equipment and piping, deck)	Residues of former process chemicals and chemicals used for deactivation potentially present in process equipment (pipes and vessels) and as contaminants on surfaces from spills and leaks. Acetylene tetrabromide (red oil) and mercury heels present in some deactivated instruments.	Residuals remaining following deactivation.	Equipment and piping flushed to remove residual contamination during deactivation; process chemicals include nitric acid, aluminum nitrate, ammonium fluoride, sodium hydroxide, and ammonium dichromate; chemicals used in deactivation (i.e., flushing) include permanganate, dilute nitric acid, oxalic acid.	WHC (1994), hazards evaluation workshop.
	202-S Canyon Building: Dissolver cells (A, B, and C cells), waste transfer lines, waste treatment cell (D cell)	Beryllium in process equipment and piping.	Trace quantities.	Small quantities of beryllium were used in the fabrication of fuel elements. Trace quantities of beryllium are conceivably present in the dissolver and waste processing cells and associated piping.	Staff interviews.
	202-S Canyon Building: North and south pipe galleries	Sodium hydroxide.	Minor quantity.	Bulk removal of sodium hydroxide performed but lines and funnel drains not flushed.	WHC (1994), staff interviews.

Table A.2-1. REDOX Facility Hazards Identification. (10 Pages)

Hazard Type	Location	Form	Quantity	Remarks	References
Hazardous material (e.g., toxic, carcinogenic) (cont.)	202-S Canyon Building: AMU section of silo	Sodium hydroxide.	Residual quantities.	Bulk sodium hydroxide removed from AMU tanks but funnel drains and floor drains not flushed.	Staff interviews.
	202-S Canyon Building Service areas	Solvents and cleaners.	Minor quantities.	Placed in storage cabinet in southwest corner of office area.	Staff interviews.
	276-S Solvent Handling Building	None.	None.	Facility deactivation (triple flushing) removed bulk materials; the effectiveness of the flushing was determined to be high when some tanks were re-opened and sampled, tanks are confirmed empty.	WHC (1994) and WHC (1989).
	276-S hexone tanks	Residual solids.	Unknown. Assumed to be 250 gal of distillation sludge and 30 gal hexone-contaminated liquid.	Remaining material following distillation and removal of 35,000 gal of mixed-waste hexone solvents. Testing indicates residual hazard remains.	WHC (1992) and BHI (1998b).
	211-S liquid chemical storage tank farm	Residual process chemicals in piping and equipment.	Residual volumes are unknown but very small.	Facility deactivation removed bulk materials; process chemicals include nitric acid, aluminum nitrate, ammonium fluoride, sodium hydroxide, and ammonium dichromate.	Facility walkdown.
	REDOX Facility: All buildings (except 2715-S and 2710-S)	Asbestos insulation, friable if degraded or damaged.	Unknown quantities.	Asbestos abatement program was carried out with stabilization of existing asbestos for 202-S Canyon Building galleries and office areas, 276-S, and 211-S tank farm piping and, ongoing equipment annual assessment performed.	BHI (1996), WHC (1994), facility walkdown.

Table A.2-1. REDOX Facility Hazards Identification. (10 Pages)

Hazard Type	Location	Form	Quantity	Remarks	References
Hazardous material (e.g., toxic, carcinogenic) (cont.)	REDOX Facility: All buildings	Lead-based paint.	Not quantified.	None.	Staff interviews.
Biohazard	REDOX Facility: All buildings	Rodents, insects, snakes; bird and animal feces.	Greater activity than normally occupied facilities.	Because there is very little human activity in an around the REDOX Facility, increased rodent, insect and snake activity can be expected.	WHC (1994).
Flammable/ combustible material	202-S Canyon Building: Canyon (including process cells, equipment and piping, deck)	Wooden box.	One wooden jumper storage box on canyon deck per FHA (Appendix D).	Assessed as negligible to low.	See FHA (Appendix D).
	202-S Canyon Building: PR cage	PMMA.	See PR cage fire evaluation.	Walls of cage.	See PR cage fire evaluation (Appendix C).
	202-S Canyon Building: Galleries and service areas	Transient loading.	See FHA (Appendix D).	Assessed a negligible to low.	See FHA (Appendix D).
	202-S Canyon Building: Silo	Potentially PCB-contaminated mineral oil contained in lead glass windows.	Total of 17 mineral oil-filled viewing windows located between 5 levels of AMU.	See FHA (Appendix D).	See FHA (Appendix D).
	291-S Exhaust Fan Building	Oils and greases.	See FHA (Appendix D).	See FHA (Appendix D).	See FHA (Appendix D); hazard evaluation workshop
	292-S Control and Jet Pit House Building	--	Negligible.	None.	Facility walkdowns.
	293-S Nitric Acid Recovery and Iodine Backup Building	--	Negligible.	None.	Facility walkdowns.
	276-S Solvent Handling Building	--	Negligible.	None.	Facility walkdown.
	211-S tank farm	--	Negligible.	None.	Facility walkdown.

Table A.2-1. REDOX Facility Hazards Identification. (10 Pages)

Hazard Type	Location	Form	Quantity	Remarks	References
Reactive material	202-S Building	Residual process and deactivation chemicals within process piping/equipment.	Residual quantities.	Residual quantities of chemicals exist in separate process piping/equipment that, if mixed, could generate heat/gas (e.g., residues of nitric acid and sodium hydroxide).	Hazards evaluation workshop.
Explosive material	202-S Canyon Building: North service area (battery room)	Hydrogen gas.	Sixty 2.2-vol direct current lead-acid batteries.	Hydrogen gas can be generated during charging of batteries.	See FHA (Appendix D).
Electrical energy	REDOX Facility: All buildings	None outside that routinely encountered in industry.	None outside that routinely encountered in industry.	Electrical system is designed/defined/ controlled for S&M activities (e.g., lock and tag), electricity as fire initiator evaluated in FHA.	See FHA (Appendix D); staff interviews.
Thermal energy	202-S Canyon Building: Service areas	Space heaters.	Quantity of temporary heaters listed in work package.	None.	Hazard evaluation workshop.
	291-S Exhaust Fan Building: (outside)	Diesel generator.	None outside that routinely encountered in industry.	None.	Hazard evaluation workshop.
Kinetic energy	REDOX Facility: All buildings	Structural components.	Not applicable.	Facilities occupied only infrequently during S&M activities.	Facility walkdown and staff interviews.
	202-S Canyon Building	Air compressor, elevators, crane, miscellaneous rotating equipment.	None outside that routinely encountered in industry.	Industrial hazard.	Facility walkdown and staff interviews.
	291-S Exhaust Fan Building	Rotating equipment (i.e., exhaust fans).	One fan runs during normal operation.	Industrial hazard.	Facility walkdown and staff interviews.
	REDOX Facility: All buildings	Aircraft crash.	Not applicable.	Probability of such an event is extremely low.	Facility walkdown and staff interviews.
	REDOX Facility: All building	Vehicle impact.	Not applicable.	Probability of such an event is low.	Facility walkdown and staff interviews.

Table A.2-1. REDOX Facility Hazards Identification. (10 Pages)

Hazard Type	Location	Form	Quantity	Remarks	References
High pressure	202-S Canyon Building 291-S Exhaust Fan Building 292-S Control and Jet Pit House	Compressed air.	None outside that routinely encountered in industry.	Air compressor, air receiver, and instrument air dryer located in compressor room in south service area of the 202-S Canyon Building.	Hazards evaluation workshop.
	202-S Canyon Building	P-10 gas (10% methane in argon).	None outside that routinely encountered in industry.	P-10 gas is used in gas proportional radiation detectors (i.e., hand/foot counters) located at select entry/exit points.	Hazards evaluation workshop.

AMU = aqueous makeup unit
BHI = Bechtel Hanford, Inc.
FHA = fire hazard analysis
PCB = polychlorinated biphenyls
PMMA = polymethyl methacrylate
PR = product receiver
RHO = Rockwell Hanford Operations
S&M = surveillance and maintenance
WHC = Westinghouse Hanford Company

Table A.2-2. REDOX Preliminary Hazards Evaluation. (10 Pages)

Item	Hazard Summary				Preventative and/or Mitigative Features		Event Ranks		Detailed Hazards Eval.
	Potential Event	Location	Hazard Type from Table A-1	Event and Possible Causes	SSCs	Administrative	C	L	
1	Seismic Event	202-S Canyon Building	Radioactive material, toxic material, kinetic energy	Structural damage results in a loss of confinement and ventilation. Shock/vibration and movement of structure/equipment suspends hazardous materials resulting in an uncontrolled release to the environment.	Building structure, cell cover blocks.	ERC Emergency Management Program, controlled re-entry	I	C	Yes
2	Seismic Event	291-S Exhaust Fan Building, sand filter, and 291-S-1 stack	Radioactive material, toxic material, kinetic energy	Structural damage results in a loss of confinement and loss of ventilation for 202-S Canyon Building. Possible collapse of stack and collapse of sand filter cover blocks. Shock/vibration and movement of structure/equipment suspends hazardous materials resulting in an uncontrolled release to the environment.	Building structure, sand filter cover blocks. Assume structure met UBC at time of construction.	ERC Emergency Management Program, controlled re-entry	III-2	D	No (bounded by 202-S)
3	Seismic Event	211-S liquid chemical storage tank farm	Toxic material, kinetic energy	Capability of the tanks to resist seismic ground motions unknown; possible failure of tanks and piping resulting in a release of residual toxic materials to the environment.	Building structure, tanks, and piping. Assume structure met UBC at time of construction.	ERC Emergency Management Program, controlled re-entry	III-3	D	No (bounded by 202-S)
4	Seismic Event	292-S Control and Jet Pit House Building	Radioactive material, toxic material, kinetic energy	Capability of facility to resist seismic ground motions unknown. Possible structural damage and breach of piping with associated release of residual hazardous material. Possible leakage of contaminated liquid to soil column via seismic-induced cracks in pit.	Sump and pit structure. Assume structure met UBC at time of construction.	ERC Emergency Management Program, controlled re-entry	III-3	D	No (bounded by 202-S)
5	Seismic Event	293-S Nitric Acid Recovery and Iodine Backup Building	Radioactive material, toxic material, kinetic energy	Capability of structure and equipment to resist seismic ground motions unknown. Possible structural damage and breach of scrubber and absorption columns and piping with associated release of residual hazardous material to the environment.	Building structure. Assume structure met UBC at time of construction.	ERC Emergency Management Program, controlled re-entry	III-3	D	No (bounded by 202-S)

Table A.2-2. REDOX Preliminary Hazards Evaluation. (10 Pages)

Item	Hazard Summary				Preventative and/or Mitigative Features		Event Ranks		Detailed Hazards Eval.
	Potential Event	Location	Hazard Type from Table A-1	Event and Possible Causes	SSCs	Administrative	C	L	
6	Seismic Event	276-S Solvent Handling Building	Radioactive material, toxic material, kinetic energy	Capability of facility to resist seismic ground motions unknown. Possible failure of tanks and piping resulting in a release of residual hazardous materials to the environment.	Building structures and tank/piping. Assume structure met UBC at time of construction.	ERC Emergency Management Program, controlled re-entry	III-3	D	No (bounded by 202-S)
7	High Wind	202-S Canyon Building	Radioactive material, toxic material, kinetic energy	Failure of 202-S Canyon Building roof results in loss of confinement function for canyon and galleries; active ventilation for all areas lost. (Note: Little energy is available to suspend hazardous material within the canyon and only minor hazardous material are present in galleries.)	Building structure; PR cage confinement. Assume structure met UBC at time of construction.	ERC Emergency Management Program, controlled re-entry	III-1	D[a]	No (bounded by seismic)
8	High Wind	291-S Exhaust Fan Building, sand filter, and 291-S-1 stack	Radioactive material, toxic material, kinetic energy	Capability of 291-S Exhaust Fan Building to resist high wind forces unknown; possible structural damage and release of radioactive material. Loss of ventilation for 202-S Canyon Building.	Building structure. Assume structure met UBC at time of construction.	ERC Emergency Management Program, controlled re-entry	III-3	D	No (bounded by 202-S)
9	High Wind	211-S liquid chemical storage tank farm	Toxic material, kinetic energy	Capability of tanks and remaining piping to resist high wind forces is unknown; possible failure of tanks and piping with associated release of residual toxic materials to the environment.	Building structure and tanks/piping. Assume structure met UBC at time of construction.	ERC Emergency Management Program, controlled re-entry	III-3	D	No (bounded by 202-S)
10	High Wind	292-S Control and Jet Pit House Building	Radioactive material, toxic material, kinetic energy	Capability of structure to resist high wind forces unknown. Possible damage to above-ground structure and breach of piping with associated release of residual radioactive/hazardous material.	Building structure, piping. Assume structure met UBC at time of construction.	ERC Emergency Management Program, controlled re-entry	III-3	D	No (bounded by 202-S)

Table A.2-2. REDOX Preliminary Hazards Evaluation. (10 Pages)

Item	Hazard Summary				Preventative and/or Mitigative Features		Event Ranks		Detailed Hazards Eval.
	Potential Event	Location	Hazard Type from Table A-1	Event and Possible Causes	SSCs	Administrative	C	L	
11	High Wind	293-S Nitric Acid Recovery and Iodine Backup Building	Radioactive material, toxic material, kinetic energy	Capability of structure to resist high wind forces is unknown. Possible damage to above-ground structure and breach of absorption columns/piping with associated release of residual radioactive/hazardous material.	Building structure. Assume structure met UBC at time of construction.	ERC Emergency Management Program, controlled re-entry	III-3	D	No (bounded by 202-S)
12	High Wind	276-S Solvent Handling Building	Radioactive material, toxic material, kinetic energy	Capability of facility to resist high wind forces unknown; possible failure of aboveground structures and piping resulting in a release of residual toxic materials to the environment.	Building structure, piping. Assume structure met UBC at time of construction.	ERC Emergency Management Program, controlled re-entry	III-3	D	No (bounded by 202-S)
13	Ash and/or Snow Loading	202-S Canyon Building	Radioactive material, toxic material, kinetic energy	It is assumed that 202-S Canyon Building roof fails under excessive ash and/or snow loading resulting in impacts to hazardous materials in canyon and galleries.	Building structure.	ERC Emergency Management Program, controlled re-entry. Inclement weather and conditions procedures.	III-2	D	No (bounded by seismic
14	Ash and/or Snow Loading	291-S Exhaust Fan building, sand filter, and exhaust stack	Radioactive material, toxic material, kinetic energy	Capability of 291-S Building to resist ash and/or snow loading unknown. Possible damage to exhaust fans and loss of ventilation to 202-S Canyon Building. Weather cover over sand filter survives no impact.	Building structure.	ERC Emergency Management Program, controlled re-entry. Inclement weather and conditions procedures.	III-2	D	No (bounded by 202-S)

Table A.2-2. REDOX Preliminary Hazards Evaluation. (10 Pages)

Item	Hazard Summary				Preventative and/or Mitigative Features		Event Ranks		Detailed Hazards Eval.
	Potential Event	Location	Hazard Type from Table A-1	Event and Possible Causes	SSCs	Administrative	C	L	
15	Ash and/or Snow Loading	292-S Control and Jet Pit House Building	Radioactive material, toxic material, kinetic energy	Capability of structure to resist ash and/or snow loading unknown. Possible roof failure and breach of piping with associated release of radioactive/hazardous material.	Building structure.	ERC Emergency Management Program, controlled re-entry. Inclement weather and conditions procedures.	III-3	D	No (bounded by 202-S)
16	Ash and/or Snow Loading	293-S Nitric Acid Recovery and Iodine Backup Building	Radioactive material, toxic material, kinetic energy	Capability of structure to resist ash and/or snow loading unknown. Possible roof failure and breach of absorption column and scrubbers/piping with associated release of radioactive/hazardous material.	Building structure.	ERC Emergency Management Program, controlled re-entry	III-3	D	No (bounded by 202-S)
17	Loss of Electrical Power	202-S Canyon Building	Radioactive material	Loss of electric power leads to the loss of negative pressure differentials in 202-S due to loss of exhaust fan in 291-S. Possible migration of surface contamination to the environment. Possible causes: loss of electrical feed to the facility, system or component failure within facility.	Backup diesel generator.	Evacuation of building, controlled re-entry	III-3	A	Yes (as an initiator for item 31)
18	Loss of Electrical Power	291-S Exhaust Fan Building	Radioactive material	Loss of power leads to loss of exhaust fan resulting in a loss of negative pressure differentials in 202-S. Possible causes: loss of electrical feed to the facility, system or component failure within facility.	Backup diesel generator.	Evacuation of 202-S, controlled re-entry	III-3	A	Yes (as an initiator for item 31)
19	Aircraft Impact	REDOX Facility	Radioactive material, toxic material, kinetic energy	The probability of an aircraft impacting a REDOX structure is qualitatively assessed as being of significantly low probability that further consideration is not required.	None.	None	III-1	E	No (improbable)

Table A.2-2. REDOX Preliminary Hazards Evaluation. (10 Pages)

Item	Hazard Summary				Preventative and/or Mitigative Features		Event Ranks		Detailed Hazards Eval.
	Potential Event	Location	Hazard Type from Table A-1	Event and Possible Causes	SSCs	Administrative	C	L	
20	Vehicle Impact	211-S liquid chemical storage tank farm	Toxic material, kinetic energy	Ground vehicle impacts a tank, compromising tank integrity and releasing residual chemicals in the tanks or piping. Possible causes: mechanical failure, vehicle operator error/incapacitation.	Fencing.	Access control	III-3	C	No (low consequence)
21	Inadvertent Transfer	202-S Canyon Building Canyon	Radioactive material, toxic material	Inadvertent transfer of tank farm tank waste to 202-S via 151-S/152-S diversion boxes. Possible causes: operator error identifying proper transfer route, operator error establishing proper transfer route (e.g., valve misalignment).	Transfer lines from tank farms blanked outside diversion boxes 151-S, 152-S, building structure, jet transfer system deactivated.	Access and configuration of external pipelines are controlled by other RL contractors.	IV	C	No (low consequence)
22	Inadvertent Transfer	202-S Canyon Building Canyon	Radioactive material, toxic material	Inadvertent transfer from 222-S Laboratory via 219-S. Possible causes: operator error identifying proper transfer route, operator error establishing proper transfer route (e.g., valve misalignment).	Transfer line blanked at 222-S Laboratory; jet transfer system deactivated.	Access and configuration of external pipelines are controlled by other RL contractors.	IV	C	No (low consequence)
23	Water Intrusion	202-S Canyon Building Canyon and galleries	Radioactive material, toxic material	Water intrusion into canyon or galleries leads to spread of contamination. Possible causes: degradation of facility roof.	Building structure, ventilation system.	Surveillance procedures, spill response procedures.	IV	D	No (low consequence)
24	Water Intrusion	202-S Canyon Building PR cage	Radioactive material	Water intrusion into the PR cage leads to spread of contamination. Possible causes: water intrusion in Building 233-S process hood with subsequent flow to PR cage via interconnected drain lines.	Building structure, ventilation system, PR cage sump.	Surveillance procedures, spill response procedures.	IV	D	No (low consequence)

Table A.2-2. REDOX Preliminary Hazards Evaluation. (10 Pages)

Item	Hazard Summary				Preventative and/or Mitigative Features		Event Ranks		Detailed Hazards Eval.
	Potential Event	Location	Hazard Type from Table A-1	Event and Possible Causes	SSCs	Administrative	C	L	
25	Water Intrusion	202-S Canyon Building column laydown trench	Radioactive material	Water intrusion into trench leads to spread of contamination. Possible cause: local flooding, degradation of weather cover.	Weather cover, concrete-lined trench.	Weather cover S&M.	IV	C	No (low consequence)
26	Water Intrusion	291-S Exhaust Fan Building, sand filter, and exhaust stack	Radioactive material	Water intrusion into sand filter leads to spread of contamination. Possible cause: local flooding, degradation of sand filter weather cover.	Weather cover, sand filter sump/drain, 292-S pit level monitoring instruments.	Weather cover S&M, spill response procedures.	IV	C	No (low consequence, see also item 32)
27	Fire	202-S Canyon Building process cell	Radioactive material, toxic material	Fire in process cell suspends radioactive/toxic materials present as surface contamination. Possible causes: inadvertent introduction of combustible materials and ignition source into process cell.	Sand filter system, sand filter.	Emergency response.	III-2	E	No (improbable)
28	Fire	202-S Canyon Building PR cage	Radioactive material, toxic material, flammable material	Transient combustibles accumulate in close proximity to PMMA windows and ignite. Fire suspends radioactive/toxic materials present as surface contamination within PR cage. Possible causes: operator failure to remove combustibles. Possible ignition sources include electrical short, welding/cutting activities.	Sand filter system, HEPA filter system.	Combustible material control, restriction on open-flame activities (e.g., welding and cutting), communication systems, evacuation of facility.	III-2	D	Yes

Table A.2-2. REDOX Preliminary Hazards Evaluation. (10 Pages)

Item	Hazard Summary				Preventative and/or Mitigative Features		Event Ranks		Detailed Hazards Eval.
	Potential Event	Location	Hazard Type from Table A-1	Event and Possible Causes	SSCs	Administrative	C	L	
29	Fire	202-S Canyon Building silo	Radioactive material, toxic material, flammable material	Mineral oil leaks from oil-filled silo viewing windows and ignites. Burning oil and transient combustibles suspends radioactive/toxic materials. (Note: This scenario is the maximum possible fire loss analyzed in FHA.) Possible causes: degradation of window seals, damage to window. Possible ignition sources include electrical short, welding/cutting activities.	Sand filter system.	Good housekeeping practices, restriction on open-flame activities (e.g., welding and cutting), communication systems, evacuation of facility.	III-3	D	No (dose consequence bounded by PR cage fire)
30	Loss of Confinement	202-S Canyon Building	Radioactive material	Loss of ventilation as a result of loss of offsite power, mechanical failure, or air pressure results in a loss of confinement for the hazardous materials in the 202-S Canyon Building; see discussion under item 17 (loss of electric power). Note: This event has already occurred without a release, but the consequence rank assigned is bounding.	Building structure, diesel generator, secondary fan.	S&M for ventilation system equipment, communication systems, evacuation of facility, procedures for controlled re-entry.	III-3	A	Yes
30a	Fire	276-S-141 and 276-S-142 tanks	Radioactive material, hazardous material, flammable	Spark or static discharge causes deflagration in one of the tanks, causing minor damage to tank and filter. Release of radioactivity and minor amounts of hexone.	Nitrogen-purge system	S&M procedure and administrative TSR.	III-3	C	0200W-US-N0183-02
31	Criticality	202-S Canyon Building PR cage, silo, canyon	Radioactive material, direct radiation	The potential for a criticality accident can only occur with simultaneous addition of moderator and redistribution of the fissionable material into a near optimum geometry.	None.	PR cage should be posted with a Category C fire-fighting symbol.	I	E	Yes

Table A.2-2. REDOX Preliminary Hazards Evaluation. (10 Pages)

Item	Hazard Summary				Preventative and/or Mitigative Features		Event Ranks		Detailed Hazards Eval.
	Potential Event	Location	Hazard Type from Table A-1	Event and Possible Causes	SSCs	Administrative	C	L	
32	Criticality	291-S Exhaust Fan Building, sand filter, and exhaust stack	Radioactive material, direct radiation	Water intrusion inundates sand filter redistributing material and providing moderation leading to a criticality (assumes potentially critical mass/geometry present on filter). Possible cause: local flooding, degradation of sand filter weather cover.	Weather cover, sand filter differential pressure monitors, sand filter sump/drain.	Weather cover S&M, remote monitoring system.	I	E	Yes
33	Criticality	292-S Control and Jet Pit House Building	Radioactive material, direct radiation	Water intrusion into sand filter washes fissionable material into drain system, critical mass collects in 292-S drain seal tank. Possible cause: local flooding, degradation of sand filter weather cover.	Sand filter weather cover, 292-S pit level monitoring instruments.	Weather cover S&M, remote monitoring system.	I	E	Yes
34	Liquid Spray Release	292-S Control and Jet Pit House Building	Radioactive material	Spray release of contaminated liquid during transfer from drain seal tank to receiver vessel (e.g., tank truck). Possible causes: transfer line failure, valve/fitting failure.	As identified in activity-specific work package	As identified in activity-specific work package.	III-3	C	No (activity will require USQ evaluation)
35	Liquid Spill	202-S, D cell	Low level radioactive liquid waste	Failure of tanks D-10 or D-13, personnel error, overflow of tanks, transfer error.	Spill into D cell and radioactive liquid drain; tank level monitor.	Monitoring of tank level is only authorized S&M activity.	III-3	C	No (low consequence; activity not authorized and requires USQ)
36	Liquid Spill to Ground	292-S Control and Jet Pit House Building	Radioactive material	Spill of contaminated liquid to ground during transfer from drain seal tank to receiver vessel (e.g., tank truck). Possible causes: transfer line failure, valve/fitting failure, tanker overfill.	As identified in activity-specific work package.	As identified in activity-specific work package.	III-3	--	No (activity will require USQ evaluation)
37	Container Spill	202-S Canyon Building	Toxic material	Chemical container fails or is manipulated such that its contents are spilled. Possible causes: degradation of container, human error, container pressurization.	Storage cabinet.	Surveillance for leaking or suspect containers, spill response.	III-3	D	No

Table A.2-2. REDOX Preliminary Hazards Evaluation. (10 Pages)

Item	Hazard Summary				Preventative and/or Mitigative Features		Event Ranks		Detailed Hazards Eval.
	Potential Event	Location	Hazard Type from Table A-1	Event and Possible Causes	SSCs	Administrative	C	L	
38	Spread of External Surface Contaminants	All outdoor surface contamination	Radioactive material	Surface contamination is spread from designated areas. Possible causes: high winds; biological agents (birds, rodents, etc.).	None.	Routine surveys and radiological protection controls (e.g., posting).	III-3	C	No (low consequence)
39	Flammable Gas Explosion	202-S Canyon Building	Flammable material	Hydrogen generated during recharging of batteries located in battery room ignites. Possible causes: overcharging of batteries results in excess off-gassing.	Ventilation, hydrogen recombiners.	Emergency response.	II	D	No (see FHA, Appendix D)
40	Facility Worker Exposure to External Radiation	See Section 3.3.2.1 for identification of radiation and high radiation areas	Radioactive material	Facility worker resides in radiation or high radiation area for extended period of time. Possible causes: human error in surveying and/or posting of radiation or high radiation areas, radiation survey instrument failure.	Shielding, physical access control of high radiation areas.	Posting of areas, radiological work package requirements, personnel dosimetry.	II[b]	D[b]	No
41	Facility Worker Uptake of Radio-active Material	See Section 3.3.2.1 for identification of surface contamination and airborne radioactive material areas	Radioactive material	Facility worker enters airborne radioactive material area or works in surface contamination area without proper personal protection equipment. Possible causes: human error in surveying and/or posting of surface contamination and/or airborne radioactive material areas.	Confinement ventilation system.	Posting of areas, radiological work package requirements, air sampling, air monitoring.	II[c]	D[c]	No
42	Facility Worker Exposure to Toxic Materials	202-S Canyon Building	Hazardous materials	Breach of process piping/equipment results in spread of residual quantities of process chemicals. Possible causes: corrosion, human error.	Confinement ventilation system.	ERC Project HASP, site-specific HASP, spill response.	II[d]	D[d]	No

Table A.2-2. REDOX Preliminary Hazards Evaluation. (10 Pages)

Item	Hazard Summary				Preventative and/or Mitigative Features		Event Ranks		Detailed Hazards Eval.
	Potential Event	Location	Hazard Type from Table A-1	Event and Possible Causes	SSCs	Administrative	C	L	
43	Facility Worker Exposure to Toxic Materials	202-S Canyon Building Silo	PCBs	Breach of PCB-contaminated, oil-filled window results in spread of PCBs. Possible causes: degradation of window housing, operator error.	None.	ERC Project HASP, site-specific HASP, spill response.	II[d]	D[d]	No

[1] Per WHC (1991), it is estimated that the annual building failure probability for extreme wind will be lower than that for earthquake loading.

[2] Based on historical dose rate data for areas accessed during S&M activities, an exposure resulting in a consequence rank of II is judged to be essentially incredible. However, exposures in excess of administrative limits are possible, and a consequence rank of II is more applicable than III based on their respective definitions (i.e., "severe" versus "unplanned release").

[3] Based on historical airborne radioactive material concentration data for areas accessed during S&M activities, an uptake resulting in a consequence rank of II is judged to be essentially incredible. However, uptakes in excess of administrative limits are possible, and a consequence rank of II is more applicable than III based on their respective definitions (i.e., "severe" versus "unplanned release").

[4] Based on historical information, an exposure resulting in a consequence rank of II is judged to be essentially incredible. However, exposures are possible, and a consequence rank of II is more applicable than III based on their respective definitions (i.e., "severe" versus "unplanned release").

ERC = Environmental Restoration Contractor
FHA = fire hazard analysis
HASP = health and safety plan
HEPA = high-efficiency particulate air
PMMA = polymethyl methacrylate
PR = product receiver
RL = U.S. Department of Energy, Richland Operations Office
S&M = surveillance and maintenance
SSCs = structures, systems, and components
TSR = technical safety requirement
UBC = Uniform Building Code
USQ = unreviewed safety question

A.3 REFERENCES

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BHI, 1998a, *291-S Loading Estimate,* Calculation No. 0200W-CA-N0007, Bechtel Hanford, Inc., Richland, Washington.

BHI, 1998b, *Hexone Tank Facility Status and Recommendations,* CCN 054742, internal memorandum from A. G Dada to J. J. McGuire, dated January 5, 1998, Bechtel Hanford, Inc., Richland, Washington.

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WHC, 1991, *Qualitative Structural Evaluations of U Plant and REDOX Buildings,* WHC-SD-DD-SA-001, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992, *The Distillation and Incineration of 132,000 Liters (35,000 Gallons) of Mixed-Waste Hexone Solvents from Hanford's REDOX Plant*, WHC-EP-0570, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994, *Risk Management Study for the Hanford Site Facilities*, WHC-EP-0619, Vols. 1 through 4, Westinghouse Hanford Company, Richland, Washington.

APPENDIX B

202-S CANYON BUILDNG RADIATION CONTROL AREAS

TABLE OF CONTENTS

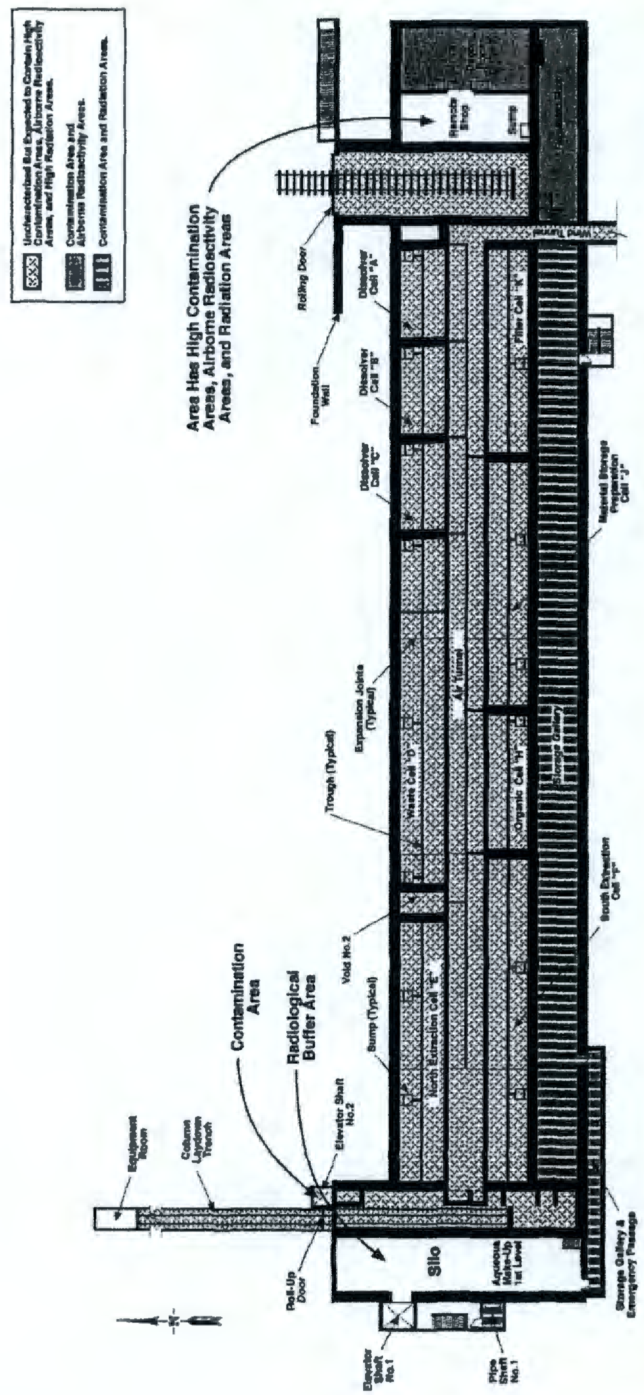
FIGURES

APPENDIX B

202-S CANYON BUILDING RADIATION CONTROL AREAS

The following figures (B-1 through B-7) show the location of radiation areas, high radiation areas, surface contamination areas, and airborne radioactive material areas posted within the 202-S Canyon Building as of December 1997. The figures are provided for information only and should not be used for work planning purposes, as conditions within the building change over time.

Figure B-1. Plan View Cell Floor Level.



Ref. HW-18700 / Figure XI-5b / From DWG. H-2-7402

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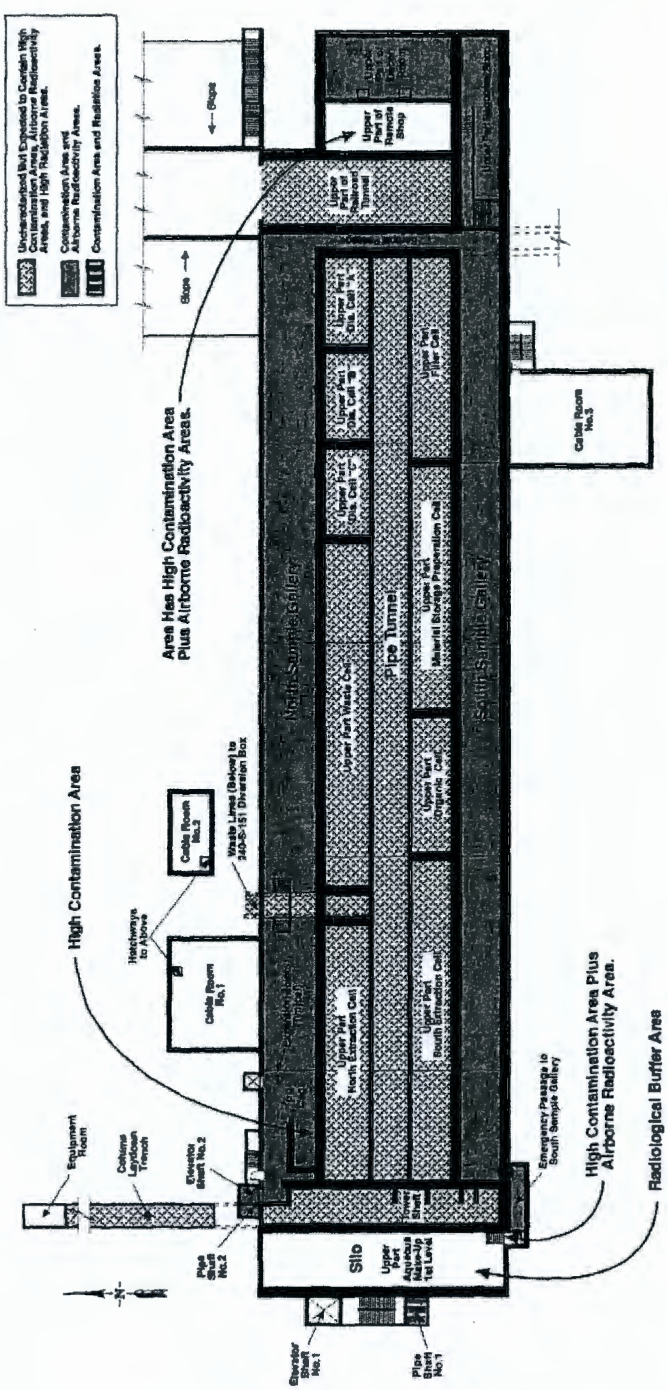
Radiological Conditions Subject to Change.
Contact Radiological Controls for Current Conditions.

Figure B-2. Plan View Sample Gallery Level.



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Radiological Conditions Subject to Change.
Contact Radiological Controls for Current Conditions.

Ref. HW-18700 / Figure XI-5a / From DWG. H-2-7402
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Figure B-3. Plan View Pipe Gallery Level.

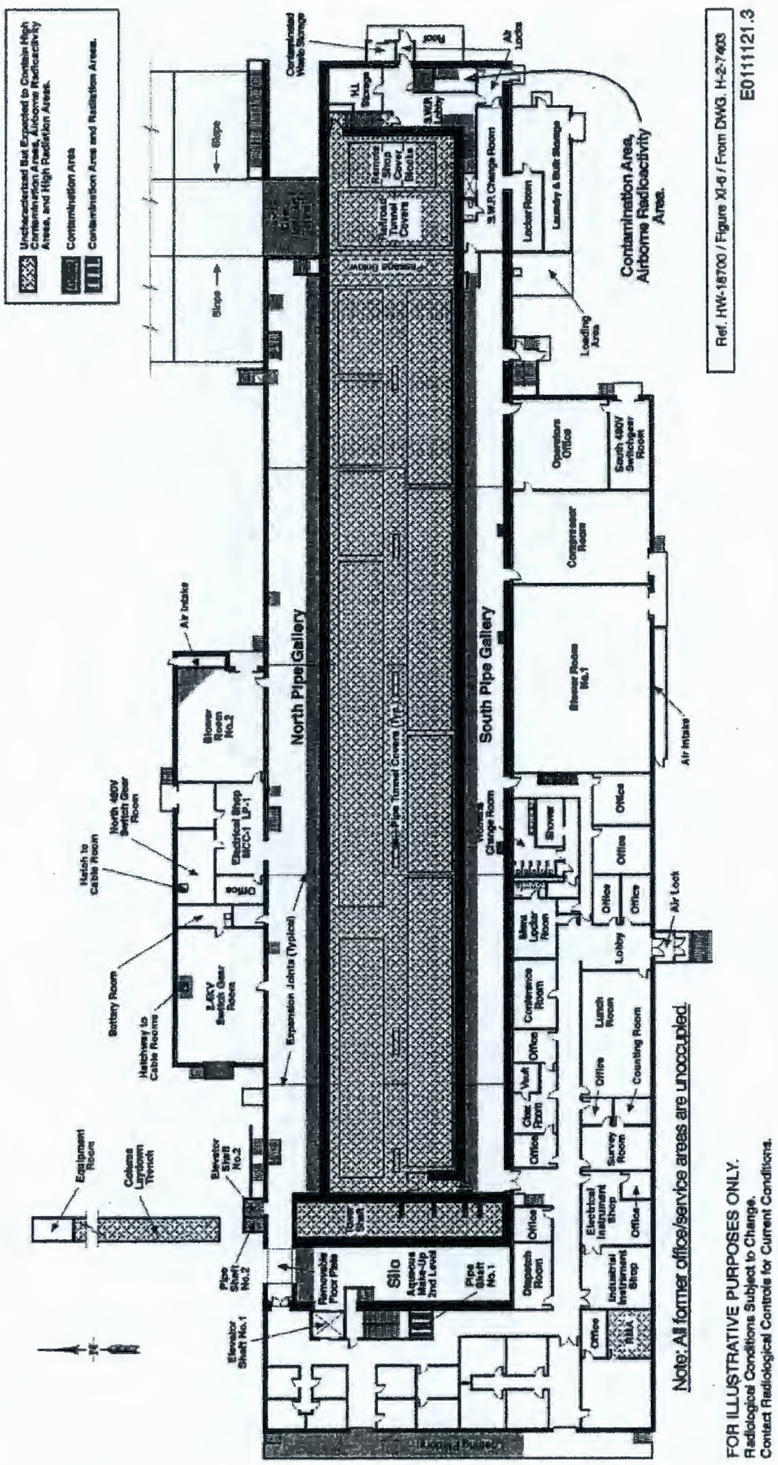


Figure B-4. Plan View Operating Gallery Level.

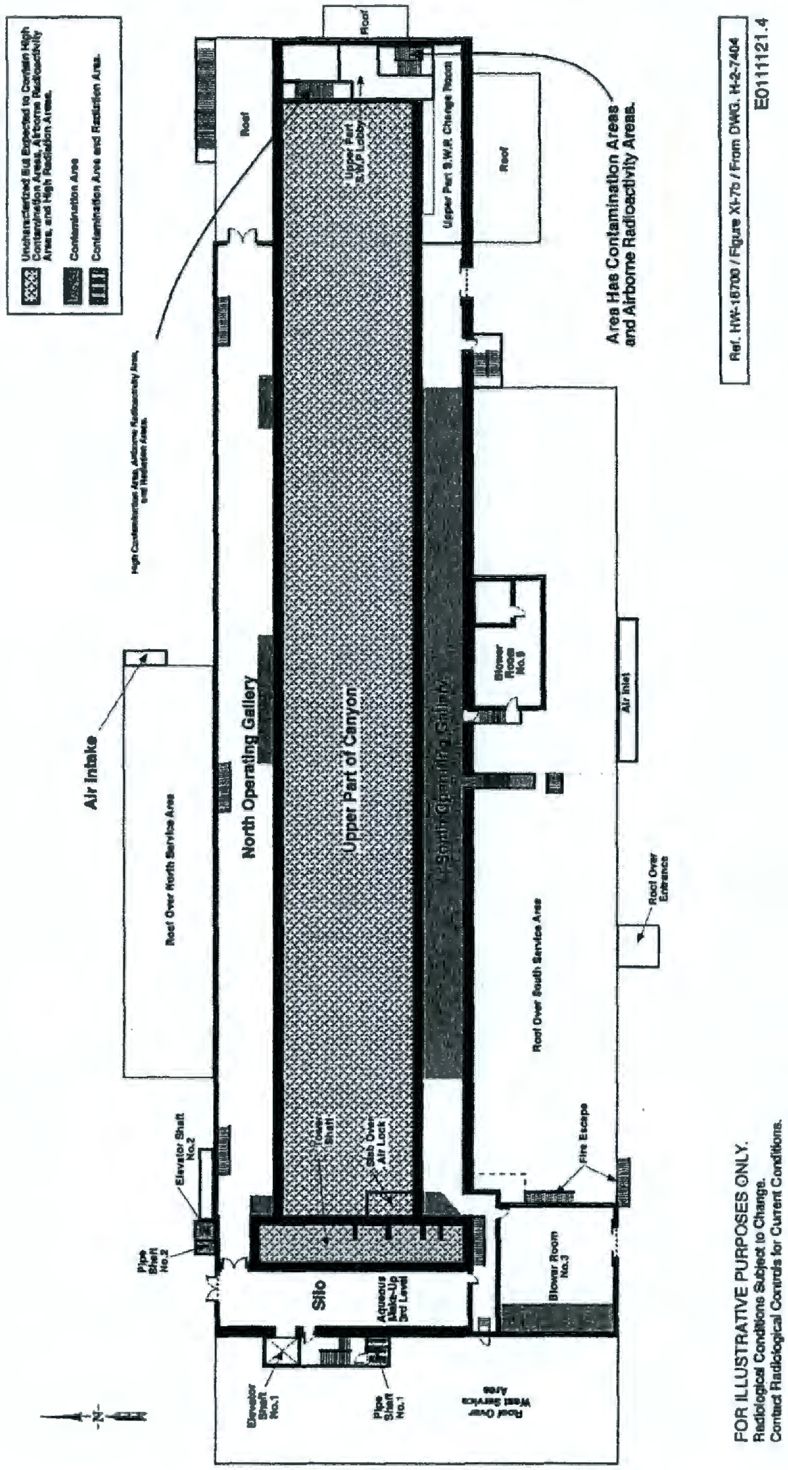
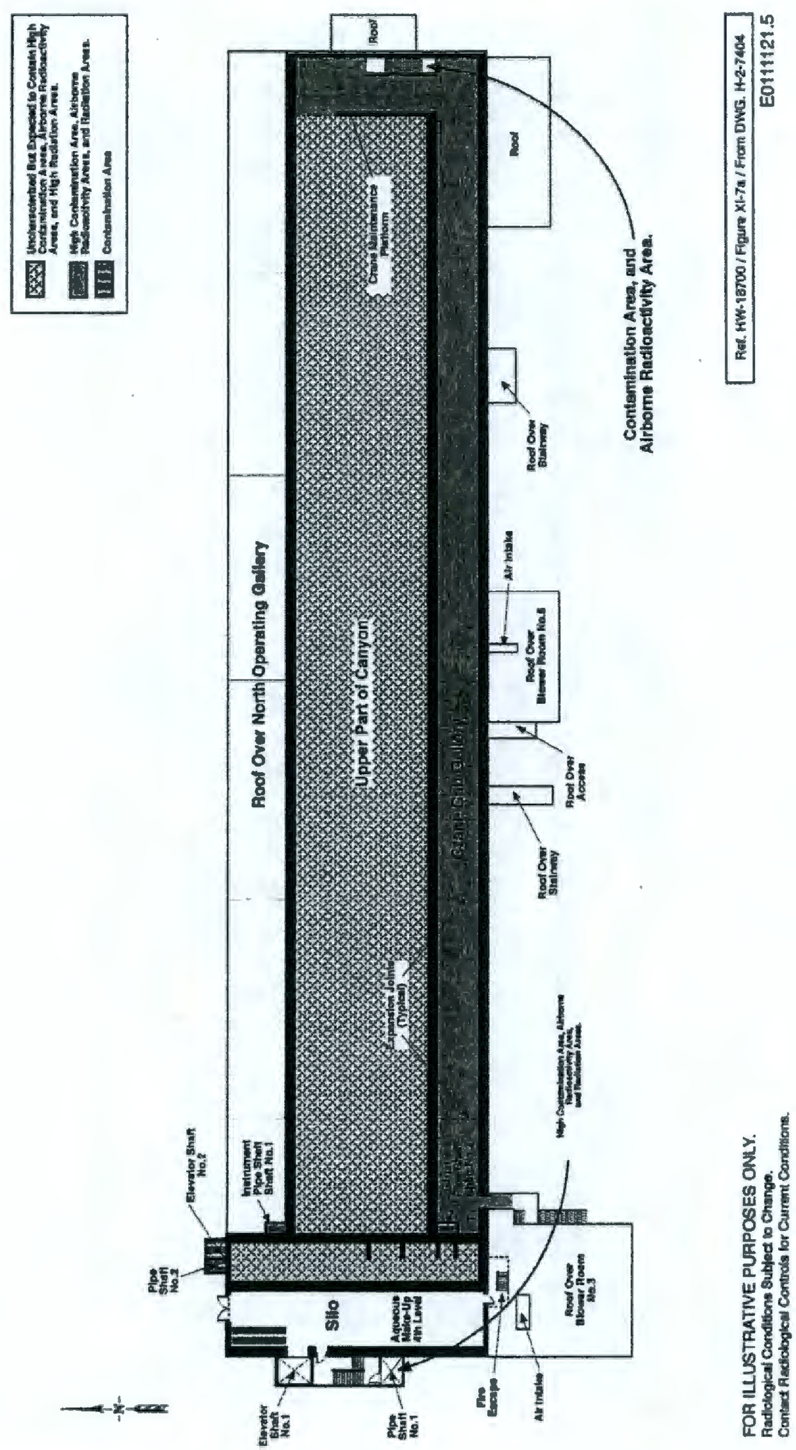


Figure B-5. Plan View Above Crane Cab Gallery Level.



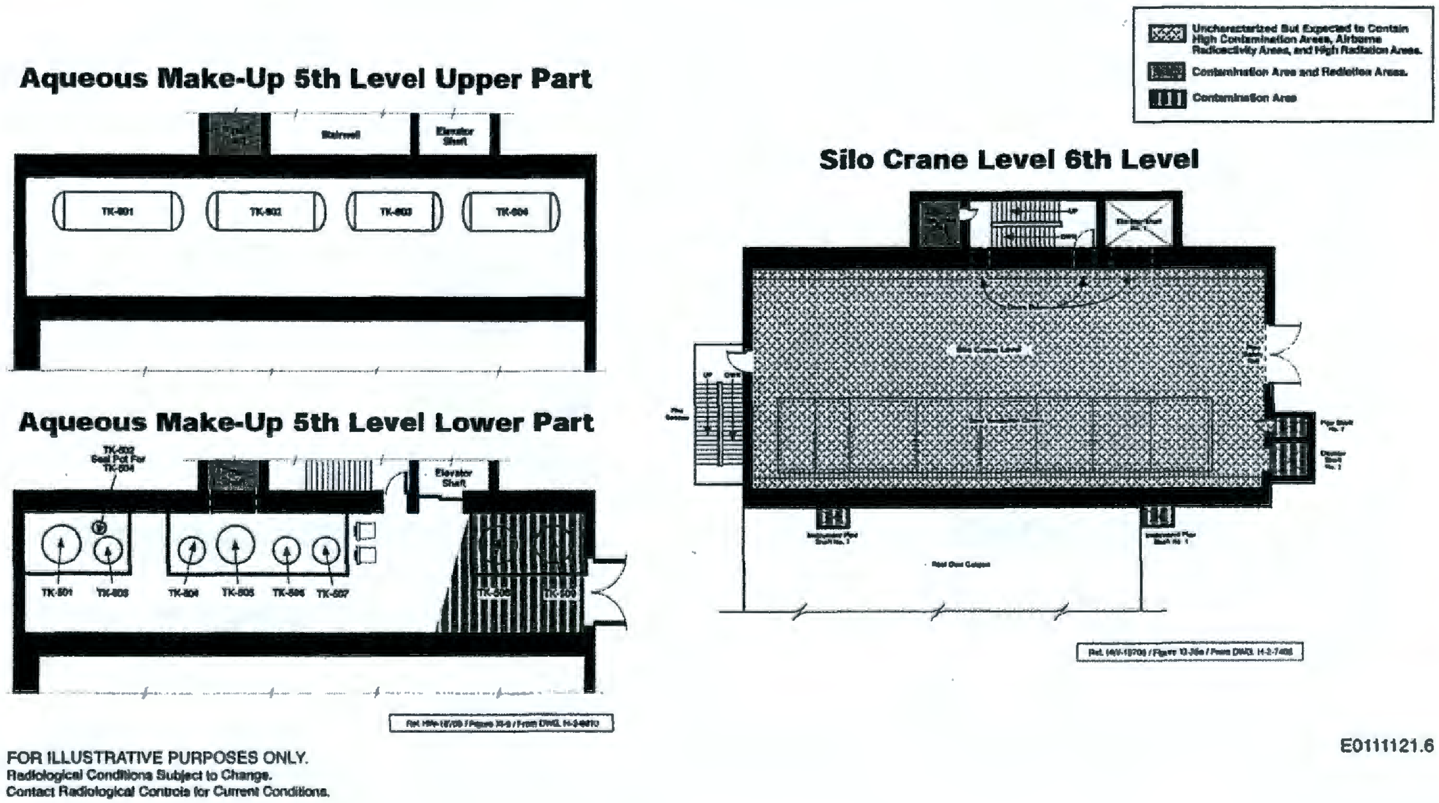
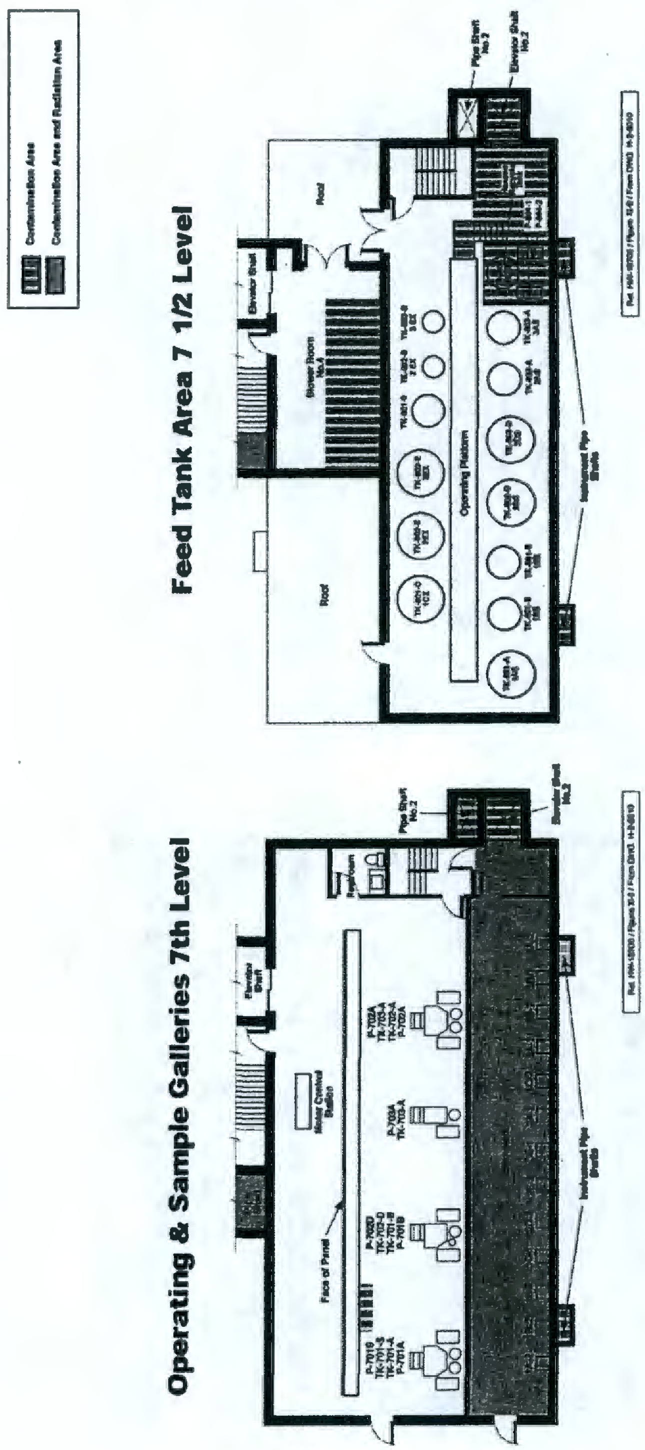


Figure B-6. Plan View Silo Processing.

Figure B-7. Plan View Silo Processing.



FOR ILLUSTRATIVE PURPOSES ONLY.
Radiological Conditions Subject to Change.
Contact Radiological Controls for Current Conditions.

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APPENDIX C

PRODUCT RECEIVER CAGE FIRE EVALUATION

TABLE OF CONTENTS

APPENDIX C

PRODUCT RECEIVER CAGE FIRE EVALUATION

C.1 GENERAL DISCUSSION

To determine if a fire in the product receiver (PR) cage would result in a significant release of contaminants, a PR cage fire was postulated (BHI 1998). The PR cage is known to contain substantial amounts of contaminants and is constructed of combustible materials in the form of polymethyl methacralate (PMMA) panels. With the exception of the PMMA panels, there is no combustible loading of significance in, or adjacent to, the PR cage or contained within the north sample gallery.

Actions initiated in 1999 further stabilized the PR cage and deactivated its exhaust system (i.e., EF-8 HEPA filter bank, EF-8 exhaust fan, and 296-S-2 stack). A layer of absorbent was placed over the waste in the sump of the PR cage and the exterior of the PR cage was sealed to ensure that contaminants cannot migrate into the north sample gallery. After the stabilization of the PR cage was completed, the EF-8 exhaust filter and the stack were shut down and isolated.

C.2 POTENTIAL FOR UNFILTERED RELEASE

Although there is no ignition source in the area of the PR cage that is adequate to achieve the minimum radiant flux (18 KW/m^2) and auto-ignition temperature (885°F) of the PMMA, a postulated fire was modeled using the CFAST zone model (NISTIR 1997). A list of inputs and assumptions is provided in the calculation package but, for illustrative purposes, the initiation and spread of the postulated fire is described in Section C.4.

The PR cage is located in the west end of the north sample gallery. Also near and to the northwest of the PR cage is the elevator shaft No. 2, which is part of the process silo of the REDOX Facility and terminates approximately 40 m above the north sample gallery. Although the north sample gallery is exhausted by the 291-S exhaust system, it is assumed that should the postulated fire occur, an unfiltered release could occur through the elevator No. 2 shaft. Consequently, the stabilization of the PR cage included sealing the potential leak points. Cracks around the doors of the elevator on the silo shaft and the dumb waiter will be sealed with a sealant with a life of 10 years or greater.

C.3 FIRE PROPAGATION DESCRIPTION

The postulated fire is an unmitigated fire that consumes the approximately 400 ft^2 of 0.375-in.-thick PMMA panels that form the PR cage walls, as well as an assumed additional combustible loading of 400 British thermal units (BTU)/ft^2 (approximately 20 lb of Class A combustibles) to account for other combustible materials such as wiring, insulation, and sisal craft paper. For modeling purposes, all combustible materials were normalized to the BTU loading of PMMA.

To maximize the effects of heat and smoke, the fire is assumed to start inside the PR cage at floor-level with an unlimited supply of oxygen. The fire burns unabated, consuming the PMMA and other combustible materials that remain in the PR cage. As the fire continues to burn, the PMMA panels will burn through, opening a direct ventilation path to the north sample gallery. Although it is likely that the 291-S exhaust system would continue to run, the capacity of the exhaust system is likely to be minimal in the area of the PR cage. The smoke is anticipated to slowly spread from the north sample gallery, into the corridor, and eventually would be influenced by the 291-S exhaust air flow. Exhaust from the north sample gallery exits through the corridor to the north and south sample galleries, then down through the remote shop, and then into the building exhaust tunnel (i.e., the wind tunnel).

C.4 PMMA BURN-THROUGH

After the PMMA panels burn through, a direct ventilation path to the north sample gallery would open. After burn-through occurs, the products of combustion would flow into the north sample gallery.

It is also possible that some of the air may flow down the north sample gallery, through the corridor, and down through the regulated shop, decontamination room, and remote shop into the wind tunnel as a result of the operation of the 291-S-1 ventilation system.

C.5 CONSERVATISMS USED IN CFAST CALCULATION

The conservativisms used in the CFAST calculation are as follows:

- The actual mass of combustible material in the PR cage is 460 kg (approximately 900 lb of PMMA and 400 BTU/ft^2 [approximately 20 lb of combustibles]) of additional combustible materials normalized to the BTU loading of PMMA.
- Thermal absorption and convection into concrete, steel, and air mass were ignored, which results in higher-than-actual temperatures.
- The assumed fire growth rate was greater than the actual growth rate for PMMA, as cited in published test data.

- The height of compartment was set to zero to maximize compartment volume and, therefore, create the highest possible temperature output.

- There are no ignition sources inside the PR cage. A fire originating inside the PR cage will be oxygen-limited. The limited oxygen will control a fire until a PMMA panel fails. After a panel fails, the majority of smoke and hot gas will be vented to the north sample gallery.

C.6 CONCLUSIONS BASED ON CFAST CALCULATION

Based on the CFAST calculation, the following conclusions can be made:

- Peak upper layer temperature of 725°F is significantly less than flashover temperatures (900°F to 1,100°F); therefore, flashover will not occur.

- When burn-through of the PMMA panels occur, the PR cage will be exhausted directly to the north sample gallery and will mix with the large volume of cooler air in the gallery before being drawn through the 291-S exhaust system.

- After burn-through of the PMMA panels, the ventilation flow reversal will result in plate-out of combustion products due to cooler temperatures of the building structures.

- Peak temperatures are not expected to cause structural failure of the sample gallery (e.g., concrete walls, floor, and ceiling), the stainless-steel ion-exchange vessels and piping within the PR cage, or the stainless-steel ductwork (NFPA 1997).

C.7 REFERENCES

BHI, 1998, *PR Cage Fire Evaluation*, Calculation 0200W-CA-N0008 (2REDOXPRHOOD), Bechtel Hanford, Inc., Richland, Washington.

NFPA, 1997, *Fire Protection Handbook*, Section 7, Chapter 4, "Structural Integrity During Fire," Eighteenth Edition, National Fire Protection Association, Quincy, Massachusetts.

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APPENDIX D

FIRE HAZARDS ANALYSIS

TABLE OF CONTENTS

FIGURES

TABLES

APPENDIX D

FIRE HAZARDS ANALYSIS

D.1 PURPOSE

A fire hazard analysis (FHA) is required for the Reduction-Oxidation (REDOX) Facility because it is classified as a "nuclear" facility. This FHA provides a comprehensive assessment of the risk from fire within individual fire areas in the REDOX Facility. Using a graded approach, this assessment only addresses sections of U.S. Department of Energy (DOE) Order 5480.7A that are relevant to a deactivated facility in the surveillance and maintenance (S&M) phase. There is no personnel occupancy in any portion of the facility, except for limited surveillance tours and maintenance activities.

D.1.1 Methodology

This FHA was prepared using the following methodology:

- Relevant documents were researched (e.g., drawings, pre-fire plans, and published reports) to identify fire protection features and fire hazards.
- Interviews were conducted with cognizant operations, engineering, and management personnel.
- Fire areas were tentatively defined, and potential fire scenarios were identified.
- Building walkdowns were performed by a fire protection engineer (FPE) with more than 35 years of field experience, and a member of the engineering staff with 3 years of commercial nuclear fire protection experience.
- As a result of walkdowns, both the fire areas and postulated fire scenarios were redefined.

In addition, the FHA was reviewed by operations, engineering, and safety personnel.

D.1.2 Summary of Document

This FHA addresses the REDOX Facility structures, remaining combustibles, and the planned S&M phase activities. Sections D.1.1 through D.6 address the elements required by DOE Order 5480.7A, *Fire Protection,* Section 9.a (3). A graded approach was used to evaluate the impacts of a fire within each fire area, and a qualitative analysis was performed for the balance of other fire areas (Section D.7). The requirements of DOE Order 5480.7A, Section 4, were subjectively evaluated and are addressed in this FHA.

As a result of the approach used, it was natural to present most of the topics of interest by fire area. Accordingly, the fire areas are defined first, with construction information, fire hazards (e.g., combustible loading, ignition sources, and exposure hazards), fire detection, barriers, maximum possible fire loss (MPFL), and maximum credible fire loss (MCFL) arranged by individual fire areas. This did not prove to be burdensome, as only two fire areas were involved.

Some topics of interest were presented at the facility (in lieu of fire area) level. Fire suppression features (i.e., firefighting water supplies) were discussed at the facility level, as there is no active wet or dry sprinkler system in any part of the facility.

Sections D.1 through D.2 identify the buildings included in the REDOX Facility and the property-loss basis used to define the buildings that require fire hazard evaluation. Section D.3 presents the definition of individual fire areas. Section D.4 describes the fire-suppression features provided in the facility.

Section D.5 contains the fire hazard evaluation for each defined fire area during the S&M phase. For each fire area, the construction, construction classification, combustible loading, ignition sources, exposure hazards, fire detection, fire barriers are described, and the MPFL and MCFL are estimated.

Section D.6 addresses the impacts of routine S&M activities, the likelihood of a fire occurring during the S&M phase, the protection of essential safety class equipment, and life safety code requirements.

D.2 DEFINITION OF REDOX FACILITY

The REDOX Facility consists of the buildings identified in Table D-1.

Table D-1. REDOX Facility Buildings. (2 Pages)

Building Identifier	Building Name	Aliases
202-S	Canyon Building	REDOX Canyon, Silo, and Office Building Canyon Building (REDOX) REDOX and Canyon Building
211-S	Liquid chemical storage tank farm	Liquid chemical storage tank farm
276-S (includes underground storage Tanks 276-S-141 and 276-S-142)	Solvent Handling Building	Solvent Handling Facility Cold Solvent Handling Facility
291-S	Exhaust Fan Building, sand filter, and exhaust stack (291-S-1)	Exhaust Fan Facility Exhaust Fan House and control stack 291-S-1 Fan House, sand filter, and stack
292-S	Control and Jet Pit House	Control and Jet Pit House Valve Pit House Jet Pit House

Table D-1. REDOX Facility Buildings. (2 Pages)

Building Identifier	Building Name	Aliases
293-S	Nitric Acid Recovery and Iodine Backup Building	Nitric Acid Recovery and Iodine Backup Facility Off-Gas Treatment Facility Off-Gas Treatment and Recovery
2706-S	Storage Building (demolished)	Storage Building
2710-S	Nitrogen Storage Building	Nitrogen Storage Facility
2711-S	Stack Gas Monitoring Building	Stack Gas Monitoring Building Stack Monitoring Station Stack Gas Monitoring
2715-S	Storage Building	Building Oil Storage Facility
2718-S	Sand Filter Sample Building	Sand Filter Sample Building Sand Filter Sampler Monitoring Station Sand filter sampler
2904-SA	Cooling Water Sampling Building	Cooling Water Sampler Building

D.3 IDENTIFICATION OF VALUED PROPERTY

To determine the current value of property involved, a Richland Property System database report was obtained. The property number, description, and replacement value of the buildings and contained equipment of the REDOX Facility are identified in Table D-2. Valued property is currently limited to the perimeter fence, air compressor, stack sampling equipment, backup diesel generator (which is located outside the perimeter fence), and the railroad tracks. All other buildings and equipment have a property value of zero.

Table D-2. REDOX Facility Valued Property Descriptions. (2 Pages)

Property	Managing Contractor	Information Source	Replacement Value
F039078 chain-link fence	BHI	RL Property Management System Database	$110,550
FA23311 generator (located outside perimeter)	BHI	RL Property Management System Database	$145,956
FA25801 air compressor (located in 202-S)	BHI	RL Property Management System Database	$217,282
F265314 296-S-4 stack sampler	BHI	RL Property Management System Database	$80,160
F265325 296-S-6 stack sampler	BHI	RL Property Management System Database	$44,588

Table D-2. REDOX Facility Valued Property Descriptions. (2 Pages)

Property	Managing Contractor	Information Source	Replacement Value
Cost of monitoring and control upgrade modification attributable to 202-S Building	BHI	Design Engineer responsible for modification	Estimated REDOX replacement value of $1,125,000. $2 million total cost less $0.5 million design cost = $1.5 million value, prorated as follows: 75% REDOX = $1,125,000 25% U Plant = $375,000

BHI = Bechtel Hanford, Inc.

The replacement cost of a ventilation, monitoring, and control upgrade at the 202-S, 221-U, and 271-U Buildings has not yet been reflected in the Property System database. However, the pro-rata portion of this upgrade for the REDOX Facility was determined and is reflected in Table D-2.

D.4 ESTIMATION OF PROPERTY LOSS/RECOVERY COSTS

Because the property value of the above buildings and contents is zero for all buildings and contents (except the 202-S Building), the MPFL and MCFL estimates for these buildings are appropriately based on recovery costs and cleanup of fire-induced releases of contaminants. For the 202-S Canyon Building, the MCFL and MPFL are appropriately based on costs of damage to valued property in addition to the costs associated with cleanup of fire-induced releases of contaminants.

The value, as well as the radiological, toxicological, and biological release potential and the combustible loading for each building within the facility, was considered. The majority of buildings within the REDOX Facility contain only minor amounts of contaminants. For each building, it is judged that the property replacement value (zero) and cleanup cost that would result from a consuming fire would not exceed $1 million. Fire hazard evaluation is not warranted for buildings for which the valued property replacement costs and cleanup costs are less than $1 million. Accordingly, the 211-S, 276-S, 291-S, 292-S, 293-S, 2706-S, 2710-S, 2711-S, 2715-S, 2718-S, and 2904-SA Buildings were screened from further consideration.

However, the 202-S Canyon Building contains significant amounts of radionuclides that could potentially be released as a result of a fire. Accordingly, a fire hazard evaluation is required. A MCFL and MPFL have been estimated for each fire area of the 202-S Building to determine if recovery costs, as a result of the postulated fire, would exceed $1 million.

D.5 CONSTRUCTION FEATURES

The construction features of the 202-S Canyon Building were identified through a combination of document reviews and facility walkdowns. The construction features were used to define the individual fire areas. The specific discussion of construction features that support the defined fire area is contained in the individual fire area evaluations. For the REDOX Facility, the following fire areas were defined:

- Fire Area 1 – All contiguous or communicating areas of the 202-S Canyon Building (i.e., canyon, silo, east end, north service area, south and west service areas, wind tunnel, 291-S sand filter, fan house, exhaust ventilation fans, and 291-S-1 stack).
- Fire Area 2 – The special work permit (SWP) storage annex.

A plan view of the location of these fire areas in the REDOX Facility is shown in Figure D-1.

D.6 FIRE PROTECTION FEATURES

D.6.1 Fire Suppression

There are no wet or dry pipe sprinkler systems in any buildings within the REDOX Facility. There are no portable fire extinguishers located in the 202-S Canyon Building.

Sanitary water supplies used for manual firefighting are provided by the 200 Area water system. The location of the sanitary and raw water supplies is shown in Figure D-2. An existing 20-in. raw water main and a parallel 12-in. sanitary water main are located on the west side of the REDOX Facility. From these mains, a 12-in. raw water line and a 6-in. sanitary line are extended east to the facility on the north side of the 202-S Canyon Building. The 6-in. sanitary water line is terminated in the yard and the 12-in. raw water line is terminated exterior to the 202-S Canyon Building. A 12-in. raw water line and a 12- to -6 in. sanitary water line are extended down the west and south side of the 202-S Canyon Building, also terminating exterior to the 202-S Canyon Building.

Five hydrants are supplied by the sanitary water system near the REDOX Facility. These hydrants are shown in Figure D-2. The flow capability of these hydrants was deemed adequate to meet the fire-flow requirements for the facility, as established by periodic Hanford Fire Department flow tests.

D.6.2 Fire Detection

Fire detection features are discussed in the individual fire area evaluations.

Figure D-1. Plan View Location of Fire Area.

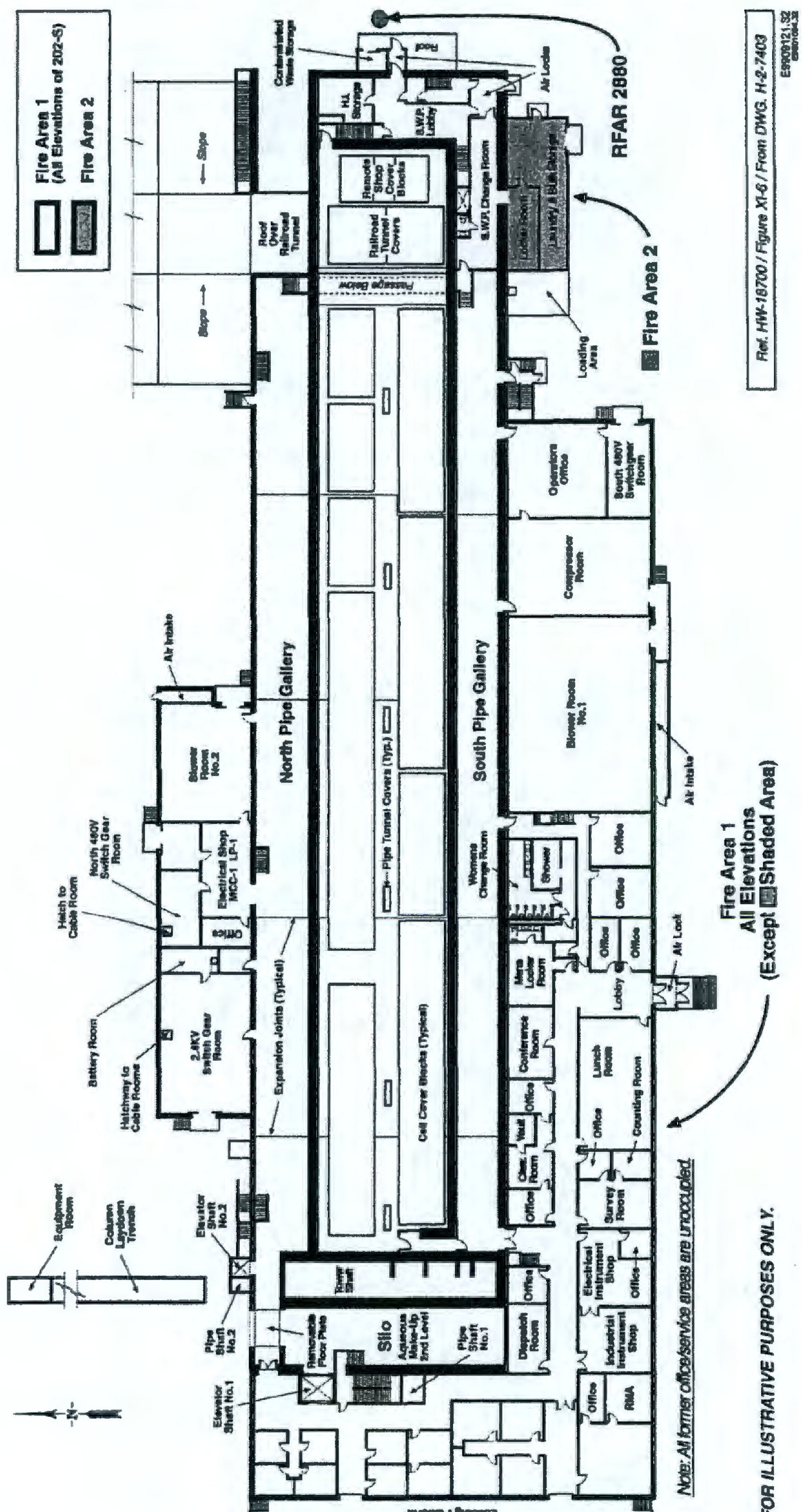
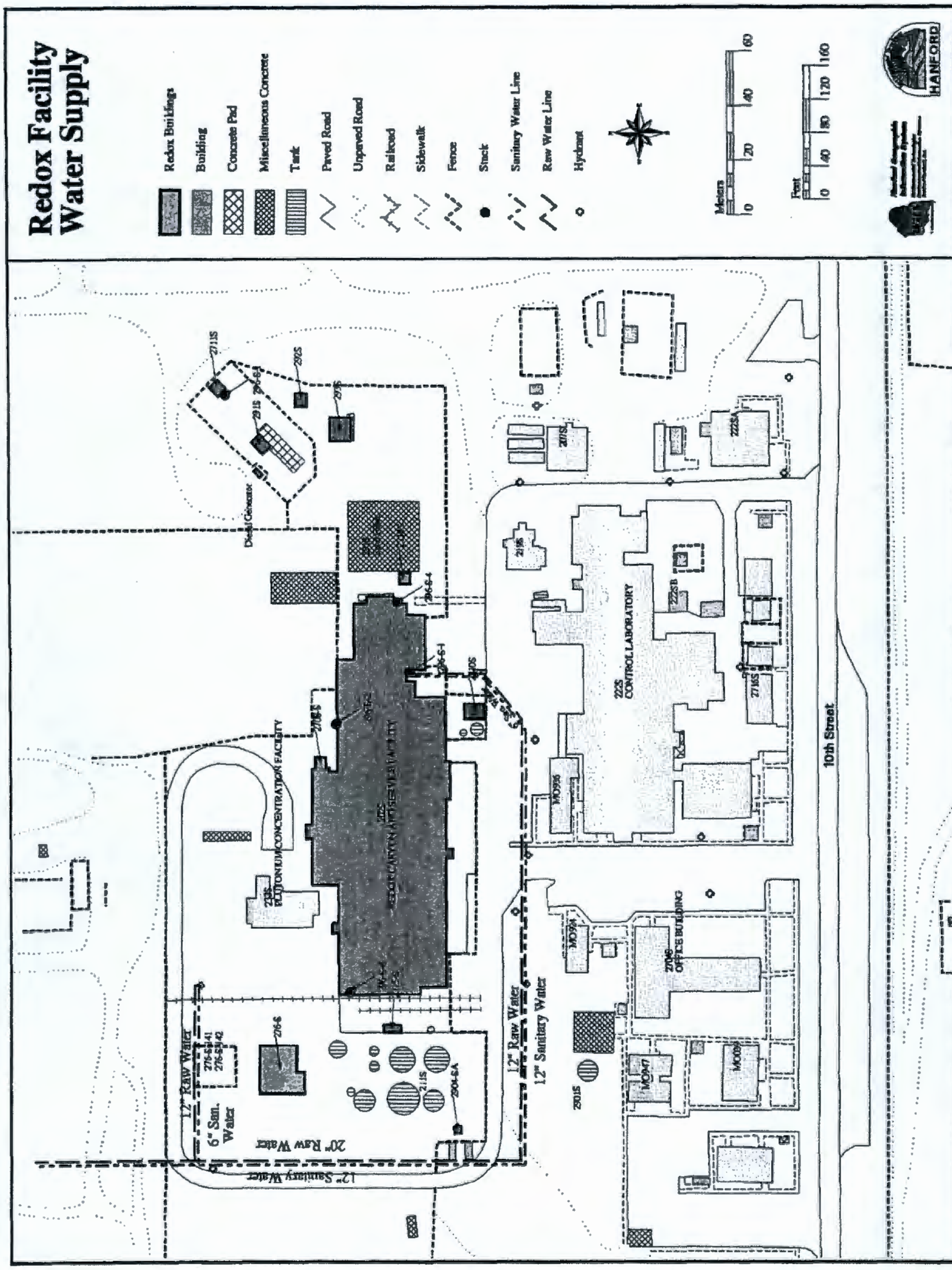


Figure D-2. REDOX Facility Area Water Supply.



D.6.3 Fire Barriers

With the exception of one rated fire barrier (i.e., the door and wall separating the SWP change room from the SWP storage annex), there are no qualified fire or smoke barriers, dampers, or doors in the REDOX Facility. The construction features of the buildings that have inherent fire-resistant properties are discussed in the individual fire area evaluations.

D.6.4 Limiting Oxidant Concentration

Two underground tanks contain residual tars and liquids from the deactivation activities performed in 1991. The tanks, 276-S-141 and 275-S-142, are horizontal, carbon-steel tanks located northwest of the 202-S Building, at a distance of approximately 140 ft from the building (see Figure D-2). A nitrogen supply system is maintained to limit oxidant concentration in the tank void space (NFPA 69).

Characterization records of the contaminated residual in the tanks are limited. Records from 1999 indicate that up to 250 gal of residual tars and up to 30 gal of hexone liquids from the distillation process remained in each tank. Contaminants anticipated include radionuclides, hexone, normal paraffin hydrocarbon and tributyl phosphate.

Tank vapor samples were taken in 1999 in preparation to deactivate the nitrogen system that limits the oxygen concentration in the tanks. Monitoring with field instruments and sampling within the tanks indicated that the vapor concentrations were higher then anticipated. From the verification testing, it was concluded that hexone concentrations would eventually exceed lower flammability limit in one or both of the tanks.

An unreviewed safety question (USQ) safety evaluation (BHI 2000) was performed to evaluate the impact of the 1999 sample data to Rev. 0 of the *REDOX Facility Safety Analysis Report* (BHI 1998). The 1999 evaluation concluded that the worst-case event is a deflagration in either of the tanks. The evaluation concluded that damage would be limited to the tank, the high-efficiency particulate air filter, and the filter enclosure; however, no damage to adjacent structures was predicted. Parts of the tank and the associated vapor handling system (ductwork and filter housings) could become airborne, endangering personnel with a missile hazard. A significant risk of airborne debris exists, which would endanger personnel and could result in a lost-time accident with irreversible injury (e.g., loss of eye). The worst-case release was postulated to be relatively minor. Additional details are found in the USQ safety evaluation (BHI 2000). Controls applied to prevent potential combustion events include (1) limiting access into the fenced area, (2) controlling work procedures compliant with a flammable environment and (3) limiting oxygen levels within the tanks as required by NFPA 69.

D.7 FIRE HAZARD EVALUATIONS FOR EACH FIRE AREA

D.7.1 Fire Area 1

Fire Area 1 consists of all elevations of the 202-S Building canyon, silo, east end, north, south and west service areas, wind tunnel, 291-S sand filter, 291-S exhaust fan facility, and 291-S-1 stack. Fire Area 1 is shown in simplified form in Figure D-1. For additional plan and elevation drawings of Fire Area 1, refer to the figures in Section 2.0 (main text).

Construction

The 202-S Canyon Building is a multi-story, reinforced-concrete structure that is 161 ft wide, 468 ft long, and 75 to 107 ft high. The building is subdivided into three main structural segments (i.e., the canyon, the silo, and the east end) and associated service areas. The three main structural segments are constructed of reinforced concrete, with exterior walls varying from 2 to 5 ft thick.

Canyon

The canyon is 362 ft long, 64 ft wide, and 83 ft high (the upper 60 ft above grade) and consists of nine process cells arranged in two parallel rows (separated by a pipe tunnel) and associated galleries. The north and south faces of the canyon are 5 to 5.5 ft thick from the base of the structure to 33 ft high, then stepped down to an 8-in.-thick sidewall in the top 25 ft of the building. The east and west end sidewalls are 3 ft thick. A 9-in. concrete slab roof is provided. Refer to the plan drawings in Section 2.0 (main text) for additional information on construction details.

Concrete walls, 18 in. in thickness, separate the process cells from the pipe tunnel. Process cells are separated by 4.5-ft-thick walls and are covered by 4-ft-thick removable cover blocks.

Operating, pipe, and sample galleries (which parallel the process cell area) are located on the north and south sides of the canyon. In addition, a storage gallery is located under the south sample gallery. The walls, floors, and ceiling of the gallery areas vary from 1 to 2 ft in thickness.

Silo

The silo segment contains deactivated solvent extraction columns, aqueous makeup units (AMUs), and associated support equipment. The silo is located on the west end of the building, is 84 ft wide, 41 ft deep, and 132 ft high, and contains a process area (tower shaft) and an operating area that has eight separate levels. The process area is 11.5 ft deep by 69 ft wide by 86 ft high. The east, west, and south walls are 3.5-ft-thick concrete and the north wall is 1.5-ft-thick concrete.

Of the eight levels in the operating area of the silo, the first five levels were used for chemical makeup, and the sixth level is the silo crane platform. The seventh level consists of the operating gallery (with a floor area of 2,133 ft^2) and the silo sample gallery (with a floor area 880 ft^2). The eighth level is an equipment area (with an area of 1,874 ft^2) that houses deactivated ventilation equipment.

The exterior walls of the silo vary from 1.5 ft to 3.5 ft in thickness. Interior walls are also constructed of reinforced concrete. The interior wall separating the aqueous makeup area from the tower shaft area is 3 ft in thickness, with a total of 17 lead-glass, mineral-oil-filled viewing windows distributed between the first, second, third, fourth, and fifth levels of the aqueous makeup area. The tower shaft side of the windows are sealed with lead sheeting for shielding purposes.

East End

The east-end segment is 84 ft wide, 66.5 ft deep, and 83 ft high. This segment contains the former hot shops for the facility and the railroad access tunnel to the canyon processing area. The exterior walls of this segment vary from 1.5 to 4 ft in thickness.

Attached Service Areas

In addition to the three canyon segments noted above, three major service areas are attached. A single-story support structure (also known as the north service area) is located on the north side of the building at grade level. A single-story L-shaped support structure (at the south and west service area) is attached to the south and west sides of the canyon building. An exterior annex located south of the SWP change room (SWP storage annex) is used to store SWP clothing and other items.

North Service Area

The north service area contains a 2.4-kV switchgear room, a wet-cell battery room, the north 480-V switchgear room, blower room #2, and the former electric shop and office. Blower room #2 contains a supply fan for the north pipe and operating galleries, which is deactivated. The electrical shop contains the motor control center and lighting panel for the REDOX operating equipment. Because this service area opens directly into the north pipe gallery, it is considered to be a contiguous part of the building.

South and West Service Areas

The south and west service areas contain blower room #1, a compressor room, the south 480-V switchgear room, and former chemical storage, shop, and office areas. Blower room #1 houses deactivated supply fans for the REDOX Facility. The compressor room contains a station air compressor and an instrument air dryer. The south 480-V switchgear room contains deactivated motor control centers.

The interior finish of the service areas is concrete masonry unit walls and/or gypsum board over wood studs. There are dropped ceilings (i.e., ceiling tile on metal grid) in numerous former office spaces. In the administrative areas, flooring is asphalt tile over concrete. The remainder of the flooring is exposed concrete. Because this service area opens directly into the south pipe and operating galleries, it is considered to be a contiguous part of the facility.

Construction Classification

The roof covering of all areas of the 202-S Canyon Building and north service area is tar and gravel over pre-cast concrete-reinforced panels. The roof covering of the south and west service area is Underwriter Laboratory (UL)-listed, Factory Mutual (FM)-approved urethane foam and overcoat. Exterior building seams around the doors are covered with a UL-listed polyurethane foam to preclude water and air infiltration. The 202-S Canyon Building and all contiguous areas are noncombustible structures with a construction classification of Type II (000) in accordance with NFPA 220, *Standard on Types of Building Construction*.

Wind Tunnel, 291-S Sand Filter, 291-S Exhaust Fan House, and 291-S-1 Stack

The 202-S ventilation system consists of two exhaust fans located near the 291-S-1 stack. These fans draw a slight negative pressure on the 202-S Canyon Building, with air flowing from noncontaminated to increasingly contaminated areas through the wind tunnel and an underground sand filter before discharge through the 291-S-1 stack. The wind tunnel, sand filter, fan house, and stack are considered to be a contiguous part of the 202-S Canyon Building.

Both the 291-S sand filter and fan house are construction Type II (000), in accordance with NFPA 220.

Combustible Loading

The amount of fixed combustible loading within Fire Area 1 was qualitatively evaluated by the FPE. Quantitative estimates of fixed combustible loading were not made. Fixed combustible loading in the canyon, east end, and silo segments consists of contamination protective coatings, small amounts of organics (e.g., oil and grease) in equipment and crane gearboxes, deactivated and flushed tanks, other deactivated hydraulic equipment (e.g., pulsers and tunnel door hydraulics), and minor amounts of electrical wiring. In addition, the walls of the product receiver (PR) cage located in the north sample gallery are polymethyl methacralate (PMMA), which represents moderate, localized combustible loading.

A substantial amount of potentially polychlorinated biphenyl (PCB)-contaminated mineral oil is contained in the lead-glass viewing windows of the silo area. A total of 17 mineral-oil-filled viewing windows are located in the shield wall separating the AMU area from the tower shaft area.

Fixed combustible loading in the north service area consists primarily of paint coatings, minor amounts of electrical wiring, and minor amounts of lubricant in deactivated equipment. Fixed combustible loading of the equipment rooms in the south service area is basically the same as that of the north service area. The office areas in the south and west service areas are partially constructed of gypsum board over wood. There is no fixed combustible loading associated with the 291-S sand filter, which is constructed of concrete, aggregate, and sand. Minimal amounts of combustible coatings and electrical wiring are associated with the 291-S fan house.

An open wood skip box (with approximate dimensions of 15 ft by 30 ft by 8 ft) containing contaminated stainless-steel jumpers and deactivated equipment is stored on the canyon deck, away from ignition sources. Because there are no plans to remove this box in the near future, for evaluation purposes this box is considered to be fixed combustible loading. The sole box does not pose a problem, as is it difficult to postulate a realistic fire scenario involving this one particular box. Chemicals (e.g., oils, paint, and solvents) may exist in residual amounts in these areas.

There is a general lack of continuity of combustibles in the building. Although there are some transient combustibles located throughout Fire Area 1 (e.g., wood bulletin boards and signs), the amount is considered inconsequential for an area of this size and construction. A somewhat larger transient combustible loading is present in the SWP change room, where several pairs of SWPs are typically stored in the racks provided. Even if the racks were full, this amount of transient loading is acceptable.

As a result of building walkdowns and document reviews, the fixed combustible loading of Fire Area 1 was assessed as negligible-to-low in the majority of areas within these buildings. The combustible loading of the mineral oil-filled viewing windows located in the silo area and the PR cage PMMA panels is assessed as moderate and localized.

Ignition Sources

Electrical power is provided to the 202-S Canyon Building by an aboveground service entry. Voltage is supplied in energized 2.4-kV, 480-V, 220-V, and 110-V circuits, encased in thin-wall steel conduit. These circuits provide electrical power to the exhaust ventilation fans, lighting, fire detection and alarm systems, batteries, and electrical space heaters.

The battery room, located in the north service area, contains sixty 2.2-V wet-cell batteries and their charging station. These batteries provide the breaker control power to the 2.4-kV switchgear. Although not in a fire-rated separation, the batteries are located in a cast concrete room that is spatially separated from the north pipe gallery by the 2.4-kV switchgear room. The spatial separation is adequate. Explosion, as the result of hydrogen generation in the battery room is not a concern. Adequate ventilation is provided through open doors and a louvered vent that communicates with other areas. In addition, each cell has hydrocaps that recombine hydrogen off-gassing (due to battery charging) and return the resultant water vapor to the cells.

Electric area space heating is provided seasonally (i.e., roughly October through May) in the north and south operating and pipe galleries, south service area compressor room, and the SWP change room. The wall-mounted resistance heaters are thermostatically controlled, permanently mounted, and adequately separated in an elevated position away from combustible materials. These heaters, therefore, do not represent a significant ignition hazard. The circuits supplying the space heaters are energized at all times. General area lighting is provided in the majority of gallery and operating areas. The lights remain turned on continuously in most of these areas.

There are no high-temperature processes conducted in Fire Area 1. With the exception of the possible battery off-gassing addressed above, flammable gases are not produced or stored in Fire Area 1.

Exposure Hazards

Two operating and six deactivated transformers are located outside the north and south service areas. The two operating transformers are located approximately 4 ft north of the north service area on concrete pads surrounded by gravel, without fire-separating enclosures. The two operating transformers are 13.8-kV rated, and each contains 197 gal of fire-resistant dielectric coolant (R-temp fluid). There is no curbing to contain a spill. Of the six deactivated transformers, three transformers are located to the north of the north service area and three transformers are located to the south of the south service area. The cooling oil has been removed from the deactivated transformers.

Building 2710-S also represents an exposure hazard to the 202-S south service area structure because of openings in the south exterior wall of the 202-S south service area to blower room #1. A fire in the 2710-S Building (which is the former nitrogen storage building) is a potential exposure concern, as the building is constructed of combustible materials in close proximity to the 202-S south service area. A consuming fire in the 2710-S Building would result in a total loss of the building, but would not cause a fire of sufficient size to substantively damage the exposed exterior or propagate to the inside of blower room #1. Accordingly, recovery costs would be limited to removal of the 2710-S Building residue and would not exceed $1 million.

Fire Detection

Fire Area 1 has a three-zone fire detection/fire alarm system that currently responds to heat detection or manual pull stations. Zone 3 of the system also includes detectors in the SWP storage annex (located in Fire Area 2). This three-zone system transmits alarm signals via Radio Fire Alarm Reporter (RFAR) Box 2880 to the central fire alarm system at the 200 West Area fire station. A fire alarm control panel is not used in this system. The location of the RFAR box is shown in Figure D-1. The fire detection zones are described in Table D-3.

Table D-3. Fire Area 1 – Fire Detection Zones. (2 Pages)

Zone	Detection/Alarm Capability	Location of Detection	RFAR Box
1	Heat detectors Manual pull station	Cable room #3 (located at sample gallery level) Pull station in cable room outside office	2880
2	Heat detectors Manual pull station	Heat detectors in east end storage (health instrument storage) room Manual pull station on east wall SWP lobby inside east airlock	2880

Table D-3. Fire Area 1 – Fire Detection Zones. (2 Pages)

Zone	Detection/Alarm Capability	Location of Detection	RFAR Box
3	Heat detectors Manual pull station	Heat detectors in SWP lobby (lobby) and southeast corner airlock Pull station in the southeast corner airlock Heat detectors in SWP storage annex (Fire Area 2)	2880

With the exception of the 1.5-hour-rated fire barrier that separates Fire Area 1 from Fire Area 2, Fire Area 1 has no qualified fire barriers, smoke barriers, dampers, or doors for which credit is taken in the evaluation. However, structural elements of reinforced concrete (e.g., walls, floors, and the roof) typically yield a fire-resistance rating of 1 to 3 hours, depending on the thickness of the element.

Maximum Possible Fire Loss

The MPFL estimates that property damage would be expected from a fire, assuming the failure of both automatic fire suppression systems and manual fire fighting efforts. The MPFL estimate is to include the cost of decontamination and cleanup and the consequent effects on related areas.

Selection of MPFL

Each level of the AMU contains one or more mineral-oil-filled windows. The capacity of the windows varies with the type of window. Each thick viewing window has a capacity of 238 gal, and each typical viewing window has a capacity of 137 gal. Accounting for the number and types of windows on each level of the AMU, the capacity potentially available for combustion on each level is 238 gal; 1,125 gal; 613 gal; 649 gal; and 512 gal (for levels 1 through 5, respectively).

All five levels of the AMU are constructed of noncombustible materials, contain no unsealed penetrations, and (with minor exceptions) are noncontaminated areas. In selecting the postulated MPFL, both the combustible loading (i.e., capacity of oil) and the potential for propagation of fire from level to level were considered. Although the floor of the second level is several feet lower than the exterior stairwell, the floors of all other levels are at the stairwell elevation. To determine if a fire on levels 1, 3, 4, or 5 could reasonably propagate to other levels by pool spread, a film thickness was calculated. The calculations assumed the capacities of all windows were released simultaneously and resulted in film thickness ranging from 0.21 in. on level 1 to a maximum of 0.59 in. on level 4.

Although there are no curbs or sills to prevent oil flowing into the stairwell on levels 1, 3, 4, or 5, the size of the door opening (as compared to the room area) would limit the amount available to flow into and down the stairwell. Of the oil flowing down the stairwell, it is reasonable to expect that even less would tend to flow back into lower AMU levels.

In addition, assuming simultaneous release of the total capacities of all windows would require concurrent failures of all windows on a given level. This is highly unlikely because each window is framed in a massive concrete wall with generally substantial spatial separation. It was judged that the propagation of fire through the stairwell was highly unlikely and relatively insignificant when compared to the substantially greater combustible loading of the second level, and the increased upper-layer temperatures that would result from the containment of a fire in the second level.

Accordingly, the MPFL that is postulated in Fire Area 1 results from an unmitigated fire that consumes the mineral oil-filled windows on the second level of the AMU. The second level of the AMU represents the worst-case fire loading for a postulated fire because it has the largest number of oil-filled windows (i.e., six), and also the largest total capacity (i.e., 1,125 gal) on a per-floor basis.

Both the design of the concrete penetration and the location of the drain line and valve for each window will direct window leakage to the AMU side. Accordingly, the entire capacity of mineral oil was assumed to be available to the AMU area. The arrangement of these windows and penetrations is shown in Figure D-3. The postulated fire was modeled using the CFAST zone model to determine if sufficient structural damage to the AMU area or component damage (to the columns located in the tower shaft area) would occur, leading to a significant release of contaminants.

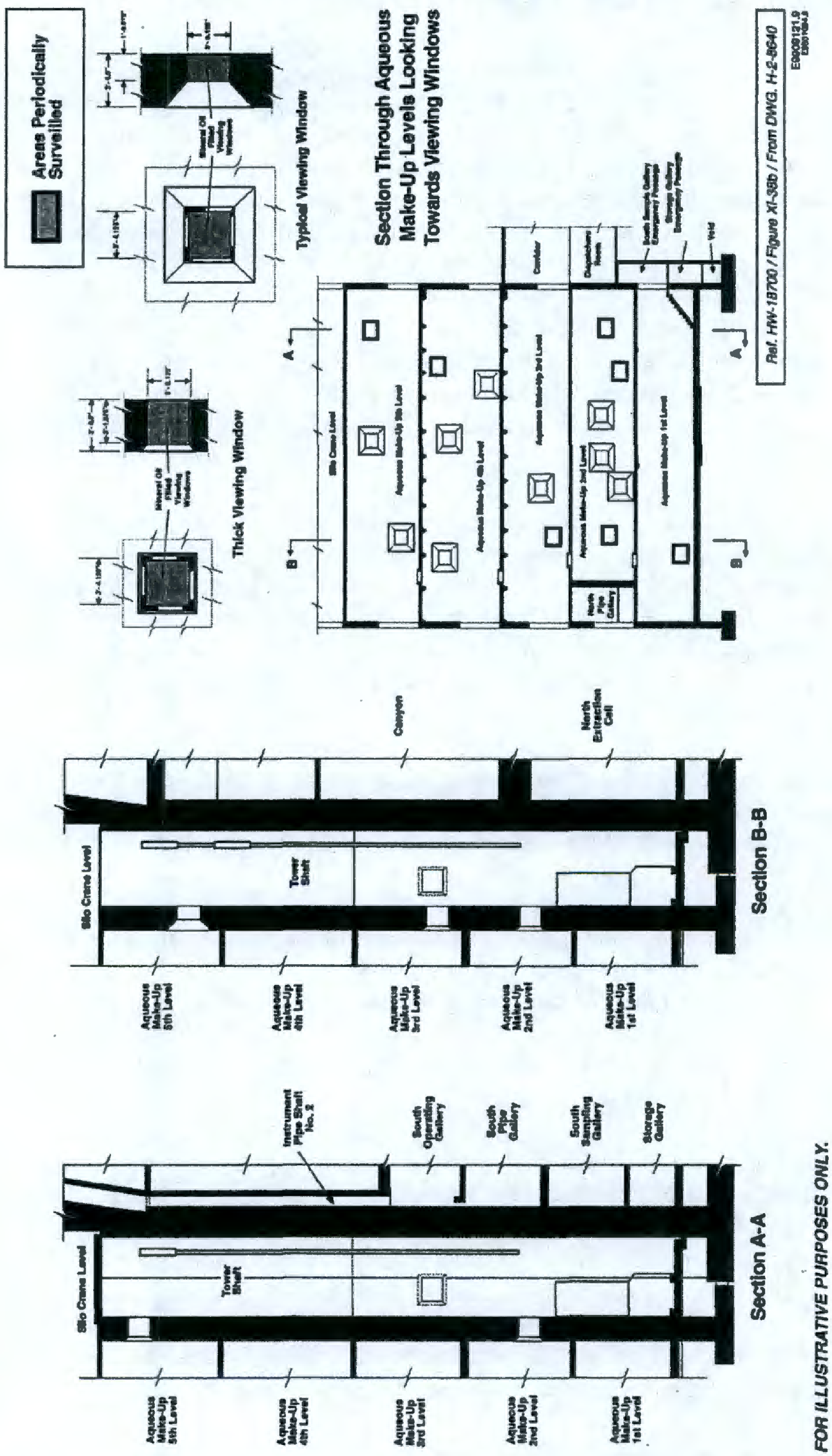
Because all five AMU levels are not contaminated, are constructed of noncombustible materials, and the floor of each level is lower than the entrance door and has no unsealed penetrations between levels (i.e., floors), the oil is assumed to be contained within the room. Because of this containment, the fire does not propagate to other floors.

The postulated MPFL assumes that the entire capacity of mineral oil is immediately available for ignition. The postulated fire instantaneously ignites the oil, which spreads across the concrete floor, consuming the oil and the insignificant amounts of combustibles present in the room. Due to the elevation of the floor with respect to the stairwell doorway, the oil is contained within the room. As a result of elevated temperatures, the lead glass windows will break, opening a ventilation path to the tower shaft.

Smoke will be drawn down the tower shaft into the air tunnel, through the sand filter, and exhausted through the 291-S-1 stack.

Because the sand filter is made of noncombustible materials and is located approximately 550 ft from the fire, failure of the sand filter as a result of elevated temperatures or particulate plateout will not occur. Some smoke may infiltrate the stairwells and escape to the environment. Although a significant release of burning potentially PCB-contaminated oil to the environment is not expected, it is possible that minor amounts may escape through the stairwells.

Figure D-3. Silo Viewing Window Placement.



FOR ILLUSTRATIVE PURPOSES ONLY.

Mineral oil has an ignition temperature of 380°F. A thermal analysis (using the CFAST model) resulted in an upper layer temperature of 979K and a duration of less than 10 minutes. The results of these calculations are shown in Attachment A of this appendix.

As a result of the CFAST calculation, the concrete floor, walls, and ceiling of the room are expected to sustain minor structural damage (e.g., spalling of concrete), and a spread of potentially PCB-contaminated residue within the room is likely to occur and require cleanup. Based on the CFAST calculation, it is judged that the integrity of the extraction columns in the silo (tower shaft) would not be compromised. (See Section D.7.1 for a description of construction and combustible loading in this area.) Recovery costs would be limited to cleanup costs, as there is no valued property associated with the ventilation upgrade modification in the AMU areas.

Because the majority of combustion products will be ventilated through the tower shaft to the sand filter and exhausted through the 291-S-1 stack, environmental cleanup would be limited to localized decontamination and disposal of potentially PCB-contaminated wastes. However, the costs are greatly minimized by the fact that the majority of cleanup activities would be concentrated on the involved elevation of the AMU. The cleanup costs of the postulated MPFL would be substantially less than $1 million.

With regard to the distribution of valued property associated with the ventilation upgrade in the 202-S Canyon Building, the estimated property value is attributable primarily to the cabling and conduit installed for remote-monitoring capability. Because this property is not concentrated in any one area of the 202-S Building, no fire was postulated that could exceed $1 million in damage and cleanup costs.

Maximum Credible Fire Loss

The MCFL estimates property damage that would be expected from a fire assuming that all installed fire protection systems function as designed, and that fire department intervention occurs. However, this intervention is limited to post-fire actions.

Because there is no installed fire protection system in the AMU area, the MPFL and MCFL are the same.

D.7.2 Fire Area 2

Fire Area 2 consists of the SWP storage annex, which is separated from Fire Area 1 by a 1.5-hour-rated fire barrier. Fire Area 2 is shown in Figure D-1.

Construction

The SWP storage annex is a steel-panel/steel-purlin-constructed building that shares a common wall with the south wall of the 202-S Canyon Building (Fire Area 1). The SWP storage annex is separated from Fire Area 1 by a 1.5-hour-rated fire barrier. The roof is constructed of sheet metal.

Construction Classification

The SWP storage annex is a noncombustible structure with a construction classification of Type II (000) in accordance with NFPA 220.

Combustibles

Inconsequential amounts of fixed combustibles (e.g., minor amounts of electrical wiring) are located in Fire Area 2. However, the SWP storage annex is used to store a significant amount of combustible materials.

Up to 35 bags of clean anti-contamination apparel, as well as a supply of respirators, step-off pads, cloth rags, swipes, flexible cords, waste bags, and laundry bags are contained in this area.

Ignition Sources

Energized electrical circuits in conduit are present in Fire Area 2. No flammable gases or compressed gases are stored or produced in this area.

Exposure Hazards

No exposure hazards were identified for Fire Area 2.

Fire Detection

Fire Area 2 shares a fire detection system with Fire Area 1. Heat detectors located in the SWP storage annex initiate a Zone 3 alarm.

Fire Barriers

While there are no qualified fire barriers, smoke barriers, dampers, or doors throughout Fire Area 2, the barrier between Fire Area 1 and Fire Area 2 is a 1.5-hour-rated fire door, and the separating wall of 18 in. of concrete typically yields a fire-resistance rating of 2 hours. No open penetrations are found between Fire Area 1 and 2.

Maximum Possible Fire Loss

The MPFL that is postulated will result from an unmitigated fire that consumes all combustible materials in the SWP storage annex, resulting in a total loss of the building. The postulated MPFL assumes that all stored clothing is available and simultaneously ignites. The subsequent fire would consume the combustibles and destroy the sheet-panel structure.

Negligible amounts of contamination may exist on the "clean" anti-contamination clothing; therefore, it is postulated that a negligible amount of contamination could be released as a result of a totally consuming fire. Cleanup costs for removal of the structure and residue would be incurred, but are not expected to exceed $1 million.

Maximum Credible Fire Loss

Because there is no installed automatic fire protection systems in the SWP storage annex, the MPFL and the MCFL are the same.

D.8 FIRE PROTECTION CONSIDERATIONS DURING SURVEILLANCE AND MAINTENANCE

D.8.1 Combustible Loading During Surveillance and Maintenance Phase – All Fire Areas

The S&M activities in fire areas introduce minor amounts of combustibles to the facility. These combustibles are maintained as low as reasonably achievable and include protective clothing, respirators, step-off pads, cloth rags, swipes, and flexible cords. With the exception of the contamination clothing storage in the SWP change room (in Fire Area 1) and the SWP storage annex (in Fire Area 2), the transient combustibles are typically removed from the facility at the conclusion of the S&M activities.

D.8.2 Protection of Essential Safety Class Equipment

No safety class equipment is located in the 202-S Canyon Building.

D.8.3 Likelihood of Fire During Surveillance and Maintenance

The purpose of evaluating the MCFL is to assess damage limitation provided by automatic suppression systems. The term "credible" is applied only when assessing the protection afforded by an automatic fire protection system for mitigation of property loss and program interruption and is applied without considering the probability of a fire occurring.

The probability of a fire occurring in the 202-S Canyon Building during routine S&M activities was assessed by the FPE. The ignition temperatures of the combustibles are high, and the combustibles are not physically located in the proximity of the ignition sources. The S&M activities typically do not introduce significant amounts of combustibles or ignition hazards, nor occur in highly contaminated areas (e.g., canyon, cell, and process hood areas). The S&M activities typically do not include dismantling, cutting, or removing process equipment, or do not involve welding, grinding, or cutting operations that would lead to a fire-induced release of material.

Accordingly, the likelihood of a fire occurring during S&M activities was considered highly unlikely. It is difficult to postulate a credible fire scenario that could lead to a release of contaminants due to the general lack of combustibles, lack of ignition sources, and the fact that most contaminants are confined in process vessels, piping, or building areas that have inherent fire-resistant properties. It is the opinion of the fire protection and engineering staff that the likelihood of a fire-induced release resulting from S&M activities in the 202-S Canyon Building is not a credible event.

D.8.4 Life Safety Code

The 202-S Canyon Building is not normally occupied and has an occupancy classification of "Special Purpose Industrial," as defined by NFPA 101, *Life Safety Code*. All portions of the REDOX Facility are unoccupied. Adequate means of egress and exits are provided for all areas. There were no life-safety deficiencies identified that warrant corrective action under the current occupancy status of the 202-S Canyon Building.

Periodic entries are made to perform S&M activities. Exit doors in the 202-S Canyon Building do not have self-illuminating exit signs. The 202-S Canyon Building does not have emergency lighting provided, and all personnel entering these buildings are required to carry flashlights and communications devices (i.e., radio and/or cellular phone) to report emergencies, as the fire detection and alarm systems are limited to specific areas.

There are no special locking mechanisms on the personnel exit doors, which are maintained available and accessible at all times when personnel are working in the facility. The anticipated occupancy load for the facility during S&M activities does not exceed 10 personnel. The personnel performing S&M are familiar with all exits, emergency warning signals, and required responses.

Fire Department Response

Response to a fire at the 202-S Canyon Building would be from Hanford Fire Station #2, which is located midway between the 200 East and 200 West Areas. Fire Station #2 currently has the following response apparatus: an aerial device/pumper, a tanker/pumper, a foam/dry chemical fast-attack vehicle, a hazardous material incident vehicle, and an ambulance.

The present strategy for initial fire response is to dispatch a single aerial device/pumper and an ambulance from the closest fire station to provide the initial response/attack capability. A backup aerial device/pumper is also dispatched from the next closest fire station to provide a combined two-engine response capability. Response time is estimated to be between 4 and 5 minutes.

No credit was taken in the MPFL or MCFL for response or action by the fire department.

D.8.5 Fire Restrictions During Surveillance and Maintenance Phase

In addition to good housekeeping practices and existing generic fire protection and life safety code program requirements, the following specific fire restrictions apply to S&M activities:

- There shall be no open flame (i.e., welding or cutting operation) authorized in any fire area without the prior review and concurrence of both the field safety and the FPE. Compliance with existing job control/work planning requirements is required for all other grinding or shearing operations that may be required during S&M activities.
- Exits shall be maintained available and accessible at all times when personnel are working in the facility.

D.9 REFERENCES

BHI, 1998, *REDOX Facility Safety Analysis Report*, BHI-01142, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2000, *Safety Evaluation Update for Hexone Tanks 276-S-141 and 276-S-142*, 0200W-US-N0183-02, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

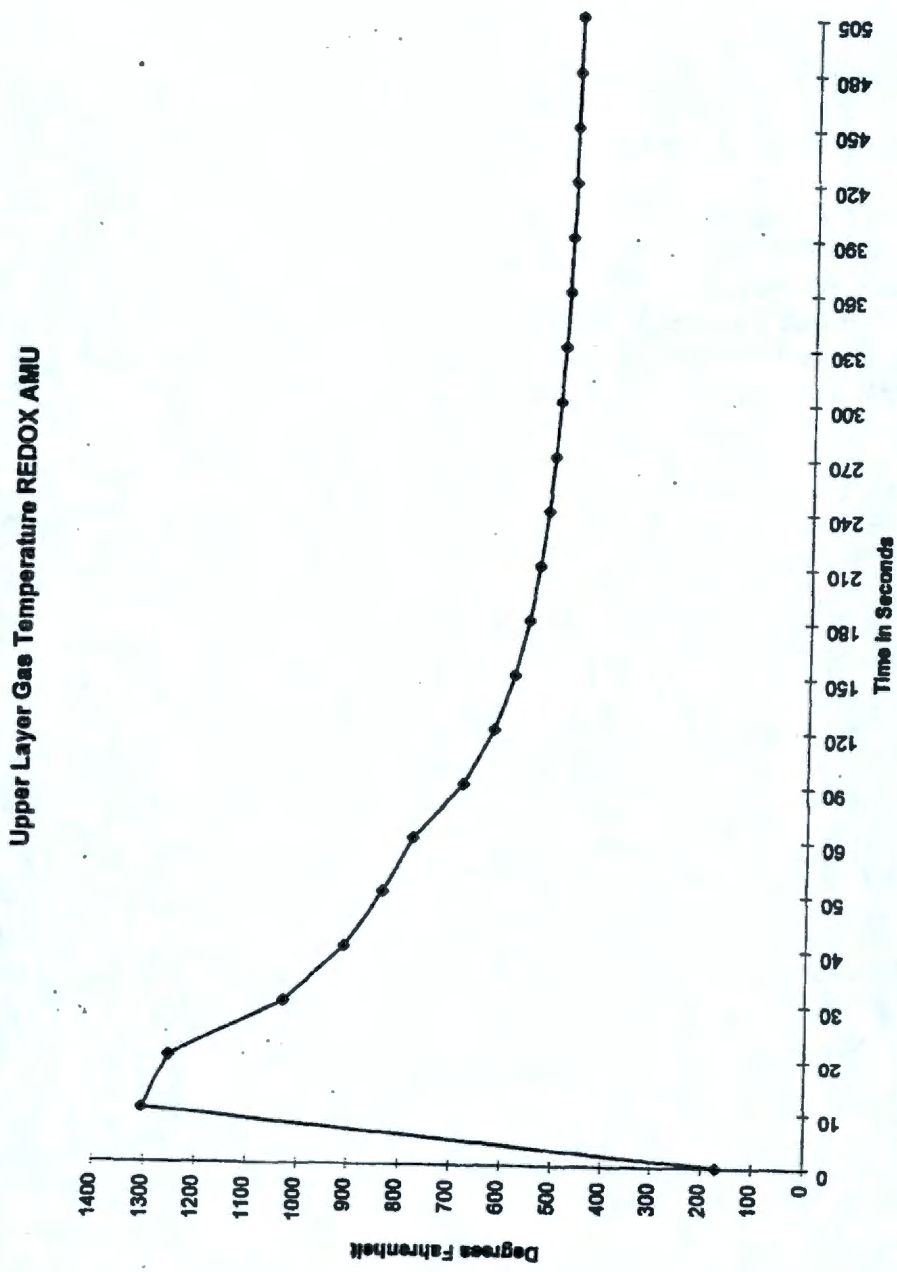
DOE Order 5480.7A, *Fire Protection*, as amended, U.S. Department of Energy, Washington, D.C.

NFPA 69, *Standards for Explosion Prevention Systems*, as amended, National Fire Protection Association, Quincy, Massachusetts.

NFPA 101, *Life Safety Code*, as amended, National Fire Protection Association, Quincy, Massachusetts.

NPFA 200, *Standards for Types of Building Construction*, as amended, National Fire Protection Association, Quincy, Massachusetts.

ATTACHMENT A


Upper Layer Gas Temperature REDOX AMU
Degrees Fahrenheit
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
Time in Seconds
0
10
20
30
40
50
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
505

REDOX AMU

Inputs.
6 windows – 1125 gallons mineral oil total
Ignition Temperature – 380°F (SFPE Handbook, Table 2-1.2)
Energy: 46.0 mj/kg (SFPE Handbook. Table 2-1.2)

1776.5 sq ft. floor area
18" sill to stairwell
8" reinforced concrete floor
12" reinforced North, East and West walls
22" wall separating canyon/windows slope and drain to the AMU.
Vent – 36" x 6'8" door (3' x 6.7')

```
**      CFAST  Version   2.0.1  Run  1/3/97        **
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**              Gaithersburg, MD  20899            **
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Time = 0.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	350.0	350.0	9.8	0.000	0.000
Outside					0.000

Time = 10.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	979.1	355.3	0.23	1.29	6.000E+07
Outside					0.000

Time = 20.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	952.5	403.8	0.38	1.29	3.092E+07
Outside					0.000

Time = 30.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	828.1	411.8	0.33	1.29	1.715E+07
Outside					1.413E+05

Time = 40.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	762.4	407.3	0.32	1.29	1.230E+07
Outside					7.748E+05

Time = 50.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	719.8	402.1	0.31	1.29	9.839E+06
Outside					1.661E+06

Time = 60.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	689.3	398.9	0.30	1.29	8.405E+06
Outside					2.756E+06

Time = 70.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	666.5	399.4	0.30	1.29	7.442E+06
Outside					3.858E+06

Time = 80.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	648.4	399.6	0.30	1.29	6.737E+06
Outside					4.953E+06

Time = 90.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	633.6	399.5	0.30	1.29	6.196E+06
Outside					6.046E+06

Time = 100.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	621.1	399.2	0.30	1.29	5.768E+06
Outside					7.133E+06

Time = 110.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	610.6	398.8	0.30	1.29	5.419E+06
Outside					8.206E+06

Time = 120.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	601.5	398.3	0.29	1.29	5.128E+06
Outside					9.263E+06

Time = 130.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	593.5	397.8	0.29	1.29	4.882E+06
Outside					1.030E+07

Time = 140.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	586.6	397.3	0.29	1.29	4.670E+06
Outside					1.132E+07

Time = 150.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	580.4	396.8	0.29	1.29	4.487E+06
Outside					1.232E+07

Time = 160.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	574.9	396.3	0.29	1.29	4.326E+06
Outside					1.330E+07

Time = 170.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	570.0	395.8	0.29	1.29	4.184E+06
Outside					1.426E+07

Time = 180.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	565.6	395.4	0.29	1.29	4.059E+06
Outside					1.520E+07

Time = 190.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	561.6	394.9	0.29	1.29	3.946E+06
Outside					1.612E+07

Time = 200.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	558.0	394.5	0.29	1.29	3.845E+06
Outside					1.702E+07

Time = 210.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	554.7	394.2	0.29	1.29	3.755E+06
Outside					1.789E+07

Time = 220.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	551.7	393.8	0.29	1.29	3.673E+06
Outside					1.875E+07

Time = 230.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	549.0	393.5	0.29	1.29	3.598E+06
Outside					1.959E+07

Time = 240.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	546.5	393.1	0.29	1.29	3.530E+06
Outside					2.041E+07

Time = 250.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	544.2	392.9	0.29	1.29	3.467E+06
Outside					2.121E+07

Time = 260.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	542.1	392.6	0.29	1.29	3.410E+06
Outside					2.200E+07

Time = 270.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	540.2	392.3	0.29	1.29	3.358E+06
Outside					2.276E+07

Time = 280.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	538.4	392.1	0.29	1.29	3.310E+06
Outside					2.351E+07

Time = 290.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	536.7	391.9	0.29	1.29	3.265E+06
Outside					2.425E+07

Time = 300.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	535.2	391.7	0.29	1.29	3.224E+06
Outside					2.496E+07

Time = 310.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	533.8	391.5	0.29	1.29	3.185E+06
Outside					2.566E+07

Time = 320.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	532.4	391.3	0.29	1.29	3.150E+06
Outside					2.635E+07

Time = 330.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	531.2	391.2	0.29	1.29	3.117E+06
Outside					2.702E+07

Time = 340.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	530.1	391.0	0.29	1.29	3.086E+06
Outside					2.768E+07

Time = 350.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	529.0	390.9	0.29	1.29	3.058E+06
Outside					2.832E+07

Time = 360.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	528.1	390.7	0.29	1.29	3.031E+06
Outside					2.895E+07

Time = 370.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	527.1	390.6	0.29	1.29	3.006E+06
Outside					2.956E+07

Time = 380.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	526.3	390.5	0.29	1.29	2.982E+06
Outside					3.016E+07

Time = 390.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	525.5	390.4	0.29	1.29	2.960E+06
Outside					3.075E+07

Time = 400.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	524.8	390.3	0.29	1.29	2.940E+06
Outside					3.133E+07

Time = 410.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	524.1	390.3	0.29	1.29	2.921E+06
Outside					3.189E+07

Time = 420.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	523.4	390.2	0.29	1.29	2.902E+06
Outside					3.244E+07

Time = 430.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	522.8	390.1	0.29	1.29	2.885E+06
Outside					3.298E+07

Time = 440.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	522.3	390.1	0.29	1.29	2.869E+06
Outside					3.351E+07

Time = 450.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	521.8	390.0	0.29	1.29	2.854E+06
Outside					3.403E+07

Time = 460.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	521.3	390.0	0.29	1.29	2.840E+06
Outside					3.453E+07

Time = 470.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	520.8	389.9	0.29	1.29	2.826E+06
Outside					3.503E+07

Time = 480.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	520.4	389.9	0.29	1.29	2.814E+06
Outside					3.551E+07

Time = 490.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	520.0	389.9	0.29	1.29	2.802E+06
Outside					3.599E+07

Time = 500.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	519.7	389.9	0.29	1.29	2.790E+06
Outside					3.645E+07

Time = 505.0 seconds.

Compartment	Upper Temp. (K)	Lower Temp. (K)	Inter. Height (m)	Pyrol Rate (kg/s)	Fire Size (W)
1	519.1	388.8	0.30	0.000	0.000
Outside					0.000

APPENDIX E

TECHNICAL SAFETY REQUIREMENTS FOR REDOX SURVEILLANCE AND MAINTENANCE

TABLE OF CONTENTS

TABLES

APPENDIX E

TECHNICAL SAFETY REQUIREMENTS FOR REDOX SURVEILLANCE AND MAINTENANCE

E.1 USE AND APPLICATIONS

This section contains basic information and instructions for using and applying the technical safety requirements (TSRs) and complies with U.S. Department of Energy (DOE) Order 5480.21, as implemented by Bechtel Hanford, Inc. (BHI) agreements and procedures. See Section 5.0 (main text) for the project-specific implementation commitments regarding TSRs.

E.1.1 Definitions

NOTE: Defined terms in this list appear in uppercase type throughout these TSRs.

Term	**Definition**
ADMINISTRATIVE TSRs	Provisions relating to organization and management, procedures, record keeping, assessment, and reporting necessary to control operation of the facility such that the AUTHORIZATION BASIS is maintained.
AUTHORIZATION BASIS	Those aspects of the facility design basis and operational requirements considered to be important to safety and relied on by DOE to authorize nuclear facility operation.
DESIGN FEATURE	Passive design features of the facility which, if altered or modified, would have a significant effect on safety operation.
FISSIONABLE MATERIAL	Radionuclides capable of sustaining a neutron chain reaction. Natural uranium, depleted uranium, and thorium are not considered to be fissionable materials for the purpose of maintaining a criticality safety program.
LIMITING CONDITIONS FOR OPERATION (LCOs)	The lowest functional capability or performance levels of essential safety-related hardware.
LIMITING CONTROL SETTINGS (LCSs)	Settings on safety systems that control process variables to prevent exceeding the SAFETY LIMITS.

Term	**Definition**
NORMAL OPERATIONS	(See Section E.1.2.)
OPERABLE/ INOPERABLE OPERABILITY	A system, subsystem, train, component, or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified function(s), and when all necessary attendant instrumentation, controls, electrical power, cooling or seal water, lubrication, or other auxiliary equipment that are required for the system, subsystem, train, component, or device to perform its function(s) are also capable of performing their related support function(s). (See Section E.1.8.)
OPERATING LIMITS	LCS and LCO.
OPERATIONAL MODES	OPERATIONAL MODES for the Reduction-Oxidation (REDOX) Facility are NORMAL OPERATIONS. (See Section E.1.2.)
RECOVERY PLAN	A RECOVERY PLAN shall be developed following a violation of an Administrative Control. The recovery plan shall describe the steps necessary to return to compliance with the requirements contained in the Administrative Control.
SAFETY LIMITS (SLs)	Limits on process variables associated with those physical barriers that are necessary for the intended facility function and found to be required to guard against the uncontrolled release of radioactive and other hazardous materials.
SURVEILLANCE REQUIREMENTS (SRs)	Requirements related to testing, calibration, or inspection to ensure OPERABILITY of safety-related equipment and required support systems, or to ensure that operations are within the specified LCO.
VIOLATION	(See Section E.1.7.)

E.1.2 Operational Modes

The operational conditions and modes that apply to the REDOX Facility and its operations are defined as follows:

Term	Definition
NORMAL OPERATIONS	Surveillance and maintenance (S&M) activities are performed. The radioactive material inventory meets or exceeds the hazard category 3 threshold as defined in DOE-STD-1027-92 (DOE 1992).

E.1.3 Frequency Notations

The frequency notations, as used in the SRs and elsewhere in the TSRs, are defined as follows:

Table E-1. Frequency Notations.

Notation	Minimum Frequency (Periodicity Notation)	Maximum Extension Between Surveillance[a]
Weekly	At least once every 7 days	Not to exceed 9 days
Monthly	At least once every 31 days	Not to exceed 39 days
Quarterly	At least once every 92 days	Not to exceed 115 days
Annually	At least once every 12 months	Not to exceed 15 months

[a] Each SURVEILLANCE REQUIREMENT shall be performed within the specified interval, with a maximum extension of 25% of the interval between any two consecutive surveillances. This extension is intended to provide operational flexibility and should not be relied upon as a routine extension of the specified interval.

E.1.4 Acronyms

BHI	Bechtel Hanford, Inc.
DOE	U.S. Department of Energy
EDPI	Engineering Department Project Instruction
EF	exhaust fan
LCO	limiting condition for operation
LCS	limiting control setting
LOC	limited oxygen concentration
PR	product receiver
SAR	safety analysis report
REDOX	Reduction-Oxidation (Facility)
RL	U.S. Department of Energy, Richland Operations Office
RWP	radiation work permit
S&M	surveillance and maintenance

SL	safety limit
SR	surveillance requirement
TSR	technical safety requirement
USQ	unreviewed safety question

E.1.5 Purpose and Application of Technical Safety Requirements

The SRs are requirements relating to test, calibration, or inspection to assure that the necessary function of systems and components is maintained. Rules for application of SRs are listed in Table E-2.

Table E-2. Rules for Application of Surveillance Requirements.

SRs must be met for all equipment/components/conditions to be considered OPERABLE.
Each SR shall be performed within the specified interval, with a maximum extension of 25% of the interval between any two consecutive surveillances. (See Table E-1.)
Failure to perform a surveillance within the required time interval, or failure of a surveillance test shall result in the equipment/component/condition being declared INOPERABLE and the action stipulated for the INOPERABLE equipment/component/condition being taken.

E.1.6 Alternate Emergency Actions

Emergency actions may be taken in special circumstances. In an emergency, if a situation develops that is not addressed by the TSRs, staff members are expected to use their training and expertise to take actions to correct or mitigate the situation. Also, staff may take actions that depart from a requirement in the TSRs provided that the following conditions apply:

- An emergency situation exists.
- These actions are needed immediately to protect the public health and safety.
- No action consistent with the TSR can provide adequate or equivalent protection.

Such actions shall be approved, as a minimum, by either the S&M Task Lead, S&M Project Manager, or the REDOX Building Emergency Director. If emergency actions are taken, verbal notifications shall be made to the U.S. Department of Energy, Richland Operations Office (RL) Facility Representative within 2 hours, and written reports shall be made to DOE-Headquarters within 24 hours (DOE Order 5480.22, paragraph 9.i, and Attachment 1, paragraph 3).

E.1.7 Technical Safety Requirement Violation

VIOLATION of a TSR occurs as a result of any of the circumstances presented in Table E-3 (DOE Order 5480.22, Attachment 1, paragraph 2).

Table E-3. Definition of Technical Safety Requirement Violation.

Failure to perform a SR within the required time limit.
Failure to comply with an ADMINISTRATIVE TSR.

E.1.8 General Principles of Operability

GENERAL PRINCIPLE 1: A system is considered OPERABLE as long as an assurance exists that it is capable of performing its specified function(s).

GENERAL PRINCIPLE 2: A system can perform its specified safety function(s) when all of its necessary support systems are capable of performing their related support functions.

GENERAL PRINCIPLE 3: Assuring the capability to perform a safety function is an ongoing and continuous process.

GENERAL PRINCIPLE 4: When all systems designed to perform a certain safety function are not capable of performing that safety function, a loss of function condition exists. Facility operation with such a condition may not continue.

GENERAL PRINCIPLE 5: When a system is determined to be incapable of performing its intended safety function(s), the declaration of INOPERABILITY shall be immediate.

GENERAL PRINCIPLE 6: Any exception to an immediate determination of INOPERABILITY must be justified.

E.1.9 References

ANSI, 1986, *Nuclear Accident Alarm System*, ANSI/ANS-8.3-1-1986, American National Standards Institute, American Nuclear Society, LaGrange Park, Illinois.

BHI, 2000a, *Hexone Tank Facility Status and Recommendations*, CCN 054742, internal memorandum from A. G. Dada to J. J. McGuire, dated January 5, 1998, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2000b, *Safety Evaluation Update for Hexone Tanks 276-S-141 and 276-S-142*, 0200W-US-N0183-02, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI-DE-01, *Design Engineering Procedure Manual*, Bechtel Hanford, Inc., Richland, Washington.

DOE, 1992, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, DOE-STD-1027-92, Change 1, U.S. Department of Energy, Washington, D.C.

DOE O 232.1, *Occurrence Reporting and Processing of Operations Information,* as amended, U.S. Department of Energy, Washington, D.C.

DOE Order 5480.21, *Unreviewed Safety Questions,* as amended, U.S. Department of Energy, Washington, D.C.

DOE Order 5480.22, *Technical Safety Requirements,* as amended, U.S. Department of Energy, Washington, D.C.

NFPA, 1997, *Explosion Prevention Systems,* NFPA 69, National Fire Protection Association, Quincy, Massachusetts.

E.2 SAFETY LIMITS

There are no SLs for the REDOX Facility.

E.3 OPERATING LIMITS AND SURVEILLANCE REQUIREMENTS

The access controls necessary for personnel entry into the 202-S Building and the sample galleries are defined in Sections E.4.1 and E.4.3, respectively. The access control necessary for intrusive activities, (i.e., activities that create a potential for disturbing radioactive contaminants in specified areas) is defined in Section E.4.6.

E.4 ADMINISTRATIVE TECHNICAL SAFETY REQUIREMENTS

This section presents the ADMINISTRATIVE TSRs for the REDOX Facility. ADMINISTRATIVE TSRs are provisions relating to organization and management, procedures, record keeping, assessment, and reporting necessary to control operation of the facility so the AUTHORIZATION BASIS is maintained.

E.4.1 Administrative Technical Safety Requirement for the 202-S Canyon Building Exhaust Ventilation Systems

E.4.1.1 Applicability. This ADMINISTRATIVE TSR applies during the conduct of NORMAL OPERATIONS within the 202-S Canyon Building.

E.4.1.2 Objective. The objective of this ADMINISTRATIVE TSR is to establish an access control for entry of personnel into the 202-S Building:

- The 202-S Canyon Building is maintained at a negative air pressure relative to the environment.
- The process cells and silo tower shaft are maintained at a negative air pressure relative to adjacent areas (e.g., galleries and silo aqueous makeup unit).
- Exhaust air is filtered.

E.4.1.3 Administrative Requirements. The following administrative actions ensure that the functions identified in Section E.4.1.2 are implemented:

- Exhaust fans (EFs) EF-1 and EF-2 shall be maintained OPERABLE.
- Either EF-1 or EF-2 shall be in operation.
- The sand filter shall be tested to verify efficiency of at least 99.95 %.

E.4.1.4 Surveillance Requirements. The following are the committed SRs:

- The atmosphere to wind tunnel differential pressure shall be verified weekly as equal to or greater than 0.20-in. water gauge.
- The sand filter shall be tested annually to have an efficiency of at least 99.95 % for particle removal, as defined by site testing requirements.

E.4.1.5 Recovery. The following actions are to be taken if the access control requirements are not met:

- NORMAL OPERATION may continue up to 60 days with either EF-1 or EF-2 INOPERABLE, provided that one of the 291-S-1 exhausters is in operation.
- If 291-S-1 is INOPERABLE, re-entry for repair or other special work requirements is permitted with an approved radiological survey and work procedures/instructions consistent with radiological precautions specified by BHI radiological control program.
- If 291-S sand filter fails the efficiency test, the ventilation system would be allowed to continue operating, with the stack pack monitoring stack emissions. The decision to continue to operate the ventilation system would be made by RL, the Washington State Department of

Health (WDOH), and Environmental Restoration Contractor (ERC) personnel after review of monitoring results with respect to air permit requirements.

E.4.1.6 Reporting Requirements. All reporting shall conform to the requirements of DOE O 232.1.

Conditions Resulting in Unusual Occurrence

- Failure to evacuate the 202-S Building upon loss of ventilation.

- Failure to enforce access control or entry without an approved radiological survey and work plan when ventilation is inoperable for 221-U Building as defined in the administrative requirements, Section E.4.1.3.

Conditions Resulting in an Off-Normal

- A discovery that requires the initiation of a RECOVERY PLAN.
- Failure to document specific SR in Section E.4.1.4.

E.4.1.7 Basis. Based on the detailed hazard evaluation presented in Section 3.3.2.3, the system provides a defense in depth function. The hazards evaluation credits operation of one 291-S-1 exhauster with maintaining the negative air pressure differential. A second 291-S-1 exhaust fan is credited as a backup. The 291-S sand filter is credited with filtering exhaust air prior to release to the environment.

Testing of the 291-S sand filter is to be performed in accordance with 7-GN-140, *In-Place Testing of HEPA Filters*, or equivalent.

E.4.2 Administrative Technical Safety Requirement for Nuclear Criticality Safety

E.4.2.1 Applicability. This ADMINISTRATIVE TSR applies to the following:

- The 202-S Canyon Building as follows:
  - Deck above canyon cells.
  - Canyon cells and all former process piping and vessels associated with these cells.
  - Silo extraction columns and tower shaft area associated with this columns and all former process piping.

NOTE: Crane maintenance platform, crane cabway, crane, and associated cab are not included in these administrative TSRs.

- Entry to 202-S Canyon Building product receiver (PR) cage with the exception of (a) performance of nondestructive assay measurements, and (b) collection of smear samples.
- The 202-S Canyon Building exhaust and air tunnel.
- The 291-S Exhaust Fan Building sand filter or exhaust duct and drain line to 191-S.
- The 292-S Control and Jet Pit House Building drain seal tank (191-S) or sump.

E.4.2.2 Objective. Ensure that prior to any intrusive activities in areas specified in Section E.4.2.1, precautions relating to criticality safety are defined and documented in applicable work packages.

E.4.2.3 Administrative Requirements. The S&M Project Manager (or designated appointee) shall ensure that a criticality safety program is implemented for activities at locations cited in Section E.4.2.1 and these activities shall not be performed prior to the following:

- Neutron and/or gamma nondestructive assay measurements sufficient to estimate quantities and distributions of fissionable materials.
- A criticality safety evaluation in accordance with BHI-DE-01, *Design Engineering Procedures Manual*, Engineering Department Project Instruction (EDPI) 4.35-01, "Criticality Safety Reviews."
- The establishment of controls based on the results of the criticality safety evaluation.

E.4.2.4 Surveillance Requirements. The Project Engineer and Field Engineer (or designated appointee) shall verify that a criticality safety evaluation has been accomplished prior to initiating characterization in areas cited in Section E.4.2.1.

- The Project Engineer (or designee) shall verify that the conditions and precautions required by the criticality safety evaluation have been properly reflected in the work instructions when applicable.

- Applicable work instructions shall incorporate hold points to document criticality precautions when applicable.

E.4.2.5 Recovery. Upon detection of the conduct of an unauthorized activity, work shall immediately stop and personnel shall leave the applicable location. The Project Engineer and Nuclear/Decontamination and Decommissioning/Design Engineering Specialist shall be notified to define the appropriate recovery action.

E.4.2.6 Reporting Requirements. All reporting shall conform to the requirements of DOE O 232.1.

Conditions Resulting in Unusual Occurrence

- Failure to conduct a criticality safety evaluation for activities involving facility areas listed in Section E.4.2.1.

- Failure to include conditions and restrictions imposed by criticality safety evaluation in the work plan, activity hazard analysis, and RWP (when applicable).

- Failure to comply with restrictions and conditions imposed by criticality safety evaluation report in the execution of the work plan procedures.

Conditions Resulting in an Off-Normal Condition

- A discovery that requires the initiation of a RECOVERY PLAN.
- Failure to document specific SR of Section E.4.2.4.

E.4.2.7 Basis. The form, quantity, and distribution of FISSIONABLE MATERIAL in the locations are not sufficiently characterized to permit the performance of other than basic surveillance activities. The hazard evaluation in Section 3.3.2.3 (main text) assumes that activities with the potential to significantly alter form, distribution, reflection or moderation, will not be performed until the FISSIONABLE MATERIAL inventory is characterized. A criticality safety evaluation shall be performed, and proper controls are established prior to the commencement of nontypical surveillance activities. While access into the areas listed in Section E.4.2.1 are restricted by both administrative controls and physical configuration, it is important to note the areas of potential hold-up of fissionable material.

E.4.3 Administrative Technical Safety Requirement for Control of Transient Fire Loading

E.4.3.1 Applicability. This ADMINISTRATIVE TSR applies to controlling transient combustibles within the aqueous makeup unit of the silo and the north sample gallery in the 202-S Building.

E.4.3.2 Objective. Compliance with this ADMINISTRATIVE TSR minimizes transient combustibles within the accessible areas listed in Section E.4.3.1 in the 202-S Building.

E.4.3.3 Administrative Requirements. The Project Manager (or designated appointee) shall ensure that project and work package procedures/instructions include provisions for removing combustible materials (when applicable) upon completion of the job.

E.4.3.4 Surveillance Requirements. The following SRs ensure that the administrative requirements identified in Section E.4.3.3 are accomplished:

- Periodic surveillances shall be documented on a routine route sheet for the presence of transient combustibles.

- Demand work packages that implement requirements of Section E.4.3.3(2) or (3) shall define hold points when applicable.

E.4.3.5 Recovery. RECOVERY PLANS are not applicable to this ADMINISTRATIVE TSR except to remove the transient combustible as soon as reasonably achievable.

E.4.3.6 Reporting Requirements. All reporting shall conform to the requirements of DOE O 232.1.

<u>Conditions Resulting in Unusual Occurrence</u>

- Failure to identify and/or remove combustibles as required in Section E.4.3.3.

<u>Conditions Resulting in an Off-Normal Condition</u>

- Failure to document specific SR of Section E.4.3.4.

E.4.3.7 Basis. As documented in the fire hazard assessments (Appendices C and D and accident analysis of Section 3.0 [main text]), combustible loading and ignition source within 202-S Building does not support large conflagrations. Damage to the exhaust ventilation-system, the process piping and vessels, or building confinement structures is minimal. Control of transient combustibles in the areas specified by Section E.4.3.1 will ensure that the potential to release radionuclides in minimized.

E.4.4 Administrative Technical Safety Requirement for Seismic Event

E.4.4.1 Applicability. This ADMINISTRATIVE TSR applies to access control of the 202-S Building after a seismic event reported to the ERC by the RL Cognizant Project Manager.

E.4.4.2 Objective. Compliance with this ADMINISTRATIVE TSR prohibits personnel entry to the 202-S Building because of potential structure degradation following a notified seismic event.

E.4.4.3 Administrative Requirements. The S&M Project Manager (or designated appointee) shall ensure the procedures are in place to limit access to the 202-S Building when directed by the RL Cognizant Project Manager. Access will be limited until the RL Cognizant Project Manager concurs that the restriction can be removed. The S&M Project Manager shall ensure that procedures and resources are provided to assess potential structural damage.

E.4.4.4 Surveillance Requirements. Within 30 days, the inspection shall be conducted and a report prepared that defines the building condition relative to safe entry shall be provided to the RL Cognizant Project Manager.

E.4.4.5 Recovery. Recovery actions, if necessary, shall be documented in a seismic event inspection report.

E.4.4.6 Reporting Requirements. All reporting shall conform to the requirements of DOE O 232.1.

Conditions Resulting in Unusual Occurrence

- Failure to restrict access upon notification of the RL Cognizant Project Manager.

Conditions Resulting in an Off-Normal Condition

- Failure to conduct and document the inspection within 30 days following formal notification of the event.

E.4.4.7 Basis. The basis for this ADMINISTRATIVE TSR stems from structural analyses discussed in Section E.3.4.2. An earthquake of a lower magnitude then typical structural design requirements, 0.03g to 0.054g horizontal, could cause structure damage or perhaps failure to the canyon roof structure. Should a seismic event take place, it is prudent and in consonance with good engineering practices to evaluate the structural integrity of the 202-S Building before personnel are permitted normal access.

E.4.5 Stack Monitoring

E.4.5.1 Applicability. This ADMINISTRATIVE TSR applies to activities related to the 202-S Building silo, process cells, process vessels and piping, air and pipe tunnels, sand and high-efficiency particulate air filters, PR cage, exhaust ducting, and exhaust stacks.

E.4.5.2 Objective. The objective of the ADMINISTRATIVE TSR is to establish a for work activities associated within areas defined in Section E.4.5.1.

E.4.5.3 Administrative Requirements. Prior to commencing activities that have the potential to release significant radionuclides in areas defined in Section E.4.6.1, the record sampler for the affected stack (291-S-1) must be OPERABLE.

E.4.5.4 Surveillance Requirements. The work plan associated with the activity shall require that the affected stack record sampler must be OPERATING during work activities in areas defined in Section E.4.5.1.

E.4.5.5 Recovery. Action taken should conditions be discovered during work processes that show the administrative requirements can not be met are:

- Stop work and evacuate the work area.
- Restart record sampler (291-S-1) prior to recommencing work.

E.4.5.6 Reporting Requirements. All reporting shall conform to the requirements of DOE O 232.1.

Conditions Resulting in Unusual Occurrence

- Failure to have the appropriate stack record sampler operating during work activities in areas defined in Section E.4.5.1.

Conditions Resulting in an Off-Normal Condition

- A discovery that requires the initiation of a RECOVERY PLAN.
- Failure to document specific SR of Section E.4.5.4.

E.4.5.7 Basis. Work in areas of high contamination has a greater potential for creating gaseous effluents with elevated radioactive contaminants. For environmental and reporting requirements, the data from the record sampler is required to confirm and provide knowledge of the magnitude of these releases.

E.4.6 Cell Cover Blocks

E.4.6.1 Applicability. This ADMINISTRATIVE TSR applies to the 202-S Building cell cover blocks.

E.4.6.2 Objective. The objective of the ADMINISTRATIVE TSR is to ensure cell cover blocks are not moved or removed.

E.4.6.3 Administrative Requirements. Cell cover blocks are not to be lifted from their present position.

E.4.6.4 Surveillance Requirements. None.

E.4.6.5 Recovery. The action to be taken if conditions are discovered that show the administrative requirements are not met is: Stop work and evacuate the work area.

E.4.6.6 Reporting Requirements. All reporting shall conform to the requirements of DOE O 232.1.

Conditions Resulting in Unusual Occurrence

- Failure to comply with Section E.4.6.3.

Conditions Resulting in an Off-Normal Condition

- A discovery that requires the initiation of a RECOVERY PLAN.

E.4.6.7 Basis. The accident analysis assumes the cover blocks are in place and this assumption limits the consequences of a seismic event. Therefore, to maintain the validity of this assumption, the cover blocks shall not be moved.

E.4.7 Contractor Organization and Responsibility

E.4.7.1 Applicability. This ADMINISTRATIVE TSR applies to the 202-S Building and the 291-S exhaust system.

E.4.7.2 Objective. The objective of this ADMINISTRATIVE TSR is to specify administrative requirements that ensure the REDOX authorization basis remains current and operations are conducted within this authorization basis. The S&M Project Manager (or designated appointee) is responsible for this assurance.

E.4.7.3 Administrative Requirements. Conduct annual review and update (if applicable) of the REDOX safety analysis report (SAR).

- Apply the unreviewed safety question (USQ) program to the 202-S Building and 291-S exhaust system.
- Perform self-assessments at least every two years.
- Conduct training and maintain qualifications compliant with RL Training Implementation Matrix within 6 months of SAR approval or within 6 months of hire of applicable personnel.

E.4.7.4 Surveillance Requirements. The S&M Project Manager (or designated appointee) shall maintain auditable records that demonstrate the following:

- Review of the REDOX SAR annually.
- Conduct of self-assessment every 2 years.
- Personnel training and qualification.

E.4.7.5 Recovery. Not applicable.

E.4.7.6 Reporting Requirements. All reporting shall conform to the requirements of DOE O 232.1.

Conditions Resulting in Unusual Occurrence

- Failure to comply with Section E.4.7.3.

E.4.7.7 Basis. The basis for this ADMINISTRATIVE TSR is derived from good engineering and management practices.

E.4.8 Limiting Oxidant Levels in Hexone Tanks

E.4.8.1 Applicability. This ADMINISTRATIVE TSR applies to the 276-S-141 and 276-S-142 tanks until such time that flammable materials have been removed or the tanks have been safely stabilized or closed.

E.4.8.2 Objective. This ADMINISTRATIVE TSR specifies the requirement to operate the nitrogen system to ensure that oxidant levels are limited as required under Section E.4.8.1.

E.4.8.3 Administrative Requirements. The S&M Project Manager (or designated appointee) shall ensure that procedures are maintained to ensure the adequate surveillance and maintenance of the nitrogen suppression system as required under Section E.4.8.1:

- The nitrogen supply system shall be surveyed monthly to ensure that tanks receive a supply of nitrogen at a rate of at least 2.0 ft^3/hr to each tank.
- Procedures shall ensure that observations indicating potential system degradation are noted and forwarded to management as soon as reasonably possible.
- Procedures shall ensure that a full nitrogen dewar is available at the site, prior to the operating dewar being empty.

E.4.8.4 Surveillance Requirements. Records shall be maintained documenting the surveillance requirements of Section E.4.8.3.

E.4.8.5 Recovery.

- Should surveillance find restricted or loss of nitrogen flow as required by Section E.4.8.3(1), then measures shall be taken to recover the system as soon as reasonably possibly. Engineering shall be consulted to confirm the appropriate recovery.
- If it is determined that the oxygen level has likely risen to 11%, then personnel access in the proximity of the 276-S-141 and 276-S-142 tanks shall be administratively limited to 30 m or greater.

E.4.8.6 Reporting Requirements. All reporting shall conform to the BHI procedures implementing the requirements of DOE O 232.1.

Conditions Resulting in Unusual Occurrence

- Failure to implement surveillance requirements required by Section E.4.8.
- Failure to implement recovery as specified in Section E.4.8.5(1).
- Failure to comply with access restrictions defined in Section E.4.8.5(2).

Conditions Resulting in an Off-Normal Condition

- A discovery that requires the initiation of the recovery in Section E.4.8.5.
- Failure to document specific SR required by Section E.4.8.4.

E.4.8.7 Basis. An oxygen concentration of 11% is defined as the level where hexone vapors cannot burn. Requirements of fire protection standards (NFPA 69 [NFPA 1997]) define the safe oxygen concentration at 60% of the limiting oxygen concentration (LOC) of 11% for systems using manual verification of its operating status and having an LOC greater than 5% (i.e., the safe oxygen concentration is 6.6%). This provides reasonable assurance that if the system fails, a safe recovery can be made. A hexone tank without the nitrogen-purge operating and with an oxygen concentration of 6.6% would slowly increase the oxygen concentration from diurnal changes of the atmosphere. Approximately 676 days of a loss of purge-ambient environment are required before oxygen concentrations would reach 11% from an initial 6.6%. Additional detail can be found in Attachment 3 of *Safety Evaluation Update for Hexone Tanks 276-S-141 and 276-S-142,* 0200W-US-N0183-02, Rev. 0 (BHI 2000b).

E.5 DESIGN FEATURES

DESIGN FEATURES are those features not covered elsewhere in the TSRs and that, if altered or modified, would have a significant effect on safety. DESIGN FEATURES are normally built-in features that do not require, or infrequently require, S&M and are normally not subject to change by operations personnel.

Changes in DESIGN FEATURES are considered significant modifications. The USQ process required by DOE Order 5480.21, ensures that changes to DESIGN FEATURES are appropriately analyzed and controlled so they do not adversely affect safe operation.

E.5.1 202-S Canyon Building Process Cell Walls and Cover Blocks

The 202-S Canyon Building process cell walls and associated cover blocks have been designated as safety-significant structures. The accident analysis in Sections 3.0 and 3.4 (main text) take credit for the walls and cover blocks withstanding seismic-induced ground motions. By remaining intact, these structures significantly reduce the amount of radioactive and hazardous material potentially released by a seismic event.

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