18 STA. 2

OCT 0 5 1999

ENGINEERING DATA TRANSMITTAL

Page 1 of _____

1. EDT 625891

2. To: (Receiving Organization)	3. From: (Originating Organization)	4. Related EDT No.:
Distribution	B&W Hanford Co.	N/A
5. Proj./Prog./Dept./Div.: B Plant/Facility Stabilization	6. Design Authority/ Design Agent/Cog. Engr.: Design Auth.: Steve Giamberardini Cog. Engr.: Ben Schwehr	7. Purchase Order No.: N/A

8. Originator Remarks:

This EDT is submitted to document approval and release of the B Plant Surveillance and Maintenance Phase Safety Analysis Report, HNF-3358 and the B Plant Surveillance and Maintenance Phase Technical Safety Requirements, HNF-4243.

9. Equip./Component No.: N/A

10. System/Bldg./Facility: B Plant

11. Receiver Remarks: 11A. Design Baseline Document? [X] Yes [] No

12. Major Assm. Dwg. No.: N/A

13. Permit/Permit Application No.: N/A

14. Required Response Date: ASAP

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	HNF-3358		0	See block #8	SQD	1	1	1
1	HNF-4243		0	See block #8	SQD	1	1	1

16. KEY

Approval Designator (F)	Reason for Transmittal (G)		Disposition (H) & (I)	
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information	4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment	4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
(See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name (K) Signature (L) Date (M) MSIN	(G) Reason	(H) Disp.	(J) Name (K) Signature (L) Date (M) MSIN
1	1	Design Authority: S.J.Giamberardini 3/25/99 S6-70	1	1	BWHC SRB Chairman:C.D. Wollam C.D. Wollam 3/26/99 R3-56
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1	1	Safety B.A. Schwehr 3/25/99 S6-70			
		Env. N/A			

18.	19.	20.	21. DOE APPROVAL
3/25/99 B.A.Schwehr Signature of EDT Originator Date	B.H. Lueck 3/26/99 Authorized Representative for Receiving Organization Date	S.J. Giamberardini 3/25/99 Design Authority/ Cognizant Manager Date	Ctrl. No. 99-TPD-348 [✓] Approved [ ] Approved w/comments [ ] Disapproved w/comments

BD-7400-172-1

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B PLANT SURVEILLANCE AND MAINTENANCE PHASE SAFETY ANALYSIS REPORT

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U.S. Department of Energy Contract DE-AC06-96RL13200

EDT: 625891 UC: 510
Org Code: 16A00 Charge Code: 101242
B&R Code: EW7050000 Total Pages: 369

Key Words: B Plant, Fire Hazards Analysis, Hazards Analysis, Safety Analysis Report (SAR), Accident Analysis, Safety Equipment, Safety Significant

Abstract: This document identifies the hazards remaining in the B Plant facility during the B Plant surveillance and maintenance phase. The hazards are analyzed. Prevention/mitigation features are identified. When approved by the DOE-RL, this document is part of the B Plant safety authorization basis. Look for the associated B Plant Surveillance and Maintenance Phase Technical Safety Requirements document, HNF-4243.

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OCT 05 1999
DATE:
HANFORD RELEASE
STA: 2
ID: 18

Release Approval 10/5/99 Date

Approved for Public Release

B PLANT

SURVEILLANCE AND MAINTENANCE PHASE SAFETY ANALYSIS REPORT

August 1999

B Plant

Surveillance and Maintenance Phase

Safety Analysis Report

Prepared
by

B&W Hanford Company

EXECUTIVE SUMMARY

E.1 FACILITY BACKGROUND AND MISSION

B Plant was built in 1945 in the 200-East Area of the Hanford Site. The facility was designed to chemically process spent nuclear fuel.

B Plant began separations processing using actual irradiated uranium feed from Hanford's B and D Reactors on April 13, 1945. The original separations process used at B Plant was the bismuth-phosphate process, and produced a plutonium (Pu) nitrate product that was shipped to the Los Alamos Site in New Mexico for fabrication into atomic weapons.

In 1952, due to the greater efficiency of a new radiochemical separations process at the Hanford Site known as REDOX (reduction oxidation), B Plant closed as a plutonium separations facility.

In the early 1960s, the decision was made to retrofit B Plant for a large waste partitioning mission to separate strontium 90 (Sr-90) and cesium 137 (Cs-137) out of high level wastes already stored in the tank farms associated with the PUREX and REDOX plants, and also out of PUREX current acid wastes and sludges.

The canyon and process cells were extensively decontaminated of residual plutonium when the facility was being prepared for the cesium separations mission. Some plutonium may remain in the wind tunnel, the underground ducts and other portions of the canyon and the old ventilation system. However, the only known or estimated remaining plutonium is in the old ventilation system filters.

Individual strontium and cesium solutions were then transferred to the Waste Encapsulation and Storage Facility (WESF) for processing, encapsulation, and storage in pool cells.

B Plant processes, equipment, and systems have been shut down, isolated, and stabilized; hazards have been removed or isolated. B Plant has been decoupled and isolated from WESF operations. WESF operates as an independent processing facility using the WESF safety basis and procedures.

B Plant is in the Surveillance and Maintenance (S&M) phase, pending final disposition. The S&M mission, which is based on safety and cost reduction, is to safely maintain control of the hazardous materials at B Plant until entry into the next phase of plant operation (i.e., decontamination and decommissioning [D&D]) begins. This mission involves surveillance and maintenance activities of the active and passive B Plant structures, systems and components (SSCs).

According to the *Richland Environmental Restoration Project Baseline, Multi-Year Work Plan*, DOE-RL-96-105, Rev 2, (DOE 105) D&D of B Plant is scheduled to be complete by end of fiscal year 2023.

E.2 FACILITY OVERVIEW

The B Plant facility is located adjacent to WESF (Bldg. 225B) in the Hanford Site 200 East Area

(see Figure E-1). The facility is composed of deactivated buildings and associated process equipment used for dissolution of irradiated reactor fuels and subsequent separation of uranium, plutonium, cesium, and strontium, as well as deactivated equipment formerly used for waste concentration, waste neutralization, and solvent recovery.

The facility has active and passive structures and systems in place to prevent accidental releases of the residual radiological inventory.

Unauthorized access to the facility is prohibited. The facility structures are locked. A six foot cyclone fence encloses the immediate deactivated area. Unauthorized access to the Hanford Site is prohibited. Fluor Daniel Hanford infrastructure provides general site security, fire protection, emergency preparedness, waste disposal, utilities (water, electrical power) services and supports integrated health, quality, and safety programs.

B Plant is physically adjacent to WESF, but physically interfaced systems have been isolated. All systems from B Plant to other Hanford sites/systems, such as Tank Farms and liquid effluents, have been isolated, with the exception of electrical power and water. Electrical power is provided to the facility to operate the canyon exhaust system, liquid level detection, and lighting systems. Water is served to fire hydrants near B Plant. No water is served to any B Plant structure or system.

E.3 FACILITY HAZARD CLASSIFICATION

The B Plant facility has been categorized as a Hazard Category 2 nuclear facility based on the sum-of-ratios approach prescribed in DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (DOE 1027).

E.4 SAFETY ANALYSIS OVERVIEW

E.4.1 SURVEILLANCE AND MAINTENANCE PHASE OPERATIONS

This Safety Analysis Report (SAR) is written to demonstrate that the S&M phase activities can be performed safely and that these activities are adequate to maintain the safety envelope demonstrated by this SAR. The S&M phase activities are:

- Operation, S&M of the Canyon Exhaust System
- S&M of the Cell 10 Liquid Level Monitoring System
- S&M of the Retired Filters and Passive Vent System
- S&M of the Facility Structures' Integrity
- S&M of the Barriers and Postings
- S&M of the Confinement Systems
- S&M of the Structural Components
- Container Management
- Equipment Calibration, Testing, Maintenance, and Repair
- Inspection for and Response to Spills
- Stabilization or Removal of Unstable Hazardous Substances

- Identification and Removal of Unstable or Friable Asbestos
- Hazardous Substance Disposal
- Nondestructive Assay Waste Characterization and Sampling
- Removal of Non-process Equipment
- Radiological Surveys
- General Inspections and Tours.

E.4.2 SIGNIFICANT HAZARDS

The principal hazards at the B Plant facility (above and beyond standard industrial and occupational safety hazards) are related to the inventory of residual radioactive material. Hazards related to this inventory include worker exposure and uptake and uncontrolled release to the environment. Significant quantities of residual radioactive materials remain in the B Plant Canyon Building 221-B and in the retired filter vaults (A, B, C, D, E and Sand Filter). Substantially smaller quantities remain in the other B Plant structures. Table 3.3-3 shows the estimated radiological materials inventory. The known chemical material hazards have been removed or stabilized.

Structural hazards exist due to the potential for structural integrity degradation during the deactivated duration. Structural degradation could result in partial or total loss of radiological material confinement and/or worker injury. The integrity of the major concrete structures that contain the largest remaining quantities of radiological contamination (the 221-B Canyon Building, the underground retired filter vaults in the 291-B area, and the 212-B Cask Station hot cell) is currently in good condition and is not expected to degrade at a rapid rate. These three structures are expected to maintain their structural integrity if the canyon structure roof and roofing material, the underground vaults soil cover, and the 212-B building shell are maintained. Maintaining these features precludes freeze and thaw cycles from direct contact with the top surfaces of the concrete structures containing the radioactive materials, thereby prolonging degradation of the concrete structures. All of the B Plant buildings and structures could present worker injury hazards if the building structures degrade. If the buildings and structures degrade, portions of the buildings could become falling or tripping hazards, or missile type hazards generated by winds could be lifted and blown against workers. In addition, it could become hazardous for workers requiring roof access.

The rate of degradation cannot be accurately estimated. Therefore, the operating contractor will implement a surveillance and maintenance program to monitor and maintain the structural integrity of B Plant structures, systems and components in accordance with the safety authorization basis. A technical safety requirement administrative control is established to ensure this control requirement is established.

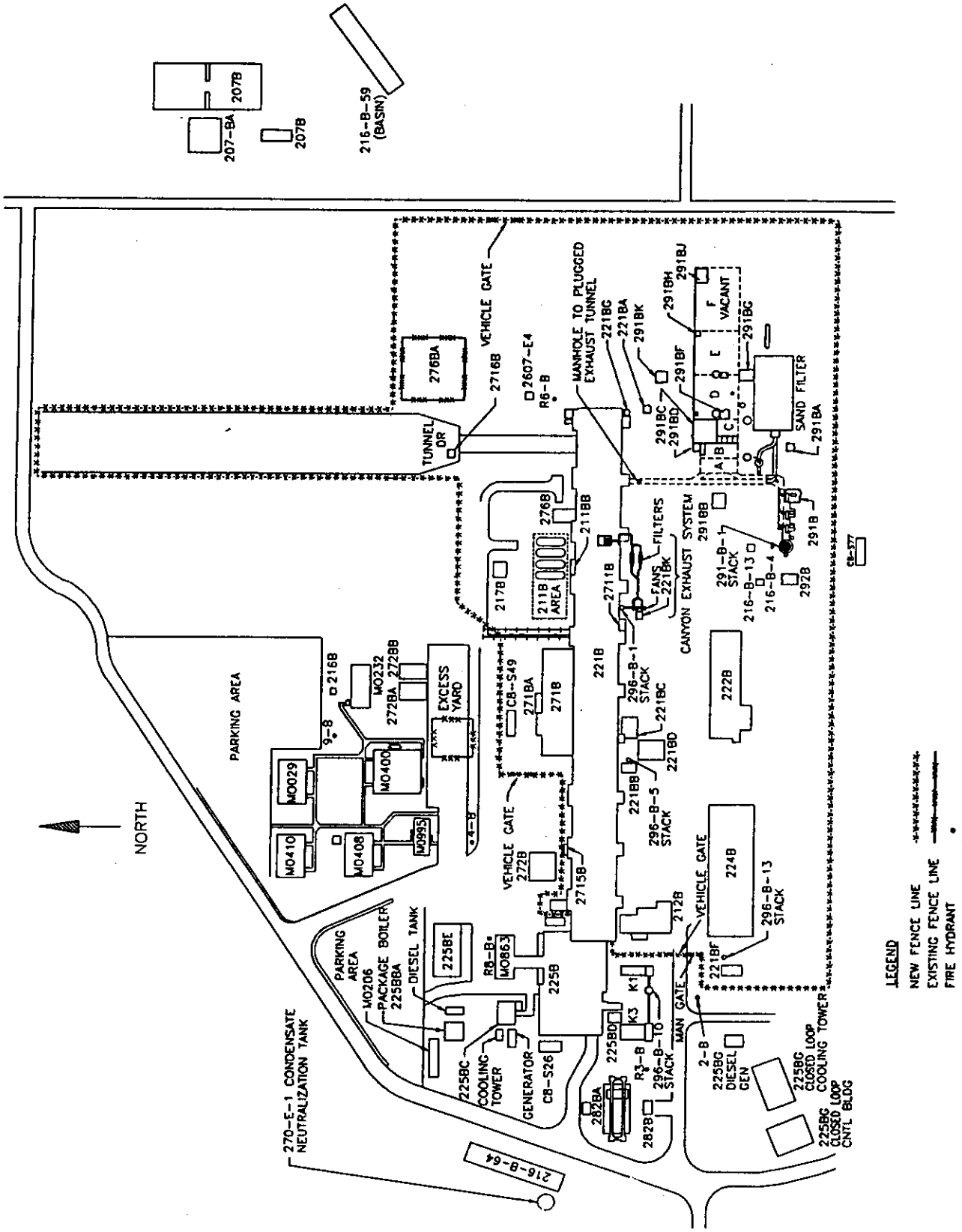

Figure E-1: B Plant Facility Layout

It is estimated that the canyon contains 25,300 Ci of ^{90}Sr and 43,700 Ci of ^{137}Cs (Table 3.3-3). The majority of this material is contained in former processing equipment and structures within the canyon (e.g., tanks and piping). The retired canyon exhaust filters contain the most significant radiological inventory. Filters A through E contain an estimated 456,000 Ci of ^{90}Sr and ^{137}Cs. It is estimated that 2.625 Ci of ^{239}Pu are contained within the B Plant retired filters, with the majority (1.93 Ci) in the sand filter in the 291-B Sand Filter Building, and the balance being equally distributed in filters A, B, C, and D. F vault does not contain filters.

The most significant accidents analyzed for the facility are the design basis earthquake, a canyon roof load and collapse, and an explosion in the retired filter vaults. A design basis earthquake (DBE) (0.12g) could cause a release from the canyon and the retired filters. This accident is considered to have only moderate consequences and a low frequency of occurrence. Although a hydrogen explosion in the retired vaults is extremely unlikely, the postulated unmitigated offsite and onsite consequences could be severe.

E.4.3 PREVENTION AND MITIGATION FEATURES

The primary preventative and mitigative features for B Plant during the S&M Phase are the design features of the retired filter vaults and the canyon and surveillance and maintenance of the configuration of those structures. Secondary preventative features are Technical Safety Requirements (TSRs) and institutional safety programs requirements. Surveillance will be conducted to detect confinement anomalies and maintenance will be conducted to prevent and correct them.

E.4.3.1 RETIRED EXHAUST SYSTEM CONFINEMENT

The primary control against a release of the radioactive inventory from the deactivated vaults is configuration control. By maintaining the existing configuration, water cannot get into the vaults, thus preventing hydrogen generation in the vaults.

The passive vent system on the retired filter vaults is defense in depth to enhance prevention of hydrogen accumulation. The vault area is devoid of designed water sources and electrical energy sources that could produce an ignition source.

An administrative control requires that routine surveillance be conducted to ensure the hydrogen concentration in the retired vaults is not accumulating to dangerous levels. Surveillance will also be performed to monitor the retired vaults area for indications of water intrusion into the vaults by observing the vaults configuration and water level. The liquid level detection system is also a defense in depth feature.

E.4.3.2 CANYON CONFINEMENT

An administrative control requires that routine surveillance be conducted to ensure that the canyon structural integrity is monitored by observing the physical structure. The roofing system on building 221-B will be maintained.

E.4.3.3 WORKER PROTECTION

Worker protection will be provided by maintaining and implementing administrative and institutional safety programs to ensure safety is the foremost priority addressed in all surveillance and maintenance activities.

E.5 ORGANIZATIONS

This SAR was developed in a team effort by B&W Hanford Company (BWHC) under contract with the Fluor Daniel Hanford Company, and Bechtel Hanford, Inc. (BHI).

The B Plant facility is currently operated under Fluor Daniel Hanford (FDH) by B&W Hanford Co. (BWHC). It is anticipated that B Plant stewardship may be transferred to BHI in 1999. Chapters 6-17 of the SAR demonstrate administrative safety functions that will be maintained while B Plant is operated by BWHC. When B Plant is transferred to BHI, that contractor will maintain the safety functions in accordance with Appendices B and C and replace chapters 6-17 in an upcoming safety basis annual update.

E.6 SAFETY ANALYSIS CONCLUSIONS

A thorough hazards analysis, including a fire hazards analysis, has been conducted and documented to demonstrate the hazards associated with the deactivated configuration of B Plant. The analysis has addressed remaining hazardous and dangerous materials and the anticipated S&M activities for the S&M phase, including coverage of S&M activities to monitor the facility configuration for long-term structural degradation. A thorough accident analysis has been conducted to address the hazards identified in the hazards analysis. Appropriate controls have been established to prevent and/or mitigate the postulated accidents and consequences. The analyses and established controls were developed in accordance with the appropriate DOE Orders and Standards and Hanford prime contractor's implementing procedures.

The thorough hazards and accident analyses and specific controls demonstrate that, even though the facility is deactivated and the remaining inventory is reduced from the previous safety basis levels, there are still significant hazards at B Plant. Conservatism and defense in-depth principles are implemented to assure the hazards are controlled and the potential consequences are minimized to As Low As Reasonably Achievable (ALARA). This SAR demonstrates that the contractor operating B Plant within the bounds of this SAR can protect the facility workers, the Hanford Site workers, the public, and the environment. This is an appropriate safety basis for the deactivated B Plant facility during the S&M phase.

E.7 SAFETY ANALYSIS REPORT ORGANIZATION

The main body of this SAR parallels the format delineated in DOE-STD-3009-94 (DOE 3009), *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports.*

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LIST OF TERMS

Δp	differential pressure
AC	administrative control
ACT	air cleanup train
ALARA	As Low As Reasonably Achievable
Am	Americium
AMU	aqueous makeup unit
ARF	airborne release fraction
χ/Q'	atmospheric dispersion coefficient
B&W	Babcock & Wilcox
BCP	B Plant Process Condensate
BDBA	Beyond Design Basis Accident
BDBE	Beyond Design Basis Earthquake
BIO	Basis for Interim Operation
BR	breathing rate
BWHC	B&W Hanford Company
CBC	B Plant Cooling Water
CES	canyon exhaust system
CFR	Code of Federal Regulations
Ci	Curie
Cs	Cesium
D_2EHPA	di-2-ethylhexyl phosphoric acid
D&D	decontamination and decommission
DBA	design-basis accident
DCF	dose conversion factor
DBE	design-basis earthquake
DOE	U.S. Department of Energy
EDE	effective dose equivalent
ERDF	Environmental Restoration Disposal Facility
ERPG	emergency response planning guidelines
FDH	Fluor Daniel Hanford
FDNW	Fluor Daniel Northwest
FHA	Fire Hazards Analysis
FPMCS	facility/process monitor and control system
HA	hazards analysis
HEPA	high-efficiency particulate air (filter)
HI&E	Hazard Identification and Evaluation
HNF-PRO	Hanford procedure
HNO_3	nitric acid
HRHE	Hanford Regional Historical Earthquake
H_2SO_4	sulfuric acid
IP	instrument panel
ISB	interim safety basis
JCO	justification for continued operations
LCO	limiting condition for operations
LCS	limiting control setting
LFL	lower flammability unit

LLW	low level waste
LPF	leak path factor
MAR	material at risk
MCC	motor control center
MOV	motor operated valve
mSv	milli Seiverts
$NaNO_3$	sodium nitrate
NaOH	sodium hydroxide
NDA	nondestructive assay
NDRC	National Defense Research Committee
NPH	normal paraffin hydrocarbon
NRC	U.S. Nuclear Regulatory Commission
OIU	operator interface unit
PCB	polychlorinated biphenyl
PE	plutonium equivalent
PHA	Preliminary Hazards Analysis
PLC	programmable logic controller
PHMC	Project Hanford Management Contract
PMF	probable maximum flood
PNL	Pacific Northwest Laboratories
Pu	Plutonium
REG	risk evaluation guidelines
rem	roentgen-equivalent-man
RF	respirable fraction
S&M	Surveillance and Maintenance
SAR	Safety Analysis Report
SC	Safety Class
SL	safety limit
SNF CSB	212H Spent Nuclear Fuel Canister Storage Building
SR	surveillance requirement
SS	Safety Significant
SSC	structures, systems, and components
Sr	Strontium
SWP	Special Work Permit (protective clothing)
TBP	tributyl phosphate
TEDE	total effective dose equivalent
TNT	trinitrotoluene
TSP	trisodium phosphate
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System
UDE	Unit Dose Equivalent
UPR	Unplanned Release Site
UPS	uninterruptible power system
USQ	unreviewed safety question
WESF	Waste Encapsulation and Storage Facility
WHC	Westinghouse Hanford Company
WIDS	Waste Identification System

1.0 SITE CHARACTERISTICS

1.1 Introduction

This chapter describes Hanford Site characteristics relevant to hazard and accident analysis of Surveillance and Maintenance (S&M) phase activities at the B Plant Facility.

1.2 Requirements

This section uses the format discussed in DOE 3009, which represents acceptable U.S. Department of Energy (DOE) guidance for the preparation of comprehensive safety analysis reports for complex Hazard Category 2 nonreactor nuclear facilities with long operational lives.

1.3 Site Description

This section address the site characteristics of the area encompassed by and surrounding the Hanford Site.

1.3.1 Geography

The Hanford Site is a 1,450.4 km^2 (560 mi^2) area located in the southeast corner of Washington State (Figure 1-1). The B Plant facility is located on the west side of the 200-East Area on the Hanford Site (Figure 1-2).

There are two Hanford Site boundary definitions to define. These are the current Hanford Site boundary (i.e. the fence line) and an alternate site boundary, which is bounded by the near bank of the Columbia River to the north and east, the Wye barricade to the southwest, and Highway 240 to the west and south. The distances in each of 16 compass sectors are shown in Table 1-1 for boundary definitions (Hey 1997). The 99.5% χ/Q values are compared for each of the 16 directions with the greatest value selected as the offsite χ/Q. Potential dose consequences are evaluated at both boundary definitions for each of the accidents quantified. In general, consequences at the alternate site boundary are 40% higher that at the fence line.

The Columbia River enters the Hanford Site boundary at the northwest corner and crosses over to the eastern boundary as it flows southward. This section of the river on the Hanford Site is a free-flowing stretch commonly referred to as the Hanford Reach. The Columbia River makes its closest approach to the B Plant Facility 11 km (7 mi) northwest of the B Plant Facility. The Yakima River flows south of the Hanford Site from west to east, and empties into the Columbia River at the adjacent cities of Richland, Kennewick, and Pasco.

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 121.9 m (400 ft) above mean sea level (amsl) along the Columbia River, to greater than 1097.3 m (3,600 ft) amsl at Rattlesnake Mountain. The central 200 Area Plateau (located on a broad, arid, flat area high in the center of the site) ranges in elevation from 189 to 243.8 m (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 (located in the center of the central plateau), and sand dunes near the Columbia River.

The Hanford Site extends into Benton, Franklin, Grant, and Adams counties. State Route (SR) 240 passes through the Site within 8 km (5 mi) of the 200-East Area facilities, and within 8.26 km (5.13 mi) of the B Plant 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. DOE 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 on the Hanford Site are managed under a multipurpose 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 SR 4 and the Yakima and Rattlesnake Barricades on SR 240. Traffic counts in 1996 indicate that an average of 61 vehicles per hour travel on SR 240, approximately 10% of which are driven by members of the general public. Hanford Patrol, the Site security organization, is responsible for access control at the barricades. An additional access point into the 200-East and 200-West Areas from SR 240, with limited hours of operation, is located near the southeast corner of the 200-West Area. Public access through the Hanford Site on SR 24, 240, or 243 is not DOE-controlled under normal circumstances.

Traffic on the Columbia River, in the airspace over the Hanford Site, and on 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 not subject to DOE access controls under normal circumstances. Under emergency plan conditions, all access to the Site (with the exception of the Columbia River which is jointly controlled by the Pacific Northwest National Laboratories, 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.

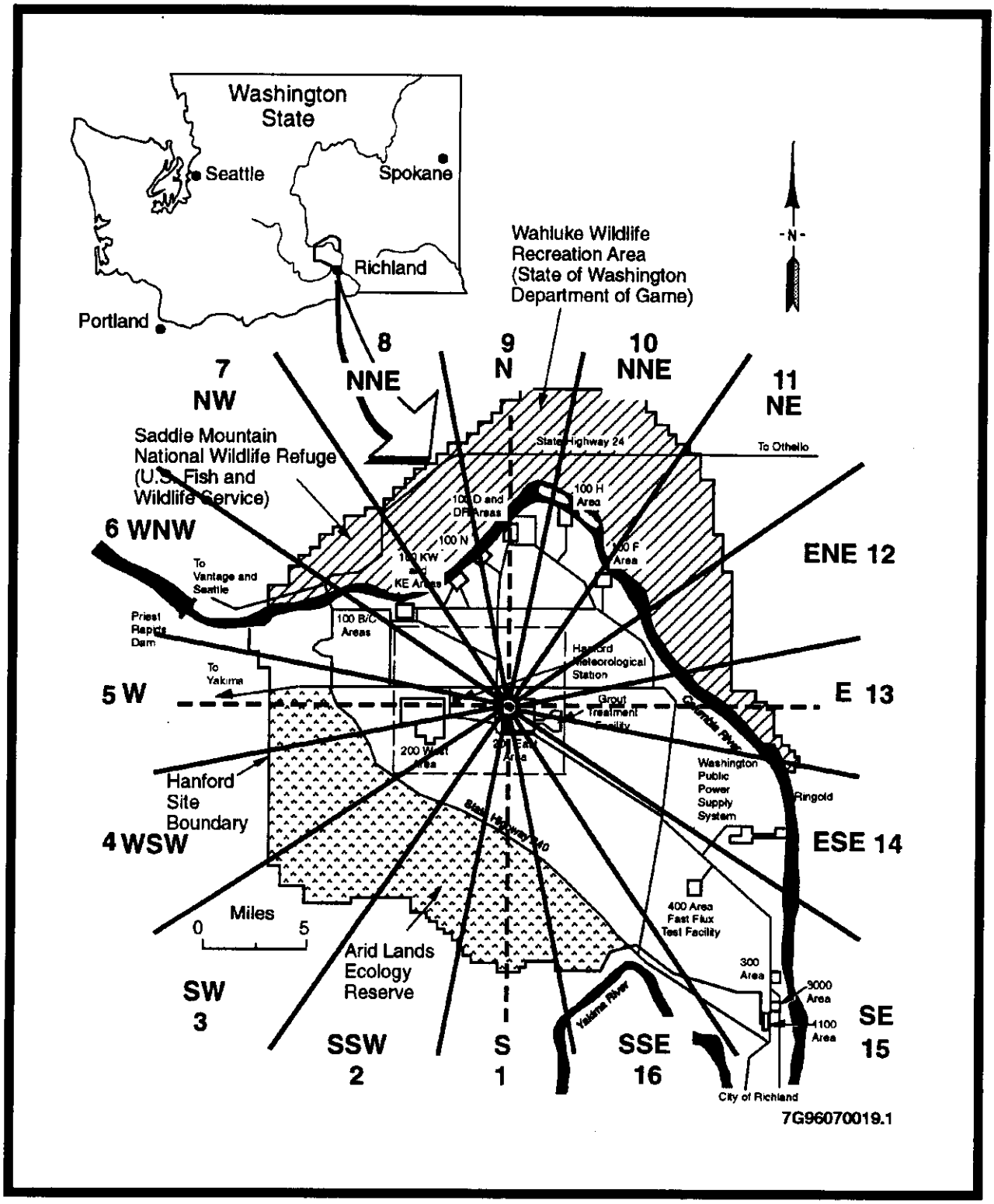

Figure 1-1: Hanford Site Map

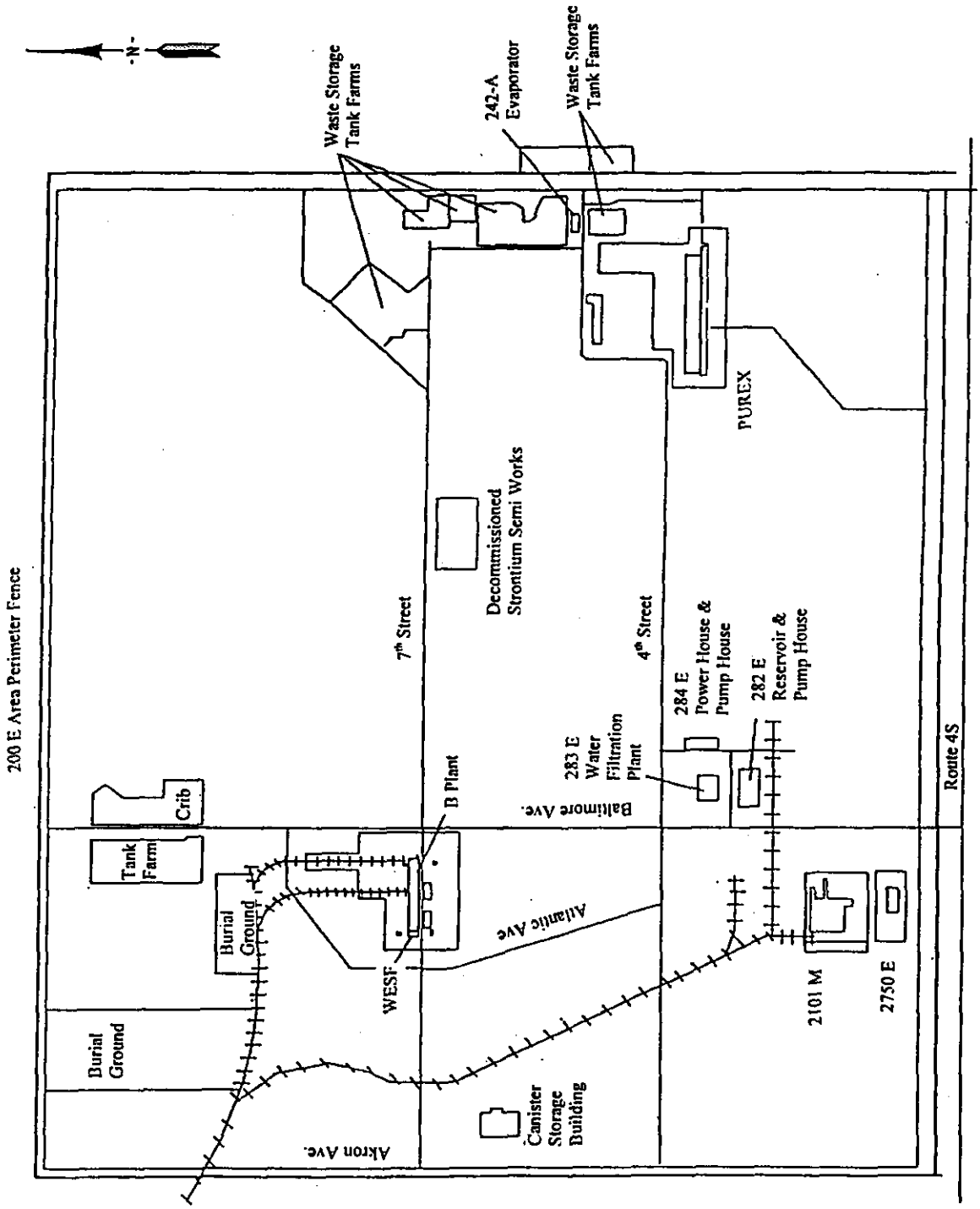

Figure 1-2: 200 East Area

Table 1-1: Site Boundary Distances Used in Offsite Dispersion Calculation (Hey 1997)

Transport direction	Fence-line distance (km)	Alternate site boundary distance (km)
S	19.31	8.94
SSW	16.64	8.26
SW	18.08	8.26
WSW	19.29	9.71
W	18.89	11.04
WNW	19.39	14.36
NW	19.81	11.49
NNW	19.55	11.33
N	22.78	12.99
NNE	25.45	14.01
NE	19.88	12.27
ENE	17.04	12.14
E	16.87	13.65
ESE	21.04	20.88
SE	25.17	14.19
SSE	21.08	11.71

1.3.2 Demography

There is no residential or public occupancy on the Hanford Site. Most of the adjacent areas east, north, and west of the Site are farm or range land, populated with scattered farming communities.

Communities nearest the Site include Richland, Kennewick, Pasco, West Richland, Benton City, Prosser, Grandview, Sunnyside, and Mesa. The 1990 census data for these communities are presented in Table 1-2.

The following table identifies the local municipalities and associated populations as of 1990.

Table 1-2: Census Data for Nearby Communities			
Municipality	**Population**	**Municipality**	**Population**
Benton City	1,806	Quincy	3,738
Connell	2,005	Richland	32,315
George	253	Royal City	1,104
Grandview	7,169	Selah	5,113
Granger	2,053	Sunnyside	11,238
Irrigon, OR	737	Toppenish	7,419
Kennewick	42,155	Umatilla, OR	3,046
Mabton	1,482	Union Gap	3,120
Mattawa	941	Wapato	3,795
Mesa	252	Warden	1,639
Moxee City	814	West Richland	3,962
Pasco	20,377	Yakima	58,827
Prosser	4,476	Zillah	1,911

Source: WHC 1993, *Solid Waste Operations Complex Site Characteristics Description*, WHC-SD-112-RPT-001, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Individuals on the Columbia River or on SR 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 DOE Richland Operations Office (RL) to access areas within the Hanford Site (e.g., Fitzner-Eberhardt Arid Lands Ecology Reserve) are also considered transient. RL, in accordance with DOE RLID 1210.1, *Hanford Visitor Policies and Procedures* (DOE 1210.1), may permit uncontrolled access to the Hanford Site; however, all unescorted individuals, permitted either controlled or uncontrolled access, are required to receive emergency preparedness training.

Approximately 15,000 people were employed on the Hanford Site in late 1995. Some Hanford Site work assignments include shift and weekend coverage; therefore, the total number of personnel 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-East Area is 1,329. This number is distributed across the entire area and includes those workers who are the closest adjacent populated area (those involved in the construction of the Spent Nuclear Fuel Canister Storage Building), the largest adjacent populated area (2704-HV Building), and numerous other structures in the 200-East Area.

No hospitals, nursing homes, or penal institutions operate within the Hanford Site boundary. The three closest schools (Edwin Markham Elementary School, Cypress Gardens School, and Country Christian School) are at least 20.9 km (13 mi) southeast of the 200-East 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 mid-latitude semi-arid or mid-latitude desert. The summers are warm and dry with abundant sunshine; winters are cool with occasional precipitation. The mean surface air temperature at the Hanford Meteorological Station (HMS) averages about 11.8 °C (53.3 °F). Temperatures average 24.4 °C (76 °F) in July and - 1.1 °C (30 °F) in January as reported in *Climatological Data Summary 1994, with Historical Data* (PNL 1995). Mean average precipitation at the HMS averages 160 cm (6.3 in.). Prevailing near-surface wind around the HMS is primarily from the northwest with an average wind speed of 3.4 m/s (7.6 mph) as documented in *Hanford Site National Environmental Policy Act (NEPA) Characterization* (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 35.76 m/s (80 mph) in 1972. A peak wind gust of 38 m/s (85 mph) is expected to occur once every 100 years (Neitzel, et al. 1996). The effects of high wind on the B Plant Facility are addressed in Section 3.0.

The Hanford Site is well outside established tornado alleys. The probability of a tornado striking anywhere on the Hanford Site is 9.6×10^{-6} per year (Neitzel, et al. 1996). There is no Hanford Site design criteria established for a tornado. Accordingly, evaluation of the effects of a tornado on the B Plant Facility is not warranted.

Thunderstorms occur on the Hanford Site, although severe thunderstorms are rare. The Hanford Site is vulnerable to lightning strikes and lightning protection is provided. Lightning strikes leading to a loss of production capability is no longer pertinent because the B Plant 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.

The Hanford Site receives an average of 15-in. of snowfall each year, with a range varying from 0.01 to 1.42 m (0.3 to 56 in.) as reported in PNL 1995. The Hanford Site design criteria for existing facilities specifies a roof design load of 957.6 kiloPascal (kPa) (20 psf) for combined snow and ashfall.

Important historical ashfalls affecting the Hanford Site were from eruptions of Glacier Peak (about 12,000 years before common era [bce]), Mount Mazama (about 6200 bce), and Mount St. Helens (about 3800 bce). 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 (especially in conjunction with snow), the Hanford Site criteria is 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 5.2 Hectare (ha) (12.85 acres) and less than .91 m (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 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. As the B Plant Facility is located in the 200 Area, further consideration of PMF impacts is not warranted.

A flood risk analysis of Cold Creek along the western edge of the Hanford Site was previously conducted. This analysis concludes the maximum level that would be reached is the 196.6 m (645 ft) elevation of certain areas within the western portion of the 200-West Area. The lowest elevation of the B Plant Facility is 213.4 m (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 situated 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 called 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

Current DOE requirements for natural phenomena hazard (NPH) mitigation for DOE sites and facilities are in DOE 5480.28, *Natural Phenomena Hazards Mitigation*, and DOE-STD-1020-94, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities* (DOE 1020). Design and evaluation requirements are based on performance categories (PC), which are defined for Hanford facilities in the PHMS procedure *Engineering Design and Evaluation*, HNF-PRO-097. The performance category is determined by applying the B Plant characteristics to the criteria outlined in the PHMC Hanford procedure, HNF-PRO-097. B Plant must be assigned a Performance Category (PC) because one of the four screening criteria is applicable: B Plant contains some hazardous material. Applying the B Plant characteristics to Table 2.1 in HNF-PRO-0097 results in determining the PC for B Plant. Based on results of the analyses in this safety analysis report, there are not safety class or safety significant SSCs and there are not occupational and/or worker safety controls required that are not already instituted by institutional safety programs. Thus, B Plant is designated to be a Performance Category 1 (PC-1)

facility.

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 8 times in the last 35 years. The Hanford Site Fire Department provides response capability. The area surrounding B Plant is basically devoid of vegetation, and tumbleweed accumulations are periodically removed. A range fire could lead to a fire at the B Plant facility. Basically, all of the structures at B Plant are made of noncombustible material, such as concrete and metal or steel. However, residual combustible material could exist and tumbleweeds could accumulate next to the buildings and structures. Fire scenarios are analyzed that bound the probability of occurrence and consequences of fires that could be initiated by a range fire.

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 human perception of the shaking, as classified by the Modified Mercalli Intensity 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 approximately 1960.

Large earthquakes (i.e., magnitude greater than 7 on the Richter scale) in the Pacific Northwest have occurred in the vicinity of the Puget Sound in 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 Modified Mercalli Intensity ranging from VII to IX and an estimated magnitude of 7 on the Richter scale.

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 magnitudes of 4.4 and an intensity of V. The ability of the B Plant Facility to withstand the effects of an earthquake is evaluated in Section 3.0 using criteria defined by DOE 6430.1A, *General Design Criteria*, as amended, U.S. Department of Energy, Washington, D.C. and DOE 5480.28, *Natural Phenomenon Hazard Mitigation*, as amended, U.S. Department of Energy, Washington, D.C. Seismic loading criteria are defined by *Design and Evaluation Criteria for Department of Energy Facilities Subjected to Natural Phenomena Hazards*, UCRL-15910, Lawrence Livermore National Laboratory, California. (UCRL 1988).

1.6 External Man-Made Threats

External explosion potential is limited due to the relative isolation of the 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. Although it could be postulated that an explosion of some magnitude would cause localized damage, Hanford Site design criteria does not currently exist for this hazard. There are no explosive types of energy sources near B Plant that could breach the structures containing radiological inventories. There is a steam package boiler and a backup electrical power generator, both with associated diesel fuel

supply tanks, located northwest of the canyon building, and there are water well diesel engine pumps with associated diesel fuel tanks to the west of the canyon building. These energy sources do not present a threat of breaching the B Plant structures, based on the distance they are located from the B Plant structures.

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 730 m (2,400 ft) amsl over the Site. There are three airports located within 40 km (25 mi) of the Site, but none within 32 km (20 mi) of the B Plant facility.

A plane crash analysis was previously performed for a major processing plant, the Plutonium Finishing Plant, on the Hanford Site. This analysis indicated the probability of an aircraft crash occurring at this major facility is less than 1.0×10^{-6} per year, as reported in *Plutonium Finishing Plant Final Safety Analysis Report*, WHC-SD-CP-SAR-021, Westinghouse Hanford Company, Richland, Washington (WHC 1995). Based on this analysis, the probability of a plane crash at the B Plant 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. SR 240 is the closest public transportation route to the 200 East Area. The closest section of the route is about 12.87 km (8 mi.) in the south and southwest directions from B Plant. Although this public road is used for transportation of commercial fuels and hazardous materials, an offsite transportation accident is not considered to have a credible impact on the facility due to distance and precautions imposed by the Department of Transportation in licensing of transporting hazard materials. This conclusion is also consistent with other 200-East Area facility SARs.

An onsite transportation accident or vehicle crash could occur and, should the vehicle strike the building, some structural damage could occur. If a vehicle strikes the smaller buildings, the structures could be breached. The smaller buildings contain negligible radiological inventory and hazardous materials compared to the canyon building and the deactivated underground filter vaults. If a vehicle strikes the canyon building, it is not expected that the structure will be breached, because the exterior walls are very thick concrete walls. Accident scenarios are postulated for a vehicle impact to the new canyon exhaust system and the risers extending out the tops of the deactivated underground filter vaults. The postulated consequences of these scenarios bound the consequences that could occur from impacts to the smaller, less contaminated buildings and structures.

If a vehicle carrying hazardous materials has an accident at B Plant while personnel are present, the personnel may need to evacuate the facility. Evacuation will not result in a release of hazardous materials from B Plant, because there are no ongoing processes anticipated fro B Plant during the S&M phase. Personnel evacuation and nearby facility personnel evacuation would be directed by the Hanford Emergency Preparedness organization. B Plant activities could be suspended until the emergency is resolved. The only activity that must be performed at B Plant in specified durations are surveillance of the facility. Of special importance is surveillance of the hydrogen concentration in the deactivated underground filter vaults. This activity has a specified

duration of once per quarter of a year. The duration of this surveillance could be extended due to an evacuation emergency, but the circumstances would have to be understood and managed by the operating contractor to manage the risks of hazards to the facility and onsite workers, the public, and the environment.

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. 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 B Plant in Section 3.0, there are no nearby facilities directly impacted by B Plant S&M operations. Emergency preparedness procedures may require evacuation of area, facility, or nearby workers as a result of an earthquake-induced 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 to ALARA.

The Waste Encapsulation & Storage Facility (WESF) is directly adjacent to the west end of B Plant. About 125 people are located at WESF and in the mobile offices near WESF. The WESF safety authorization basis (WESF BIO) is the Waste Encapsulation and Storage Facility Basis for Interim Operations, HNF-SD-WM-BIO-002 (HNF-002). The WESF BIO was issued in 1998. The WESF mission is to store cesium and strontium capsules. The majority of the capsules are stored in water pools, but some are stored in concrete process cells. The WESF BIO contains analyses of postulated accidents that are prevented with established features and controls to keep the onsite and offsite consequences below the risk evaluation guidelines. The WESF facility workers are also protected from the hazards and accident consequences that could occur inside the 225-B building with worker protection features. There are no worker protection features, beyond institutional safety requirements, that are needed to protect the workers outside the WESF building. Since the B Plant workers are essentially as close to WESF as the WESF workers, the B Plant S&M Phase workers are not threatened by uncontrolled accidents that could occur at WESF. The WESF 225-B building structural/seismic resistance interface with the B Plant building is addressed in Section 3.4.2.7.1.1.1. Additional interface information of these adjacent structures is provided in Section 2.10.1.

The 224-B Plutonium Concentration building is a deactivated building located just south of the 221-B Canyon building, between 222-B and 221-BF. The 224-B building is managed and operated by the current Hanford Environmental Restoration Contractor, Bechtel Hanford, Inc. The safety authorization basis for 224-B is the 224-B Facility Safety Analysis, BHI-01156 (BHI 1999). According to BHI 1999, the 224-B building contains some plutonium, but not in any form or quantity that presents a criticality risk, unless the material is disturbed, in which case the activities must be analyzed to ensure proper criticality controls are established. The B Plant ventilation system maintains a slight negative atmosphere in the 224-B process cells via an underground duct, as described in Section 2.10.2 of this document. Other physical interfaces are also discussed in that section. The 224-B chemical and radiological inventories are not absolutely

known. There are no known quantities of chemicals, beyond suspected residual materials that may exist in liquid, solid or sludge form in the deactivated pipes, vessels, and cells. The BHI 1999 safety analysis document contains analyses for natural phenomena, and internal and external hazards. There is defense in depth that protects the 224-B facility workers. The primary defense in depth features are the building structure and the equipment that provide barriers between the hazardous and dangerous materials and the facility workers. In addition, there are administrative and operational procedures to protect the workers. These same defense in depth features protect the B Plant facility workers from hazards associated with, but outside of, the 224-B building, such as the potential for residual contamination in pipes between the 224-B building and the B Plant buildings. These hazards and controls are further discussed in this document.

The 2704-HV Building, located to the west of B Plant, is an office building housing approximately 365 people, primarily during the hours of day shift. It is the most populated building near B Plant. The 212H Spent Nuclear Fuel Canister Storage Building (SNF CSB), a storage building for encapsulated SNF located to the southwest of B Plant, is currently under construction and is not yet active. Construction forces are present at the SNF CSB during daylight hours. The 2711E Garage, located to the south of B Plant, houses approximately 24 fleet service personnel on day shift. MO-414 and other office buildings and the first aid station are in the same area as the 2711E Garage.

Accidents (uncontrolled releases) at nearby facilities could occur and may require evacuation of the B Plant facility. Because the B Plant 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. The B Plant facility is normally unmanned. Only during S&M activities are there people in and near B Plant, except for WESF, which is continually manned with operating personnel in the WESF main structures and in the support buildings (shops and office trailers). To the south west of B Plant, just outside the B Plant fence, there is a contractor's construction support area. This area has contractor shops, equipment yard, and offices.

2.0 FACILITY DESCRIPTION

2.1 Introduction

This chapter provides a summarized facility description as required by DOE 5480.23, *Nuclear Safety Analysis Reports*, using the guidance described in DOE 3009. 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).

2.2 Requirements

The B Plant facility was constructed and modified in accordance with the design codes, standards, and regulations in place at the time of construction and modification. The canyon exhaust system and passive vent system on the retired filter vaults were designed and constructed in accordance with the appropriate codes and standards specified in *Functional Design Criteria, B Plant Canyon Ventilation Upgrade, Project W-059*, HNF-SD-W059-FDC-002 (HNF, 1997). The Unreviewed Safety Question process required by DOE Order 5480.21, *Unreviewed Safety Questions* is conducted for all facility configuration modifications and procedure changes. This facility description section is written in compliance with the requirements of DOE Order 5480.23 using the guidelines provided DOE 3009.

2.3 Facility Overview

The B Plant facility consists of a former fuel processing facility (the 221-B Canyon Building) and ancillary support structures. The facility structures and components associated with the S&M phase activities are listed in Table 2-1.

B Plant was designed to chemically process spent nuclear fuels using the bismuth-phosphate flowsheet. Radiological containment and confinement features were incorporated in the various facilities and support systems to prevent exposure of plant personnel and the general public to excessive radiation. After plant production was terminated in 1952, B Plant was thoroughly decontaminated and, later, modified to provide for separation and purification of cesium and strontium from the fission product waste stream following plutonium and uranium recovery from irradiated reactor fuels. Purified cesium and strontium were delivered to the Waste Encapsulation and Storage Facility (WESF) where they were encapsulated and are being stored. B Plant supported WESF by providing utility support, such as water and chemical supplies, and effluent discharge storage and transfer to Hanford tank farms. Following the end of the separation mission in 1984, B Plant was maintained in a safe condition. The B Plant entered a cleanout and stabilization program in 1992, was declared an inactive surplus facility, and entered a deactivation program in 1995 prior to being declared deactivated in 1998. In 1995, DOE formally declared that B Plant was to be an excess facility. From 1995 through 1998, the primary activity in B Plant was deactivation of the structures and equipment. Deactivating B Plant involved eliminating the WESF operations reliance on B Plant, minimizing the hazards at B Plant by removing the majority of residual process products, isolating the remaining hazards, shutting down all processes at B Plant, and installing safety systems for the significant remaining hazards.

All of the old operating systems in B Plant have been deactivated, which means they have been

shut down, deenergized of electrical power, and abandoned in place. Equipment that could contain solutions has been drained or pumped empty, as much as possible utilizing existing equipment configuration. The majority of hazardous material consists of fairly adherent radioactive films and residues in deactivated equipment and structures.

B Plant is now is an S&M phase. The future mission for B Plant is currently not established.

No process activities are anticipated for this S&M phase. Surveillance activities will be performed to monitor the facility conditions for potential changes that could impact the safety basis. Maintenance activities will be performed to maintain the operating and passive systems, which are:

- canyon exhaust system
- retired filters passive vent system
- liquid level detection in Cell 10 and retired filter vaults
- surveillance lighting in 221B, 271B, 212B

2.4 Facility Structures

The B Plant facility is located on the west side of the 200-East Area on the Hanford Site. The physical layout is shown in Figure E-1 in the Executive Summary. Facility structures and systems are listed in Table 2-1.

This section presents information on the major B Plant structures and systems: 221-B Canyon Building, 271-B Support Building, 212-B Cask Station Building, retired canyon ventilation system, and new canyon exhaust system. The old *B Plant Safety Analysis Report* (WHC 1996) contains much more detailed descriptions of the main B Plant structures and systems. This document is referenced only for information of past mission configuration.

All of the electrical power (normal and backup) that served B Plant SSC's prior to deactivation were physically isolated from the SSC's during the deactivation mission by having Electrical Utilities (EU) remove the service conductors from the electrical utility power lines. New electrical power services and lighting systems were installed to enhance longevity of operable electrical systems during the S&M Phase; to minimize maintenance on the old systems of the deactivated facility; and to minimize the probability of hazards associated with the old electrical systems, such as electrical short circuits and fires.

On the north side of the 221-B and 271-B buildings, two overhead 13.8 KVA EU power lines served B Plant's main substation, C8-S49. The service conductors from the connections to the overhead lines to the substation were removed. This isolated electrical power from the B Plant facility, except for systems and components energized by the normal backup power served from the south side of the 221-B building. The facility backup power was routed from the south side of the 221-B building. The backup power was isolated by removing the service conductors and a portion of the conduit on the south side of 221-B.

On the south side of the 221-B building, there were a few normal power electrical systems that were physically isolated from the facility. Substation C8-S77 provided electrical power to the

SSC's in the 291-B area. The 291-B area is immediately adjacent to, and associated with, the old ventilation system, which is now deactivated. Substation C8-S77 was isolated from electrical power when EU personnel removed the overhead pole-mounted high voltage switches and transformers that were located just south of the 292-B building. Power was removed from the 291-BJ building when EU personnel removed the service conductors and the pad mounted transformer that was located just east of the 291-BJ building. Power was isolated from the remaining SSC's on the south side of the 221-B building by removing the service conductors for the buildings located on the south side.

New electrical service conductors were installed for the newly installed operational system which are: the new canyon exhaust system; new surveillance lighting systems for portions of buildings 212-B, 271-B, the electrical and pipe galleries of 221-B; and the liquid level detection system in tank Tk-10-1 in Cell 10 in the 221-B canyon; and the liquid level detection system in the retired underground filter vaults. In order to reduce the potential of electrical hazards, the new electrical systems do not use any portions of the old electrical systems. The new electrical utilities systems are described in Section 2.8.1.

The estimated radiological inventory at B Plant is given in Table 3.3-3: *B Plant Radioactive Material Inventories* in Chapter 3 of this SAR. Table 3.3-3 only shows the structures that contain the major contamination inventory. That is, only the contamination inventory in the deactivated filter vaults, the 221-B canyon, and the 212-B process cells is shown in Table 3.3-3. There are several ancillary structures that have much less contamination, such as buildings 271-B, 222-B, 221-BC, and 291-BC, among others that have even less contamination. The contamination levels of the ancillary buildings in the B Plant yard are recorded in radiological dose maps being maintained by the operating contractor in the facility deactivation files. The dose levels are not reported in this document. There are underground pipes that are contaminated, such as the pipes between 221-B and buildings 212-B and 224-B. The levels of contamination in these pipes is unknown. It is expected that most contamination in underground pipes is relatively fixed to the interior of the pipes, because it was normally required that all transfers to other buildings and/or facilities, such as these buildings and tank farms, were followed by wash and rinse solutions. There are some contaminated soils around B Plant that are covered with dose and contamination spread barrier materials to protect facility workers and prevent further spread of the contamination. Known areas with contaminated soils are posted and identified as Unplanned Release Sites or Waste Sites. These sites are listed in Table 2-1. Deactivated effluents underground pipes and associated basins may have some contamination in them.

2.4.1 221-B Canyon Building

The 221-B canyon building, shown in Figures 2-1, 2-2, and 2-3, is a reinforced concrete and steel structure 247.4 m (811.5 ft) long and 24 m (77 ft 2 in) high overall, with partial embedments of 7 m (22.5 ft) and 5 m (16 ft) on the south and north sides. The cross-sectional width of 20 m (66 ft 2 in) is constant to a height of 18 m (59 ft 9 in) and then increases to a maximum of 21 m (68 ft 2 in) at the roof top. The roof slab varies in thickness from 0.9 m (3 ft) at midspan to 1.2 m (4 ft) at the edges where it is supported by the exterior walls. The building is supported on a 2 m (6 ft) thick concrete slab.

The 221-B canyon building is divided into 20 sections with transverse section joints provided at

approximate 12 m (40 ft) intervals, with the exception of sections 1, 2, and 20. The transverse expansion joints for sections 1, 2, and 20 are spaced at 13 m (44 ft), 13 m (43 ft), and 14 m (44.5 ft). All expansion joints are keyed and offset to ensure necessary shielding requirements.

The canyon is comprised of 40 cells, a hot pipe trench, an air tunnel, a crane cab gallery, service area, and the operating, pipe, and electrical galleries. The cells and the hot pipe trench are covered with removable concrete blocks. There is a 41-metric ton (45 ton) capacity overhead bridge crane that spans the total internal width of the building. In 1998 a lighting system was installed in the electrical and pipe galleries and stairwells 1, 3, 11, 13, and 19, and a liquid level detection system was installed in Tk-10-1 in Cell 10.

A canyon exhaust system maintains a negative atmosphere in the canyon service area, cells, hot pipe trench and air tunnel (Figure 2-4). Figure 2-4 shows the airflow diagram. The service area is the canyon area above the process cell cover blocks. The cells, hot pipe trench, and air tunnel are below the service area (Figure 2-1). The canyon exhaust system is located outside the canyon (Figure E-1). The canyon exhaust system is described in Sections 2.5.1 and 2.6.1.

The Waste Encapsulation and Storage Facility (WESF), Building 225-B, is adjacent to the west end of the 221-B canyon building. This document does not address hazards and accident analysis related to WESF, because WESF is a separate facility with its own safety basis. WESF is identified here to present the interfaces between B Plant and WESF and describe the deactivated configuration. WESF is structurally independent of 221-B (Wagenblast et al. 1997).

2.4.2 271-B Support Building

The 271-B Support Building shown in Figures 2-1, 2-2 and 2-3, is a reinforced concrete and cement block structure 49 m (160 ft) long, 15 m (48 ft) wide, and 18 m (60 ft) high, consisting of a basement and three floors. This building is attached to the north-center gallery side of the 221-B Canyon Building. The 271-B Building is no longer occupied, except to perform S&M activities. All the systems are deactivated, deenergized, and abandoned in place, except for a new lighting system installed in 1998 in portions of 271-B to support S&M activities. This lighting system will be energized only during S&M activities.

The basement in 271-B contained the building maintenance and instrument shops, process air compressor room, filters for the building ventilation air supply, and electrical distribution panels.

The first floor provided space for offices, locker rooms, and rest rooms. The former sodium bicarbonate and sodium bisulfate makeup tanks and receiving dock are located on the east end of the first floor.

The second floor contained administrative and supervisory offices, a lunchroom, and the dispatcher's facilities. Within the dispatcher's office is an abandoned operational interface unit for the facility/process monitor and control system (FPMCS). The FPMCS provided monitoring and control interface for the operating systems.

The third floor contained offices, the chemical makeup head tanks, space for dry and wet chemical storage, the continuous deionization unit, and the canyon backup lighting uninterruptible power

supply (UPS) system. The batteries for the UPS have been removed. No chemicals are stored in the facility. Some of the tanks contain minimum heels. The remaining heels are described in the deactivation files.

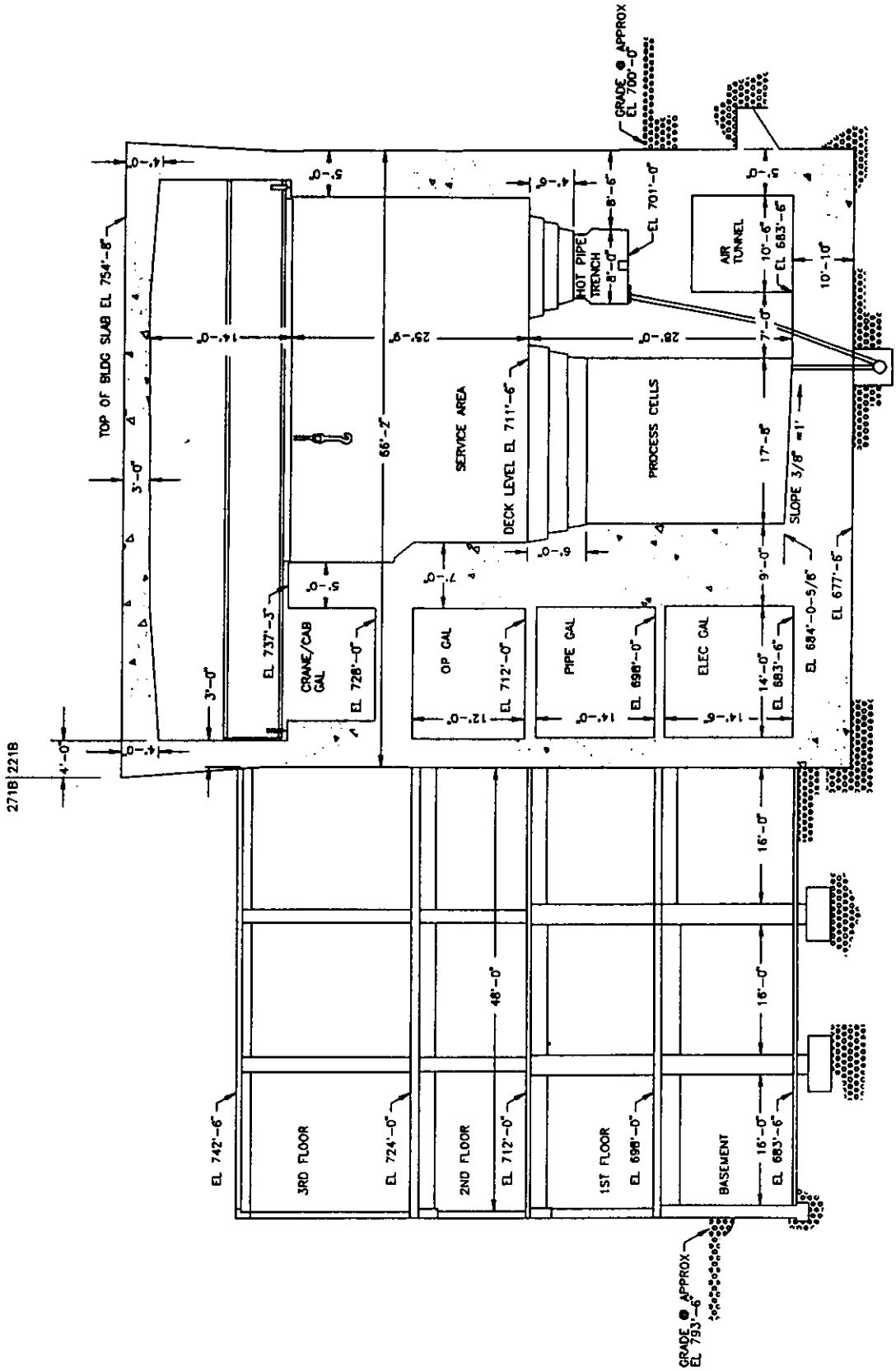

Figure 2-1: 221-B Canyon Building and 271-B Support Building Cross-Section View

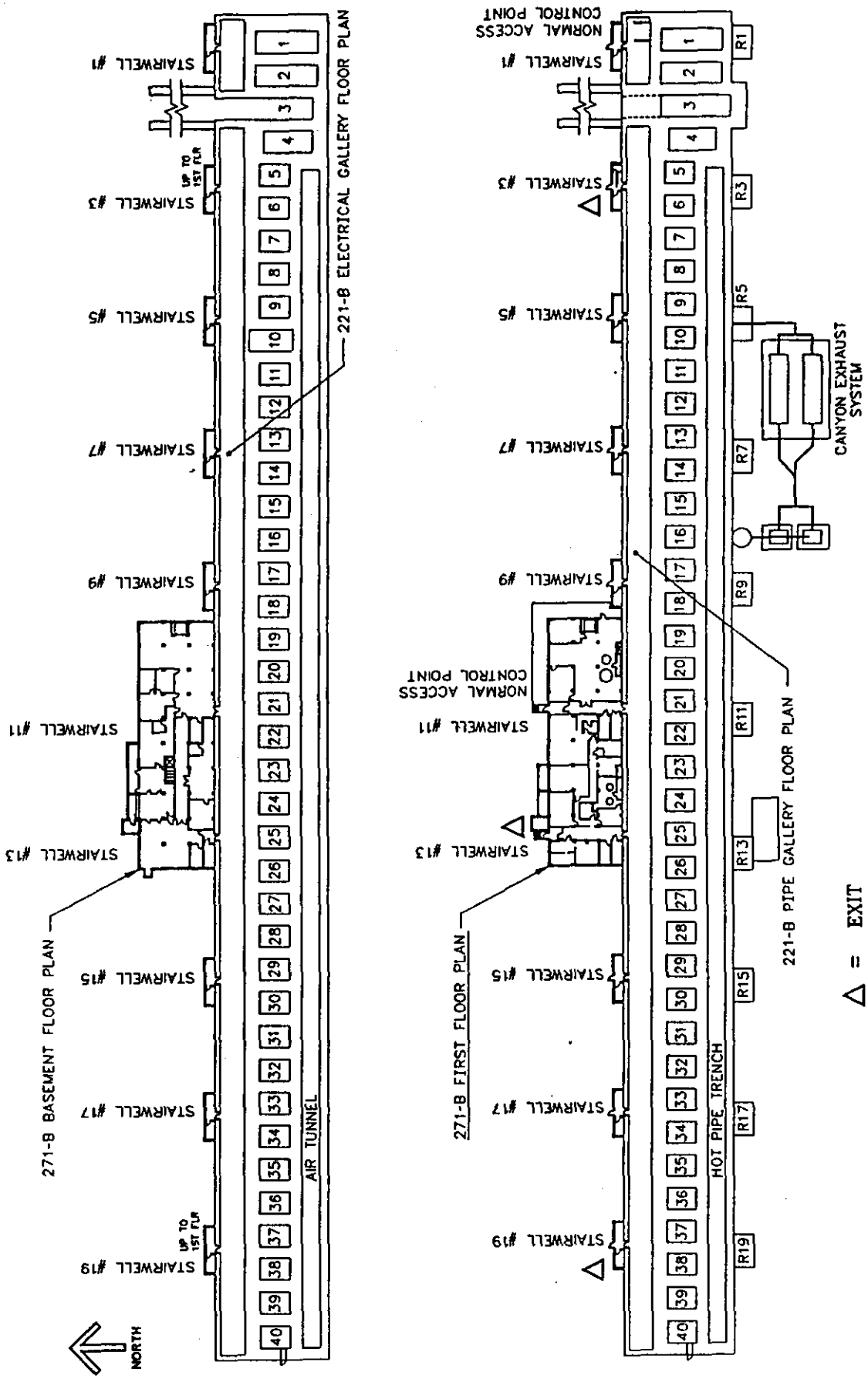

Figure 2-2: 221B and 271B Basement and First Floors Plans

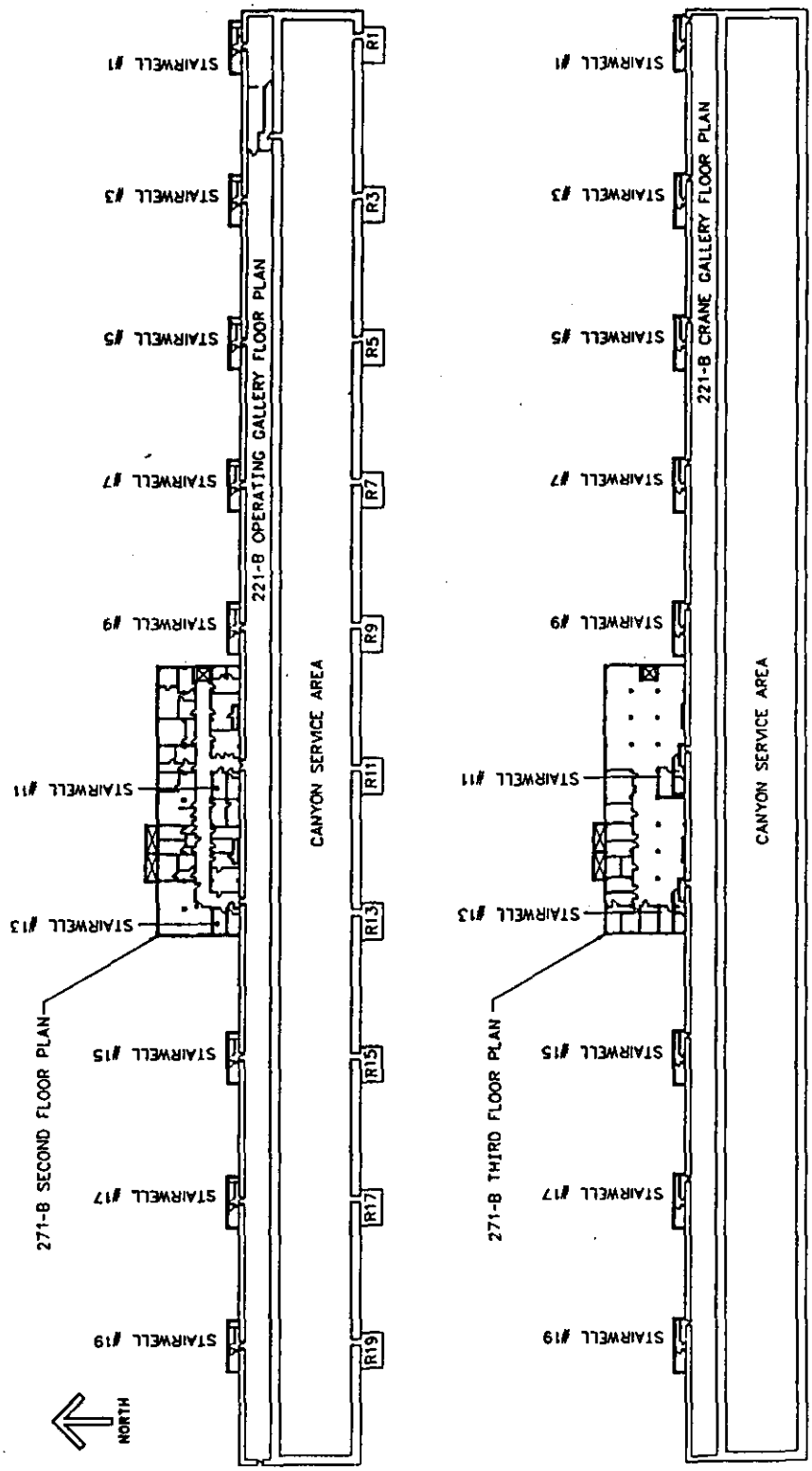

Figure 2-3: 221B and 271B Second and Third Floors Plans

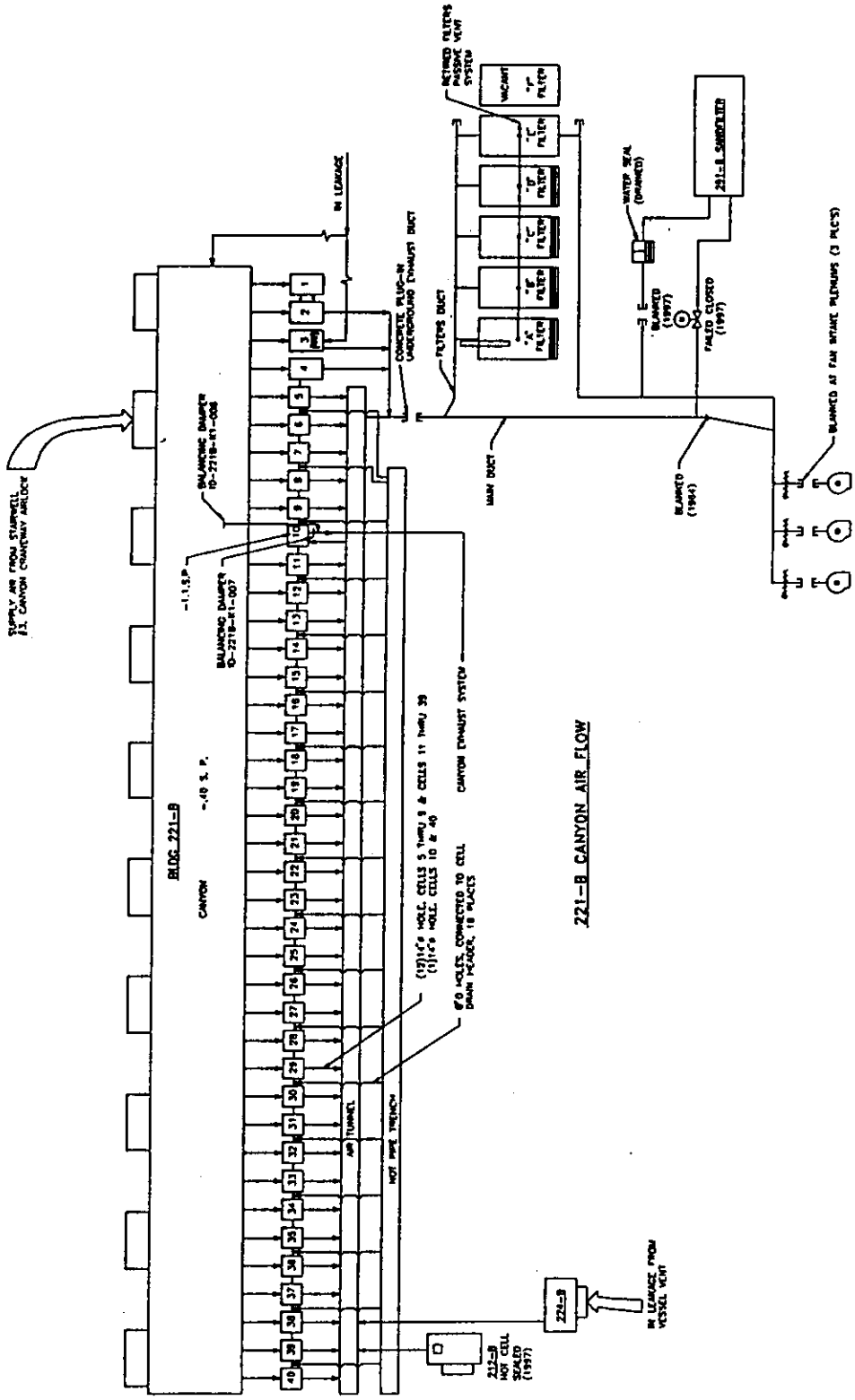

Figure 2-4: B Plant Air Flows Diagram

2.4.3 212-B Cask Station Building

The 212-B Cask Station Building, as shown in Figure 2-5, is a sheetmetal covered, steel-frame structure, 23 m (76 ft) long by 15 m (48 ft 7 in) wide. The inside height of the building varies from 7 m (22 ft) in the cask handling and surveillance room to 11 m (35 ft) in the cell area.

The 212-B Cask Station facility includes a truck port, a cask handling and surveillance room (canyon), an underground operating gallery and process cell, and laundry storage and change rooms (Figure 2-5). There are two personnel access doors on the east side of the building. The 221-B Canyon Exhaust System draws a vacuum on the 212-B Process Cell to maintain confinement through a duct connecting the Process Cell to the 221-B Air Tunnel (Figure 2-6). The ventilation duct from the 212-B process cell is routed underground and enters the west end of the 221-B air tunnel. Figure 2-4 shows the airflow, but not the exact duct route. Figure 2-6 shows an elevation view of the duct from 212-B to the 221-B air tunnel.

Facilities for loading and unloading fission products from the shielded transfer casks were in the 212-B Cask Station and Cell 35 in the 221-B Canyon Building. The 212-B Cask Station was sited at the southwest corner of B Plant so that process and utility piping and other supporting services in B Plant could be conveniently used. These fission product transfers are no longer performed at B Plant. All systems in the 212-B Building were deactivated in 1997. The 27-metric ton (30 ton) crane in the canyon is deactivated in place. A new lighting system was installed in 1998 in portions of 212-B to support S&M activities.

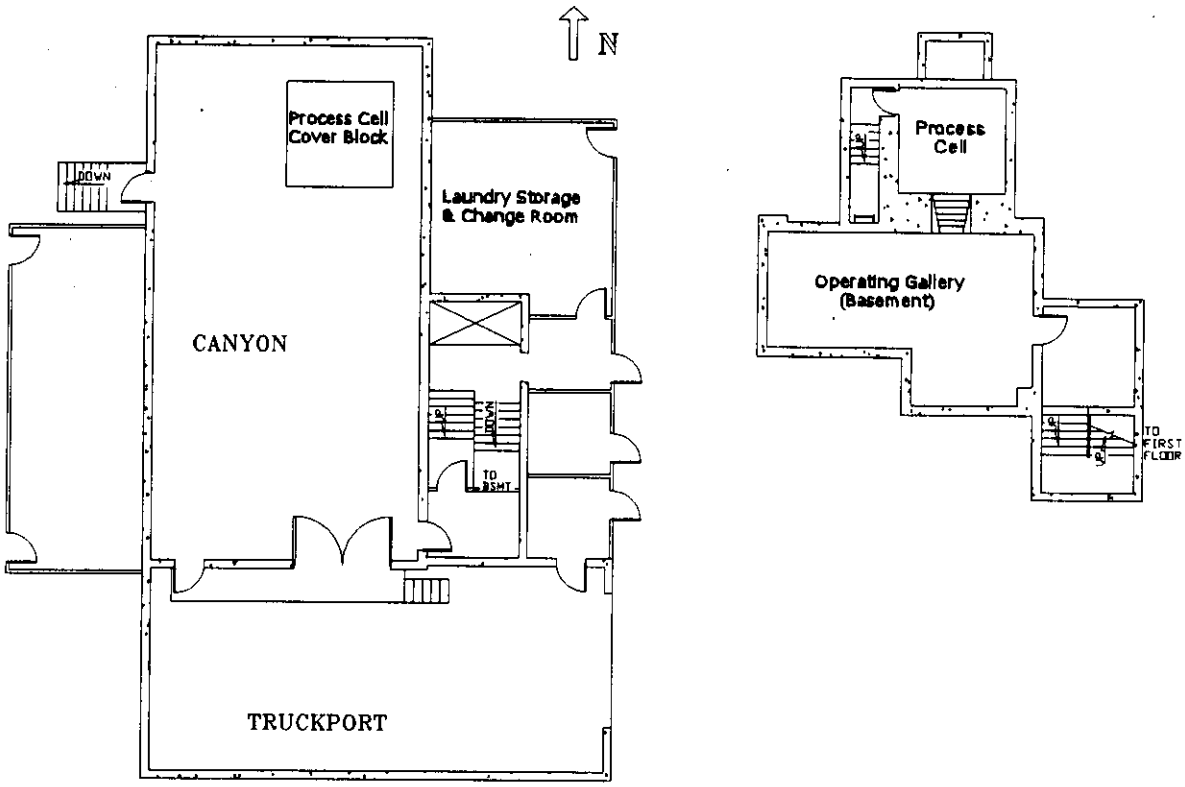

Figure 2-5: 212-B Cask Station Layout

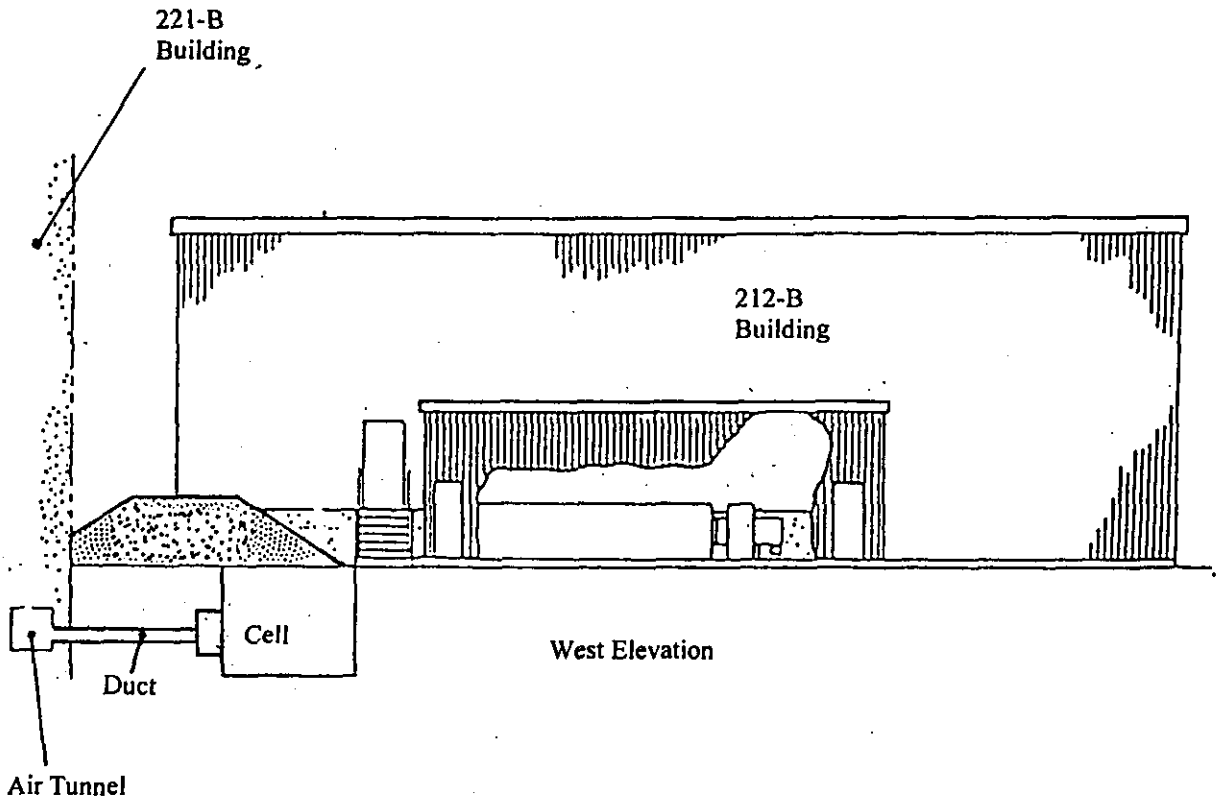

Figure 2-6: 212-B Elevation

2.4.4 Retired Canyon Ventilation System

The retired 221-B canyon ventilation system provided confinement and ventilation during the operational phase of B Plant life, and has now been isolated and deactivated. This section will describe which structures will still maintain confinement in the S&M phase. Figure 2-7 shows the canyon ventilation system that was in service before B Plant was deactivated.

2.4.4.1 Exhaust Ventilation Duct

The air tunnel is under the canyon deck, below the hot pipe trench (Figure 2-1). The exhaust duct is a concrete rectangular duct that extends underground perpendicularly about 59.3 m (194.5 ft.) from the air tunnel, south from the canyon building to the 291-B area. The 291-B area contains the underground concrete exhaust ducts, the underground filters concrete vault, filter instrument buildings, the sand filter concrete structure, the fans and the stack. The sand filter is described below. The estimated inventory in the filters is identified in Table 3.3-3. The canyon and process cells were extensively decontaminated of residual plutonium when the facility was being prepared for the cesium separations mission. Some plutonium may remain in the wind tunnel, the underground ducts and other portions of the canyon and the old ventilation system. However, the only known or estimated remaining plutonium is in the old ventilation system filters.

The exhaust duct is blocked with a concrete plug poured in place through a manhole access to the exhaust duct. The manhole is located about 15m south of the canyon. See Figures E-1 and 2-4.

The exhaust duct splits into an underground main duct and an underground duct routed to the underground HEPA filters vaults. The main duct, which routed exhaust air to the sand filter, was blocked with two concrete walls in 1964.

2.4.4.2 291-B Filter Vaults Outlet Duct

An underground concrete exhaust duct from the filter vaults merges with the main exhaust duct downstream of the two concrete walls that block the main duct. The main duct extends to the exhaust fans. There is one steam turbine driven fan and two electric energy driven fans. Stainless steel ducts routed exhaust air from the underground main duct to the sand filter structure above ground and to the above ground fans. Stainless steel plates have been installed in flanges of the above ground stainless steel ducts to isolate the fans and sand filter from the retired HEPA filters vaults. A HEPA filtered passive vent system is installed on the retired vaults system to allow gases to dissipate if generated in the vaults.

Stainless steel ducts routed the exhaust from the fans to the underground duct between the fans and the 291-B-1 stack. The fans and stack are also retired. The isolations and configuration can be seen in Figure 2-4.

2.4.4.3 291-B HEPA Filters and Filter Vaults

The retired 291-B HEPA filters are in underground vaults in the 291-B area, which is located approximately 46 - 61 m (150 - 200 ft) south of the east end of the 221-B Canyon Building. The vaults are reinforced concrete with steel filter frames inside. The vaults are covered by

approximately 1 m (3.1 ft) of soil and gravel, and are bermed with soil and gravel on three sides. The east end has a vacant vault (F vault) east of and adjacent to the last in-service filter (E Filter). A, B, C, D, and E Filters were equipped with multiple banks of HEPA filters; some filters were also equipped with one or more banks of pre-filters. The filters and vaults have been isolated as noted above, and abandoned in place.

2.4.4.4 Sand Filter

The sand filter is located 52 m (171 ft) south and 19 m (62 ft) west of the east end of the 221-B Canyon Building. The filter is connected to the canyon with above grade, 1.5 m (5 ft) wide by 2.1 m (6 ft) deep stainless steel ducts 5.5 m (approximately 18 ft) long. The filter is 34 m (110 ft) long, 17 m (55 ft) wide, and 6.4 m (21 ft) high, except at the west end where it is 8 m (approximately 26.5 ft) high. The filter is a reinforced concrete structure with a floor slab 30 cm (12 in) thick at an elevation of 1.2 (4 ft) below grade.

The sand filter roof consists of 60 precast concrete slabs 18 cm (7 in) thick, 5.1 (16 ft 8 in) long, and 1.5 (4 ft 11 in) wide, covered by waterproofing membrane composed of layers of asphalt and fabric. The roof is supported by 30 cm (12 in) thick concrete walls and by 30 cm by 46 cm (12 in by 18 in) precast concrete beams upheld by two rows of 31 cm by 31 cm (12-1/4 in by 12-1/4 in) reinforced concrete columns spaced 3 m (10 ft) apart. The floor has 20 cm by 30 cm by 41 cm (7 3/4 in by 12 in by 16 in) hollow concrete blocks laid longitudinally and separated by 1 mm (0.04 in) wood dowels for distributing the incoming air.

The sand filter is a deep bed of rock, gravel, and sand constructed in layers graded with about 2 to 1 variation in granule size from layer to layer. Airflow direction is upward, and granules decrease in size in the direction of the airflow. The collection mechanism of a sand filter is largely gravity settling and Brownian diffusion. A top layer of moderately coarse sand prevents fluidization of the finer sand.

The sand filter has been isolated and deactivated by disabling of a 120 cm (48 in) sand filter inlet duct motor operated valve (MOV) in the closed position, and by installation of a pancake flange in the sand filter outlet duct directly downstream from the deactivated outlet water seal tank, which is now empty (Figures E-1, 2-4 and 2-7). Utility water is isolated from the 291-B area and all water seal vessels and pipes.

2.5 Process Description

This section provides a description of the activities and operations envisioned for B Plant during the S&M phase, prior to its ultimate disposition (e.g., decontamination and decommissioning [D&D]). The ensuing paragraphs provide additional detail; however, the scope of work generally involves surveillance and maintenance activities. They are planned/routine and unplanned/non-routine activities. The anticipated non-routine activities involve cleanup and/or stabilization activities for hazardous substances or contamination that are found not stable; replacement or upgrades of postings or barriers; container management; repairs to structures, systems, and components (SSCs); spill response; characterization; and response or investigation of nontypical surveillance reports. Activities directed by approved procedures involve planned S&M activities.

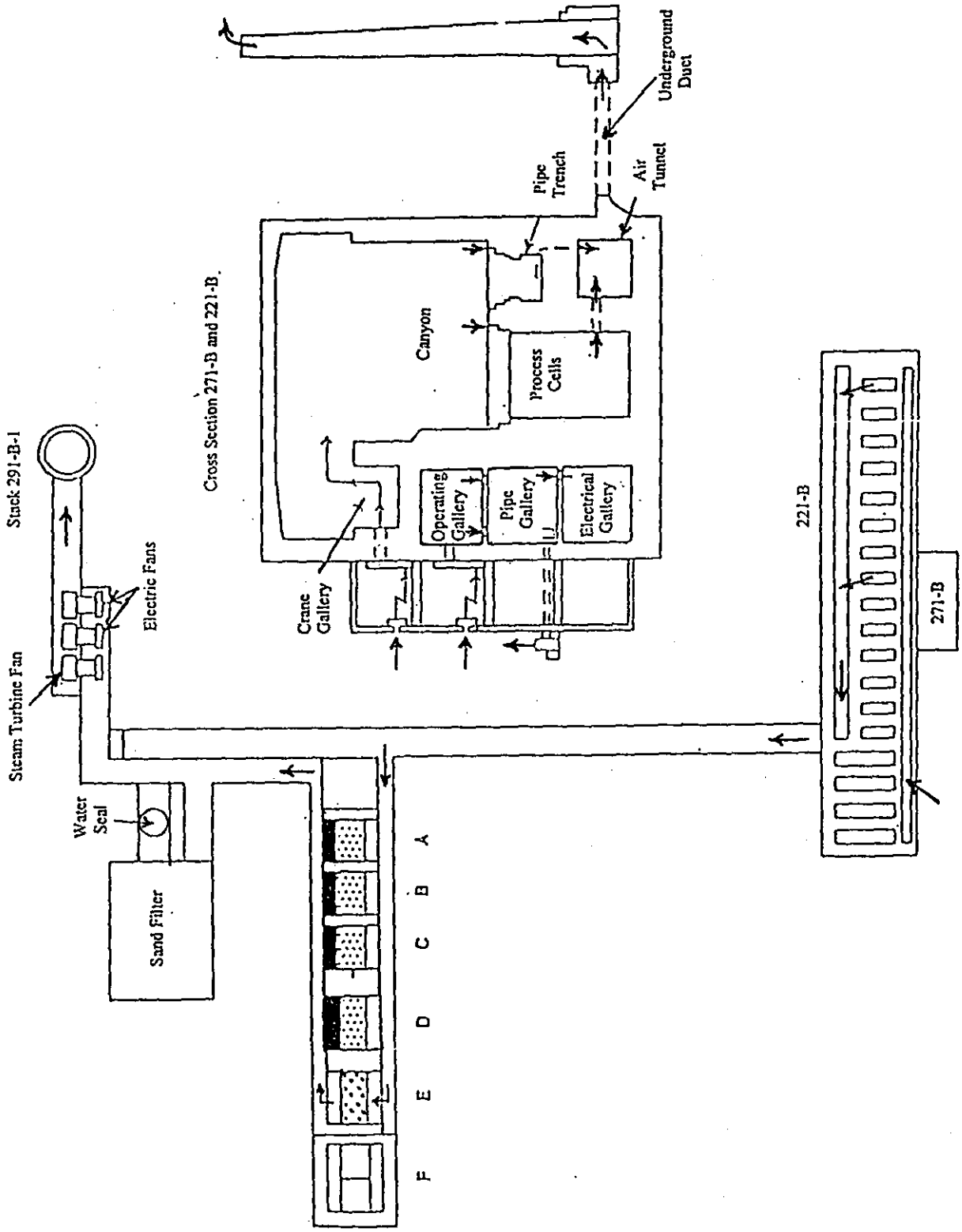

Figure 2-7: Retired Canyon Ventilation System

The unreviewed safety question (USQ) process is a programmatic control used in configuration control. Pre-approved procedures, when revised, are screened and evaluated as required under USQ requirements. Work packages will be screened and evaluated as required under the USQ process.

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

The 221-B canyon building is unoccupied, except for periodic, planned, S&M activities. S&M activities (routine surveillances) will occur at or in the 221-B Canyon building electrical and pipe galleries; the 271-B Support Building; the canyon exhaust system; ancillary buildings, including the 212-B Cask Station and the 222-B Office Building; and the 291-B area, which includes the retired filters.

2.5.1 Operation, Surveillance and Maintenance of the Canyon Exhaust System

Operation, surveillance and maintenance of the canyon exhaust system is required by this SAR and the S&M Plan. The S&M Plan describes the criteria that will be applied to establish and maintain the operation, surveillance and maintenance of the systems at B Plant during the S&M phase. Chapter 5 of this SAR document establishes a requirement for the operating contractor to maintain the system operable and/or notify the Department of Energy if the system will be inoperable for a duration established in the control definitions.

The canyon exhaust system (Figures 2-4 and 2-8) is designed to operate with one exhaust fan and both Air Cleanup Trains (ACTs) in service at one time, at an average airflow of 6.4 - 8.3 m^3/sec (13,600 to 17,600 scfm). This flow should maintain the canyon air space pressure approximately 100 Pascal (Pa) (0.4 in water column) negative with respect to the outside atmosphere. The HEPA filter unit for each ACT is rated at 50% flow capacity of one exhaust fan, to a maximum of 4.25 m^3/sec (9,000 scfm). An interlock is present to prevent the operation of both fans at once. Section 2.6.1 provides additional canyon exhaust system design and operation details and shows that the system design precludes breaching the HEPA filter materials from differential pressures.

The system may be operated with only one ACT in service when maintenance (e.g., filter changeout) is performed in the other ACT. In the reduced-flow mode, the manual inlet vane dampers of the operating exhaust fan are set to provide a flow of 3.54 to 4.15 m^3/sec (7,500 to 8,800 scfm); at the reduced flowrate, infiltration airflow to the canyon is automatically adjusted by static pressure backdraft dampers to maintain canyon pressure at approximately 100 Pa (0.4 in water column) negative with respect to the outside atmosphere.

The canyon exhaust system is monitored and controlled from a programmable logic controller (PLC) located in the 221-BK Building. An operator interface unit (OIU) with Windows NT™ menu-driven displays is used to operate the canyon exhaust system and the Cell 10 liquid level monitoring system, as well as provide local indication and alarm for the system's operation. The PLC is connected to a paging system to provide a notification of an alarm indication received at the canyon exhaust system PLC. The OIU interfaces with a remote monitoring station in the 271-U building, where the Environmental Restoration Contractor monitors systems. There is an

Uninterruptible Power Supply (UPS) provided in building 221-BK to provide backup electrical power long enough to support transmission of a system alarm to the remote monitoring station and the paging system upon loss of power to the canyon exhaust system.

The canyon exhaust system PLC also monitors and controls the 296-B-1 stack emissions monitoring components, which collect stack discharge particulates on a record sample filter paper for later laboratory analysis. The record sample filter paper and instrumentation for controlling sample line heat trace and sample line flow rate are contained in a dedicated sample cabinet located at the base of the 296-B-1 stack. Redundant sample pumps are contained in a dedicated pump cabinet located in the 221-BK Building. The OIU has displays for setting the sample line flowrate and for configuring the redundant sample pumps. The OIU will provide an alarm indication for stack sample system failure. The OIU maintains a display of totalized sample line airflow and totalized stack discharge airflow which are used in conjunction with the record sample filter paper to characterize emission concentrations for the stack.

The OIU contains displays for local indication of the following exhaust system operating parameters:

- 221-BK Room Temperature
- Canyon to Atmosphere ΔP
- Stack Flow Rate and Temperature
- Canyon Temperature
- ACT Filter Total ΔP
- ACT Filter Radiological Loading
- Exhaust Fan Bearing Temperature and Bearing Vibration
- Cell 10, Tk-10-1, Liquid Level Status.

In addition, instrument panel IP-200, located near the ACT units provides indication of individual filter bank ΔPs and ACT radiological loading.

The canyon exhaust system is not relied on for keeping accident consequence below any risk evaluation guidelines, nor is the system required to be continuously operating for the safety basis. The system is operating to maintain a negative pressure on the canyon to prevent unknown releases during normal operations. Without a negative pressure on the canyon there could be a potential for unknown contamination releases from the canyon by natural phenomena, such as wind induced drafts from the canyon, because the canyon is not sealed. Contamination could potentially spread at two places where the canyon is not 100% sealed: the stairwell 3 on the north side where the backdraft damper is located to allow air to enter the canyon building, and the stairwell R1 on the south side where the door is not sealed for life safety egress code compliance. The rear stairwell, Stairwell R-13, is also not sealed, but this stairwell leads to the inside of building 221-BC.

If the canyon exhaust system fails, the operating contractor will receive a signal in the 271-B building surveillance base. The operating contractor will investigate the situation and regain operation of system. The potential for any level of contamination spread to outside the canyon building is expected to be very low because of the low levels of contamination in the areas inside the canyon building by the unsealed doorways.

Contamination is not expected to spread from the canyon to the galleries because the galleries are sealed from the canyon. Due to the low levels of contamination inside the unsealed doorways leading to outside the canyon, and due to the low number of unsealed penetrations, it is expected that the canyon exhaust system could be repaired and returned back in service long before any significant contamination would occur outside the building.

As stated in Section 3.4.2.7.2.8, a hydrogen explosion in the canyon building will not occur, due to inadequate hydrogen generation configuration and the extremely large airspace available to absorb any hydrogen that could be generated. Therefore, the canyon exhaust system is not required to prevent a hydrogen hazard.

2.5.2 Surveillance and Maintenance of the Cell 10 Liquid Level Monitoring System

The liquid level in Cell 10 will be continuously monitored at the Operator Interface Unit (OIU) located in building 221-BK. Tank Tk-10-1 is a collection tank for fluids that leaked into the cells and air tunnel during past missions. The tank will serve to collect any fluids that may exist in the cells and air tunnel during the S&M phase. Drains from all the cells are connected to a common drain header that is routed to Cell 10. In Cell 10, tank Tk-10-1 is the lowest tank in the canyon building. The top of the tank is at the bottom of Cell 10, such that the common drain headers drain into Tk-10-1. Tk-10-1 has a 37.85 kl (10,000 gallon) capacity. The liquid level monitor system will monitor the level of water in Tk-10-1.

There is a no fluid accumulation in Tk-10-1 since the facility was deactivated in September, 1998. The tank was emptied to minimum heel. It is anticipated that there may be small discharges to Tk-10-1 from pipes if unknown fluids were left in pipes and they drain out. There may be discharges to the tank if water leaks into the canyon from rain, snowmelt, or groundwater.

There are four resistance type probes in the tank, which provide alarm contacts corresponding to liquid levels of 0.5 m (20 in), 1.0 m (40 in), 1.5 m (60 in) and 2.0 m (80 in). The tank is a completely open, rectangular stainless steel lined vault, 5.5 m (8 ft) long, 3.4 m (11 ft) wide, and 2.1 m (7 ft) high in the bottom of cell 10. The top of the tank is at the bottom of the cell. The alarm contacts correspond to 25, 50, 75 and 100% tank volumes. The water level in Tk-10-1 is continually monitored by instrumentation installed in the 221-BK building. The liquid level detection system signal can be observed in 221-BK. The signal is transmitted to the monitor station at building 271-U.

There is a concrete plug in a small access port provided in the Cell 10 cover block. The port is provided to allow for future installation of a submersible sump pump in the event liquids accumulate and need to be pumped out of Tk-10-1.

The S&M Plan requires that the Tk-10-1 liquid level be monitored. Upon indication in the tank at the 25% level, an analysis will be conducted to determine if the water will be pumped out of the tank. If it is determined that the water needs to be pumped from the tank, then the operating contractor will conduct the activities necessary to safely remove the water. A specific plan will be developed to address the hazards and requirements applicable to sampling and removing the liquid, including designating appropriate disposal of the contaminated materials and liquids. Controls and procedures will be developed as the process is planned. Authorization will be

acquired to perform the activities in accordance with the appropriate safety and authorization programs.

2.5.3 Surveillance and Maintenance of the Retired Filters and Passive Vent System

Surveillance and maintenance of the Retired Filters and Passive Vent System are conducted in accordance with an approved operating procedure. Hydrogen concentration levels within the retired filters vaults airspaces are monitored by taking air samples from ports provided on the passive vent system for this purpose. The hydrogen levels are monitored to meet the recommendation in the *B Plant Surveillance and Maintenance Phase Fire Hazards Analysis*, HNF-3756 (HNF 3756).

Liquid levels in retired Filter vaults A, B, D, and E are monitored by reading the liquid level monitoring system digital indicators provided near the vaults. There was not a riser available on Vault C to insert a liquid level probe. The liquid level system will indicate the water level in Vaults A, B, D, and E when the water in these vaults is in the range from about .4 m (18 in) to about 1.5 m (54 in) deep. The water level in Vault C can be monitored with this system only if the water level in Vault C rises over about 1 m, at which depth the water will flow into Vaults B and/or D. It was determined acceptable to monitor the water level in Vault C in this manner, because any hydrogen that could be generated in this vault can readily diffuse to the adjacent vaults through the inlet ventilation duct common to all of the vaults.

The Retired Filters' Passive Vent System HEPA filters are monitored and maintained in accordance with applicable requirements in accordance with the radiological program described in Chapter 7.

2.5.4 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 B Plant. Examples include locks and tags, door locks, fencing, confined space postings, and radiological area postings. Inspection of barriers and postings are conducted as part of the S&M activities. Any discrepant conditions regarding barriers or postings are identified on associated data/inspection sheets. Corrective action will address discrepant conditions.

2.5.5 Surveillance and Maintenance of the Confinement Systems

The B Plant confinement systems are defined in Section 2.6. Surveillance and maintenance of confinement systems is performed to ensure hazardous materials remain confined within the systems. Confinement, as used in this document, means that there is a barrier that prevents uncontrolled release of contamination to the environment or facility workers. Upgrades or modifications to these systems may be undertaken if the changes are necessary to provide equivalent or improved confinement. Changes will be evaluated using the USQ process on a case basis to ensure the changes are implemented within an approved safety authorization basis.

Surveillance and maintenance of the ventilation systems has been addressed in Sections 2.5.1 and 2.5.3. Section 2.5.6 addresses surveillance and maintenance of the confinement structures.

2.5.6 Surveillance and Maintenance of Confinement Structures

As described in Section 2.6, there are major and minor confinement systems, with respect to the levels of contamination inside the structures. The integrity of these confinement systems will be monitored in order to identify anomalies and correct them. Maintaining the confinement is of the utmost concern, but there are other reasons to maintain the integrity for all B Plant facility structures. Maintaining confinement for radioactive materials inherently enhances maintaining confinement of other remaining hazardous materials, such as lead and asbestos. In addition, surveillance and maintenance of the SSCs is important to enhance protecting facility workers and SSCs from hazards associated with parts of structures falling or being blown about by wind.

Thus, during the S&M phase, facility workers will perform well defined surveillances of the SSCs. The workers will look for:

- changing conditions with respect to known remaining hazardous materials,
- accumulation of water or other solutions,
- indications of leaking roofs, pipes, vessels, or other SSCs,
- indications of degradation of the SSCs.

As anomalies are identified from surveillances, appropriate corrective actions will be implemented to correct and/or prevent increase in SSC integrity degradation and risk of maintaining the facility as authorized by this safety authorization basis.

2.5.7 Container Management

There are no containers external to the B Plant confinement structures mentioned above that contain significant (with respect to accidental releases) quantities of hazardous materials. There are vessels inside 221BB and 221BF that contain residual radioactive contamination. These buildings, as well as all B Plant buildings, are monitored for structural and roofing degradation. Monitoring the structural and roofing integrity for degradation provides a means of detecting and correcting water and pest intrusions that could lead to spreading contamination in cells, vessels, and pipes.

2.5.8 Equipment Calibration, Testing, Maintenance, and Repair

Calibration and testing is 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. Procedures and schedules for these activities are described in the B Plant Surveillance and Maintenance Plan.

2.5.9 Inspection for and Response to Spills

The B Plant facility is routinely monitored for indications of leaks and spills of hazardous substances. Depending on the location, magnitude, and hazards, spills may/may not be cleaned. When a leak or spill is discovered, corrective measures will be performed, as appropriate, to protect the workers, the public, and the environment.

2.5.10 Stabilization or Removal of Unstable Hazardous Substances

All known hazardous substances have been removed or stabilized. During surveillance of the facility unstable hazardous substances may be found. Upon analysis of the substance and condition a decision will be made whether to stabilize or remove the substance, based on cost, benefit, and magnitude of the hazard.

2.5.11 Identification and Removal of Unstable or Friable Asbestos

Asbestos-containing materials or presumed asbestos-containing materials are inspected during routine surveillances. 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 undertaken through the asbestos abatement program and appropriate radiological and industrial hygiene requirements.

2.5.12 Hazardous Substance Disposal

Any hazardous substance removed from the B Plant facility may, after proper waste designation, be disposed of at the Environmental Restoration Disposal Facility (ERDF) or another disposal facility as appropriate, in accordance with appropriate hazardous substance disposal programs.

2.5.13 Nondestructive Assay Waste Characterization and Sampling

Nondestructive assay (NDA), waste characterization, and sampling may be performed in the B Plant facility. The activities will be performed in accordance with established programs and procedures and shall comply with this safety basis. 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.

2.5.14 Removal of Nonprocess Equipment

Removal of nonprocess equipment may be performed in the B Plant facility in support of reducing the risks from known hazards (e.g., removing abandoned conduits, removing deactivated electrical equipment) and redeploying obsolete equipment as spare and replacement equipment (e.g., switchgear and MCCs, etc.). These SSCs may contain surface and internal contaminants, such as PCBs in electrical equipment or other chemicals. However, the removal process shall minimize and control disruption, intrusion, or alterations to process vessels and piping or confinement structures. Removal activities will be performed in accordance with established programs and procedures.

2.5.15 Radiological Surveys

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

2.5.16 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

This section discusses confinement systems at the B Plant facility. There are three confinement systems: the canyon building, which has a Canyon Exhaust System; the retired filter vaults, which have a passive vent system; and 212-B, which has a sealed process cell.

2.6.1 Canyon Exhaust System

The new canyon exhaust system is shown in Figure 2-8. A plan view is shown in Figures E-1 and 2-9. The new canyon exhaust system consists of ducts, two parallel ACTs (each consisting of a bank of maintainable prefilters, two banks of maintainable HEPA filters), two parallel exhaust fans, exhaust stack 296-B-1, and control and monitor equipment.

A new cover block was constructed for Cell 10 to provide three penetrations into the cell. A 76 cm (30 in) penetration is provided for a duct to route an exhaust air stream from Cell 10 to the ACT inlets. Another penetration is provided for access to the tank to allow pumping fluids out of Tk-10-1, if necessary. This penetration is blocked with a removable concrete plug. The third penetration is provided for the Tk-10-1 liquid level monitoring system cable. Section 2.5.2 describes tank Tk-10-1 and the liquid level monitor system operation. The new cover block, which replaced the two south cover blocks, is now the key cover block. Being the key cover block, it would have to be removed first to gain access into the cell. Access into the cell is not anticipated for the S&M phase.

A 76 cm carbon steel pipe is used for the duct from the cover block penetration to the ACT inlets. Another inlet to the steel pipe exists above the pipe trench cover block near Cell 10 to provide an air stream to be drawn from the canyon service area. The service area is the large airspace above the cells and pipe trench cover blocks. Thus, there are two inlets for air from the canyon to the ACTs. Each inlet air flow is controlled by a manually adjusted volume damper. The dampers are above the cover blocks, which are often referred to as the canyon deck. These two dampers have been manually set to a fixed position during system startup testing and air balance to maintain the cells at a negative pressure relative to the canyon. Approximately 40% of the airflow is from the canyon service area air space through the duct inlet on the canyon deck. The remaining airflow is from Cell 10 through the duct inlet penetration in the Cell 10 cover block. Since the cells are at a negative pressure relative to the canyon service area, air is drawn from the service area into the cells through gaps between the cells' cover blocks. Air is then drawn from the cells through the cells' common drain header and the air tunnel to Cell 10 and then out to the ACTs. The steel duct extends through a hole core drilled through the R5 stairwell 1.5 m (5 ft) thick concrete outer wall. This hole does not weaken the canyon structure, since the outer stairwell wall is not a main canyon structural component.

The two parallel ACTs are arranged adjacent to, and parallel with, the canyon wall between stairwells R5 and R7 (Figures E-1 and 2-9). The exhaust fans are located downstream (west) of the ACTs and discharge into exhaust stack 296-B-1. Each exhaust fan is a 45 kW (60 hp), belt-

driven centrifugal fan with manual inlet vane dampers to control fan flow. Backdraft dampers on each fan preclude backflow through the standby fan and isolation valves are provided for maintenance.

Exhaust stack 296-B-1 is constructed of 81 cm (32 in) painted carbon steel pipe. The stack is 29 m (95 ft) high, and is immediately adjacent to and anchored to the 221-B Canyon Building. A stack emissions sampling system is installed to collect particulate samples from the exhaust air stream.

All canyon exhaust system equipment is immediately outside a 57.3 m (188 ft) radius from the retired 291-B-1 ventilation exhaust stack, which was isolated and abandoned in place. The 291-B-1 stack is approximately 57.3m high.

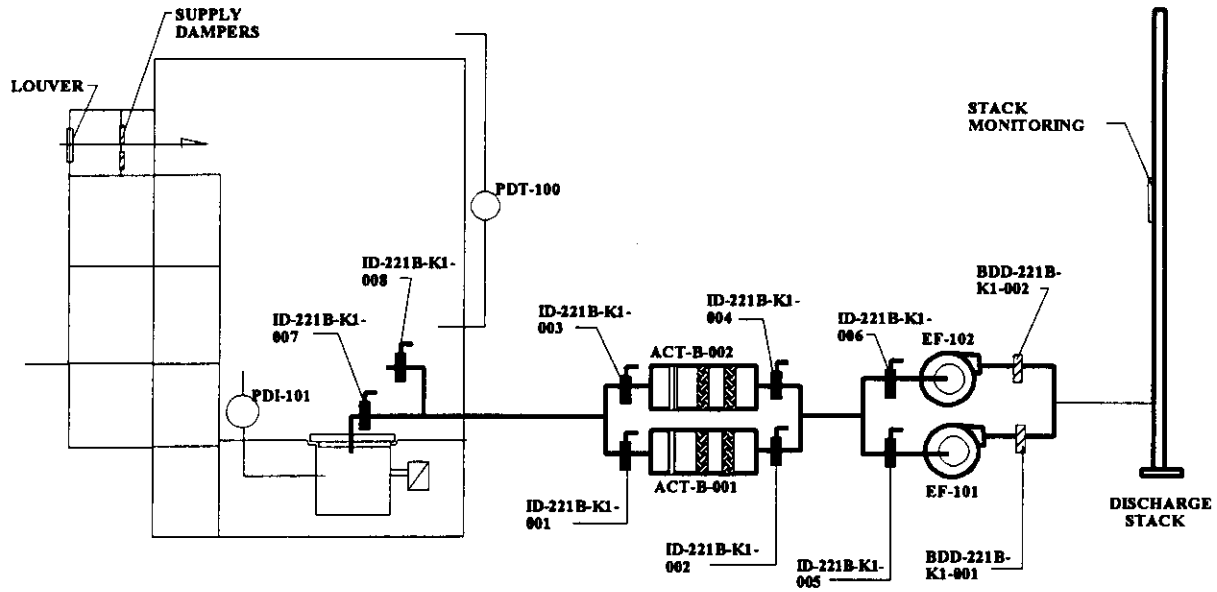

Figure 2-8: Canyon Exhaust System

Air enters the canyon by infiltration and through a designed plenum at Cell 3 on the north side of the canyon. This plenum directs outside air through the Cell 3 stairwell upper floor and the airlock to the canyon craneway. The points of potential infiltration are associated with the canyon structure, the railroad tunnel, and the hot cells in the 212-B and 224-B buildings, since those cells are connected to the canyon exhaust wind tunnel. There is limited potential of infiltration from the galleries and canyon access stairwells. Previously, air entered the canyon from the canyon air supply system. The canyon air supply system has been deactivated. There is not a forced air supply system. The supply dampers are static pressure controlled backdraft dampers that will close when no vacuum is drawn on the canyon airspace.

Control valves and a branch duct with an inlet plenum allow flow control and a balance of the mix of air from Cell 10 and the canyon airspace above the cells cover blocks. Air enters the cells from the canyon through gaps between the cell cover blocks, except that the Cell 10 cover block gaps are sealed to prevent short-circuiting airflow between the cell and the canyon air space above the cells.

Air is drawn from Cell 10 and the canyon airspace through the ACTs and is exhausted out the stack. Air entering each of the ACTs passes through one prefilter stage and two HEPA filter

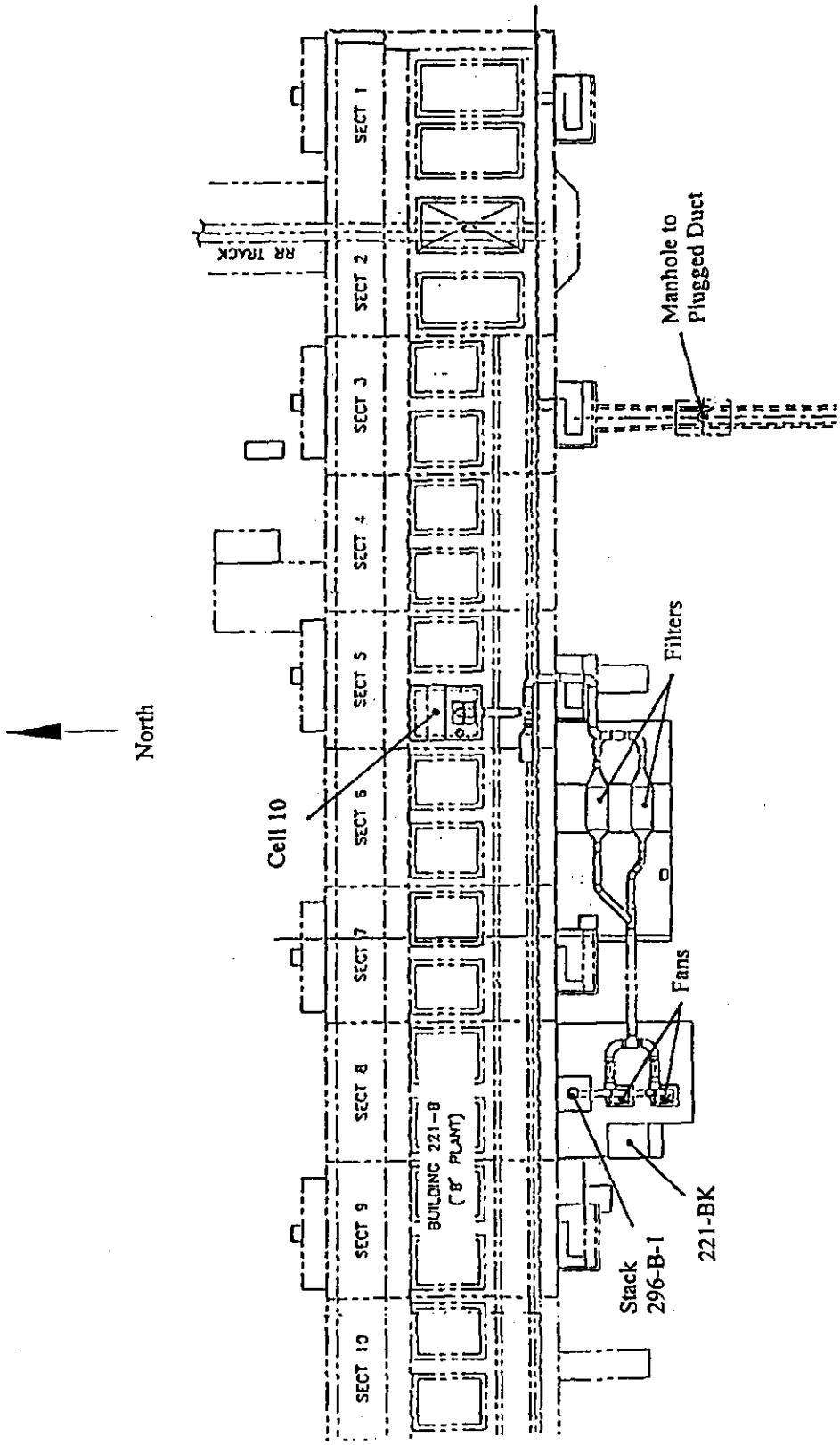

Figure 2-9: Canyon Exhaust System Plan View

stages. New HEPA filters are designed and tested for 99.97% efficiency for the removal of particulate with a median diameter of 0.3μm. The prefilter associated with each HEPA assembly is listed with a 45% efficiency for dust. The prefilters are designed to catch larger particles and thus prolong the life of the HEPA filters. Each stage is a 3-filter-wide by 3-filter-high arrangement. Dampers exist to isolate one or both ACTs and are expected to be operated only to isolate a single ACT for filter changeout. Differential pressure gauges provide a signal which is used to monitor the condition of, and the loading on, each filter. Radiation monitors provide an alarm condition for high radiation loading on the filters.

The exhaust system design precludes failing the HEPA filters. The fans cannot produce enough ΔP (differential pressure) across the filters to breach them by separation of the filter materials or seals, even if they are plugged with particulate. The fans can produce a maximum static differential pressure of 4 kiloPascal (kPa) (16 in water column). The filters are known to fail from static ΔPs ranging from 9.0 to 20 kPa (36.1 to 80.3 in. water column) *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, DOE-HDBK-3010-94 (DOE 3010). The exhaust fans cannot draw a vacuum large enough to fail the canyon structure. As a defense in depth design feature, an interlock will shut down the fans if the HEPA ΔP exceeds 2.3 kPa (9.23 in water column).

2.6.2 291-B Filter Vaults Passive Vent and Liquid Level Monitoring System

The retired filter vaults are equipped with a passive, HEPA-filtered vent system (Figures 2-10 and 2-11) to allow any gases generated from radiolytic decomposition of water or other substances in the filters or filter vaults to dissipate naturally, while preventing transfer of contaminants to the atmosphere.

Two-inch vent lines connected to a riser at each of the five filter vaults are intertied to a common vent line header. Air exhausting from the filter vaults is filtered through two HEPA filters placed in series prior to release through vent line stack 296-B-2. The first HEPA filter serves to filter the vent stream and prevent a release of contaminants to the atmosphere. The second HEPA filter serves as an approved alternative to a record sampler, and is used to perform in-place non-destructive assay (NDA) for reporting emissions from the passive vent discharge.

The vent system contains ports at each vent line riser connection to allow for sampling the vaults air space gases to determine hydrogen concentration. The passive vent system includes provisions (a sealed flange available for blower installation) for active air purging of the retired filter's airspace, if mitigation of hydrogen concentrations should be necessary. The S&M phase FHA (HNF 3756) requires that the hydrogen concentration in the retired vaults airspaces be maintained below 1% to comply with fire protection requirements.

Liquid level detectors are installed at vent line connections in vaults A, B, D, and E (Figure 2-12). Installation of a detector in vault C was impractical due to equipment configuration. Liquid detection consists of intrinsically safe level detectors (to prevent the existence of an ignition source in case hazardous or explosive gases are present) with local indication only. Liquid level monitoring is present to detect flooding within the filter vaults. Flooding of C vault to the level assumed in the accident analysis (Section 4.3.2.4) can be effectively monitored by the monitor in D vault, since either vault filling half full will run over a stub wall into the other vault.

C filter could flood to approximately 3' before overflowing to neighboring filter vaults B & D via the C filter inlet seal and the D filter inlet duct. The filter banks sit on a 6" curb on the bottom of the filter vaults so that 3' of water would flood the bottom row of filters and roughly a quarter of the second row.

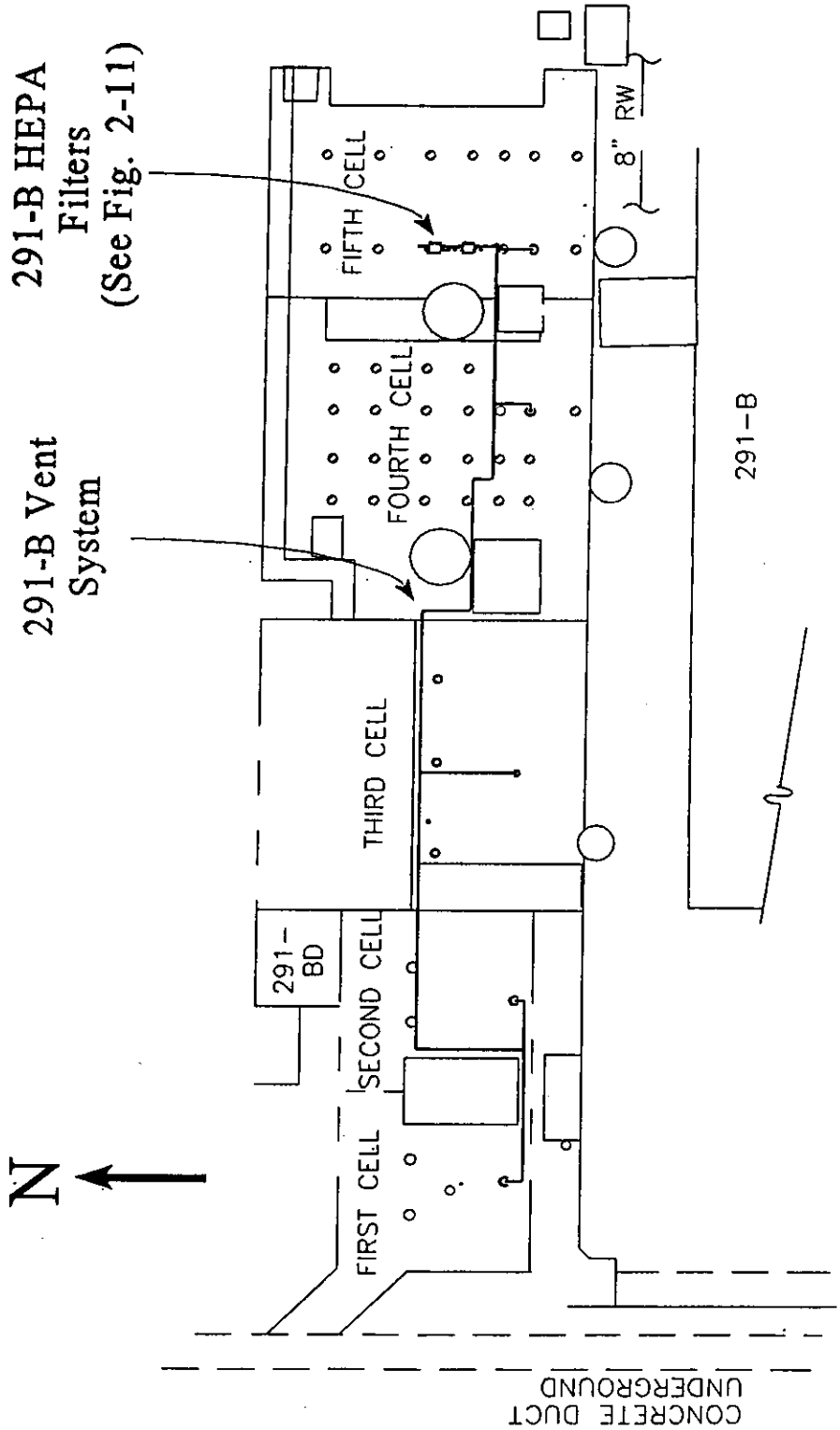

Figure 2-10: Retired 291-B Filter Vaults Passive Vent System

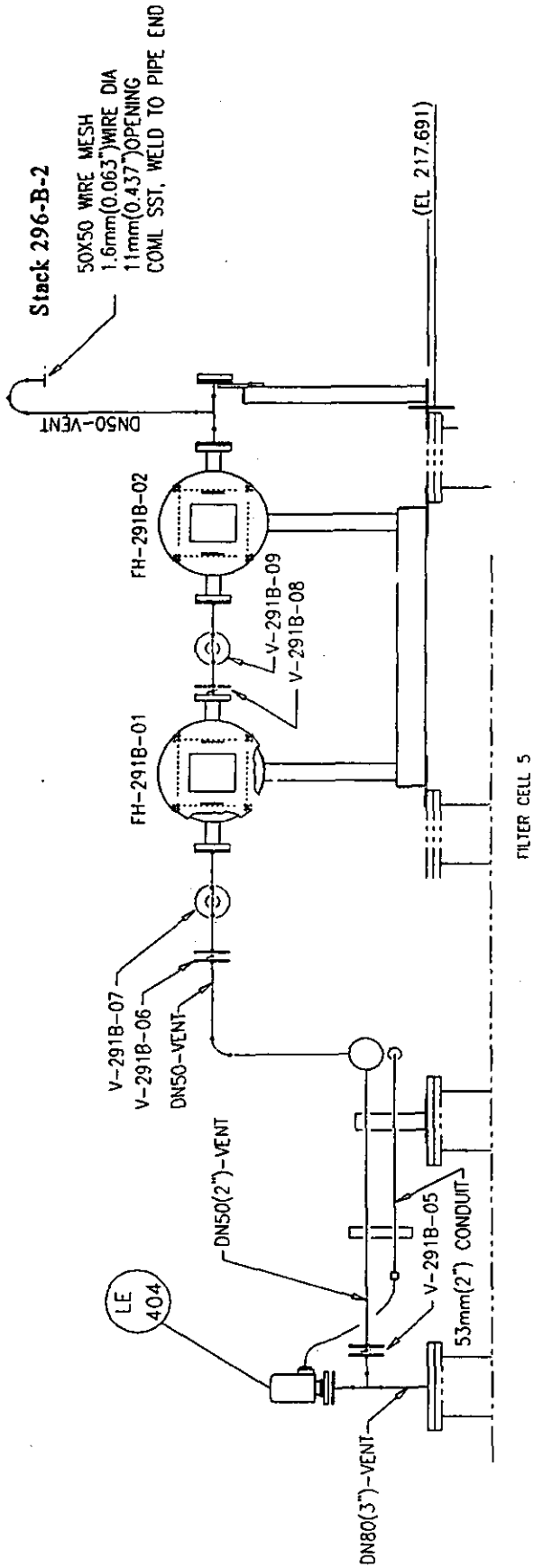

Figure 2-11: Retired 291-B Filter Vaults HEPA Filters

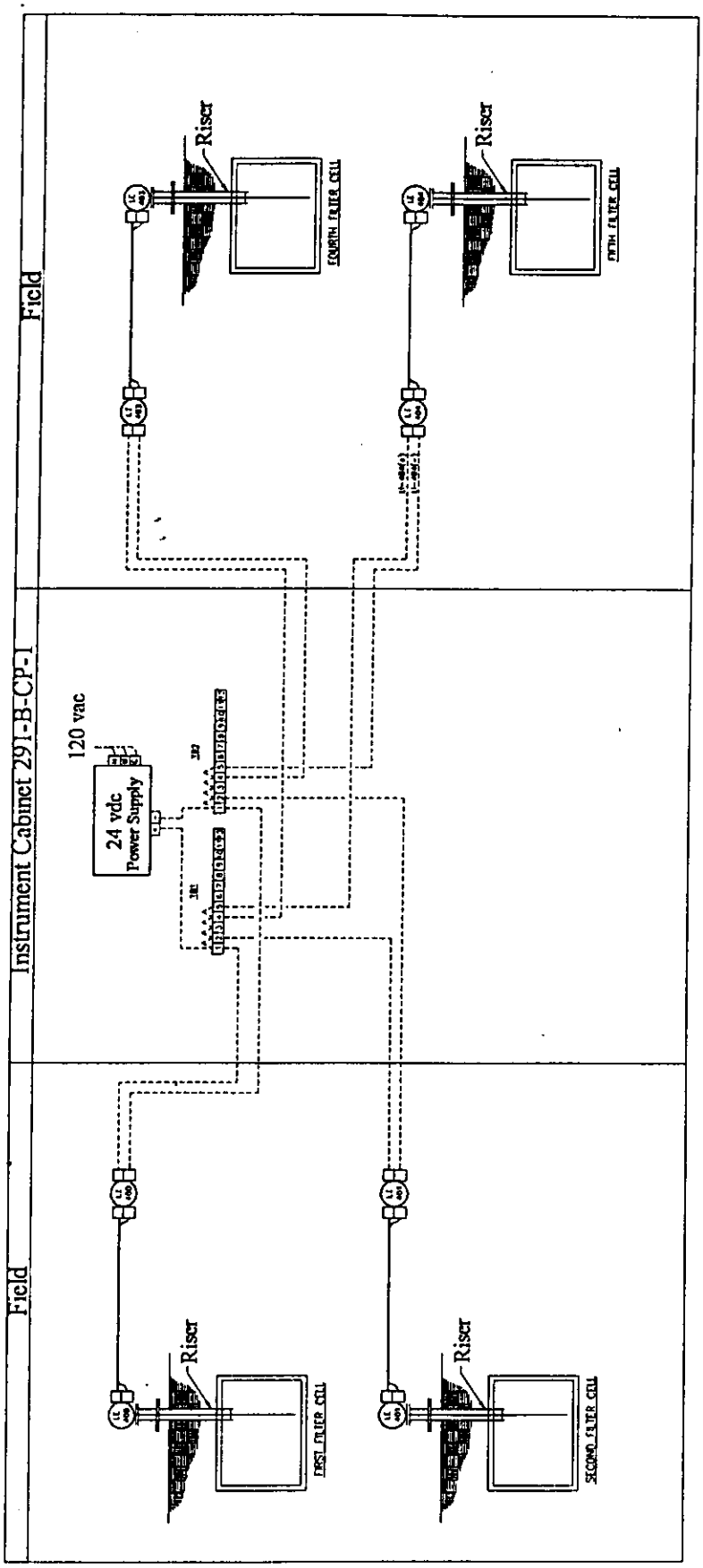

Figure 2-12: Retired 291-B Filter Vaults Liquid Level Monitoring System

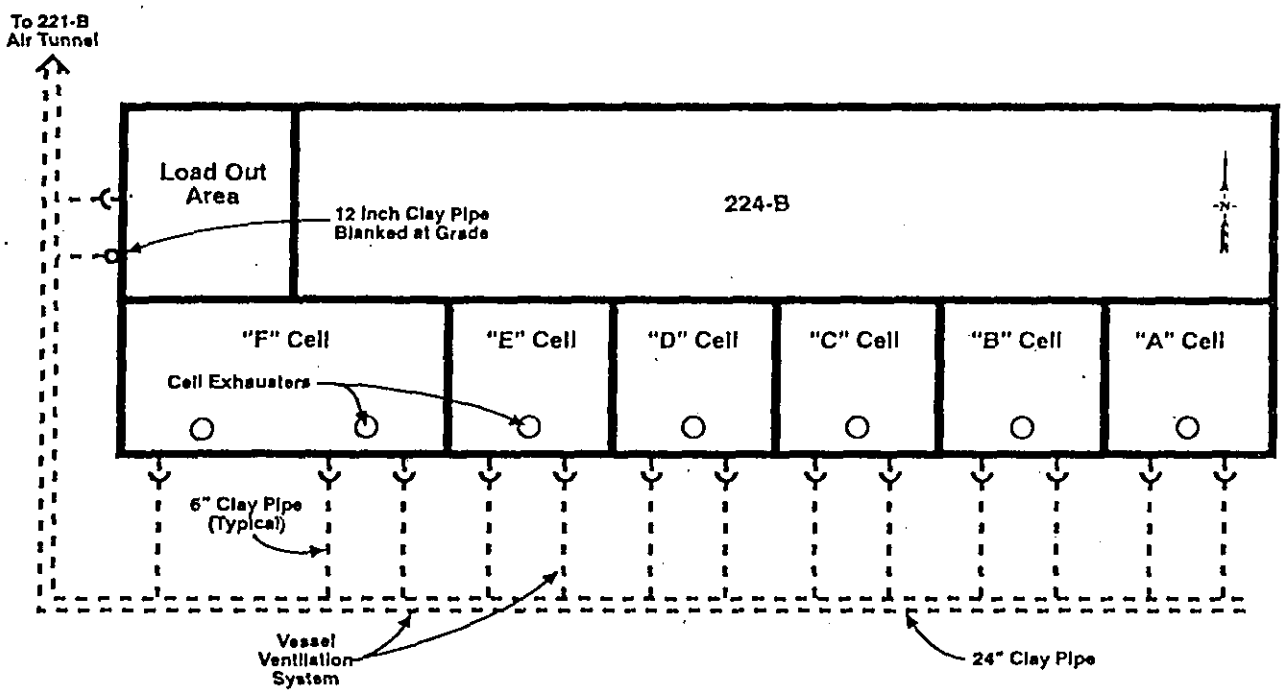

Figure 2-13: 221-B Ventilation Interface With 224-B

2.6.3 212-B Process Cell

The structure of the 212-B process cell provides confinement for the radioactive materials contained within the cell (see Table 3.3-3: *B Plant Radioactive Material Inventories* in Chapter 3 of this SAR). The process cell is maintained at a vacuum relative to atmosphere through a connection to the 221-B canyon building air tunnel and thus to the canyon exhaust system. See Figures 2-4 and 2-6.

2.7 Safety Support Systems

2.7.1 Fire Protection Systems

The facility FHA for B Plant during the S&M Phase, HNF-3756, demonstrates that there are no significant fire hazards for the deactivated facility.

The fire protection systems of B Plant facility have been isolated, drained, and deactivated, except for the following fire hydrants, which are all outside building 221-B:

- Raw Water Hydrant R6-B, located at the NE corner of 221-B
- Raw Water Hydrant R3-B, located at the WSW corner of 221-B
- Raw Water Hydrant R8-B, located at the NW corner of 221-B
- Sanitary Water Hydrant 2-B, located SW of 221-B and NW of 221-BF
- Sanitary Water Hydrant 4-B, located N of 221-B and S of the office trailers
- Sanitary Water Hydrant 9-B, located N of 221-B and E of the office trailers.

The deactivated fire protection systems encompassed fire prevention, detection, annunciation, control, confinement, suppression, and extinguishment in addition to administrative procedures. The hazard and accident analyses (Chapter 3) do not rely upon the fire detection/suppression systems to prevent or mitigate postulated accident consequences.

2.7.2 Radiological Control Systems

The canyon exhaust system, described in section 2.6.1, is operational to maintain control of the canyon building contamination for worker protection and prevention of costly cleanup if the contamination were to spread to uncontaminated areas. The canyon exhaust system discharge out stack 296-B-1 is monitored and sampled as described in section 2.6.1.

The passive vent system, described in section 2.6.2, is maintained operational to prevent dangerous gases accumulation in and pressurization of the airspace in the retired filter vaults of the 291-B area. The HEPA filters on the passive vent system prevent unfiltered release of radiological material to the environment for worker protection and to prevent costly cleanup if the radiological material in the retired vaults were to spread to the environment. As described in section 2.6.2, the passive vent outlet stack contains a HEPA filter for use as an approved alternative to a record sampler and is used to perform in-place Non-Destructive Analysis for reporting emissions from the passive vent discharge stack, 296-B-2. Hydrogen generation in the vaults is a concern/hazard, if water accumulates in the vaults. Section 2.6.2 describes provisions for air sampling, purging, and liquid level detection.

The building structures, including the roofs, also provide radiological control as described in section 2.5.6.

2.8 Utility Distribution Systems

There are two active utility distribution systems at the B Plant facility. Electrical power is provided for surveillance route lighting in the 221-B canyon building, 271-B support building, and the 212-B Cask Station; for the canyon exhaust system; 291-B filter vault and Tk-10-1 liquid level detection instrumentation. Utility water is provided to the fire hydrants described in section 2.7.1. All other utility distribution systems (water, steam, electricity, and compressed air) have been deactivated and isolated outside all the buildings and the 291-B area.

2.8.1 Electrical Power to 200 East Area

The Bonneville Power Administration, through its substations at Vernita and White Bluffs, supplies electrical power to the Hanford Site loop at 251-W substation A8 by 230 kV overhead lines equipped with static wire protection. Two independent sources are available to the loop to allow multiple component failure without irredeemable power loss. From the 251-W substation A8, with two 230-/13.8 kV transformers, power lines are routed to 200-East Area facilities via independent overhead lines C8-L5 through C8-L8.

2.8.1.1 Main Distribution Feeders to B Plant

Electric power from 251-W substation A-8 is transmitted by two independent, 13.8 kV overhead lines, C8-L6 and C8-L7, to B Plant. On the north side of B Plant, lines C8-L6 and C8-L7 supplied power to B Plant substation C8-S49. These two lines have been removed from C8-S49 to deactivate electrical power to B Plant. A pole-mounted transformer is now installed on the pole of C8-L7 to provide power to the B Plant north side for the surveillance route lighting system inside the 271-B Support Building and the 221-B Canyon Building. On the south side of B Plant, lines C8-L6 and C8-L7 provided power for B Plant SSCs. Line C8-L6 now provides power, via a pad mount transformer, to the south side of B Plant for the new canyon exhaust system, surveillance lighting in 212-B, and for the 291-B filter vaults and Cell 10 liquid level detection.

2.8.1.2 Reliability of Main Distributor Feeders

The potential for a multi-disability of B Plant electrical systems is considered remote, with the potential for a pole line structure failure from lightning or other impact. Electrical distribution personnel can be called in from their homes to the job if switching loads or other work is required. There is no requirement for backup electrical power at B Plant because no accident scenarios rely on electrical power to support mitigation or prevention of accident consequences. Loss of electrical power is analyzed in Section 3.4.2.11.2. Loss of electrical power will result in the loss of power to the surveillance lighting systems in the 271-B, 221-B and 212-B buildings, the canyon exhaust system, and the liquid level monitoring systems in Tk-10-1 and in the retired filter vaults. During a power loss event there will be no threat of a hydrogen explosion in the retired filter vaults, due to the extreme duration required for hydrogen to build up to a dangerous level in these large airspaces. This duration is from several months to years, based on the analysis in Section

3.4.2.4. Based on the analysis of Section 3.4.2.7.2.8, a hydrogen explosion in the canyon building is not a credible scenario. Based on the discussion of Section 2.5.1, loss of electrical power does not present a risk of a hydrogen hazard in the canyon building. Based on the discussion of Section 2.5.1, backup electrical power is not required to keep the canyon exhaust system operating.

2.8.2 Steam Supply System

Steam used in B Plant was produced in the 284E powerhouse. The 284E powerhouse was shut down in late 1997. The B Plant steam system and the steam turbine exhaust fan are deactivated. B Plant no longer uses steam.

There is a steam package boiler located just northwest of the 221-B Canyon building and north of the WESF facility. This package boiler provides steam for WESF operations, but not to B Plant. The package boiler is driven by a diesel fuel burner, thus, there is a diesel fuel supply tank located just north of the package boiler. There are two diesel fuel tanks for two deep well pumps, two diesel fuel tanks for the WESF closed loop cooling system, and one diesel fuel tank for the WESF diesel engine driven electric generator. An accident associated with the diesel fuel and steam presents no impacts to the B Plant configuration or S&M operations, unless an emergency alarm is initiated, to which S&M operations personnel would respond.

2.8.3 Water Supply System

The Columbia River provides the water needs for the Hanford Site. Up to 5.3 kL/s (84,000 gal/min) of water is pumped from the river at the 100-B Area to a 9,500 kL (25-million gal) reservoir at 100-B Area, then through underground export water piping to the 200 Areas.

Two alternate pumping sources, located at 100-B and 100-D reactors, feed the export water pipelines and provide a redundant system, as long as the export water pipeline remains intact.

The main water system is connected to two 11,000 kL (3-million gal) reservoirs, one in 200-East Area and one in 200-West Area. From the area reservoirs, water enters either the process water system as raw water or the sanitary water system after filtering, chlorination, and testing. To meet emergency situations, area pumphouses are provided with steam-driven backup pumps in addition to electrically driven primary pumps.

2.8.3.1 Sanitary Water System

Sanitary water was used in B Plant for safety showers, operating area washdown, drinking, toilet facilities, making deionized water for process use, and as an emergency backup for fire fighting. The sanitary water utility has been physically isolated from B Plant, by installing blank flanges in the utility water lines external to the B Plant buildings and outside of the 291-B area. The 291-B area encompasses the retired ventilation filters, fans, underground duct, and stack. Sanitary water is served to the fire hydrants as described in Section 2.7.1.

The isolations were performed underground by removing a piece of pipe and installing blind flanges on both sides as near as possible to the system main header. No radiological or chemical

contamination is expected to reside in the deactivated portions of these pipes.

The water sources closest to the 291-B area are the underground sanitary and raw water utility pipes, located about 43 m to the south of the 291-B area. These utility pipes extend east-to-west. All water vessels and pipes inside and near the 291-B area have been drained and isolated from the vaults and the utility water header.

2.8.3.2 Raw Water System

Raw water was used at B Plant as a heat transfer fluid in cooling coils for process and storage tanks; condensers for the concentrator, air compressors, and diesel engines; sprays; filter seals; and fire protection. Utility raw water has been isolated from the 221-B Canyon Building, the 212-B Cask Station, 222-B Office Building, the 271-B Support Building, and the 291-B area by installing blank flanges in the utility water lines external to the B Plant buildings and outside of the 291-B area. Raw water is served to the fire hydrants described in section 2.7.1.

The isolations were performed underground by removing a piece of pipe and installing blind flanges on both sides as near as possible to the system main header. No radiological or chemical contamination is expected to reside in the deactivated portions of these pipes.

The water sources closest to the 291-B area are the underground sanitary and raw water utility pipes, located about 43 m to the south of the 291-B area. These utility pipes extend east-to-west. All water vessels and pipes inside and near the 291-B area have been drained and isolated from the vaults and the utility water header.

2.8.4 Deionized Water

Deionized water was provided from B Plant for the WESF for pool cell makeup water and at both B Plant and WESF for dry chemical makeup, tank flushes, and general miscellaneous use.

Deionized water was produced by a continuous deionizer unit located on the 271-B Support Building third floor. The deionized water system is isolated, deactivated, and abandoned in place. Resins are removed and the tanks are empty.

2.8.5 Compressed Air Systems

The B Plant process and instrument air compressors are isolated and deactivated. The compressed air inter-tie between B Plant and WESF is isolated and blanked in WESF. There is no requirement or user for compressed air at B Plant.

2.8.6 B Plant Gallery Air Exhausters

There were seven gallery exhausters. These exhausters were located on the north side of the 221-B building at ground level. All of these exhausters were deactivated and electrical power was removed by isolating the electrical power to the canyon building. A physical gap was made between the ducts and the exhauster, and the outlets to the ducts were sealed with a sealant and metal plates bolted in place. Both the inlet and outlet of the isolated exhausters were sealed in the

same manner as the ducts. The exhauster's HEPA filters, which were located in the galleries, were removed and disposed as waste. No contamination was found on any of the exhausters. Thus, none is expected in the ducts.

2.8.7 Plant Penetrations

All door and plant penetrations were sealed with aluminum flash tape and/or insulator foam. Roof vents to the facility were plugged with a rubber stopper and sealed with two ton epoxy. This was done to prevent vermin and water intrusion to the building. The expansion joints of the building were repaired in 1990 by injecting "Masterfill CJ" epoxy into the joints. The joints were examined in 1998, and no evidence of deterioration was found.

2.8.8 Effluents

There are four effluent systems associated with B Plant: sanitary water, chemical sewer, steam condensate, and process cooling water. These systems were deactivated by isolating the effluent sources from the effluent discharge pipes.

2.8.8.1 Sanitary Sewer

The sanitary sewer received water from sinks, toilets, and showers. The sinks and toilets were removed from all the deactivated buildings. Drains to the sinks, toilets, and showers were plugged with a rubber stopper and sealed with a two-part mixed epoxy. All pipes exiting the 221-B and 271-B basement level outer accessible walls are likewise plugged and sealed from inside the buildings. It is not expected that the sanitary sewer is contaminated with chemicals or radio-nuclides.

2.8.8.2 Chemical Sewer

The B Plant Chemical Sewer (BCE) received miscellaneous liquid wastes, including nonradiological chemical make-up tank overflow, tank flushes, various floor drains and similar sources with low probability for radiological contamination. All floor drains were plugged with a rubber stopper and sealed with two-ton epoxy. Chemical sewer pipes that penetrate the outer walls were likewise plugged and sealed from inside the buildings. It is not expected that the chemical sewer is contaminated with radio-nuclides, although there may be some chemical and/or radio-nuclide contamination in the abandoned pipes.

The BCE is now used only by WESF because B Plant is isolated from the system. The WESF organization maintains a monitoring system on the BCE effluents.

2.8.8.3 Steam Condensate

As described in Section 2.8.2, steam has been isolated from B Plant. The steam condensate effluent line went from 221B to 221BB and/or 221BF. Condensate that was contaminated with radio-nuclides was routed to 221BF, where it was filtered. From 221BF, some condensate water was pumped to basin 216-B-64. During deactivation, air was blown into the condensate pipe from 221BB back into 221B to empty the pipe as much as possible of any remaining liquids. The

line was opened at the low points to drain liquids remaining in the pipe. The pipe was then capped and sealed in 221BB. There may be residual radiological contamination in the underground pipes to 221BB and/or 221BF and the 216-B-64 basin. The level of contamination in these pipes and the basin has not been quantified. It is not expected that the pipes have chemical contamination.

2.8.8.4 Process Cooling Water

Raw water was used to feed the process vessels cooling coils. There were two headers for cooling water effluents: the 38 cm (15 in) header and the 61 cm (24 in) header. The 38 cm header was used to discharge cooling water for vessels that had potential (high-risk) to be contaminated in case a coil broke. The high-risk effluent was monitored in building 221-BA. The 61 cm header was used as a cooling water discharge line for vessels with low potential (low-risk) for radiological contaminants. The low-risk effluent was monitored in building 221-BG. The high-risk header intersects the low-risk header downstream of the monitoring station via a diversion control station. Uncontaminated cooling water was automatically routed to the 271-B Pond. Contaminated cooling water was automatically routed to the 216-B-59 retention basin and resampled. If the effluent was contaminated, it was returned to the canyon building and dispositioned from there.

To isolate the effluent pipes, which are underground, jumpers were removed from the nozzles that routed cooling water to the cooling water headers. In addition, the cooling water was isolated from the buildings that discharged water to the cooling water systems. The effluent discharge lines to basins were plugged by pouring concrete in the valve pits. No sampling has been performed to determine the contamination levels in the deactivated pipes and/or basins. There may be some residual contamination in the cooling water sewers, but it is expected that the contamination levels are small. Any remaining contamination is likely to be fixed residual contamination.

2.9 Auxiliary Systems and Support Facilities

There are no operating auxiliary systems or support facilities at B Plant. Table 2-1 lists the SSCs within this document's scope:

Table 2-1: B Plant Facility Structures and Components

Building ID	Building Description / Components	Location
207-BA	CBC Sampling Building	Northwest of Facility, east of Baltimore St.
211-B	Chemical Tank Farm Area	North of 221B Bldg.
211-BB	MCC Building for 211B Area	Between 211B and 221B
212-B	Cask Transfer Building	South of West End of 221B
217-B	Demineralized Water Building	North of 221B and 211B Area
221-B	B Plant Canyon Building: • Canyon and process cells • Electrical gallery • Pipe gallery • Operating gallery • SWP Change Room • Railroad tunnel	Inside 221B Bldg
221-BA	15-inch Cooling Water Monitor Building	South of East End of 221B Bldg.
221-BB	Condensate Building for LLW Concentrator	South of 221B Bldg.
221-BC	SWP Change Building	South of 221B Bldg.
221-BD	Laundry Storage Building	South of 221B Bldg.
221-BF	BCP Diversion Pit Building	South of West End of 221B Bldg.
221-BG	24-inch Cooling Water Monitor Building	SE Corner of 221B Bldg.
221-BK	Canyon Exhaust System Instrumentation Building and Canyon Exhaust System: • Duct • Filters • Fans	South Side of 221B Bldg.
222-B	Office Building	South of 221B Bldg.
271-B	B Plant Support Building: • Basement • First Floor • Second Floor • Third Floor	North Side of 221B Bldg.
271-BA	Laundry Storage Building	North Side of 221B Bldg.
2711-B	Breathing Air Compressor Building	South Side of 221B Bldg.
2715-B	Paint and Oil Storage Building	North Side of 221B Bldg.
2716-B	Storage Bldg - RR Cut	North of RR Tunnel Door
276-B	Paint Shop	North of 221B Bldg.
276-BA	ISO Tank Area	Northeast of 221 B Bldg.
291-B	Exhaust Fans Control/Turbine Building	South of 221B Bldg.
291-BA	Exhaust Air Sample Building	South of 221B Bldg.

Table 2-1: B Plant Facility Structures and Components		
Building ID	**Building Description / Components**	**Location**
291-BB	Instrument Building - A and B filters	South of 221B Bldg.
291-BC	C Filter Building	South of 221B Bldg.
291-BD	C Filter Instrument Building	South of 221B Bldg.
291-BF	D Filter Instrument Building	South of 221B Bldg.
291-BG	E Filter Instrument Building	South of 221B Bldg.
291-BJ	F Filter Instrument Building	South of 221B Bldg.
291-BK	E Filter Monitoring Control Building	South of 221B Bldg.
292-B	Stack Monitoring Building	South of 221B Bldg.
291-B-1	Retired Canyon Ventilation Stack	South of 221B Bldg.
296-B-1	Canyon Ventilation Stack	South Side of 221B Bldg.
296-B-2	Filter Vault Passive Vent Stack	Above Vault E
296-B-5	Retired 221-BB Stack	Adjacent to 221 BB
296-B-13	Retired 221-BF Stack	Adjacent to 221 BF
296-B-21	Retired Pipe Gallery Exhauster	North Side of 221 B Bldg.
296-B-22	Retired Pipe Gallery Exhauster	North Side of 221 B Bldg.
296-B-23	Retired Pipe Gallery Exhauster	North Side of 221 B Bldg.
296-B-24	Retired Pipe Gallery Exhauster	North Side of 221 B Bldg.
296-B-25	Retired Pipe Gallery Exhauster	North Side of 221 B Bldg.
296-B-26	Retired Pipe Gallery Exhauster	North Side of 221 B Bldg.
296-B-27	Retired Pipe Gallery Exhauster	North Side of 221 B Bldg.
C8-S49	Main B Plant Substation (271-B/221-B)	North of 221B Bldg.
C8-S77	B Plant 291-B Area Substation	South of 221B Bldg. And 291B Area
A-F Filters	A-F Filter Vaults	South of 221B Bldg.
Yard	Total area inside the fence	Fence surrounds B Plant
Unplanned Release Sites	B Plant Unplanned Release Sites • UPR-200-E-1 • UPR-200-E-2 • UPR-200-E-3 • UPR-200-E-7 • UPR-200-E-32 • UPR-200-E-41 • UPR-200-E-44 • UPR-200-E-52 • UPR-200-E-64 • UPR-200-E-69 • UPR-200-E-80 • UPR-200-E-85 • UPR-200-E-90 • UPR-200-E-95 • UPR-200-E-103 • UPR-200-E-112 • UPR-200-E-140	Inside and outside the B Plant fence. See Waste Information Data System (WIDS) map.

Table 2-1: B Plant Facility Structures and Components		
Building ID	**Building Description / Components**	**Location**
Waste Sites	B Plant Waste Sites • 200-E-6, Septic Tank • 200-E-16, LLW Concentrator (in Canyon) • 200-E-25, Miscellaneous Stream #659 • 200-E-28, 221-B Steam Condensate Release • 200-E-30, 291-B Sand Filter • 200-E-55, Miscellaneous Stream #322 • 200-E-88, Miscellaneous Stream #3 • 200-E-89, Miscellaneous Stream #4 • 200-E-90, Miscellaneous Stream #5 • 200-E-91, Miscellaneous Stream #6 • 200-E-92, Miscellaneous Stream #7 • 200-E-93, Miscellaneous Stream #8 • 200-E-94, Miscellaneous Stream #9 • 200-E-95, Miscellaneous Stream #308 • 200-E-97, Miscellaneous Stream #470 • 200-E-98, Miscellaneous Stream #490 • 200-E-99, Misc Stream #570/#1 (Duplicate) • 200-E-100, Misc Stream #571/#2 (Duplicate) • 207-B, Cooling Water Retention Basin • 216-B-4, Dry Well • 216-B-13, Crib • 216-B-59, Trench • 216-B-59B, Retention Basin • 216-B-64, Retention Basin • 217-B NU, 217-B Bldg Emergency Neut Unit • 221-B-26-1, Radioactive Organic Waste Solvent Tank 1 • 221-B-27-2, Tank TK-27-2 • 221-B-27-3, Radioactive Organic Solvent Tk 2 • 221-B-27-4, Radioactive Organic Waste Solvent Tank 3 • 221-B-28-3, Radioactive Organic Solvent Tk 4 • 221-B-28-4, Radioactive Organic Solvent Tk 5 • 221-B-29-4, Radioactive Organic Solvent Tk 7 • 221-B-30-3, Radioactive Organic Solvent Tk 6 • 221-B NANU, 221-B Nitric Acid Neut Unit • 221-B SDT, 221-B Plant Settle & Secant Tank • 221-B SHNU, 221-B Sodium Hydroxide Elementary Neutralization Unit • 221-B-WS-1, B Plant Storage • 221-B-WS-2, B Plant Waste Pile • 270-E-1, Condensate Collection Tank • 2607-E3, Septic Tank • 2607-E4, Septic Tank • B Plant Filter, F-34-4 Filter	Inside and outside the B Plant fence. See Waste Information Data System (WIDS) map.

AMU = Aqueous Makeup Unit
BCP = B Plant Process Condensate
CBC = B Plant Cooling Water
LLW = Low Level Waste
MCC =Motor Control Center
SWP = Special Work Permit (protective clothing)
UPR = Unplanned Release Site
WESF = Waste Encapsulation and Storage Facility

2.10 Interfacing Facilities

There are three interfacing facilities: WESF, the 224-B building, and Tank Farms.

2.10.1 WESF

B Plant is physically adjacent to WESF. All of the interfaced systems have been isolated. The systems isolated were process water; cooling water effluents; chemical feeds to WESF (Sodium Hydroxide and Nitric Acid); compressed air; and contaminated discharges from WESF to the canyon.

WESF does not rely on B Plant for any process or utility systems support. Seismic interfaces between the 221-B and 225-B buildings are addressed in Section 3.4.2.7.2.2.1 because the buildings are so close to each other and because WESF is an operating facility with a significant mission. WESF stores strontium and cesium capsules in a controlled atmosphere and configuration.

There are two doorways between B Plant and WESF. One doorway provides access between the B Plant pipe gallery and the aqueous make-up (AMU) area on WESF's second floor. The other doorway provided access to Cell 40 in 221-B from 225-B. Both of these doorways have been locked and sealed. The seal is achieved by installing an aluminum backed adhesive tape over the gap between the door and the door frame. The seal is intended to prevent vermin intrusion and block contamination during normal facility conditions. The tape is not intended to prevent or mitigate accident consequences. This is the standard method used when deactivating structures.

The process (deionized) water pipes and chemical feed pipes were routed to WESF from the B Plant galleries. All pipes between the B Plant galleries and WESF have been isolated and blanked by removing a section of pipe and installing pipe caps in WESF and in the B Plant galleries.

Contaminated water was routed to B Plant from WESF through two routes. One route was with pipes from the WESF process cells through a pipe chase to Cells 38 and 39 in the B Plant canyon. The pipe chase has a drain to Cell 39. The pipes in this pipe chase are capped at the nozzles in the B Plant cells. The WESF steam system was used to jet WESF process cells solutions to the B Plant cells. The steam system has been isolated from the WESF process cells, so it is no longer possible to jet WESF solutions to B Plant. The second route was from WESF's tank Tk-100, through an underground pipe. Tk-100 is an underground tank, located outside of WESF, immediately south of instrument building 225-BD. To isolate discharges to B Plant from Tk-100, a section of pipe between Tk-100 and B Plant was removed near Tk-100. The remaining pipe that goes to the B Plant canyon has been capped at the end near Tk-100.

An accident in the 221-B canyon or WESF could result in some contamination spread to the other building through the pipes and/or doorways between these two buildings.

B Plant has its own process and instrument air systems, which were deactivated by shutting down the system. A backup to the B Plant process and instrument air system was provided by the WESF instrument air system. The WESF instrument air system supplied compressed filtered air to B Plant through a two inch pipe that entered B Plant at Cell 40 of the B Plant operating gallery

from the WESF AMU. The backup air system was isolated from WESF by installing caps in the instrument air line that comes from 225B (WESF) into 221B (B Plant). A section of the pipe from WESF to B Plant was removed and capped in the WESF AMU.

Sodium Hydroxide, Nitric Acid, and Demineralized Water were supplied to WESF from B Plant through pipes in the B Plant operating gallery. To isolate these interfaces, a section of piping was removed from each pipe and a Victaulic coupling was installed on the pipe leading to B Plant on the east wall of the WESF AMU as close to the penetration into B Plant as possible. The lines were opened at the lowest point located inside B Plant and emptied of all fluids. It is expected that some residual chemical may remain in the pipes, but is has not been quantified.

2.10.2 224-B Deactivated Plutonium Concentration Building

The authorization basis for the 224-B building is the *224-B Facility Safety Analysis*, BHI-01156 (BHI 1998). BHI 1998 describes the 224-B building as follows:

The 224-B building is a deactivated plutonium concentration facility that was formerly associated with the B Plant Complex. The 224-B building is located south of the 221-B Canyon building and west of the 222-B office building. Figure E-1 shows these buildings. The 224-B building was used to purify and concentrate dilute plutonium nitrate solution that was the product of the 221-B bismuth phosphate process. The solution was then shipped to the 231-Z Isolation building. The 224-B building operated from 1945 until 1976.

The 224-B building is a single canyon type building. The 224-B building contains six process cells and an associated operation gallery, offices, and support areas. Cell C was the receiving cell for product solutions for the 221-B building and wastes generated within 224-B. Chemical processing of the crude product was performed in cells A, D, and E. The B cell was initially a standby cell, but was also used to augment operation in D cell. The F cell was the final concentration area. This cell now contains an area called G cell, and was also called the loadout area.

Currently, the cells are maintained at a slight negative pressure compared to atmosphere using a connection to the B Plant exhaust ventilation system. This negative pressure results from the venturi effect caused by air flow through the B Plant air tunnel. A small volume of air is drawn into the 224-B canyon from doors and minor openings in roof vents and wall joints. Canyon air flows into the cell tanks and vessels. Stainless steel sub headers that are connected to the tanks and centrifuges exit the building above grade, but immediately connect to the 15.2 cm (6 in.) diameter, below grade clay pipes. The clay pipes connect to the 60 cm (24 in.) diameter clay header that is laid along the south and west sides of the 224-B building (Figure 2-13). The 60 cm (24 in.) line connects to the west end of the 221-B air tunnel (Figures 2-4). Figure 2-6 depicts the underground connection for the duct from 224-B to the 221-B air tunnel. The 60 cm clay pipe contains vessel vent pipes from the 224-B cells. The 60 cm pipe has been blocked with concrete, but the vessel vent pipes provide an airflow path from the 224-B cells to the 221-B air tunnel.

As described in BHI 1998, there are systems associated with the 224-B building that have abandoned pipes external to the building. These pipe systems are part of the B Plant facility. The B Plant operating contractor is responsible for these pipes and the associated hazards and

controls. The operating contractor should be extremely careful if excavations are performed for these pipes or in the vicinity of these pipes and all underground pipes around B Plant. The Hanford excavation safety programs should be thoroughly observed for all excavations.

There are currently no process activities associated with the 224-B building, so there are no discharges expected to the abandoned pipes interfacing 221-B and it's deactivated systems and 224-B. The interfacing pipe systems are:

- The vessel vent pipes,
- the plutonium process pipes from the B Plant canyon
- a pipe to the 241-B-361 settling tank,
- the chemical sewer pipe, and
- a cooling water effluent pipe that connects 224-B to the B Plant low risk cooling water system.

The vessel vent pipes are mostly underground. There are short sections of the vessel vent lines immediately adjacent and vertically oriented against the south side of 224-B building that are above the ground. There have been no studies or samples of these pipes to characterize or estimate the quantity of the remaining contamination. There is likely some plutonium in the vessel vent lines due to the small airflow from 224-B to the 221-B canyon air tunnel. Although there is no known plutonium migration from 224-B to the 221-B air tunnel, some plutonium may have traveled to the 221-B air tunnel.

The plutonium process pipes slope from the 221-B building to the 224-B building. There are three process pipes shown on reference drawings H-2-82904 and H-2-82905. The plutonium feed pipes, which are completely underground between the buildings, are routed from the canyon building process cells 33 (nozzle 11), 35 (nozzle 213), and 37 (nozzle 11), out the south side of the 221-B building to under the north side of the 224-B building, and to Cell C inside 224-B.

Even though it was common practice to flush pipes with wash solutions following transfers, it is possible that there is residual plutonium in these pipes. The contamination levels in or around these pipes are not known.

The pipe to the 241-B-361 settling tank is routed completely underground. The pipe exits 224-B on the south side and is routed around the east end of 224-B to 241-B-361. Liquids were jetted from tank C-8 to the settling tank 241-B-361. It is not known if there is contamination in the pipe or the settling tank.

The chemical sewer pipe is routed underground from the north side of the 224-B building, around the west end of the B Plant buildings and the WESF building, to the WESF (former B Plant) chemical sewer system. B Plant buildings were isolated from the chemical sewer system when B Plant was deactivated in 1998. The 224-B building drains to the chemical sewer system are plugged with grout, but the 224-B elevator pit may still drain to this system. The WESF organization maintains a system that monitors the chemical sewer system effluent.

The 224-B cooling water discharge pipes from the cells are routed to a header located underground on the south side of 224-B. The header is routed around the east end of 224-B, where it is intersected with another underground cooling water discharge header from the north

side of 224-B. The cooling water discharge pipe is routed underground to the north, where it is discharged to the B Plant low-risk cooling water sewer. The low-risk cooling water sewer is described in Section 2.8.8.4. It is not known if the 224-B branch into the low-risk cooling water system is isolated or contaminated.

2.10.3 Tank Farms

The pipe lines from the 221-B Canyon to Tank Farms were isolated, both at the B Plant side and the Tank Farm side. On the B Plant side these lines were isolated by installing blanks on the cell nozzles located in the 221-B Canyon cells. On the Tank Farms side they were isolated by disconnecting the jumpers to the wall nozzles in the diverter boxes which creates a physical gap. Due to the configuration of the diverter boxes, once the jumper is disconnected it is physically impossible to introduce liquid into the pipes. In some cases process blanks or vapor seals were installed.

Pipeline 833/8616 was isolated in the B Plant canyon. In the Tank Farm end it terminates into the pump discharge for pump P-001 in TK-001 in 244-AR Vault. The facility is scheduled to be D&D'd, and no activities or entries are planned at this time due to lack of funding. The leads to the pump were removed to assure transfers cannot occur.

Even though it was common practice to flush transfer pipes with wash solutions following transfers, there may be residual contamination in the underground pipes. The contamination levels in the pipes and surrounding ground are not known.

3.0 HAZARD AND ACCIDENT ANALYSIS

3.1 Introduction

3.1.1 Scope

This section describes the hazard and accident analyses conducted for B Plant for the Surveillance and Maintenance (S&M) phase. The S&M phase mission for B Plant is to ensure that the facility is maintained in a safe, cost effective, and environmentally secure configuration to maintain control of the hazardous radioactive materials at B Plant until the facility is transitioned into the next life-cycle phase. This mission requires that surveillance and maintenance activities are conducted on the B Plant active and passive systems.

B Plant is deactivated; there are no active processing activities during the S&M phase. During the transition to the S&M phase, process chemicals and radioactive materials were removed from the facility and clean out activities were performed. S&M activities consist principally of surveillance and maintenance of the facility structures, systems, and components. There is one active system; the new canyon exhaust system. The facility structures and the vent system on the retired 291B filter vaults are the passive systems and components.

The major hazards at B Plant during the S&M phase are associated with natural phenomena and the remaining radioactive materials. The natural phenomena of most concern is aging of the facility structures during the potentially long-term S&M phase. The S&M phase may last for up to several decades. Natural aging of the structures is a significant concern, since there is considerable radioactive contamination in the canyon building and in the retired filter vaults. Structural integrity degradation of these structures could lead to loss of containment of the internal radioactive contamination. Releases from these structures could result in consequences that exceed onsite guidelines. Therefore, it is essential that these structures and associated hazards be monitored and maintained.

There is radioactive material in some of the other B Plant structures, but those are very small quantities and the potential for mobility of that material is very low. If those small quantities were to be involved in a release from those buildings, the consequences could not exceed the onsite or offsite guidelines. However, these smaller structures and associated hazards will also be monitored throughout the S&M phase.

3.1.2 Objectives

The objectives of this chapter are:

3.1.2.1 Document a hazards identification and evaluation (HI&E) report that:

a) identifies the process related, natural phenomena, and external hazards at the facility that can affect the public, workers, and the environment due to single or multiple failures of structures, systems and components, and/or due to human error, applicable to all modes of operations at the facility and nearby facilities.

b) demonstrates that a thorough qualitative evaluation has been conducted to identify the types of accidents that could occur due to the identified hazards.

c) qualitatively identifies the risks associated with the hazards and accidents.

d) identifies the preventative and mitigative features existing and postulated for each hazard/accident bin and bounding accident. These features combined form a set of defense-in-depth safety features, as well as safety requirements (TSRs), which identify limiting conditions and administrative controls commensurate with the hazard's magnitude and degree of risk.

3.1.2.2 Document an accident selection and evaluation report that:

a) documents the formal development of the accidents selected for further review in the HI&E. The developed scenarios will result in postulated consequences which may or may not exceed risk evaluation guidelines.

b) identifies safety class and safety significant SSCs and TSRs needed to protect the public, the workers and the environment.

c) documents beyond design basis accident (BDBA) analyses to provide bases for cost/benefit considerations if postulated consequences exceed Risk Evaluation Guidelines (REG). The cost/benefit analysis will not be provided in the SAR.

3.1.2.3 Demonstrate that the hazards are prevented and/or mitigated to the degree that the risk of harm to the worker, public and environment is As Low As Reasonably Achievable (ALARA) and within the nuclear industry mandates of the applicable DOE Orders and Standards.

3.2 Requirements

U. S. Department of Energy 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 5480.22, *Technical Safety Requirements*
- DOE 5480.23, *Nuclear Safety Analysis Reports*
- DOE 5480.28, *Natural Phenomena Hazards Mitigation*
- DOE-STD-1020-94, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities* (DOE 1020)
- DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Process,* (DOE 1027).
- DOE-STD-3009-94, *Preparation Guide for U. S. Department of Energy Nonreactor Facility Safety Analysis Reports,* (DOE 3009).

Additional design codes, standards, regulations, and DOE orders relevant to specific hazards are identified in other final safety analysis report chapters.

Definitions of the site boundary, risk guidelines and other analysis details are taken from Hanford procedures. Specific procedures referenced are:

- HNF-PRO-097, Rev 0, *Engineering Design and Evaluation*
- HNF-PRO-700, Rev 1, *Safety Analysis and Technical Safety Requirements*
- HNF-PRO-701, Rev 0, *Safety Analysis Process - Existing Facilities*
- HNF-PRO-702, Rev 0, *Safety Analysis Process - Facility Change or Modification*
- HNF-PRO-704, Rev 0, *Hazard and Accident Analysis Process*
- HNF-PRO-517, Rev, 0 *Safety Analysis Program Glossary.*

3.3 Hazard Analysis

The HI&E report is Appendix A. This section will summarize the HI&E methodology, present the identified hazards, report the facility hazard classification, and summarize the hazard evaluation results.

3.3.1 Hazard Identification and Evaluation Methodology

Hazard Identification and Evaluation is the process of highlighting natural phenomena, material, system, process, and facility characteristics with the potential to initiate accidents having undesirable consequences. The method of HI&E used for B Plant S&M was a Preliminary Hazards Analysis (PHA) which uses a form-driven approach to identify hazards and candidate controls and to ensure that standardization and completeness occur. A PHA focuses on the basic elements of a facility or system and identifies the hazards, evaluates potential causes and effects, and proposes potential preventative and mitigative measures. The PHA was performed by personnel with experience in safety analysis methodology and personnel with knowledge of the B Plant design. The PHA results are used for binning and screening of hazards and the selection of representative and unique accident scenarios.

This hazards identification and evaluation process was conducted in accordance with the requirements in the Project Hanford Management Contract (PHMC) procedure HNF-PRO-704 Rev 0, *Hazard and Accident Analysis Process.*

3.3.1.1 Hazard Identification

This PHA was developed focusing on the potential hazards associated with the B Plant S&M Phase. The current and most recent authorization basis, PHAs and fire hazards analyses (FHAs) for B Plant were used as input to this hazard analysis. These documents are listed in Table 3.3-1.

Table 3.3-1: Source Material for Accident Analysis Critique		
Document Number	Title	Year
WHC-SD-WM-PHA-008, Rev 1	*B Plant Preliminary Hazards Analysis* (WHC 1996c)	1996
HNF-SD-WM-BIO-003, Rev 0	*B Plant Basis for Interim Operation* (HNF 1998)	1998
HNF-SD-W059-PHA-001, Rev 0	*B Plant Ventilation Project W-059 Preliminary Hazards Analysis* (HNF 1997)	1997
WHC-SD-WM-FHA-021, Rev 0	*Fire Hazards Analysis For The B Plant* (WHC 1996a)	1996
WHC-SD-W059-FHA-001	*Fire Hazards Analysis For The B Plant Ventilation System Upgrade Project W-059* (WHC 1996b)	1996
HNF-3756, Rev 0	*B Plant S&M Phase Fire Hazards Analysis* (HNF 3756)	1999

The PHA for the B Plant S&M Phase (Appendix A) was developed for the various locations within the facility to identify and evaluate hazardous conditions. The B Plant facility is comprised of a few large buildings and structures (vaults, basins) which contain hazardous material. Other buildings contain either small amounts of hazardous materials or none at all. For this PHA, the B Plant facility was segregated into 11 groups. The placement of a particular building or facility into a particular group was based on the amount and/or type of hazardous material contained in the building or facility and the physical isolations between buildings and groups of buildings. The building groups used in the PHA are as follows:

1. 221B Can — The areas of the 221-B building contained in this grouping are the canyon proper, process cells, wind tunnel, and hot pipe trench.

2. 221B Gal — The areas of the 221-B building contained in this grouping are the Operating Gallery, Piping Gallery, and Electrical Gallery and the SWP change room.

3. 291B — All of the buildings and structures associated with the original B Plant ventilation system, including the underground filter vaults and ducts, the filter instrumentation buildings, the fans and above ground ducts, and the 291-B-1 stack.

4. 221B-Exhst — All of the equipment associated with the new exhaust system for B Plant. This includes the equipment and ductwork from the entry point in Cell 10 through the new exhaust stack and the 221BK instrument building.

5. 271B — The 271-B Support Building

6. 212B — The 212-B Cask Receiving Station

7. 221BB/BF The 221-BB Building and Condensate Pit, and the 221-BF Building

8. 222B The 222-B Office Building

9. 211B The 211-B Chemical Tank Farm and 211-BB Building

10. UPR Unplanned Release Sites

11. Misc Miscellaneous B Plant buildings and structures, including basins

An energy check sheet was completed to identify the hazardous materials, conditions and energy sources in each of the 11 groups that could harm or contaminate the facility and onsite workers and/or the public. The check sheets are shown in Appendix A. There are no hazardous materials remaining at B Plant that are listed as toxic, reactive, flammable, or explosive in the *Occupational Safety and Health Administration Code of Federal Regulations,* 29CFR 1910.119, Process safety management of highly hazardous chemicals (29 CFR 1910.119).

Facility is defined as the group of SSCs associated with B Plant. These SSCs are listed in Table 2-1.

Facility workers are personnel assigned to the potentially occupied work area within the boundary of the facility, segment, or project in which the identified hazard is located or manifested.

Onsite workers are personnel assigned to perform work on the Hanford site. For a spacial distinction, onsite workers are assumed to be located in the range from 100 meters of the hazard or accident location to the Hanford site boundaries.

The Hanford site boundaries are described in Section 1.3.1. There are two Hanford site boundaries defined in Section 1.3.1. They are the Hanford site boundary and an alternate site boundary. Table 1-1 shows the distances to these boundaries from B Plant in 16 evenly divided directional sectors. There are two respective definitions for the public. The offsite public are the public that are outside the Hanford site boundary. The onsite public are the public that are inside of the Hanford site boundary on the portions of Highway 240 that lie within the Hanford site boundary and/or on the property between the near shore of the Columbia River and the Hanford site boundary north and east of the Columbia River.

3.3.1.2 Hazards Evaluation

Preliminary Hazard Analysis forms, also shown in Appendix A were then filled out by the team. Together team members looked at the hazards in each area and developed potential accidents by applying questions addressing (1) the activity or function intended or expected to be seen at specific time intervals, (2) the definition of equipment malfunction and task failure, (3) the characteristics or modes associated with the failure, (4) the hazardous material affected with such a malfunction or failure, and (5) the estimated consequence and frequency, taking no credit for administrative and engineered features.

The qualitative consequence and frequency estimates for accidents potentially resulting from

postulated events were assigned by the PHA team using the team member's experience and judgement. The consequence and frequency categories criteria as listed in Appendix A are as follows:

SO1, S1, S2 and S3 are designated to identify the postulated safety consequences, with SO being the least significant and S3 the most significant category. Similarly, EO through E3 are environmental consequence category designations and FO through F3 are postulated frequency of occurrence category designators.

The selection of accidents for further quantitative analysis was performed using a binning process, as recommended by DOE 3009 and HNF-PRO-704.

All the hazardous conditions identified in the PHA tables are binned according to the postulated causes and consequences identified in the PHA tables (Appendix A). Details of the evaluation methodology are in Appendix A. This binning process is comprised of the following steps:

1. Initial Screening, which screens out all hazardous conditions having assessed consequences designators S0 and S1 and consequence-frequency designator combinations of less magnitude than S2-F0. Hazardous conditions have assessed consequence-frequency designator combinations of greater than S2-F0 are selected for further evaluation.

The S1 scenarios are those scenarios that could involve injury to facility workers. Although the S1 scenarios are screened out of the accidents selected for further analysis, worker protection is addressed throughout the accident analysis and controls development process. Institutional safety programs are required to be implemented for general occupational hazards. Scenarios identified in the hazards analysis having S1 consequences have an associated S2 or S3 scenario selected for further analysis. Special worker protection features are identified when the controls to mitigate or prevent the S2 or S3 scenario or its bounding scenario do not inherently protect the facility worker, such as the case where administrative controls have been established for protecting workers following a seismic event and/or a roof collapse from snow/volcanic ash loading on the roof.

Worker protection is covered for all the scenarios identified in the hazards analysis in general, either through prevention of the postulated accident(s) or through commitment to implement the required institutional safety programs and work programs, such as the Integrated Safety Management System, which includes the Automated Job Hazards Analysis. Commitments are provided on this subject is Section 3.3.2.3.3.

2. Assignment of Accident Release Attributes that describe each accident using its accident release attributes as related to the uncontrolled release of the material at risk.

The Accident Release Attributes are:

A. Initial energy available to release the hazardous material. The attributes related to energy level have three designations: high, moderate, and low.

High energy level, designation "A" assigned to energetic events such as explosions, fires and nuclear criticality.

Moderate energy level, designation "B" assigned to events such as ventilation system breach while the fans are running, liquid sprays from pressurized line, and dropping hardware or equipment into a dispersable material.

Low energy level, designation "C" assigned to events such as leaks from non-pressurized liquid containers and breach or leak of a passive ventilation system.

B. Initial release location. The attributes related to the initial release location have three designations: (1) atmospheric, (2) ground surface, and (3) subsurface. Sometimes, the accident may result in release to more than one destination. The destination of the most severe consequence is assigned.

C. Initial form of the release. Three attributes are related to the initial form of the release: (a) vapor/gas/aerosol, (b) liquid/slurry, and (c) solid/sludge. If the accident results in the release of more than one form of material, the attribute associated with more severe consequence is assigned.

3. Accident Release Categories. Once the release attributes are assigned to the hazardous conditions, an accident release category identifier is assembled by grouping the Accident Release Attributes.

4. Binning Hazardous Conditions by Cause and Accident Release Category. Examination of the causes supports selection of representative sets of accidents for each Accident Release Category. After identifying the hazardous conditions causes from the PHA tables, the hazardous conditions are binned by grouping the conditions that have both a common cause and a common Accident Release Category.

The results of these steps is a list of hazardous conditions in a binned and tabular format. After the hazardous conditions are binned, representative bounding accidents are developed for consequence analysis.

The results of the binning process are provided in Table 3.3-2. The table covers each hazard presented in the PHA. The potential accidents were grouped into seven bins: Seismic events, Rain/Snow/Ash, Wind, Exhaust Filter Failure, Fire/Explosion, Hanford Site Accidents, and Worker Safety.

Table 3.3-2 also includes the selection of the representative accident for each bin. The representative accident and the basis for its selection are given in the last column and are identified with shaded text. Discussion of the basis for selection is given in Section 3.3.2.2.

Table 3.3-2: Binning, Screening, and Representative Accident Selection.[1]

Bin No.	Title	Consequence Category			Representative Accident Basis
		E	S	F	
1	Seismic				
	221B-Sei-01 Release due to failure of 221B structures from BDBE	E3	S2	F1	All four of the accidents with S2 consequences chosen . Will analyze DBE and BDBE (separately) for complete facility.
	221B-Sei-02 Release due to failure of 221B structures from DBE	E1	S2	F2	
	291B-Sei-01 Release due to failure of A, B, or C filter building structures	E3	S2	F2	
	291B-Sei-02 Release due to failure of D or E filter building structures	E3	S2	F2	
	221B-Can-02 Release of TSP to process cell floor	E0	S0	F1	Accidents of S1 and S0 consequences do not require further analysis.
	221B-Can-06 Release due to collapse of canyon crane	E0	S1	F1	
	291B-Sei-03 Release due to failure of filter building	E1	S1	F2	
	291B-Sei-04 Release due to collapse of exhaust stack	E0	S1	F2	
	291B-Sei-05 Release due to collapse of ACT filter	E1	S1	F1	
	221B-Ehst-01 Release due to collapse of new stack on ACT	E1	S1	F2	
	212B-01 Release due to failure of 212B structures	E1	S1	F1	
	221BB/BF-01 Release due to failure of 221BB/BF structures	E1	S1	F2	
2	Rain/Snow/Ash				
	221B-Load Release due to structure failure by volcanic ash or snow	E2	S2	F2	Both of the accidents with S2 consequences are chosen to be representative accidents because it is not clear which accident is bounding.
	221B-Rain Release due to structural degradation & failure	E3	S2	F3	
	291B-Rain-02 Release due to structural degradation & failure	E3	S1	F2	Accidents of S1 and S0 consequences do not require further analysis.
	291B-Rain-03 Release due to structural degradation & failure	E3	S0	F2	
	212B-03 Release due to structural degradation & failure	E3	S0	F1	
	212B-04 Release due to roof collapse	E1	S1	F0	
	271B/222B-02 Release due to structural degradation & failure	E1	S0	F3	
	221BB/BF-02 Release due to structural degradation & failure	E1	S1	F3	

Table 3.3-2: Binning, Screening, and Representative Accident Selection.[1]

Bin No.	Title		Consequence Category E	Consequence Category S	Consequence Category F	Representative Accident Basis
3	Wind					
	291B-Wind-01	Release due to high wind missile damage	E2	S2	F2	Three accidents with S2 consequences are chosen to be representative accidents because any one of the three accidents could be bounding.
	221B-Ehst-03	Release due to high wind missile damage	E2	S2	F2	
	B-Plant-02	Release due to high wind missile damage	E2	S2	F2	
	221B-Wind	Release due to failure of 221B structure caused by high winds	E2	S2	F0	Accidents of S2-F0 and S1 and S0 do not require further analysis.
	291B-Wind-02	Release due to damage to sand filter structures	E2	S2	F0	
	291B-Wind-03	Release due to wind damage	E0	S0	F2	
	212B-02	Release due to wind damage	E1	S1	F0	
4	Exhaust Filter Failure					
	221B-Ehst-02	Release due to filter failure in canyon exhaust system (CES)	E2	S2	F2	Two accidents with S2 consequences are chosen to be representative accidents because either of the accidents could be bounding.
	221B-Ehst-06	Release due to filter seal failure CES	E2	S2	F2	
	291B-Impact-01	Release from filters due to aircraft impact	E3	S2	F0	Aircraft Accident has a frequency of occurrence determined to be Beyond Extremely Unlikely (HNF 1997d) so no further analysis is required. Accidents of S2-F0 and S1 and S0 consequences do not require further analysis.
	221B-Ehst-10	Release from filters due to aircraft impact	E2	S2	F0	
	221B-Ehst-11	Release from filters due to tornado	E2	S2	F0	
	221B-Can-05	Release from drums due to drum failure	E0	S0	F2	
	291B-Impact-02	Release from filter due to vehicle impact	E1	S1	F2	
	291B-Impact-04	Truck Fuel Tank Leaks creating a fire hazard	E0	S0	F2	
	221B-Ehst-04	Worker exposure due to high filter loading	E0	S1	F3	
	221B-Ehst-05	Worker exposure due to high filter loading	E0	S1	F2	
	221B-Ehst-08	Release due to loss of ventilation	E0	S1	F3	

Table 3.3-2: Binning, Screening, and Representative Accident Selection.[1]

Bin No.	Title		Consequence Category E	Consequence Category S	Consequence Category F	Representative Accident Basis
5	Fire/Explosion					
	291B-Rain-01	Release due to hydrogen explosion in A, B, C, D, & E filter	E3	S2	F1	Four of the accidents with S2 consequences are chosen to be representative accidents because any one of the four accidents could be bounding.
	291B-Impact-03	Release from A, B, C, D, & E filters caused by vehicle impact	E2	S2	F1	
	221B-Ehst-07	Release from CES due to vehicle impact	E2	S2	F2	
	221B-Ehst-09	Release from CES due to fire	E2	S2	F2	
	221B-Can-03	Release due to red oil explosion	E2	S2	F0	Accidents of S2-F0 and S1 and S0 consequences do not require further analysis.
	221B-Can-07	Release due to fire in 221B canyon	E0	S2	F0	
	221B-Can-04	Release due to hydrogen burn/explosion	E1	S1	F1	
	291B-Light	Release due to fire in A, B, C, D, & E filters	E1	S1	F2	
	221B-Fire-01	Release from 221B caused by range fire	E0	S0	F1	
	211B-01	Release of toxic material from 211B tank farm due to natural phenomena	E1	S1	F3	
6	Hanford Site Accidents					
	B-Plant-03	Dose consequences to B-Plant from release from other site facilities	E0	S2	F3	B-Plant-03 chosen to be representative accident.
	211B-02	Release of toxic material due to vehicle impact	E0	S1	F1	Accidents of S1 consequences do not require further analysis.
7	Worker Safety					
	221B-Can-01	Exposure of worker to toxic vapors	E1	S1	F1	Accidents of S1 consequences do not require further analysis.
	221B-Ind	Industrial hazards	E0	S1	F3	
	221B-Gal-01	Exposure of worker to radiological material	E0	S1	F3	
	221B-Gal-02	Exposure of worker to radiological material	E0	S1	F1	
	212B-05	Personnel injury due to falls caused by leaks and spills	E0	S1	F3	
	271B/222B-01	Personnel injury due to falls caused by leaks and spills	E0	S1	F3	
	211B-03	Industrial hazard from 211B	E0	S1	F3	
	B-Plant-01	Industrial hazards	E0	S1	F3	

ACT = Air Cleanup Train
BDBE = Beyond Design Basis Earthquake
CES = Canyon Exhaust System
DBE = Design Basis Earthquake
TSP = Trisodium Phosphate

3.3.2 Hazard Analysis Results

The results of the hazards analysis process are presented below, along with the accident scenarios to be further analyzed.

3.3.2.1 Hazard Identification

Because the PHA consequence ranking is based on the worst case potential consequence, it is important to recognize that accidents with potential consequences affecting the general public offsite would generally also have potential consequences affecting both onsite individuals and workers at the facility. Furthermore, even though various accidents could have essentially the same consequences, the accidents could be initiated by a variety of events.

The hazards identified during the PHA are documented as hazards with potential effects to the facility worker, onsite worker, offsite public and the environment. Completed hazard identification data/check sheets and PHA forms are presented in Appendix A. The PHA identified 58 hazardous conditions associated with the B Plant S&M phase.

These 58 hazardous conditions are presented in Table 3.3-2. The number of events in each of the safety (S) and environmental (E) consequence categories is summarized below. The alphanumeric designators are described in section 3.3.1.1.

SO - 8
S1 - 27
S2 - 23
S3 - 0

Of the 58 hazardous conditions, 2 were categorized as S0-E3, indicating an environmental release threat only. (Table 3.3-2)

3.3.2.2 Hazard Classification

B Plant has been categorized as a Hazard Category 2 nuclear facility. The inventory present in the facility is given in Table 3.3-3.

Table 3.3-3: B Plant Radioactive Material Inventories

Location	Type	Inventory (Ci)
A filter	^{137}Cs	≤ 18,000
	^{90}Sr	≤ 12,000
	Pu-mix	≤ 1 gm or 0.175 Ci
B filter	^{137}Cs	≤ 43,000
	^{90}Sr	≤ 29,000
	Pu-mix	≤ 1 gm or 0.175 Ci
C filter	^{137}Cs	≤ 25,000
	^{90}Sr	≤ 16,000
	Pu-mix	≤ 1 gm or 0.175 Ci
D filter	^{137}Cs	≤ 70,000
	^{90}Sr	≤ 14,000
	Pu-mix	≤ 1 gm or 0.175 Ci
E filter	^{137}Cs	3
	^{90}Sr	2
Sand filter	^{137}Cs	2,000
	^{90}Sr	3,000
	Pu-mix	≈11 gm or 1.925 Ci
Canyon contamination	^{137}Cs ^{90}Sr	81,000 44,000
212-B cask loading station	^{137}Cs ^{90}Sr	≈100 to 1,000

For purposes of this document, the Pu in the filters is assumed to be a mix of ^{238}Pu through ^{242}Pu and ^{241}Am, with a specific activity of 0.175 PE-Ci/g (Himes, D.A., 1997). PE is plutonium equivalent.

The 212B and filter inventory values are maintained from Table 1-9 of the previous safety basis document (HNF 1998). The canyon contamination inventory is reported from HNF 3208.

The canyon radionuclide inventory was estimated using results of an inventory estimation campaign performed in 1998 while the canyon was being deactivated, through use of a GammaCam system as described in *Documentation of Remaining Hazardous Substances/Dangerous Waste in B Plant* (HNF 3208).

The retired filters inventory was estimated based on plant operating knowledge and result of sampling campaigns. Filter inventory estimation basis documents are referenced in B&W Hanford Co. internal memorandum *B Plant Radioactive Inventory and Material Status*, 16C00-97-BAS-009 (BWHC 1997).

The sand filter cesium and strontium inventory was estimated in 1994 using the sand filter operating history and previous samples and estimates of wind tunnel air concentrations as the basis. The estimates are rough order of magnitude estimates, based on assumption and calculations documented in Westinghouse Hanford Company internal memo 16500-94-075-JWG, *Estimate of Sand Filter Inventory*, dated June 29, 1994 (WHC 1994).

The sand filter plutonium inventory was estimated in 1994 using sand filter operating history and radionuclide release data. The estimates are rough order of magnitude estimates, based on assumptions and calculations documented in Westinghouse Hanford Company internal memo 16550-94-130-JWG, *Preliminary Estimate of Pu Inventory on B Plant Sand Filter*, dated October 25, 1994 (WHC 1994a).

Initial Hazard/Category Classification

A preliminary hazard categorization can be performed by adding the activities divided by threshold values as determined from DOE 1027. The threshold activities for category 2 are 22,000 Ci for ^{90}Sr and 89,000 Ci for ^{137}Cs. The sum of fraction for the two isotopes are:

$$\text{Sum of fraction} = \frac{^{90}\text{Sr Activity}}{^{90}\text{Sr threshold}} + \frac{^{137}\text{Cs activity}}{^{137}\text{Cs threshold}} + \frac{\text{Pu-mix activity}}{^{239}\text{Pu threshold}}$$

Using the inventories shown in Table 3.3-3 and the sum of fractions equation, the preliminary hazard categories are determined from the following equations:

221B Canyon Building

$$= \frac{44{,}000}{22{,}000} + \frac{81{,}000}{89{,}000} = 2.0 + 0.91 = 2.91$$

291B Retired Filters

$$= \frac{74{,}000}{22{,}000} + \frac{158{,}000}{89{,}000} + \frac{2{,}625}{56} = 3.36 + 1.78 + 0.047 = 5.19$$

212B Cask Station (No ^{90}Sr)

$$= \frac{1{,}000}{89{,}000} = 0.01$$

The criterion for a Hazard Category 2 is a sum of fractions greater than 1. The B Plant complex therefore meets the Hazard Category 2 criterion.

Final Hazard Category Classification

Adjustments to the inventory to reflect the material at risk and to the release fractions to reflect

realistic accident scenarios are permitted for the final hazard categorization. Much of the radioactivity in B Plant is contamination that is fixed. The accident analyses given in Section 3.4 demonstrate one event with significant offsite doses. Because the accident analyses use the total inventories for the material at risk, they support the Hazard Category 2 classification.

3.3.2.3 Hazard Evaluation

The PHA forms in Appendix A present the hazard evaluation results. The forms identify potential accidents in terms of hazardous conditions and consequences; location and cause of the event; material at risk; consequence; frequency and consequence categories; and engineered and administrative preventive and mitigative features.

The most significant hazards at B Plant involve accidental release of the remaining radiological inventory in the 212-B building, the canyon building and the retired filters. There are no significant hazards associated with chemicals, since the liquid chemical inventories have been removed and the significant quantity of dry chemical that remains in the canyon is stable, dry Tri-Sodium Phosphate.

The *Occupational Safety and Health Administration Code of Federal Regulations*, 29 CFR 1910.119, "Process safety management of highly hazardous chemicals" (29CFR 1910.119) was reviewed to determine if B Plant has the type and quantities of chemicals that directive lists. B Plant does not have any remaining chemicals that are listed in that directive.

The most significant risks associated with the remaining radiological inventories in the canyon and the retired filters are postulated to be initiated by natural phenomena (seismic event causing the retired vaults to collapse and the stack to collapse on the retired filters, ash/snow load causing canyon roof collapse) and hydrogen explosion in the retired filters vaults.

The hazards associated with the other buildings listed in Table 2-1 (besides 221-B, 212-B, retired filters vaults) and the UPRs, waste sites, and yard areas are considered insignificant with respect to accident releases, due to the stability and low volume of the contamination in those buildings, sites and areas. There are no special activities or treatments necessary for these buildings, UPRs and waste sites associated with postulated hazards or accidents.

Less consequential hazards resulting in potential releases from the canyon and/or the retired filter vaults were identified. These hazards are due to impacts to the new canyon exhaust system and to the retired filter vaults risers and passive vent system from missiles or vehicles or by fires in or adjacent to the structures/systems.

Aging of the structures by natural phenomena (rain, freeze/thaw cycles) could cause degradation to the structures. The structural integrity degradation could eventually lead to release of radiological inventory to the environment.

3.3.2.3.1 Planned Design and Operational Safety Improvement

There are currently no plans for design modifications at B Plant. There are plans to replace the roofing material on the canyon building, since the existing roofing material is degrading.

According to the *Multi-Year Work Plan*, HNF-SP-1234, Rev 1 (HNF 1234), it is planned to replace the roofing material on the canyon building in fiscal year 2000. Repairing the roofing material is necessary to prevent degradation of the canyon's structural integrity by natural phenomena, and to prevent water from rain and snow melt from entering the canyon. As explained in Section 3.4.2.7.2.2.1, degradation of the canyon structural integrity could have a negative impact to the WESF safety basis. If the B Plant canyon structure, especially the west end wall, degrades such that it fails at a lower energy earthquake, which may have a higher frequency of occurrence, then the WESF safety basis could be impacted. The impact is based on having an event of a higher frequency, which forces the WESF safety basis to compare A cell consequences to risk evaluation guidelines for higher probability occurrences. The rain/water barrier over the retired filters' vaults does not need renovation.

The last paragraph of Section 3.4.2.7.1.1.1 describes a judgement that, if the canyon building roofing material is maintained such that the water is kept from direct contact with concrete roof slab and ponding is prevented, the roof and walls of the canyon may maintain their seismic integrity for up to a couple decades. However, proposed structural integrity surveillances may indicate degradation that could in the future call into question the structural seismic integrity. Thus, the operating contractor should watch for features already known or suspected of having questionable integrity. For instance, the evaluation referenced in Section 3.4.2.7.1.1.1 recognized that there may be a crack in the roof deck above the Cell 4 area. This area should be carefully analyzed and avoided, especially while repairing and/or replacing the roofing material or assessing structural integrity in the future.

Another noteworthy structural aspect to consider when performing surveillance or analyzing the structural integrity is the fact that it is known that the canyon endwalls are not reinforced with steel. Additionally, it is known that the crane had at some time in the past impacted the east canyon wall, causing some damage near the top of the canyon east endwall. Thus, it may be noteworthy to identify the endwalls as needing a more thorough and/or professional structural surveillance on a specific frequency, such as every two years or so.

If the seismic integrity degrades such that the canyon structure cannot resist a DBE, the beyond DBE consequences of Section 3.4.3.1 could occur. The section does not analyze consequences for all ancillary buildings at the B Plant facility. The ancillary buildings have not been analyzed; they could and should be expected to fail from a DBE now and in the future. The ancillary buildings do not contain significant radiological contamination, so the dose consequences of Section 3.4.3.1, in general, include the total B Plant facility consequences.

Surveillance and/or maintenance is performed for all the B Plant buildings, on a graded approach consistent with the associated hazards. The current level of quarterly surveillance is sufficient for the current mission and anticipated hazards. If surveillances indicate that more S&M is needed, an added level of S&M can be implemented.

3.3.2.3.2 Defense In Depth

This section describes the significant aspects of defense in depth at B Plant, with respect to the significant hazards. Lesser layers of defense in depth are identified in a respective subsection of each analyzed accident of Section 3.4, but not in this section.

Before discussing the significant defense in depth features, the following terms are defined to ensure the terms are clearly understood in the following discussions.

Defense in depth is the existence of multiple features (design and administrative) that are relied upon for accident prevention or consequence mitigation to a degree proportional to the hazard magnitude. This applies particularly to SSCs that are relied upon to prevent or mitigate uncontrolled releases of hazardous material, controls over these SSCs and the integrated safety and management programs that control facility operations.

SSCs are structures, systems, and components defined as follows:

Structures are elements that provide support or enclosure, such as buildings, vaults, basins, dikes, and stacks. Systems are collections of components assembled to perform a function, such as a ventilation, control, or monitor system. Components are items of equipment, such as pumps, valves, relays, or elements of a larger array such as computer software, lengths of pipe, elbows, or reducers.

A safety SSC is an SSC identified as safety class (SC) or safety significant (SS).

3.3.2.3.2.1 Significant Defense in Depth Aspects, SSCs, and TSRs

There are two significant aspects of defense in depth relied upon to manage the hazards at B Plant. These aspects and their associated safety SSCs or safety controls will be identified and described in this section.

The two significant aspects of defense in depth relied upon to manage the hazards at B Plant are configuration and administration control.

Configuration Control

The 221B canyon building and the "retired filters/vaults" contain significant quantities of radionuclide materials. Configuration control of these two structures is important.

A canyon building roof collapse scenario is analyzed in section 3.4.2.6 to determine the potential radiological release consequences from the canyon if the roof collapses. A design basis earthquake (DBE) is analyzed in Section 3.4.2.7 to determine the combined potential consequences of radiological releases from the canyon and the retired filter vaults. The postulated unmitigated offsite and onsite consequences are less than the respective risk evaluation guidelines. This provides the determination that there is no SC or SS SSC designation required for these events. It is important to maintain the structural integrity of the canyon building, so that the analyses results remain valid over the long duration of the facility's importance. The facility contains significant radiological contamination. If the structural integrity degrades, then the analyses may need to be updated to ensure the hazards and risks are known. Furthermore, the facility could pose significant occupational hazards if the structural integrity fails, such that portions could fall or personnel could get injured, or the building fails to provide a barrier between people and the buildings internal contamination. Maintaining the structural integrity may rely on maintaining the roofing material to prevent water damage to the structure and to prevent

water from washing or leaching the contamination out of the building(s). Thus, administrative controls can be established to maintain and implement surveillance and maintenance programs to ensure the structural integrity of the structures that contain contamination are maintained capable of performing a containment function. At the same time the controls enhance keeping the structures safe to work in and around, thereby providing worker protection.

An analysis for a hydrogen explosion in the retired filter vaults (Section 3.4.2.4) shows that if the postulated explosion could occur, the postulated unmitigated offsite consequences exceed the Safety Class criteria of Table 3.4.1.6-1. However, based on the configuration of the filter vaults it is not expected that an explosion will occur in the vault. This is based on the following defense in depth features:

- A primary defense in depth feature is the configuration, which precludes water from getting into the vaults. The vaults are concrete. There are no known cracks, holes, or other openings where water can get into the vaults. The known water sources are isolated by removal of sections of pipe, so that there are no piped water sources to the vaults or the area within about 40 meters of the vaults. The top of the vaults are about a half a meter above the original grade in the area. The vaults have a water resistant membrane applied on the top horizontal surfaces. The vaults are buried by about one meter of soil and are bermed around the sides.

  The only expected source of water in the area is natural precipitation (i.e. rain, snowmelt). The maximum recorded annual rainfall is 12 in. The average recorded annual rainfall is about 7 in.

- Another primary defense in depth feature is surveillance and maintenance of the configuration. The most important aspect of the surveillance of the configuration is the durations required for the configuration to be impacted. A worst case flood and hydrogen scenario was completed to determine the duration required to get the worst case volumes of water and hydrogen. Based on these durations, the accident can be easily prevented by monitoring for hydrogen in the vaults. Hydrogen will only accumulate if water is in the vaults. Water will only get in the vaults if the configuration of the vaults is not maintained. Thus, surveillance of the hydrogen concentration in the vaults at a conservative frequency is a primary defense in depth feature.

- Additional defense in depth is provided with the passive vent system, the liquid level detection system, and the provisions for purging the vaults with air if a hydrogen accumulation problem exists.

Based on the potential of a hydrogen accident being prevented through administrative control, it is deemed not necessary to assign a Safety Class or Safety Significant SSC to prevent the accident. One or more administrative controls can be implemented to maintain programs that will ensure the accident is prevented.

This set of significant defense in depth features and the hydrogen concentration monitoring activity are prime candidates for TSR administrative controls.

Administrative Control

The canyon and retired filter vaults' structural integrity could degrade over time if not monitored and maintained. The same concern exists for the SSCs associated with the active and passive ventilation systems. The functional capability of these SSCs could be reduced by uncontrolled modifications as well. Administrative controls are relied on to ensure these conditions do not occur. Administrative controls are also necessary to implement system operations, surveillance, and maintenance and worker safety features. These administrative controls are implemented through administrative procedures to control engineered configuration changes and operating activities. Operating procedures direct surveillance to monitor the functional capability and structural integrity of the SSCs.

Safety SSCs

As described above and shown in Chapters 3 and 4, there are no SC or SS SSCs.

TSRs

It is not necessary to establish any Safety Limits, Limiting Control Settings, or Limiting Conditions of Operation, based on the results of the postulated and known hazards for B Plant during the S&M Phase. Thus, there are no TSRs for these types of controls. It is necessary, however, to establish some administrative controls TSRs to ensure it is understood that there are some hazards that are significant to the degree that controls need to be established and maintained. Administrative controls are necessary to ensure the operating contractor establishes, implements, and maintains safety and administrative programs to operate B Plant with the bounds of this safety authorization basis. There are many commitments inherent in this document. The most significant commitments should be maintained with administrative controls.

3.3.2.3.3 Worker Safety

This section describes facility worker safety features at B Plant, with respect to the significant hazards. Hazards to facility workers were identified in the hazards identification and evaluation process. Significant worker safety features are described in the previous section and the defense in depth subsection of each analyzed accident of Section 3.4. As described in the previous section, there are significant worker safety hazards associated with the canyon roof collapse and the DBE. Worker protection controls for these hazards are to be addressed through an Administrative Control TSR. The worker protection can be implemented through an administrative procedure(s).

Facility workers will face tasks that could expose them to radiological doses, such as performing corrective maintenance to equipment that is/could be exposed to radiological material, performing surveillances in areas infrequently accessed, and changing HEPA filters or other equipment and components on the canyon exhaust system and the passive vent system. Worker/occupational safety must be addressed in all work plans. Identification and protection from hazards is integrated into work plans through implementation of the Integrated Safety Management System, which invokes a standardized job hazards analysis process.

3.3.2.3.4 Environmental Protection

Due to the significant radionuclides in the 221B canyon building and the retired filters/vaults in the 291B area, there is concern that the radioactive material could be washed out of the structures and enter the ground or be released in the air by significant accidents. Surveillance and maintenance are necessary to maintain structural integrity of identified structures that contain significant radionuclide materials. If the structural integrity is degraded, at some degree, there is a potential that the radionuclide materials could be transported by natural phenomena to the environment, to both the ground and the air. Maintaining the structural integrity and the roof barriers to rain and snow melt water intrusion provide significant control against the potential for the radioactive materials being transported to the environment. Surveillance and maintenance of the structures and the internal hazardous materials and protection against releases to the environment are the main mission of the S&M phase.

3.3.2.3.5 Selected Accidents

For each selected hazard type associated with an S2 or S3 consequence in Table 3.3-2, a representative (bounding) accident was chosen for further analysis. A representative accident bounds the consequences of similar accidents or accident types. Similar accidents challenge analogous barriers that reflect the same design philosophy for prevention and mitigation of the same accident type, even though the accidents may be in different locations.

The accidents determined to be representative and to bound consequences from the bins of accidents are summarized in Table 3.3-4 and described below.

Sixteen accidents having a qualitative consequence ranking greater than S1 and a frequency ranking greater than F0 were identified and selected for further analysis. The 16 hazardous conditions selected for further analysis are shown in the upper portion of each bin in Table 3.3-2.

3.3.2.3.5.1 Natural Phenomena

The first three bins of hazardous conditions are comprised of natural phenomena: Seismic, Rain/Snow/Ash, and Wind. If the facility structures are not maintained, the probability of failure of these structures will increase over time due to water damage, freezing, aging, etc. Facility structural failure could result in the release of radioactive and hazardous materials to the environment and onsite facility workers.

3.3.2.3.5.2 Seismic (BIN 1)

Seismic events 291B-Sei-01 and 221B-Sei-02 were identified as having a potential for causing radiological releases to workers and the environment. 221B-Sei-01 and 291B-Sei-02 are BDBEs and will be analyzed for purposes described in Section 3.4.3.

3.3.2.3.5.3 Rain/Snow/Ash (BIN 2)

Two hazards in this bin were selected for further analysis. One results in the release of radioactive material to the atmosphere or ground from the 221-B building. The cause of the release is

degradation of the building over an extended period of time with subsequent intrusion of water (221B-Rain) into the building. The second hazard is heavy snow or ash fall (221B-Load) which results in the collapse of the 221-B building roof. This results in the release of radioactive material to the atmosphere.

3.3.2.3.5.4 Wind (BIN 3)

Effects of wind driven missiles (291B-Wind-01, 221Ehst-03, B-Plant-02) were also identified as a concern with the new canyon exhaust system. The presence of B Plant buildings having metal siding and roofs presents a vulnerability to this hazard. As these building age, the probability of a portion of the siding or roof coming off during a wind storm will increase over time.

3.3.2.3.5.5 Exhaust System Filter Failure (BIN 4)

Two hazards in this bin were selected for further analysis. The first hazard (221B-Ehst-02) is a seismic event which results in a failure of the canyon exhaust system filter with a subsequent release of radioactive material to the atmosphere. The second hazard (221B-Ehst-06) is a filter failure (filter degradation, filter seal) with continued operation of the exhaust system. A release of radioactive material to the atmosphere results.

3.3.2.3.5.6 Fire/Explosion (BIN 5)

The most severe hazard in this category is a hydrogen explosion in a 291-B filter vault (291B-Rain-01) due to flooding the vault resulting in building up hydrogen in the vault. This hazard is addressed in the *B Plant Surveillance and Maintenance Phase Fire Hazards Analysis* (FHA) (HNF 3756). The hazards analysis identified a potential for Fire/Explosion accidents associated with the rupture of a fuel tank during a vehicle accident by the canyon exhaust system (221B-Ehst-07) or the 291-B filters (291B-Impact-03). The buildup of tumbleweeds next to the Canyon Exhaust system (221B-Ehst-09) has a probability of occurrence which could result in a fire next to the exhaust system and a release of hazardous material to onsite personnel. The B Plant FHA addresses this hazard.

Based on multiple layers of defense in depth features, it is stated in the FHA that the hydrogen concentration in the vaults is not expected to exceed the concentration limits of NFPA 69, *Explosion Prevention Systems*.

3.3.2.3.5.7 Hanford Site Accidents (BIN 6)

Potential accidents at other Hanford facilities (WESF, Waste Tanks, etc.) could result in hazards to facility workers at B Plant in the S&M phase. This is addressed as a general hazard (B-Plant-03) which accounts for all Hanford facilities and the hazards they represent to facility workers at B Plant in the S&M phase.

3.3.2.3.5.8 Worker Safety

Worker safety for the B Plant is assured by a combination of confinement and shielding features and institutional practices. These features and practices are integral to the facility design and

operation.

The occupational safety requirements for DOE sites are governed by 29 CFR 1910, *Occupational Safety and Health Standards* Code of Federal Regulations (29 CFR 1910), which addresses such topics as working surfaces, machinery and machine guarding, compressed gas and compressed air equipment, and electrical requirements. Protection of the facility worker from standard industrial hazards (S1 consequences) is achieved through adherence to the requirements of 29 CFR 1910 and does not require specific safety SSCs or administrative features. The major features of worker protection from S1 consequence accidents are associated with radiological hazards. The shielding design and the radiological control program are established to meet ALARA goals for radiological exposure.

Table 3.3-4: Candidate Accidents Selected for Further Evaluation

Accident Designator	Hazard Description	Facility affected	Specific Accidents/FSAR Section
221B-Sei-01	Release of radioactive material due to failure of structure due to beyond design basis earthquake (BDBE)	221B Canyon and Galleries	BDBE during S&M phase: Section 3.4.3
221B-Sei-02	Release of radioactive materials due to failure of structure due to design basis earthquake (DBE)	221B Canyon and Galleries	DBE during S&M phase: Section 3.4.2.7
221B Load	Release of radioactive materials due to failure of the structure due to volcanic ash or snow	221B Canyon including galleries or process tanks	Collapse of canyon roof Section 3.4.2.6
221B-Rain	Release of radioactive or toxic material due to failure of structure due to structural degradation, from aging, rain, etc.	221B Canyon including galleries or process tanks	Collapse of canyon roof Section 3.4.2.6
291B-Sei-01	Release of radioactive material due to failure of structures due to design basis earthquake, including stack collapse (DBE)	A, B, C, D or E filters	DBE Section 3.4.2.7
291B-Sei-02	Release of radioactive material due to failure of structures due to beyond design basis earthquake (BDBE)	Release from A, B, C, D and E filters	Beyond Design Basis Hydrogen Explosion and Filter Structure Collapse Section 3.4.3
291B-Rain-01	Release of radioactive material due to hydrogen accumulation and explosion in the filter vaults; water intrusion into the filter due to rain, snow melt, or utility water line break	291 B filters	Hydrogen Explosion Section 3.4.2.4
291B-Impact-03	Release of radioactive material due to breaching of filters confinement - vault risers/passive vent system	291B Filters Vaults	Fire in 291B Retired Filters Section 3.4.2.5

Table 3.3-4: Candidate Accidents Selected for Further Evaluation			
Accident Designator	**Hazard Description**	**Facility affected**	**Specific Accidents/FSAR Section**
291B-Wind-01	Release of radioactive material due to breaching of filter vault, risers or passive vent system from wind generated missile	291B filters	Retired Filters Fire Bounds Section 3.4.2.5
221B-Ehst-02	Release of radioactive material due to breaching of ACT filter	Canyon exhaust system	DBA - Roof Collapse or Seismic; Analyzed in Filter Failure Section 3.4.2.2
221B-Ehst-03	Release of radioactive material due to breaching of ACT filter by wind driven missile	Canyon exhaust filter system	ACT Vehicle Impact and Fire Bounds Section 3.4.2.1
221B-Ehst-06	Release of radioactive material due to ACT filter and/or seal failure	Canyon exhaust filter	ACT Filter Failure From Excessive Loading Section 3.4.2.2
221B-Ehst-07	Release of radioactive material due to breaching of ACT filter by human error/vehicle impact and fire	Canyon exhaust system ACTs	ACT Vehicle Impact and Fire Section 3.4.2.1
221B-Ehst-09	Release of radioactive material due to breaching of ACT filter; external fire affects filters due to ignition of accumulated tumbleweeds around filter	Canyon exhaust system ACTs	ACT Vehicle Impact and Fire Section 3.4.2.1
B Plant-02	Damage to SSCs due to wind and missiles generated from other B Plant complex buildings	System structures and components	Wind - Section 3.4.2.8 ACT - Section 3.4.2.1,ACT Impact 291-B - Section 3.4.2.5, Fire
B Plant-03	Hazard from other facilities	Hazard to B Plant facility workers	Neighbor Facility Events Section 3.4.2.10

3.4 Accident Analysis

3.4.1 Analysis Methodology

Analyses were performed for the selected hazardous conditions reflecting the latest inventories, and applicable analytical techniques and meteorological data. The methodology is described in this section. Where possible, qualitative analysis is used to determine the bounding scenarios, for which quantitative analysis is used to determine consequences and necessity to assign safety SSCs and/or controls.

3.4.1.1 Dose Calculation Methodology

Consequences to onsite and offsite individuals are represented as radiological or toxicological doses that have harmful effects to humans. Dose calculations were performed to determine potential consequences to onsite and offsite individuals as described below. Unmitigated consequences were calculated, assuming no credit for any safety systems.

Dose consequences are calculated by multiplying the quantity of radioactive material (curies) exposed to a receptor by a Unit Dose Equivalent (UDE), which represents the harmful effects of radiological material (per curie) exposed to the receptor.

The amount of radioactive material released to the air, in grams or curies, is called the source term.

The initial source term is the amount of radioactive material driven airborne at the accident source. The initial respirable source term, a subset of the initial source term, is the amount of radioactive material driven airborne at the accident source that can be inhaled. Lesser source terms are determined by applying filtration or deposition factors to the initial source term.

The airborne pathway is of primary interest for B-Plant. DOE 1027 quotes observations of the U.S. Nuclear Regulatory Commission's (NRC) Guide 1.145, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants* (NRC 1982a) to the effect that "for all materials of greatest interest for fuel cycle and other radioactive material licenses, the dose from the inhalation pathway will dominate the (overall) dose" (NUREG-1140). The airborne source term is typically estimated by the following five-component linear equation:

Source Term = MAR x DR x ARF x RF x LPF

where:

MAR = Material-at-Risk (curies),
DR = Damage Ratio,
ARF = Airborne Release Fraction,
RF = Respirable Fraction, and
LPF = Leak Path Factor.

The initial source term and initial respirable source term are products of the first three factors and first four factors respectively. A depleted source term after a subsequent stage of deposition or filtration is a product of the initial source term multiplied by the leak path factor of the specific stage.

<u>Material-at-Risk (MAR)</u>

The material-at-risk is the amount of radionuclides available to be acted on by a given physical stress. For B-Plant, the MAR is taken to be the maximum quantity of radionuclide present or reasonably anticipated in each location. The MAR used for the following accident analyses is provided in Table 3.3-3, unless otherwise specified.

Damage Ratio (DR)

The damage ratio is the fraction of the MAR actually impacted by the accident-generated conditions. The DR is estimated based upon engineering analysis of the response of structural materials and materials-of-construction for containment to the type and level of stress/force generated by the event. Standard engineering approximations are typically used. These approximations often include a degree of conservatism due to simplification of phenomena to obtain a useable model, but the purpose of the approximation is to obtain, to the degree possible, a realistic understanding of potential effects. DR throughout this document is 1.0, except as specified in Section 3.4.2.6.

Airborne Release Fraction (ARF)

The ARF is the coefficient used to estimate the amount of a radioactive material suspended in air as an aerosol and available for transport due to a physical stress from a specific accident. For discrete events, the ARF is a fraction of the material affected.

The ARFs used in the following analyses are taken from DOE 3010 which are based primarily upon experimentally measured values for the specific material (e.g., plutonium, uranium, mixed fission products) or surrogates subjected to the particular type of stress under controlled conditions. Attention is given to the parameters, if known, that may have a significant influence upon suspension by the specific mechanism and the uncertainty in the measurement as indicated by the variability of the results.

It is important to note that the experiments discussed in DOE 3010 evaluate release phenomena holistically. No attempt is made to precisely characterize total airborne material in terms of individual mechanisms acting within an overall given release.

Respirable Fraction (RF)

The RF is the fraction of airborne radionuclides as particles that can be transported through air and inhaled into the human respiratory system and is commonly assumed to include particles 10-µm Aerodynamic Equivalent Diameter (AED) and less.

The principal emphasis in this document is directed toward the potential downwind hazard to the populations at some distance from the point of source term generation. Airborne particles larger than 10-µm AED released from the facility may still constitute a hazard if inhaled, even though they do not enter the respirable tract. For this reason the respirable fraction for Cs-137, a gamma-ray emitter, is taken to be 1.0 thoughout this document. The RF for Sr-90 is also 1.0 thooughout this document, except as specified in Section 3.4.2.6.

Leak Path Factor (LPF)

The LPF is the fraction of the radionuclides in the aerosol transported through some confinement deposition or filtration mechanism. The LPF is a calculated or standard value based upon (1) established relationships between size of the particulate material, airborne transport mechanisms, and losses by depositions mechanisms, or (2) specified filtration efficiencies. The LPF used

throughout this document is 1.0, except as specified in Section 3.4.2.6.

The airborne release fraction and respirable fractions are based on the methodology and data described in DOE Handbook: Airborne Release Fraction/Rates and Respirable Fractions for NonReactor Nuclear Facilities, DOE-HDBK-3010-94 (DOE 3010).

3.4.1.2 Atmospheric Dispersion Factors

Unit Dose Equivalent factors account for the following:

- accident release location with respect to height of release from the ground and existence of structure(s) that could cause a building wake effect
- receptor location with respect to the accident release location
- type of exposure to the receptor; inhalation, submersion, and ingestion
- a dose conversion factor for the radionuclide(s) involved in the accident

The receptor location has an impact on the amount and type of exposure to the receptor. The amount of material assumed to be exposed to a receptor is quantified by determining material dispersal properties, such as the height of the release location, existence of building wake, and plume meander. Atmospheric dispersion coefficients (χ/Q') (normalized integrated exposure values) are used to modify release consequences commensurate with the appropriate dispersal property. Different coefficients are credited for the individual properties involved in each unique accident release scenario.

Atmospheric dispersion coefficients were calculated using the code found in the *GXQ Program Users' Guide*, WHC-SD-GN-SWD-30002, Rev. 0 (WHC 1993a). Meteorological Data for the GXQ program comes from the Pacific Northwest Laboratories' (PNL) *Recommended Environmental Dose Calculation Methods and Hanford Specific Parameters*, PNL-3777 (PNL 1993). Acute atmospheric dispersion factors are calculated for an onsite location of 100 m and for all 16 sectors of the site boundary. These calculations are referenced in *Dose Calculations for the B Plant FSAR in the Surveillance and Maintenance Mode* (Van Keuren 1998). The sector having the greatest χ/Q' value is chosen to locate the maximally-exposed offsite individual, unless the overall 95 percentiles was found to be larger.

The dispersion factors for a postulated ground-level release include the effects of building wake, assuming a minimum vertical cross-sectional area of 475 m^2 on the basis of a 23.5 m height and a width of 20.1 m. The χ/Q' value at the site boundary is determined by using the GXQ code to compare the overall 95 percentile χ/Q' value, maximum sector individual with the 99.5 percentile sector χ/Q' values. As specified by the NRC, the higher χ/Q' values are used for dose calculations.

The plume meander model and methodology were derived from NRC 1982a. Plume meander is only considered if the accident scenario release duration is 1 hour or greater. The plume meander model is applied to the horizontal diffusion coefficient for particular atmospheric stability classes and wind speeds.

For ground-level releases, the onsite receptor is normally 100 m in the direction containing the maximum χ/Q' values. The χ/Q' values at 100 m were calculated for ground-level releases with

and without plume meander for all 16 sectors. The maximum dispersion coefficients with and without plume meander were 1.13×10^{-2} s/m^3 and 3.41×10^{-2} s/m^3. In addition, acute ground-level release χ/Q' values for the 100 m onsite locations, with building wake effects considered, were calculated for all 16 sectors. The maximum onsite atmospheric dispersion coefficient with building wake effects considered is 1.14×10^{-2} s/m^3. These dispersion coefficients are shown in Table 3.4.1.4-1.

As shown on Figure 1-1, Highway 240 and the Columbia River intersect the outer Hanford site boundary. The public is allowed access to Highway 240 and the Columbia River. Along the highway and the river, the offsite receptor and the onsite public receptor locations coincide. The offsite receptor is assumed to be at the location with the highest χ/Q' along the site boundary where the site is assumed to be bounded by the nearest bank of the Columbia River and Highway 240. The offsite receptor is assumed to stay at this location for the duration of the accident. The resulting χ/Q' values are listed in Table 3.4.1.4-1. The maximum individual χ/Q' values for a ground-level release, with and without plume meander, are 1.52×10^{-5} s/m^3 and 1.90×10^{-5} s/m^3, respectively. The maximum χ/Q' values for ground-level releases, with building wake effects considered is 1.88×10^{-5} s/m^3.

The UDE factors were evaluated for ground-level releases, since all the postulated releases are too low to take credit for an elevated release. These UDE factors (includes the atmospheric dispersion factor) are shown in Table 3.4.1.4-1.

Inhalation doses are 50-yr committed doses, based on an acute uptake. Submersion doses were calculated by using a semi-infinite cloud model. Table 3.4.1.4-1 doses represent ground-level releases calculated with and without consideration of building wake effects or plume meander. The χ/Q' values and unit doses are shown in Table 3.4.1.4-1.

3.4.1.3 Radiological and Chemical Inventories

Table 3.3-3 provides the estimated amounts of remaining radioactive material at B Plant.

Nitric acid (HNO_3), sulfuric acid (H_2SO_4)and sodium hydroxide (NaOH) are all toxic chemicals that were used at B Plant. The acids have been removed and the NaOH has been reacted to form a stable solid compound trisodium phosphate (Na_3PO_4). The chemicals remaining are stable; they are not significant toxic hazards. Any release hazards will be dominated by radiological considerations.

3.4.1.4 Unit Dose Equivalent Factors

Doses are calculated initially for a unit dose factor, i.e., the dose from a unit release of 1 Ci of ^{90}Sr or ^{137}Cs, or 1 g of Pu. The factors are multiplied by the actual release amount to determine a dose for an accident scenario.

Potential dose consequences to the maximum onsite receptor at 100 m and to the offsite receptor from releases of 1 Ci of ^{90}Sr and ^{137}Cs were calculated using the dose conversion factors based on ICRP 26 methodology as reported in EPA 1988. One curie of ^{90}Y, the daughter of ^{90}Sr is assumed to be in equilibrium with ^{90}Sr. Version 1.485 of the GENII software (Napier 1988) is

utilized in this document. The dose conversion factors are presented in Table 3.4.1.4-1. The dose conversion for plutonium is obtained from *Consequence Analysis of Certain Accidents Related To The Retired Filter System At B Plant* (Himes 1997).

The unit dose factors were evaluated for ground-level releases, since no elevated releases can be credited due to low release locations. These effective dose equivalent (EDE) factors (includes the atmospheric dispersion factor) are shown in Table 3.4.1.4-1.

HNF-PRO-704 requires the inclusion of 24 hour ingestion doses in the computation of offsite doses in addition to the inhalation doses. It is assumed that following a significant accident, food ingestion would be stopped by interdiction of the food, but that 24 hours would be required for the action. The 24-hour ingestion doses were developed using the same methods as were done for Tank Waste Remediation Systems (TWRS) BIO and FSAR (SAR-016, 1998). HNF-PRO-704 also specifies that the offsite receptor dose should be calculated assuming highway 240 and the Columbia rivers are the maximum offsite receptor location. The χ/Q's were revised to include these locations.

The inhalation dose can be calculated manually (within a few percent of the GENII calculations) using the following relationship:

$$\text{Inhalation Dose} = \text{Ci}\ (\chi/Q')(\text{BR})(\text{DCF})$$

where

Ci = total curies (or g Pu) released

χ/Q' = atmospheric dispersion factor, sec/m^3
= 3.41×10^{-2} sec/m^3 for onsite receptor
= 1.90×10^{-5} sec/m^3 for the offsite receptor

BR = breathing rate, m^3/sec
= 3.3×10^{-4} m^3/sec

DCF = dose conversion factor
= 2.48×10^5 rem/Ci for ^{90}Sr (EPA 1988)
= 3.19×10^4 rem/Ci for ^{137}Cs (EPA 1988)
= 7.63×10^7 rem/g for the Pu mixture (see Table 3.4.1.4-1)

The ingestion dose is given by:

$$\text{Ingestion Dose} = \text{Ci}\ (\chi/Q')\ D_{ing}$$

where the D_{ing} is calculated using the GENII computer code (Napier 1988) for a 1 Ci release and 24 hour ingestion period:

D_{ing} = 9.1 (rem-m$^{3)}$/(Ci-s) for ^{90}Sr
= 3.3 (rem-m$^{3)}$/(Ci-s) for ^{137}Cs
= 43 (rem-m$^{3)}$/(g-s) for the Pu mixture (see Table 3.4.1.4-1)

The ingestion dose calculations are documented in HNF-3360 (Van Keuren 1998).

- The offsite doses are computed by adding the ingestion and inhalation doses. The onsite dose is based only on the inhalation dose since food crops are not grown onsite.

The submersion doses are minor when compared to the inhalation doses and therefore the manual calculations ignore the small contribution from submersion.

Table 3.4.1.4-1 shows the Unit Dose Equivalents (UDE) for the ground level releases to onsite and offsite receptors. These values will be used throughout the analyses as follows to calculate the doses:

$$\text{Onsite Dose} = \text{Ci} \times UDE_{on}$$

where $UDE_{on} = (x/Q)(BR)(DCF)$;

$$\text{Offsite Dose} = \text{Ci} \times UDE_{off}$$

where $UDE_{off}=(x/Q)[(BR)(DCF)+ D_{ing}]$

Table 3.4.1.4-1: Unit Dose Equivalents for Different Receptor Locations

Receptor	χ/Q' (s/m3)	^{90}Sr dose to receptor (rem)	^{137}Cs dose to receptor (rem)	Pu-mix[1] dose to receptor (rem)
Dose Conversion Factor -inhalation	N/A	2.48×10^{5} rem/Ci	3.19×10^{4} rem/Ci	7.63×10^{7} rem/g
24 hour ingestion dose conversion factor	N/A	9.1×10^{0} (rem-m^3)/(Ci-s)	3.3×10^{0} (rem-m^3)/(Ci-s)	4.3×10^{1} (rem-m^3)/(g-s)
Onsite	3.41×10^{-2}	2.79×10^{0}	3.59×10^{-1}	8.59×10^{2}
Offsite[2]	1.90×10^{-5}	1.73×10^{-3}	2.63×10^{-4}	4.79×10^{-1}
Onsite with building wake	1.14×10^{-2}	9.33×10^{-1}	1.20×10^{-1}	2.87×10^{2}
Offsite with building wake[2]	1.88×10^{-5}	1.71×10^{-3}	2.60×10^{-4}	4.74×10^{-1}
Onsite with Plume meander	1.13×10^{-2}	9.25×10^{-1}	1.19×10^{-1}	2.85×10^{2}
Offsite with Plume meander[2]	1.52×10^{-5}	1.38×10^{-3}	2.10×10^{-4}	3.84×10^{-1}

A breathing rate of 3.3×10^{-4} m^3/s was used for inhalation doses.

(1) For purposes of this document, the Pu in the filters is assumed to be a mix of ^{238}Pu through ^{242}Pu and ^{241}Am, with a specific activity of 0.175 PE-Ci/g (Himes, D.A., 1997). (See Table 3.4.1.4-2).

(2) Offsite doses include inhalation plus 24-hour ingestion from HNF-3360 (Van Keuren 1998).

Plutonium doses are given here based on the mixture given in Himes 1997. Since the filter plutonium contents are specified in grams rather than curies, the dose factors are reported in rem/g. Inhalation doses are computed for the Pu mixture by multiplying the activity per gram for each isotope for this mixture times the dose conversion factor and summing the results. The results are given in Table 3.4.1.4-2.

Table 3.4.1.4-2: Inhalation Dose for Plutonium Mixture

Isotope	Weight of isotope (%)	Specific activity of isotope (Ci/g)	Activity per gram of mix (Ci/g)***	Dose Conversions factor (Sv/Bq)**	Dose per gram of mix (rem/g)*
^{238}Pu	8.0×10^{-2}	1.71×10^{-1}	1.37×10^{-2}	1.06×10^{-4}	5.37×10^{6}
^{239}Pu	8.395×10^{1}	6.20×10^{-2}	5.2×10^{-2}	1.16×10^{-4}	2.23×10^{7}
^{240}Pu	1.297×10^{1}	2.27×10^{-1}	2.94×10^{-2}	1.16×10^{-4}	1.26×10^{7}
^{241}Pu	1.10×10^{0}	1.03×10^{2}	1.13×10^{0}	2.23×10^{-6}	9.32×10^{6}
^{242}Pu	3.0×10^{-2}	3.93×10^{-3}	1.18×10^{-6}	1.11×10^{-4}	4.84×10^{2}
^{241}Am	1.75×10^{0}	3.42×10^{0}	5.99×10^{-2}	1.20×10^{-4}	2.66×10^{7}
TOTAL					7.63×10^{7}

* Dose/gram = Activity/g x Dose conversion factor x 3.7×10^{12} (Bq/Sv)/(rem/Ci)
** from EPA 1988
*** from Himes 1997

3.4.1.5 Risk Evaluation Guidelines

Risk Evaluation Guidelines (REGs) as taken from HNF-PRO-704 Rev. 0, Hazard and Accident Analysis Process are given in Table 3.4.1.5-1.

Table 3.4.1.5-1: Radiological Risk Evaluation Guidelines

		Dose (TEDE)*	
Frequency Category	**Frequency (yr^{-1})**	**Offsite**	**Onsite**
Anticipated (F3)	10^{-2} /yr ≤F3 <10^{-1}/yr	5mSv (0.5 rem)	50 mSv (5 rem)
Unlikely (F2)	10^{-4}/yr ≤F2 <10^{-2}/yr	50 mSv (5 rem)	250 mSv (25 rem)
Extremely Unlikely (F1)	10^{-6}/yr ≤F1 <10^{-4}/yr	250 mSv (25 rem)	1 Sv (100 rem)

*TEDE is total effective dose equivalent

3.4.1.6 Safety Class Definition

Table 3.4.1.6-1 provides the current safety class criteria from HNF-PRO-704 Rev. 0, Hazard and Accident Analysis Process. If unmitigated results exceed the criteria in this table, safety class or safety significant SSCs will be required to mitigate results.

Table 3.4.1.6-1: Safety SSC Criteria

	Safety structures, systems, and components (SSCs):	Safety SSC Designation
1	Prevent or mitigate offsite dose in excess of 5 mSv (500 mrem) TEDE.	SC
2	Place or maintain an operating process in a safe condition that prevents or mitigates offsite dose in excess of 5 mSv (500 mrem) TEDE.	SC
3	Monitor the release of radioactive materials to the environment during and after accidents where the monitor's output initiates Emergency Response Plan or operator actions to place the operating process in a safe condition per criterion 2.	SC
4	Maintain double contingency protection against an accidental nuclear criticality.	SC
5	Support the safety function of a safety class SSC. This includes control and monitoring functions (operating air, electrical power, instrumentation, etc.).	SC
6	Prevent or mitigate a radiological dose or chemical exposure that challenges the risk evaluation guidelines of Table 3.4.1.5-1.	SS
7	Place or maintain an operating process in a safe condition that prevents or mitigates consequences that exceed criteria 6.	SS
8	Prevent or mitigate exposure in excess of 50 mSv (5 rem) TEDE or an airborne chemical concentration in excess of ERPG-2 to facility operators who are relied on to achieve the safe condition of criterion 2 or 7.	SS
9	Monitor the release of radioactive and/or hazardous materials to the environment during and after accidents where the monitor's output initiates Emergency Response Plan or operator actions to place the operating process in a safe condition per criterion 7.	SS
10	Support the safety function of a safety significant SSC. This includes control and monitoring functions (operating air, electrical power, instrumentation, etc.).	SS
11	Prevent or mitigate an acute fatality to a facility worker or serious injury to a group of workers, except where the SSCs are controlled through an implemented institutional safety or radiation protection program.	SS
12	Provide defense-in-depth prevention or mitigation of an uncontrolled release of radioactive and/or hazardous material deemed significant in the safety analysis.	SS

Table 3.4.1.6-1: Safety SSC Criteria
Notes • Consider initiating events with a frequency of greater than 0.1 per year to be planned events, and mitigate their consequences to within normal operation limit • Where a postulated accident can cause multiple system failures, evaluate bounding consequences at a common receptor location. Select safety SSCs and determine residual consequences for the purpose of designating other structures or systems. • Designate SSCs that may prevent the adequate function of safety SSCs through physical interaction (seismic, pipe whip, jet impingement, water damage, environmental changes, etc.) as the same level of importance as those potentially affected SSCs. • Water treatment systems that use chlorine are considered to pose a risk commonly accepted by the public, provided that their design is consistent with public water treatment plants. Do not designate such systems as SC or SS. • See Section 2.4 of HNF-PRO-704 for the procedure steps that this table supports. In May, 1995, this procedure descoped environmental and standard industrial SSCs from designation as safety SSCs. These and other balance of plant SSCs are considered to be "General Service" SSCs.

3.4.2 Design Basis Accidents

This section documents evaluations of postulated accident scenarios that may occur during the B Plant S&M phase. The accident scenarios chosen for this analysis are taken from the hazards analysis (HA) (Appendix A).

The HA specifically considered the impact of aging of B Plant structures. The HA systematically examined the B Plant Facility for hazards caused by aging, S&M activities, external events (earthquakes, etc.), and other hazardous conditions and potential accidents that could have undesirable consequences to the facility workers, onsite individuals, the offsite public, and the environment. The fire hazards analysis is integrated with the HA and this SAR.

The outcome of the accident analyses provides a basis for developing the safety equipment list, as well as the basis for developing technical safety requirements (TSR). The safety equipment and related technical safety requirements become the analyzed operational preventive and mitigative features, which are relied upon ensure safe operation of a facility. All safety features, including the safety SSCs, the TSRs, and the remainder of the equipment are considered defense-in-depth and function to prevent accidents or mitigate the consequences.

A summary of all radiological release accidents analyzed is given in the following table.

Table 3.4.2-1: Postulated Accident Consequences

Case	Section	Onsite Dose (mSv)	Onsite Risk Evaluation Guideline (mSv)	Offsite Dose (mSv)	Offsite Risk Evaluation Guideline (mSv)
ACT: vehicle impact and fire	3.4.2.1	2.8×10^{-1}	2.5×10^{2}	5.8×10^{-4}	5.0×10^{1}
ACT filter failure due to excess loading	3.4.2.2	8.4×10^{1}	2.5×10^{2}	6.1×10^{-2}	5.0×10^{1}
Canyon fire	3.4.2.3	None	N/A	None	N/A
Explosion in Retired Filters - Unmitigated	3.4.2.4	1.3×10^{4}	1.0×10^{3}	8.3×10^{0}	2.5×10^{2}
Explosion in Retired Filters - Prevented		None	N/A	None	N/A
Fire in 291B filters (B Filter)	3.4.2.5	9.7×10^{1}	2.5×10^{2}	6.2×10^{-2}	5.0×10^{1}
Roof collapse	3.4.2.6	8.4×10^{1}	2.5×10^{2}	6.0×10^{-2}	5.0×10^{1}
Earthquake (DBE)	3.4.2.7	1.66×10^{2}	2.5×10^{2}	1.5×10^{-1}	5.0×10^{1}
Wind	3.4.2.8	None	N/A	None	N/A
Flood	3.4.2.9	None	N/A	None	N/A
Earthquake (BDBE)	3.4.3.1	1.676×10^{3}	2.5×10^{2}	1.1×10^{0}	5.0×10^{1}
291B Filters hydrogen explosion (BDBE)	3.4.3.1	1.29×10^{4}	2.5×10^{2}	8.3×10^{0}	5.0×10^{1}

Consequences of the analyzed B Plant design basis accident scenarios are within the onsite and offsite risk evaluation guidelines (REGs), except for the hydrogen explosion in the retired filter vaults, which is prevented with one or more administrative controls. Each accident scenario is developed and discussed in the following sections.

3.4.2.1 ACT Breach From Vehicle Impact and Fire

It is postulated that a vehicle impacts the HEPA filter housing of the B Plant canyon exhaust system ACT causing the filter housing to rupture, and the filters to be heavily damaged and burned. The impact bounds any similar event or initiator. This scenario is not addressed in the B Plant FHA. However, the FHA addresses impacts to the ACT from a canyon fire and recognizes a potential for a fire external to the ACT (wildfire).

3.4.2.1.1 Scenario Development

This scenario has two release mechanisms. The first mechanism is caused by the energy of the vehicle impact. A bounding airborne release fraction (ARF) and a respirable fraction (RF) for the

static pressure breaking of a HEPA filter are used for this initial release mechanism.

The second release mechanism is caused by the thermal stress imparted onto the filter media from the burning of spilled fuel. Empirical data has shown that most of the contaminants are trapped in the filter melt.

The release duration is considered to be less than one hour. With a short duration release, credit cannot be taken for plume meander. However, building wake can be credited, because the filter housing release is in the wake of the B Plant 221-B canyon structure, which is not affected by this accident.

As stated in the FHA, the potential exists for debris or tumbleweeds to collect around the ACT filter. In addition, as stated in the FHA, a lightning strike, range fire, or spontaneous combustion of combustibles accumulated around the canyon exhaust system could damage it and/or the ACT filters. The B Plant canyon building is a massive concrete structure which will not be significantly affected by the fire.

3.4.2.1.2 Source Term Analysis

The source term is determined considering both release mechanisms. Because the vehicle impact is considered to severely disrupt the filter housing, the resulting release is modeled with the HEPA filter damage housing deformation. For a release from a HEPA filter experiencing damage, the bounding ARF and RF values are considered to be 1×10^{-2} and 1.0, respectively (DOE 3010). This release fraction is indicative of a large energy release (i.e., explosive release).

The ARF from heat-induced damage to HEPA filters is very small. The filter medium is very fine diameter glass fiber that softens and melts when heated. This melt tends to retain or trap filtered particulate materials. For the impacts of heat upon a loaded HEPA filter, the ARF and RF values are considered to be 1.0×10^{-4} and 1.0, respectively (DOE 3010). This ARF is negligible compared to the ARF for the impact from the vehicle.

The unmitigated inventory on the filter is not known. Since most of the radioactive contamination in the canyon is fixed in place, and there are no operation or processing activity in the building other than the surveillances, which are not in the airflow areas, the radioactive contamination on the filters is likely to be quite small. Section 3.4.2.6 indicates that the release from the canyon from a roof collapse is 15.7 Ci of ^{137}Cs, and 1.0 Ci of ^{90}Sr. These activities will be assumed to be the bounding activities on the ACT filters when the impact and fire occur, because the postulated consequences of the roof collapse scenario are the greatest DBA consequences found for the canyon (Table 3.4.2-1).

The potential exists for unfiltered releases from the canyon, because the filter would be damaged. The following section postulates consequences for this scenario, considering the accident causes the exhaust fans to stop running. If the fans continue to operate, the consequences would be the same as those postulated for the scenario for a failed/breached filter of Section 3.4.2.2.

3.4.2.1.3 Consequence Analysis Without Controls

Credit for building wake is taken in this analysis. Doses were calculated using the Unit Dose Equivalents (UDE) in Table 3.4.1.4-1 for a ground release, taking credit for building wake and the relationship:

$$\text{Dose} = \text{Ci} \times \text{ARF} \times \text{UDE}.$$

The dose consequences are given in Table 3.4.2.1-1 and 3.4.2.1-2.

Table 3.4.2.1-1: Potential Releases from Vehicle Impact on the ACT HEPA Filters

Receptor	Isotope	Inventory (Ci)	ARF	UDE	Dose (rem)
Onsite	^{137}Cs	15.7×10^{0}	1.0×10^{-2}	1.20×10^{-1}	1.9×10^{-2}
	^{90}Sr	1.0×10^{0}	1.0×10^{-2}	9.33×10^{-1}	9.3×10^{-3}
Total					2.8×10^{-2}
Offsite	^{137}Cs	15.7×10^{0}	1.0×10^{-2}	2.60×10^{-4}	4.1×10^{-5}
	^{90}Sr	1.0×10^{0}	1.0×10^{-2}	1.71×10^{-3}	1.7×10^{-5}
Total					5.8×10^{-5}

3.4.2.1.4 Frequency Analysis Without Controls

The hazards analysis of Appendix A assumes the event is "unlikely" to occur, based on the following:

1) The canyon exhaust system is located at least 50 yards inside a (chain link) fenced, prohibited access area.

2) Vehicles will be in the fenced area only during surveillance and maintenance activities.

3) The system is placed on a raised concrete pad and set back from the edge of the pad, which precludes a vehicle from easily running in to the system.

4) The fenced prohibited access area is not adjacent to a roadway, such that a vehicle would ever be expected to accidentally run through the fence and approach the canyon exhaust system.

5) It is anticipated that the fence will not be removed during the S&M phase.

Therefore, the frequency of occurrence of a vehicle running into the canyon exhaust system is assumed to be in the "unlikely" category. It is even more unlikely that there would also be a fuel leak and fire if a vehicle ran into the canyon exhaust system.

The frequency of occurrence for a buildup of sufficient tumbleweeds, coupled with ignition and

fire of sufficient intensity to damage the filter, is also classified as "unlikely". The hazard analysis assumed it unlikely that the filters could be damaged by a tumbleweed fire based on the following aspects, which are recognized in the FHA:

1) The chain link fence around the deactivated facility will limit the volume of combustibles/weeds that could accumulate around the canyon exhaust system.

2) The canyon exhaust system is set back more than 10 meters from indigenous vegetation.

Both of these reasons reduce the likelihood that a range fire would reach the canyon exhaust system.

3.4.2.1.5 Comparison to Guidelines

The risk of a truck impacting the filter is determined by comparing the consequences and the frequency of the event to the risk guidelines presented in Table 3.4.1.5-1. Based on this comparison, shown in Table 3.4.2.1-3 the risk evaluation guidelines are not exceeded.

Table 3.4.2.1-2: Doses for Vehicle Striking the HEPA Filter and Fire Without Controls

Receptor	Dose (mSv)[rem]	RG (mSv)[rem]
Onsite	2.8×10^{-1} [2.8×10^{-2}]	2.5×10^{2} [2.5×10^{1}]
Offsite	5.8×10^{-4} [5.8×10^{-5}]	5.0×10^{1} [5.0×10^{0}]

RG = Risk Evaluation Guidelines (Table 3.4.1.5-1)

3.4.2.1.6 Summary of Safety SSCs and TSRs

Since the risk evaluation guidelines and safety class criteria are not challenged for this accident without controls, no TSRs or safety class/safety significant equipment is required.

3.4.2.1.6.1 Accident Scenario With Controls

The accident scenario with controls is the same as without controls, except the inventory on the filter will be lower. The filter inventory will be limited by controls applied to limit filter inventory and to prevent excessive exposure of gamma radiation from the filter to personnel during filter changes.

3.4.2.1.6.2 Dose Consequences with Controls

The consequences with controls will be even less than the consequences without controls, which are much less than the risk evaluation guidelines.

3.4.2.1.7 Defense in Depth

Procedural and design features limit filter loading to protect workers changing the filters. Defense in depth items include a fence that restricts access to the B Plant yard. Entry to the fenced area will occur during the S&M activities. Personnel conducting S&M activities are trained to observe hazards and to use care in operating motor vehicles in the B Plant complex.

The fence around the B Plant yard will reduce the potential accumulation of tumbleweeds and debris.

3.4.2.2 ACT Filter Failure Due to Excessive Loading

There is a potential for excessive particulate loading onto the new canyon exhaust system HEPA filters, that could result in the filters failing due to a high or suddenly high differential pressure across the HEPA filter media. This section shows that the potential for the event to occur is unlikely and that it is bounded by the release of canyon contamination initiated by the roof collapse.

3.4.2.2.1 Scenario Development. This scenario covers consequences stemming from improper installation of the HEPA filters, degradation of the filters, or sudden failure of the filters from excessive differential pressure. It is postulated that if the filters fail, the failure occurs early in the event, so that less contamination would be held up by the filter media. This equates to taking no credit for filtration.

HEPA filters are susceptible to failure resulting from large differential pressures across the media. This analysis will assume the following mechanisms could produce a large differential pressure: (1) wetting of the filter media, (2) rapid or normal buildup of particulate on the filters with the surveillance failing to detect the buildup and changing the filters, (3) an improper operating configuration of two fans operating with one degraded filter on line because of an interlock failure, or (4) failure due to a defect in the filter.

The new canyon exhaust system has two air cleaning trains (ACT)s arranged in parallel. Each ACT contains HEPA filter units with the design capacity to accommodate the air flow from one exhaust fan. The design rated efficiency of each HEPA filter is 99.97% for the removal of particulate with a median diameter of 0.3 μm. The prefilter associated with each HEPA assembly is listed with a 45% efficiency for dust. Dampers exist for the isolation of one or both of the filters. The dampers are not expected to be operated for anything other than filter changeouts.

The system has two exhaust fans that are also arranged in parallel. The canyon exhaust system will normally operate with one fan providing airflow through both ACTs. An interlock is present to prevent the operation of both fans at once. A cross-over exists to allow either fan to draw an airflow through the ACT(s). Each fan is designed to overcome the maximum expected pressure drop through the ductwork, stack, and filter units while maintaining a building pressure of approximately 74.7 to 99.6 Pa (.3-.4 in. water column) below atmospheric pressure. The fans are sized for a volumetric flow rate of 6.4- 8.3 m^3/s (13,600 - 17,600 ft^3/min) and a static pressure of 2.2 kPa (9 in. water column). The exhaust system design precludes failing the HEPA filters. The fans cannot produce enough ΔP (differential pressure) across the filters to cause them to break,

even if they are plugged with particulate. The fans can produce a maximum static differential pressure of 4.2 kiloPascal (kPa) (16.9 in. water column). The filters are known to fail from static ΔPs ranging from 9.0 to 20 kPa (36.1 to 80.3 in water column) (DOE 3010).

By design, the fans cannot cause the filters to fail, even if they are plugged with particulate. However, there is a potential that a sudden change to the static flow or differential pressure on the filters could cause the filters to fail. A scenario could be postulated to occur (such as a DBE or roof collapse) within the B Plant causing a sudden change to the ACT air flow or differential pressure across the ACT filters and suspending a portion of the canyon contamination. With a fan running, the suspended material can be suddenly drawn into the ACT equipment and cause a rapid buildup of particulate. However, it would be more conservative to assume the filters did not exist.

Collapse of the canyon roof could cause a large, rapid pressure pulse which could cause a rapid loading of the ACT HEPA filters and breach them. The roof collapse could cause a sudden pressure pulse with more energy than the DBE. The roof collapse could involve a concrete segment larger than a cell cover block and involves a greater fall distance than that of a cover block. If a very large roof segment or the entire roof collapsed the pressure pulse to the ACT could be much greater than a pressure pulse caused by a DBE initiated cover block collapse. In the DBE analysis, the roof is assumed to remain in place. The roof collapse analysis consequences (Section 3.4.2.6) are greater than the canyon DBE consequences (Table 3.4.2.7-4). The roof collapse scenario consequences are the greatest DBA consequences from the canyon.

3.4.2.2.2 Source Term Analysis

This source term analysis considers a release from the canyon contamination that could be suspended in the canyon and drawn out by the operating fan through a breached filter or filter seal; for conservatism, no filtration is credited. In addition, this analysis will consider the release of contamination that could already be on the filter and released when the filter breaches.

According to available experimental data, a HEPA filter fails due to overpressure by tearing along the rear (downstream) folds of the filter material with a recommended release fraction of 2.0×10^{-6} (respirable fraction = 1) (DOE 3010). For conservatism and to account for uncertainties, the consequences of the mechanical/vehicle impact with a fire (section 3.4.2.1) without controls will be used to postulate the release from the contamination already on the filters when the event initiator occurs.

The fans will be assumed to continue to operate following the failure of the filters. The roof collapse evaluation in Section 3.4.2.6 reports dose consequences assuming no filtration while the exhaust fans continue to operate.

The source term applicable to this scenario would involve all of the canyon contamination. The roof collapse analysis considered all the contamination in the canyon.

The release fractions used for the roof collapse analysis is greater than the release fraction for material released that would already be on the filters when they breach. Thus, it is more conservative to assume the filter is breached before or immediately after the scenario initiator

occurs, so that no contamination would be held up by the filter. Then all of the suspended contamination is assumed to be released out of the canyon.

3.4.2.2.3 Frequency of Occurrence

The frequency assumed for the roof collapse is in the range for unlikely events. This frequency is applicable to this filter failure event, because it is the most likely initiator for this type of filter failure event.

3.4.2.2.4 Analysis Consequences

The dose consists of the releases from the filter (Table 3.4.2.1-1) plus the roof collapse release from the canyon (Table 3.4.2.6-3). The dose calculation results are reported in the following table.

Table 3.4.2.2-1: Potential Doses from Failure of the ACT HEPA Filters

Receptor	Roof Collapse (rem)	Impact/Fire (rem)	Total Dose (rem)
Onsite	8.4×10^{0}	2.8×10^{-2}	8.4×10^{0}
Offsite	6.0×10^{-3}	5.8×10^{-5}	6.1×10^{-3}

This analysis shows that the released material from inventory on the filters prior to the initiating event is negligible compared to the bounding initiating scenario.

3.4.2.2.5 Comparison to Risk Evaluation Guidelines

The risk of the unfiltered release is determined by comparing the consequences of the event to the risk guidelines presented in Table 3.4.1.5-1. The doses are compared to the unlikely criteria of 3.4.1.5-1. Based on this comparison, shown in Table 3.4.2.3-2, the risk evaluation guidelines are not exceeded.

Table 3.4.2.2-2: Doses for Failure of the ACT HEPA Filter

Receptor	Dose (mSv)[rem]	RG (mSv)[rem] (unlikely)
Onsite	8.4×10^{1} [8.4×10^{0}]	2.5×10^{2} [2.5×10^{1}]
Offsite	6.1×10^{-2} [6.1×10^{-3}]	5×10^{1} [5×10^{0}]

RG = Risk Evaluation Guidelines (Table 3.4.1.5-1)

3.4.2.2.6 Summary of Safety SSCs and TSRs

Since the risk evaluation guidelines and safety class criteria are not challenged for this accident without controls, no TSRs or safety class/safety significant equipment is required.

3.4.2.2.7 Defense in Depth

As a defense in depth design feature, an interlock will shut down the fans if the HEPA differential pressure exceeds 2.3 kPa (9.23 in water column).

Defense in depth also includes the surveillance and maintenance of the facility. Failure of the filters due to overloading will likely be prevented by changing of filters prior to failure. If failure did occur, the failure would be detected, and the filter would be replaced. The canyon exhaust system can be operated with one ACT in service while service is performed on the other ACT with it isolated from service.

3.4.2.3 Canyon Fire

The B Plant FHA analyzed the fire hazards for B Plant during the Surveillance and Maintenance phase. That analysis showed that there are no potential fires that present a hazard to safety equipment. The remaining combustibles in the canyon are identified in the B Plant FHA. Those combustibles are located on the canyon deck and in the canyon cells. Those combustibles are not expected to be ignited. This is especially true, since there will be no electrical energy sources with enough energy to ignite any combustible material. The liquid level detection components in cell 10 have inadequate energy to create an arc. The ACT and HEPA filters will not be impacted by a canyon fire. The isolated (retired) 291-B area HEPA filters cannot be impacted by a fire in the canyon. Therefore, there will be no dose consequences to the onsite or offsite receptors due to a canyon fire.

The ACT and HEPA filters will not be impacted by the fire in the canyon, based on the results of quantitative fire analysis models and the amount and configuration of remaining combustibles in the canyon. The models used conservative combustible loading analysis to show that temperatures from assumed worst case fires near the canyon exhaust system duct inlet would not exceed the rated temperatures of the HEPA filters. The remaining combustibles in the canyon are configured in accordance with FHA recommendations, consistent with the fire modeling.

3.4.2.3.1 Scenario Development

This scenario is derived in the FHA and analyzed in this SAR, even though a canyon fire was not selected for further analysis from the hazards identification and evaluation results. Combustibles are assumed to be located within the 221-B canyon, exceeding those identified in the S&M FHA and could possibly ignite and burn. The combustibles remaining in the process cells are not expected to burn, but would be bounded by this analysis due to the limited volumes, the limited air flows, and the distances from, and arduous route to, the canyon exhaust system duct inlets and filters.

Two benchmark fuel packages were selected for the analysis of a canyon deck fire. The fuel

packages consisted of 3.22 m x 1.22 m x 1.22 m stack of wood pallets, and a 38 L combustible liquid spill. The pallet fire was selected to analyze the impact on the canyon exhaust system following a prolonged fire in the canyon building. The flammable liquid fire was selected to evaluate the performance of the canyon exhaust filters under a short-term, high temperature, condition. The two benchmark fuel packages provide bounding conditions for a fire in the canyon.

The filter materials used in the system meet the requirements of UL 900 (Class 1) and UL 586 (UL 1990). Debris on the filter media will be the only source of combustible material within the canyon exhaust system. Combustible loading in the ACT will be limited by changing the ACT filters in accordance with system operational requirements (i.e., limit the low ΔP to maintain adequate airflow and limit high radioactive material loading to minimize exposure doses).

The consequences resulting from 3.2 m stack of pallets and 38 L of combustible liquids are analyzed in the FHA. The burning pallets simulates waste that might be left on the canyon deck. This is a prolonged fire. The liquid fire simulates a short duration, high temperature fire.

3.4.2.3.2 Source Term Analysis

The inventory available for release would be the canyon surface contamination directly impacted by the fire and the contamination on the burning combustibles.

3.4.2.3.3 Consequence Analysis

As analyzed in the FHA, a canyon fire would not impact the canyon exhaust system and any contamination liberated during the fires would be filtered prior to release. There are negligible dose consequences to the onsite and offsite receptors due to a canyon fire.

A canyon fire would be a localized event, impacting only the portion of canyon contamination involved at the fire location. In comparison with the DBE or roof collapse scenarios, the material at risk of release from a canyon fire is lower and bounded by the DBE and roof collapse scenarios.

Even though a canyon fire release is mitigated by the canyon exhaust system in this scenario, it is not necessary to assign the canyon exhaust system a "safety equipment". If the release was not mitigated by the filter system, the release would automatically be mitigated by building wake. The canyon building walls are credited to mitigate the roof collapse consequence through building wake effects.

Potential Toxicological Exposures

Since the organic solutions have been removed from the facility, the combustion hazard no longer exists. Due to the low volume of combustibles, the materials types, low potential for fires, and the short burn durations, no significant toxicological exposures are anticipated.

3.4.2.3.4 Frequency Analysis

A fire is not expected to occur in the canyon due to limited combustibles and the absence of an ignition source.

3.4.2.3.5 Summary of Safety SSCs and TSRs

Since no significant radiological or toxicological exposures are postulated, the risk evaluation guidelines and safety class criteria are not exceeded for this accident. No TSRs or safety class/safety significant equipment is required.

3.4.2.3.6 Defense in Depth

Defense in depth items include restricted access to the B Plant canyon. The combustible loading remaining in the canyon and the entire B Plant facility is in accordance with the FHA assumptions and recommendations and is maintained by an administrative procedure. The canyon exhaust system materials are in compliance with fire resistance requirements for a HEPA filtered system at a nuclear facility.

3.4.2.4 Explosion in Retired Filters

The scenario considered is a hydrogen explosion in the filter vaults of the retired canyon ventilation system. This event is postulated to be caused by water leaking into the filter vaults. As described in Section 3.4.2.4.4 a hydrogen explosion is deemed "extremely unlikely". However, it is deemed prudent to ensure the deactivated vaults are monitored for hydrogen and water due to uncertainties regarding water intrusion and hydrogen generation and containment.

With water in the vaults, decay energy from cesium and strontium in the filters and/or on the vault floor could radiolytically generate hydrogen gas. This hydrogen gas might then build up in the headspace if there is insufficient airflow to dilute the hydrogen or transfer it out of the vaults or the generation rate is greater than the rate that the hydrogen diffuses from the vault. If the passive vent system on the vaults is plugged and the hydrogen gas reaches sufficient concentrations and an ignition occurs, a deflagration or explosion may occur. The magnitude of the event could have sufficient energy to generate pressures that result in the air ducts, risers, and/or the vault roofs failing during the explosion. Therefore, a worst case analysis is performed to establish a periodicity for performing a surveillance for hydrogen in the vaults. The hydrogen surveillance is an established administrative control that will ensure hydrogen does not approach a dangerous concentration in the vaults.

There is a passive vent system on filter vaults A, B, C, D, and E that is designed to vent the vaults' airspaces to keep the hydrogen concentration below the hydrogen lower flammability limit (LFL). Even though the passive vent system prevents an explosion by keeping the hydrogen concentration below the LFL, the following analysis is presented to demonstrate the unmitigated consequences of the hydrogen explosion. The postulated consequences of the following analysis are used to determine if controls are needed to prevent and/or mitigate the accident.

3.4.2.4.1 Scenario Development

Because D filter contains the greatest amount of radionuclides (Table 3.3-3), D filter inventory and vault dimensions are used to calculate a hydrogen generation rate and the duration required to build up hydrogen concentrations. The dose consequences calculations will incorporate A, B, and C filters' inventory as well. As shown in Table 3.3-3, E filter and the sand filter have insignificant radioactive inventory to present a hydrogen hazard, so they are not considered in this analysis.

Water is assumed to accumulate in D filter vault. All the radioactive material (Cs and Sr) in direct contact with the water contributes to the radiolysis. In addition, half the gamma radiation from the Cs that is not in direct contact with the water is assumed to contribute to the radiolysis. The HEPA filter vaults (A, B, C, and D) are assumed to flood to the same degree. In general, these vaults have about the same internal volume.

Assuming the vaults fills with significant amounts of water is very conservative, because there are no water sources in the vaults area that support large quantities of water entering the vaults. For instance, it would take about 235 m^3 (62,080 gal) of water to fill D vault half-full. The only source of water is natural precipitation (water from rain and melting snow). According to the *Hanford Site Climatological Data Summary 1997, With Historical Data* (PNL 1998), since 1947 the average annual precipitation is about 18 cm (7 in.). The maximum annual precipitation in this area was about 31cm (12.3 in) in 1995. Based on the dry climate of the Hanford site; the assumption that the vaults concrete integrity is of good quality (i.e. no leaks); the water resistant membrane on the top horizontal surface of the vaults; and there is about a meter of soil on the top of the vaults; it is not expected that even total annual precipitation would enter the vaults. Evaporation is expected, albeit at a slow rate.

To calculate the hydrogen generation rate, the energy deposited in the water during radiolysis is needed. This energy is represented as electron volts. The total electron volts associated with D filter are calculated in the following equation:

$$\text{Total (eV/sec)} = [\text{Cs (Ci)}][F+0.5(1-F)] \times [3.7 \times 10^{10} \text{ (dps/Ci)}] \times [0.8 \times 10^{6} \text{ (eV/d)}] + [\text{Sr (Ci)}](F) \times [3.7 \times 10^{10} \text{ (dps/Ci)}] \times [1.13 \times 10^{6} \text{ eV/d)}]$$

where

1.13×10^6 eV/d	=	energy deposited per disintegration by radiation from ^{90}Sr and ^{90}Y. One beta from ^{90}Sr at 0.2 Mev average and one beta from ^{90}Y at 0.93 Mev.
0.8×10^6 eV/d	=	energy deposited per disintegration by radiation from ^{137}Cs and ^{137}Ba. One gamma at 0.662 Mev 85% of the time (0.56 Mev) along with a beta at 0.20 Mev average energy. Electrons at 0.6 Mev each are also emitted a total of 6.5% of the time (Villforth, 1970).
3.7×10^{10}	=	disintegrations per second (dps) for 1 Curie
d	=	disintegrations

dps = disintegrations per second

F = Fraction of vault filled with water

The factor of 0.5(1-F) is included in the Cs source term because one-half of the gamma energy released above water is assumed to be deposited in the water.

An example calculation is given for a vault one-half filled with water. With the vault half-filled with water, it is assumed that half of the Cs^{137} and Sr^{90} in the vault is in direct contact with the water and contributes to radiolytic generation of hydrogen. For the other half of the Cs^{137} and Sr^{90} in the vault that is not in direct contact with the water, only half of the Cs^{137} is assumed to contribute to hydrogen generation. This is assumed, because Cs^{137} releases gamma radiation, which has adequate penetrating energy to pass through the air, penetrate the water, and contribute to hydrogen generation. The Sr^{90} does not have the penetrating energy and is neglected. Thus, only 50% of the Sr^{90} in the vault contributes, but 75% of the Cs^{137} in the vault contributes to hydrogen generation in the following calculations. The Pu in the vaults is neglected, because due to the low inventory (1 gram per vault A, B, C, and D) the hydrogen generation contribution is negligible compared to that of the Cs^{137} and Sr^{90}.

The total radiolytic energy per second from the radionuclides in D filter is equal to

Total (eV/sec) = [(70,000 x 0.75)Ci x 3.7E10 dps/Ci x 0.8E06 eV/d] +

[(14,000 x 0.5)Ci x 3.7E10 dps/Ci x 1.13E06 eV/d]

= 1.85×10^{21} eV/sec.

By noting that 0.45 molecules of H_2 gas are produced for every 100 eV (standard value of $G[H_2]$) for gamma and beta in water (*Hydrogen Control in the Handling, Shipping and Storage of Wet Radioactive Waste*, RHO-WM-EV-9, Rev. 1P, [Henrie and Flesher 1985]), the number of mols of hydrogen gas produced per second are calculated. This value is then converted to a volumetric flow rate by multiplying the molecular volume and Avogadro's number, which is 6.023×10^{23} molecules/mol. This conversion factor is the volume occupied by 1 g-mol of perfect gas at the ambient temperature in the vaults. This molecular volume is calculated as follows:

The volume of 1 mole of gas at standard temperature and pressure (STP) is 22.4 L/mol.

The hydrogen generation rate (G) is equal to:

$G = 1.85 \times 10^{21}$ eV/s)(0.45 molecules/100 eV)(1 mol/6.023×10^{23} molecules)(22.4L/mol)

$G = 3.09 \times 10^{-4}$ L/s

$G = 3.09 \times 10^{-7}$ m3/s.

The internal dimensions of D filter vault are used to calculate the total vault volume. The vault volume is

D vault volume = 10.36 m (34 ft) x 5.94 m (19.5 ft) x 7.62 m (25 ft)

= 470 m^3 (1.66×10^4 ft^3).

The volume of air above water in the D filter vault is:

$$(470.06\ m^3)(0.5) = 235\ m^3\ (8.30 \times 10^3\ ft^3).$$

Assuming no ventilation is occurring, the time required to reach the lower flammability limit (4% concentration) once the vault is half full of water is

4% Time = $(235\ m^3)(0.04)/(3.09 \times 10^{-7}\ m^3/s)$
= 3.04×10^7 s
= 351 days
= 0.96 years.

With only the minimum flammable concentration, however, the flame front will propagate only vertically from the ignition source and will burn only a very small part of the hydrogen in the vault. While useful from a safety standpoint for an occupied space, the minimum flammable concentration is not a good criterion for achieving an explosion with enough energy to breach the vaults and present significant consequences. This could be the case if ignition occurs when a higher hydrogen concentration exists.

The minimum hydrogen concentration necessary to produce horizontal and downward propagation from an ignition source and to produce close to a 100% burn is about 10% (Coward and Jones 1952). The time required to build up a 10% hydrogen concentration with the vault half full of water and no venting is:

10% Time = $(235\ m^3)(0.10)/(3.09 \times 10^{-7}\ m^3/s)$
= 7.59×10^7 s
= 878 days
= 2.4 years.

These calculated durations are conservative, because with the vaults half full of water the generation rate is maximized and the 4% and 10% accumulation durations are minimized. The generation rate is maximized, because it is not expected that this much water will ever leak into the vaults.

The time for the filter to reach flammable concentrations for various water contents is given as follows.

Time to reach 4% = $0.04V(1-F)/G$

Where G is the hydrogen generation rate in m^3/s

V is the volume of the cell which is taken as 470 m^3
F is the fraction of the vault filled with water

The time to reach 10% is obtained with the same equation, except the 0.04 would be replaced by 0.10. Since F is the fraction of the vault filled with water, (1-F) is the fraction of the cell that is empty.

The time to reach 4% and 10% hydrogen fraction assuming no breathing of the cell is shown in Table 3.4.2.4-1 as a function of the fraction of the filter vault filled with water.

Table 3.4.2.4-1: Time to Reach 4% and 10% Hydrogen - No Breathing

Fraction of vault filled with water	Time to Reach 4% Hydrogen (Years)	Time to Reach 10% Hydrogen (Years)
0.05	3.0	7.6
0.10	2.7	6.70
0.25	1.9	4.6
0.50	0.96	2.4
0.75	0.39	0.99

For water contents up to 50% full, one year or longer is required to reach 4%. For lower fill fractions, more than one year is required. Monitoring of hydrogen would be effective in detecting the hydrogen generation and preventing the LFL. Monitoring is necessary as LFL levels could be reached even for small amounts of water, given long times.

The peak concentration, if the cell vents hydrogen due to barometric pressure changes, is given by the following differential equation

$$VdD/dt = G - B(1-F)VC$$

Where G is the production rate of hydrogen (m^3H_2/s),
B is the breathing rate fraction of the cell in per second (s^{-1}),
C is the concentration of hydrogen (m^3 of H_2/m^3 of air),
V is the volume of the cell (m^3), and
F is the fraction of the cell filled with water (dimensionless).

At equilibrium $dC/dt = 0$, and

$$C = G/[B(1-F)V]$$

The fraction of the volume vented through barometric pressure changes is assumed to be 0.0045/day (Ramble 1998).

The peak concentration for various water fill fractions is given in Table 3.4.2.4-2.

Table 3.4.2.4-2: Peak Hydrogen Fraction versus Fraction of Vault Filled with Water with Barometric Breathing of 0.0045/day	
Fraction of Vault Filled with Water	**Peak Hydrogen Fraction (dimensionless)**
0.05	0.0080
0.10	0.0091
0.25	0.013
0.50	0.025
0.60	0.034
0.75	0.062

The hydrogen content will never reach 4% unless the water fill fraction exceeds 60%. Even for extremely high levels of water, the time to reach flammability levels would be delayed. Thus, barometric breathing is effective in providing protection against hydrogen accumulation.

3.4.2.4.2 Source Term Analysis

The recommended bounding airborne release fraction (ARF) and respirable fraction (RF) for explosive blast effects on HEPA filters are 1.0×10^{-2} and 1.0, respectively (DOE 3010). Thus 1.0×10^{-2} of the filter contents above water (half of the total inventory), or a net fraction of 5×10^{-3} of the filter inventory is suspended in the hot gas in the vault during the explosion. Although these release fractions were estimated based on the D filter and vault, they are conservatively assumed to represent all the HEPA filters. Note that any release from E Filter and the sand filter in response to a hydrogen deflagration is assumed negligible compared to releases from the other vaults due to the relatively low inventories compared to Filters A, B, C and D. Since all the vaults are assumed be equally flooded and equally generate hydrogen, the inventories of Filters A, B, C, and D participate in the release. The resulting respirable releases is calculated using the relationship

Respirable release = (Total Inventory)(0.5)(1.0×10^{-2}), where the total inventory is the inventory of Table 3.3-3 for Filters A, B, C, and D.

The resultant respirable release is shown in the following table.

Table 3.4.2.4-3: Respirable releases due to hydrogen explosion in HEPA filter vaults		
Isotope	**Inventory**	**Release**
^{137}Cs	1.56×10^{5} Ci	7.80×10^{2} Ci
^{90}Sr	7.10×10^{4} Ci	3.55×10^{2} Ci
Pu (mix)	4 g	2.0×10^{-2} g

3.4.2.4.3 Consequence Analysis

This release was assumed to have a duration of less than 1 hour and is not near a large structure. Therefore, credit is not taken for plume meander or building wake. The unit dose equivalents from Table 3.4.1.4-1 for a ground release were used to calculate the resulting radiological doses shown below. There are no significant toxic materials on the filters. Using the relationship: Dose = Ci x UDE from Section 3.4.1.4, the dose consequences are as shown in the following table.

Table 3.4.2.4-4: Dose consequences from explosion in HEPA filter vaults

Receptor	Isotope	Release	UDE	Dose (rem)
Onsite	^{137}Cs	7.80×10^{2} Ci	3.59×10^{-1} rem/Ci	2.80×10^{2}
	^{90}Sr	3.55×10^{2} Ci	2.79×10^{0} rem/Ci	9.90×10^{2}
	Pu (mix)	2.0×10^{-2} g	8.59×10^{2} rem/g	1.72×10^{1}
Total				1.29×10^{3}
Offsite	^{137}Cs	7.80×10^{2} Ci	2.63×10^{-4} rem/Ci	2.05×10^{-1}
	^{90}Sr	3.55×10^{2} Ci	1.73×10^{-3} rem/Ci	6.14×10^{-1}
	Pu (mix)	2.0×10^{-2} g	4.79 x 10-1 rem/g	9.58×10^{-3}
Total				8.29×10^{-1}

3.4.2.4.4 Frequency Analysis

The probability of this event occurring is extremely unlikely, because three failures must occur to result in an explosion. First, significant flooding must occur as shown in Section 3.4.2.4.1. The maximum rainfall for this area is about 12 inches, with an average annual rainfall of about 7 inches. It would require at least 10 years of accumulating 12 inches per year to fill D filter vault to 3 m. Based on operating knowledge, natural precipitation has not been a major contributor to water leakage to the vaults.

All engineered water sources to the filter vaults and ducts have been drained and sealed. Engineered water sources to the filter vaults area have been isolated from the utility water systems by physical isolations at the water utility headers. All known penetrations to the vaults are sealed.

It is difficult to guarantee that water cannot enter the vaults during the S&M phase, because the vaults are buried. The vaults have a water resistant membrane covering the horizontal surfaces and are mostly below the earth grade, with a soil berm around two sides and about a meter of soil over the top of the vaults. The amount of water that could enter the vaults is limited, because only water from rain, melting snow, and the water remaining in the abandoned filter water seals could leak into the section of the vaults containing the radioactive material.

It is difficult to estimate the amount of water that would leak into the vaults from natural precipitation. Based on past operations, there have been no occasions when water was detected in the vaults following rain or snowmelt events. It is also difficult to estimate how long the water

would remain in the vaults. If water did leak into the vaults and did not evaporate or evaporated very slowly, then hydrogen would be generated. If the vaults were sealed, then the hydrogen concentration could increase and present an explosion concern.

Second, the passive vent must be blocked and the vault filled one half full of water for about a year to have 4% hydrogen concentration and at least 2 years to have 10% hydrogen concentration. Much longer times are required for lower water contents. Pressure in the filter vaults will tend to equalize with the outside pressure through leakage in pores and cracks, even if the passive filter vent is plugged. So, barometric breathing will tend to reduce the peak hydrogen contents and further reduce the probability of reaching flammable concentrations. The first two failures (water leakage plus failure of the passive vent) must remain undetected over a long duration for the accident to occur. This is not likely to occur, because surveillance will be performed as required by the TSR to ensure the hydrogen concentration in the vaults does not challenge the LFL.

Third, there must be an ignition source to ignite the hydrogen concentration. There are no active energy sources at the vaults that could generate an arc to ignite the hydrogen. The liquid level detection system is a capacitive system, which makes it intrinsically safe for flammable gas applications.

For these reasons, this event is considered "extremely unlikely" to occur during the S&M phase without controls. The hydrogen explosion event frequency is considered to be beyond extremely unlikely with the quarterly monitoring of hydrogen levels.

3.4.2.4.5 Comparison to Risk Evaluation Guidelines

Radiological doses due to a hydrogen explosion in the HEPA filter vaults and the risk evaluation guidelines are presented in the following table.

Table 3.4.2.4-5: Hydrogen Explosion dose consequences compared to RGs

Receptor	Dose mSv (rem)	RG mSv (rem)
Onsite	12,900 (1290)	1000 (100)
Offsite	8.3 (0.83)	250 (25)

RG = Risk Evaluation Guidelines (Table 3.4.1.5-1).

The unmitigated onsite consequences are much greater than the onsite risk evaluation guideline. The unmitigated offsite dose consequences are well under the offsite risk evaluation guideline, but exceed the safety class criteria presented in Table 3.4.1.6-1, Item 1. The quarterly monitoring reduces the frequency of the hydrogen explosion to beyond extremely unlikely.

3.4.2.4.6 Summary of Safety SSCs and TSRs

An administrative control is derived as explained in Chapter 5 to require configuration control and surveillance of the vault hydrogen concentration through the S&M phase to prevent a hydrogen explosion.

3.4.2.4.7 Defense in Depth

The passive vent system is a defense in depth system and is capable of providing adequate air exchanges to the vault to keep the hydrogen concentration below the LFL. The air exchanges are forced by barometric pressure and temperature changes. Surveillance is performed to ensure the passive vent system configuration is maintained in accordance with the design requirements.

The liquid level detection system is a defense in depth system that provides the ability to monitor the water level in the vaults. This feature enhances the opportunity to observe conditions that could indicate a hazard as developing and the ability to determine if there is a specific location of concern.

The configuration is defense in depth. All engineered water sources to the filter vaults and ducts have been drained and sealed. Engineered water sources to the filter vaults area have been isolated from the utility water systems by physical isolations at the water utility header. All known penetrations to the vaults are sealed.

There are no active energy sources at the vaults that could generate an arc to ignite the hydrogen if it accumulates to the LFL. The liquid level detection system is an intrinsically safe capacitive system which makes it safe for flammable gas applications. Static discharges, lightning or spontaneous combustion are the only other possible ignition sources.

3.4.2.5 Fire in the 291-B Retired Filters

3.4.2.5.1 Accident Scenario

The B Plant process ventilation system was equipped with HEPA filtration to reduce the release of radioactive particles to acceptable levels. The filters are now isolated from the canyon and the fans and stack, but still contain a significant inventory of radioactive material. Failure of the containment could result in a release of radionuclides to the environment. One possible failure mode is a fire that releases some fraction of the inventory of material that is captured in the filters. The B Plant FHA demonstrates a very low probability of a fire in these filter vaults.

This scenario postulates that a vehicle drives over the vaults, a riser or the passive vent system is breached, and burning fuel enters a vault. This bounds any initiator of a fire in the retired filters.

This analysis is derived from details of the original analysis of this accident described in *Consequence Analysis of Certain Accidents Related to the Retired Filter System as B Plant*, HNF-SD-W059-CN-001, Rev. 0 (Himes 1997).

This analysis assumes a fire will occur in only one vault at any one time, because the vaults are

isolated by concrete walls between them, except for the small opening between the vaults at their inlet ends. A fire in one vault is not expected to spread to another vault. The filter vaults are arranged in a line from west to east (A vault to F vault). Analysis is performed for vehicle entry onto the vaults from each end. Analysis is not performed for vaults A and C, because B and D vaults each contain the most significant inventory for a single vault event (Table 3.3-3). Analysis is not considered for E vault, because E vault was in service for only about a year and contains negligible radioactive material compared to the other vaults.

It would be harder for a vehicle to drive up onto the east end of the filter vaults than the west end, because the east end has a steeper grade and loose soil. The west end is less steep, but more abandoned equipment presents more obstacles. There will be no access for traffic onto the vaults from the north side because of a concrete wall or the south side because of major structures. Building 292-B, 291-BA, the abandoned steam utility pipe, and the sand filter block access onto the retired filter vaults from the south side.

Traffic will be more frequent west of the retired filters, because that end is nearer to the canyon exhaust system where personnel may drive into the fenced yard for S&M activities associated with the canyon exhaust system and the retired filters. The traffic is not expected to approach the retired vaults immediate area, because there is a radioactive buffer area. Basically, a vehicle is not expected to enter the retired filters immediate area, unless the vehicle is out of control.

If a vehicle drives onto the vaults from the west end, the vehicle would first have to pass over A vault, then B, and so on. For this analysis, it is assumed that a vehicle passes over A vault and breaches a riser or the passive vent system over B vault, because B vault has significantly more inventory than A vault.

Likewise, if a vehicle drives onto the vaults from the west end, the vehicle could first encounter risers and/or the passive vent system over A vault. For this analysis, the following assumptions are made:

- The vehicle would drive over A vault, possibly damaging risers, but continue on to breach a riser and/or the passive vent system over B vault. This is assumed, because B vault has significantly more inventory that A vault. If the vehicle stopped at A vault the consequences would be less than if the vehicle continues to B vault.

- If the vehicle damages risers or the passive vent system at A vault and does not stop at A vault, but continues to B vault, it is assumed that there will not be a fire in A vault. This is assumed, because of the limited combustibles in A vault and with the vehicle not stopping at A vault, the vehicle fuel will not leak into A vault. Only the impact to the risers or passive vent system could result in release consequences from A vault. It is assumed the consequences from the impact to the A vault risers would be negligible compared to the consequences of the fire postulated to occur at B vault from the vehicle fuel entering B vault and burning.

Likewise, if a vehicle drives onto the vaults from the east end, the vehicle could first encounter E vault, then D vault. Based on the configuration, the vehicle would have to go around F vault, because of a concrete wall on the east end of F vault. For this analysis, the assumptions described for the scenario of a vehicle driving onto B vault are applied for a vehicle driving onto D vault.

Hence, it is assumed that a vehicle drives over E vault, damaging risers and/or the passive vent system, but continues on to breach a riser and/or the passive vent system over D vault. This is assumed, because D vault has significantly more inventory than E vault.

A fire scenario is not analyzed for C vault, because C vault has less inventory than either B vault or D vault, and because a fire is not expected in more than one vault as stated above.

3.4.2.5.2 Source Term Analysis

Table 3.3-3 shows the underground HEPA filters inventory. Section 3.4.2.1.2 identifies the airborne release fraction (ARF) as 1.0×10^{-4} for the impacts of heat on a loaded HEPA filter. The inventory liberated and released from B filter by the fire is calculated as Inventory released = Inventory x ARF, and is shown in the following table.

The release fraction from the vehicle impact is bounded by the release fraction for a filter failure due to a pressure pulse in a duct. The recommended ARF for a pressure pulse event is 2.0×10^{-6} with a RF of 1.0 (DOE 3010). Applying this ARF to this scenario is considered extremely conservative, because the stress on the filter in a pressure pulse event is much greater than the stress that would be expected on the filter for this scenario. The pressure pulse ARF is negligible compared to the ARF for the fire. Thus, the fire consequences are calculated, but vehicle impact consequences are not calculated and added to the fire consequences.

Table 3.4.2.5-1: Inventory released from underground HEPA filters due to filter fire

Isotope	Inventory	ARF	Inventory released
^{137}Cs	43 kCi	1.0×10^{-4}	4.3 Ci
^{90}Sr	29 kCi	1.0×10^{-4}	2.9 Ci
Pu (mix)	1.0 g	1.0×10^{-4}	1.0×10^{-4} g

3.4.2.5.3 Frequency

Himes 1997 states that it is anticipated that a vehicle will back over a filter vault, but adds that lack of traffic around the vaults and obstacles formed by surrounding equipment would seem to place such an accident in the lower range of the assumed frequency category. That analysis covered the period when deactivation was occurring. Now, there is a fence around the facility, with locked gates, so there is less traffic in the area around the vaults. Traffic will be limited by the frequency of S&M activities.

As stated in Himes 1997, there are many obstacles, formed by all the surrounding equipment abandoned in place. At the east end there is a steep uphill grade over the filters, in loose soil. On the north side there is a concrete retaining wall. These obstacles prohibit a vehicle from driving up onto the filters and place the likelihood of a vehicle driving over the vaults in the unlikely frequency category (10^{-4}/yr to 10^{-2}/yr). Himes 1997 states that less than 1% of the vehicle accidents over the vaults would include ignited fuel entering a vault, placing this complete scenario in the unlikely category. For this analysis, it is assumed that the vehicle accident without

fire occurs at a frequency near the high occurrence ($1x10^{-2}$) end of the unlikely range, and the vehicle accident with fire occurs at a frequency near the low occurrence ($1x10^{-4}$) end of the unlikely range. Thus, the accident with or without fire is assumed to occur in the "unlikely" frequency of occurrence category.

An unlikely event frequency was also chosen, because a filter fire is not expected in the lifetime of the facility, since there is no ignition source available to start a fire, the filters contain very little combustible material, and the filters themselves are fiberglass.

3.4.2.5.4 Consequence Analysis

The analysis for this scenario is based on the following assumptions:

- No releases are expected from the HEPA filters for temperatures below 150 °C. The HEPA filter medium consists of glass fibers, which can melt and retain materials adhering to them. For this analysis, 1.0 is the assumed RF. The airborne release fraction of 1.0×10^{-4} is recommended in DOE 3010 for the impact of heat on a fully-loaded filter.

- A ground release is analyzed since, the underground filters are isolated from the canyon building and from the stack. Neither plume meander or building wake, is credited to mitigate the consequences. The passive vent system provides a ground release path.

- B and D filters have similar inventories, so both will be analyzed to determine the worst case filter fire. Simultaneous fires in more than one of the filters are unlikely. The radiological inventory for D filter is 70 kCi of ^{137}Cs and 14 kCi of ^{90}Sr. The radiological inventory for B filter is 43 kCi of ^{137}Cs and 29 kCi of ^{90}Sr. Each filter has 1 g of Pu mix, as shown in Table 3.3-3.

- It is likely that only a limited number of the individual HEPA filters in one vault are affected by the burning of the accumulated combustible material because the filter banks are relatively clean and there is no stored trash within the cell. However, for conservatism, it is assumed all individual filters in a vault are affected.

- No credit is taken for filtration ability of the undamaged filters, including the HEPA filtration on the retired filters' passive vent. An unobstructed release path is assumed.

The ground release Effective Dose Equivalent (EDE) consequences for a fire in B filter are shown in the following table.

Table 3.4.2.5-2: Doses for B Filter Fire Release

Receptor	Isotope	Inventory released	UDE	Dose (rem)
Onsite	^{137}Cs	4.3 Ci	3.59×10^{-1} rem/Ci	1.54×10^{0}
	^{90}Sr	2.9 Ci	2.79×10^{0} rem/Ci	8.09×10^{0}
	Pu (mix)	1.0×10^{-4}g	8.59×10^{2} rem/g	8.59×10^{-2}
Offsite	^{137}Cs	4.3 Ci	2.63×10^{-4} rem/Ci	1.13×10^{-3}
	^{90}Sr	2.9 Ci	1.73×10^{-3} rem/Ci	5.02×10^{-3}
	Pu (mix)	1.0×10^{-4}g	4.79×10^{-1} rem/g	4.79×10^{-5}

The ground release dose consequences for the onsite and offsite receptors are calculated in the same manner for B and D filters and are shown in the following table.

Table 3.4.2.5-3: Dose Consequences for Fire in B and D Filter Cells Compared to RGs

Receptor	B Filter	D Filter	RG
	Dose mSv (rem)		Dose mSv (rem)
ONSITE	97 (9.7)	65.1 (6.51)	250 (25)
OFFSITE	0.062 (0.0062)	0.043 (0.0043)	50 (5)

RG = Risk Evaluation Guidelines (Table 3.4.1.5-1)

3.4.2.5.5 Comparison to Risk Evaluation Guidelines

As shown in Table 3.4.2.5-3, the dose consequences from the B or D filters do not exceed the risk evaluation guidelines.

3.4.2.5.6 Summary of Safety SSCs and TSRs

Since the risk evaluation guidelines and safety class criteria are not exceeded, no SSCs or TSRs are required.

3.4.2.5.7 Defense in Depth

The filters are located underground and have berms that would prevent a vehicle from coming into position where a gas tank rupture could initiate a fire that could involve the vault interior. Vehicle access to the B Plant is restricted by a fence, except during the S&M activities.

The fire loading in the filters is limited to the filter components/materials and accumulated dust. The filter material will not burn easily or rapidly. Fires would require a sustained ignition source. The only electrical energy source to the vault is the intrinsically safe liquid level detection system. Combustibles, such as tumbleweeds, will be cleaned from the area during S&M activities.

3.4.2.6 Canyon Roof Collapse

B Plant in the S&M mode will not be continuously manned. The S&M mode may last for decades. The roof is conservatively assumed to fail in lieu of a structural analysis of the 221-B roof; however, it is highly unlikely that the roof will collapse. It is possible that damage to or degradation of the canyon roofing could occur from snow or water intrusion, wind or other aging effects, which could cause degradation of the concrete roof. This could lead to a partial or complete collapse of the roof, although this is not expected. The canyon roof could collapse also, from accumulation of volcanic ashfall and/or snow. Collapse of the roof is analyzed to cover roof loading and structural aging because there is a significant amount of contamination in the canyon process cells.

3.4.2.6.1 Scenario Development

This scenario assumes that snow or ash loads collapse the roof. Snow and ash loads could occur at the same time, but are not combined for this scenario.

B Plant was built to the *Uniform Building Code* (UBC 1940), which required the roof to withstand 97.6 kg/m^2 (20lb/ft^2). Because there is no analytically supportive documentation for roof loading, it is assumed that the roof of the 221-B Canyon will collapse under a load of 97.6 kg/m^2.

For a PC-1 facility, the ashload is the same as the snow load, which is 97.6 kg/m^2 according to HNF-PRO-097. The density of the dry, uncompacted ash is 1,155 kg/m^3. For snowloads, as noted in the *Standard Handbook for Mechanical Engineers* (Marks' 1978), the density of snow is 128 kg/m^3. For a snowload of 97.6 kg/m^2, a fall of 0.76 m (29.9 in) of snow is required. For an ashload of 97.6 kg/m^2, ash must accumulate to 0.08 m (3.14 in).

A canyon roof collapse accident could result in some contamination spread from the B Plant canyon into WESF through the pipes and doorways between these two buildings.

3.4.2.6.2 Source Term Analysis

The total canyon radionuclide inventory is shown in Table 3.3-3, but a more detailed cell by cell and area by area breakdown is shown in Table 3.4.2.6-1. Much of this information was taken from *Documentation of Remaining Hazardous Substances/Dangerous Wastes in B Plant,* HNF-

3208 (HNF 3208). In this document radioactive contamination was categorized through the use of the GammaCam™ system. The GammaCam™ was designed and constructed by AIL Systems Inc. The GammaCam™ is a camera that generates computer-based images of the gamma ray spectrum. The GammaCam™ software allows the determination of the radiation level within the sensor head field of view.

The amount of curies of cesium was calculated assuming a point source and the dose rates obtained in each cell. An assumption of 60/40 curies ratio was made between cesium and strontium. The amount of strontium was determined from the curies of cesium.

Most of the canyon contamination is below the canyon deck in vessels, jumpers, embedded and exposed pipes, and in/on cell walls and floors. Collapse and impact of roof debris, or subsequent coverblock collapse into the cell could cause a resuspension of radioactive material in some of these areas due to the shock of the impact. Some of this material is more susceptible to resuspension stresses than others. Additionally, some material is exposed on surfaces while other quantities are contained in pipes and vessels. Because there are many factors which influence the source term and not all have the same significance in every case, a more relevant source term is estimated for each area separately and totaled in the end (see Table 3.4.2.6-1). The damage ratio (DR), airborne release fraction (ARF), respirable fraction (RF), and leak path factor (LPF) assigned to represent each of these areas are discussed below.

3.4.2.6.2.1 Damage Ratio (DR)

Some contaminated areas within the canyon are more protected from the stress of a roof or cover block collapse than others. This is accounted for by the assignment of a damage ratio (DR) which, as stated in Section 3.4.1.1, is defined as the fraction of the MAR actually impacted by the accident-generated conditions.

The 221-B canyon is over 800 ft long and contains 40 process cells, most of which have four 6 ft thick coverblocks installed over them. Although a roof collapse or seismic induced failure of the coverblocks themselves could result in the resuspension of material contained within a cell, it is unlikely that all 40 cells would be subject to this stress simultaneously. However, with the exception of the air tunnel it is conservatively and simplistically assumed that the damage ratio is 1.0 for these areas.

As shown in Figure 2-1, there is 2 m (7 ft) of concrete between the air tunnel and the process cells or hot pipe trench. Furthermore, the air tunnel is adjacent to the wall of the 221-B which reduces its exposure to falling roof debris and the effects of a falling cover block. This physical arrangement is judged to significantly reduce the fraction of inventory contained within the air tunnel to resuspension stresses and a damage ratio of 0.1 is credited in the derivation of the air tunnel contribution to source term.

3.4.2.6.2.2 Airborne Release Fraction (ARF)

The ARF selected to represent radioactive releases from structural failures of either the B-Plant roof or coverblocks due to natural phenomena (i.e., DBE, excessive snow and ash load) is 1.0E-3. This selection is based on the following information obtained from DOE 3010.

DOE 3010 provides an equation in Section 4.3.3 *(Free-Fall Spill and Impaction Stress)* and in Section 5.3.3.2.1 *(Solids That Undergo Brittle Fracture)* for calculating the airborne release fraction (ARF) times respirable fraction (RF) for the situation in which brittle materials (such as concrete) are fragmented by impact. The equation is:

$$(ARF)(RF) = 2E\text{-}11(\rho)(g)(h)$$

where:

2E-11 is an empircal value with units of cm^3 per $g\text{-}cm^2/sec^2$,
ρ = the density of the material, g/cm^3, (2.2 g/cm^3 for concrete),
g = the gravitational acceleration of the earth (980 cm/sec^2), and
h = the fall height, cm.

From Figure 2.1 *(221-B Canyon Building and 221-B Support Building Cross-Section)* the maximum distance a chunk of roof could fall, assuming a cell coverblock is left off, is 70.75 ft (2156 cm), which is the distance from the top of the roof to the bottom of a cell. Substituting this fall height and the other values into the above equation and solving yields (ARF)(RF) = 9.3E-05. This is a conservative representation since the surveillance and maintenance configuration for B-Plant will have coverblocks installed over the cells. More realistically, significant radioactive material releases would occur during a DBE or roof collapse only if a coverblock were to fall into a cell. The coverblock fall distance could be 2 to 3 m before hitting the top of a tank. In such cases the (ARF)(RF) would be an order of magnitude lower. DOE 3010 Section 4.3.3 characterizes the use of the above equation to estimate the (ARF)(RF) value as being "very conservative and may be excessively so if large debris from substantial heights is considered." which is the case for B-Plant.

DOE 3010 Section 4.4.3.3.2 *(Large Falling Object Impact or Induced Air Turbulence)* provides a discussion of the ARF and RF for structural debris falling onto powders. In the experiment described in Section 4.4.3.3.2, rocks 1 to 1.82 kg in mass were dropped 3.7 m onto piles of sand, aluminum oxide (Al_2O_3) and a combination of the two, which were loacated on a pad. The quantity of powder impacted was 400 to 1000 g. The density of sand is 2 g/cm^3. The combination had 2.6% aluminum oxide. The particle size for the sand and aluminum oxide was as follows:

Sand, all particles <500μm, 1.8%<25μm
Al_2O_3, all particles <300μm, 24%<25μm

The highest measured ARF was 1.2E-3 for Al_2O_3 and the associated RF was 0.27, which gives an (ARF)(RF) of 3.2E-04. The ARF ranged from 5E-04 to 1.2E-03. The RF ranged from 0.14 to 0.36. The corresponding (ARF)(RF) ranges from 6.0E-05 to 3.2E-04. The sand and aluminum oxide piles were thick. The impact forced suspended material out of the gap between the rock and surface. These experimental results conservatively support the choice of (ARF)(AF) for B-Plant since the contamination is not expected to be powder but is the remains of dried liquid waste spills, tank heels, or surface contamination within piping and not the powder used in the experiments.

In another set of experiments, DOE 3010 Section 4.4.3.3.2 *(Large Falling Object Impact or Induced Air Turbulence)*, sand placed in a typical steel quart can without a lid was subjected to

rock impact. The rock fall distance was 3.7 m. The release and characterization of particles after impact were then determined. From those experiments a bounding ARF of 1E-03 and RF of 0.1 were determined. The open can provided no substantial barrier to the release and should not be compared to the barrier a pipe or tank in a cell would provide. Since the contamination in the cells and canyon is a very thin layer, the quantity that would be suspended and escape from beneath falling debris should be less than that measured from the open cans of powder which were the subject of these experiments. The use of an ARF value of 1E-03 and and RF value of 0.1 is therefore considered appropriate and conservative.

3.4.2.6.2.3 Respirable Fraction (RF)

The RF is the fraction of airborne radionuclides as particles that can be transported through air and inhaled into the human respiratory system and is commonly assumed to include particles 10-µm Aerodynamic Equivalent Diameter (AED) and less.

"Respirable particles" are assumed to enter the pulmonary region of the respiratory tract. Dose conversion factors are taken from EPA (1988). These tabulated values are based on the assumption that the diameters of aerosol particles are distributed log-normally, with an activity mean aerodynamic diameter (AMAD) of 1-µm .

The "larger than respirable particles" that do escape into the environment have the potential to be inhaled and deposited in the nasal pharyngeal region. These deposits are for the most part expelled over a short time with some fraction ingested. The fraction ingested can then contribute to dose of the digestion tract in the case of beta or alpha decay, or the total body in the case of gamma-ray decay. Cs-137 is about 40% more hazardous ingested than inhaled whereas Sr-90 is approximately half as hazardous ingested as inhaled, further reducing the hazard of "larger than respirable particles." For these reasons the RF assumed for Cs-137 is conservatively assumed to be 1.0 whereas for Sr-90 a value of 0.1 is used as there is no reason to deviate from the recommended 1E-03/0.1 companion values of ARF/RF as given in DOE 3010 Section 4.4.3.3.2 *Large Falling Object Impact or Induced Air Turbulence.*

3.4.2.6.2.4 Leak Path Factor (LPF)

The LPF is the fraction of the radionuclides in the aerosol transported through some confinement deposition or filtration mechanism.

The settling velocity of 10-µm AED particles is approximately 0.31 cm/s. Using the equation for stirred settling,

$$n(t)/n_0 = \exp(-V_{ts}\, t / H)$$

where V_{ts} is the terminal settling velocity and H is the enclosure height. The half-life of a 10-µm AED particle in an enclosure 3 in high (e.g., 3 in horizontal pipe) is 17 seconds. For an 8 ft high enclosure (e.g., a tank) it is 545 seconds. It can be concluded that unless there is some driving force such as forced air, resuspended particles 10-µm AED or larger will not readily escape an enclosure even if that enclosure is breached. Such driving forces are certainly not reasonable inside isolated pipes, and although tanks could be distorted it is not likely that they would be

crushed.

In Table 3.4.2.6-1 there are two basic types of contamination in the 221-B canyon. These are categorized as "spill" or "internal." Spills represent material thought to be the remnants of jumper leaks, etc. that eventually dried out on the floor. Internal contamination represents the legacy material remaining in pipes and tank heels. Since the spilled material is inherently more exposed a LPF of 1 is assumed. This assumes no credit for the confinement afforded by the cell or canyon structure, which may be considerable.

In the case of internal contamination it is judged that pipes, tanks, etc. present a significant, if unquantified, barrier to the free escape of aerosol into the environment. As discussed above, gravitational settling is a major factor in the depletion of this material. Although the impact of falling debris may be enough to cause aerosol resuspension, it is judged to be an ineffectual driving force for the expulsion of material out of pipes and tanks which could be distorted and torn, but not crushed.

3.4.2.6.3 Consequence Analysis

The released activity is calculated as

Ci = (canyon inventory) (DR x ARF x RF x LPF)

A spreadsheet was used to develop the following table.

Table 3.4.2.6-1: Radioactive Contamination in the Cells from the Gamma Cam™ Survey

CELL	LOCATION	MAR Sr (Ci)	MAR Cs (Ci)	TYPE	NOTES	DR	LPF	ARF	RF (Sr)	RF (Cs)	Sr Source Term (Ci)	Cs Source Term (Ci)
1 & 2		11	16	Spill	Assume spill on floor	1	1	0.001	0.1	1	0.001	0.016
3		0	0		Not a process cell (Railroad Tunnel)	1	1	0.001	0.1	1	0	0
4	In drums	10654	21669	Internal	WESF waste drums	1	0.1	0.001	0.1	1	0.107	2.1669
5	Southwest corner on floor	1100	1600	Spill		1	1	0.001	0.1	1	0.11	1.6
5	North end of E-5-3	27	40	Internal	On inside of condenser	1	0.1	0.001	0.1	1	3E-04	0.004
5	Southeast outlet pipe of E-5-2	140	200	Internal	Inside concentrator	1	0.1	0.001	0.1	1	0.001	0.020
6	Floor	2.8	4.2	Spill	Same process as Cell 7	1	1	0.001	0.1	1	3E-04	0.0042
6	In tanks	1.5	2.3	Internal	Floor	1	0.1	0.001	0.1	1	2E-05	0.00023
7	Southwest corner on wall	1.4	2.1	Spill		1	1	0.001	0.1	1	1E-04	0.0021
7	In TK-7-2	0.6	0.9	Internal		1	0.1	0.001	0.1	1	6E-06	9E-05
7	Northwest corner on floor	1.4	2.1	Spill		1	1	0.001	0.1	1	1E-04	0.0021

Table 3.4.2.6-1: Radioactive Contamination in the Cells from the Gamma Cam™ Survey

CELL	LOCATION	MAR Sr (Ci)	MAR Cs (Ci)	TYPE	NOTES	DR	LPF	ARF	RF (Sr)	RF (Cs)	Sr Source Term (Ci)	Cs Source Term (Ci)
7	In TK-7-1	0.9	1.4	Internal		1	0.1	0.001	0.1	1	9E-06	0.0001
8	Floor	2.8	4.2	Spill	Same process as Cell 7	1	1	0.001	0.1	1	3E-04	0.0042
8	In tanks	1.5	2.3	Internal	Same process as Cell 7	1	0.1	0.001	0.1	1	2E-05	0.0002
9	Southeast corner on wall	37	55	Spill		1	1	0.001	0.1	1	0.004	0.055
9	On TK-9-2	11	16	Spill		1	1	0.001	0.1	1	0.001	0.016
9	Northwest corner on wall	8	12	Spill		1	1	0.001	0.1	1	8E-04	0.012
9	Southwest corner on wall	83	124	Spill		1	1	0.001	0.1	1	0.008	0.124
10	Floor	525	772	Spill	Calculated from GammaCam value	1	1	0.001	0.1	1	0.053	0.772
11	Southwest corner on floor	76	110	Spill		1	1	0.001	0.1	1	0.008	0.110
11	Northwest corner on floor	110	160	Spill		1	1	0.001	0.1	1	0.011	0.160
12	Floor	37	55	Spill	Same process as Cell 14	1	1	0.001	0.1	1	0.004	0.055
13	Floor	37	55	Spill	Same process as Cell 14	1	1	0.001	0.1	1	0.004	0.055
14	Northwest corner on wall	12	18	Spill		1	1	0.001	0.1	1	0.001	0.018
14	Southwest corner on wall	12	18	Spill		1	1	0.001	0.1	1	0.001	0.018
14	West side on wall	4	5	Spill		1	1	0.001	0.1	1	4E-04	0.005
14	Northeast corner on wall	3	4	Spill		1	1	0.001	0.1	1	3E-04	0.004
14	On TK-14-2	6	10	Spill		1	1	0.001	0.1	1	6E-04	0.01
15	South end of cell	0.6	0.9	Spill		1	1	0.001	0.1	1	6E-05	0.0009
16	Northwest end of cell	160	240	Spill		1	1	0.001	0.1	1	0.016	0.24
16	Southwest end of cell	230	340	Spill		1	1	0.001	0.1	1	0.023	0.34
16	West side of cell	43	64	Spill		1	1	0.001	0.1	1	0.004	0.064
16	Northeast middle of the cell	59	87	Spill		1	1	0.001	0.1	1	0.006	0.087
16	Northeast end of cell	97	145	Spill		1	1	0.001	0.1	1	0.01	0.145
17	Southwest corner on wall	130	200	Spill		1	1	0.001	0.1	1	0.013	0.2
17	Southwest corner on floor	13	19	Spill		1	1	0.001	0.1	1	0.001	0.019

Table 3.4.2.6-1: Radioactive Contamination in the Cells from the Gamma Cam™ Survey

CELL	LOCATION	MAR Sr (Ci)	MAR Cs (Ci)	TYPE	NOTES	DR	LPF	ARF	RF (Sr)	RF (Cs)	Sr Source Term (Ci)	Cs Source Term (Ci)
17	In TK-17-1	420	630	Internal		1	0.1	0.001	0.1	1	0.004	0.063
17	Northwest corner on floor	99	150	Spill		1	1	0.001	0.1	1	0.01	0.15
17	On TK-17-2	130	200	Spill		1	1	0.001	0.1	1	0.013	0.2
17	Southeast corner on wall	52	78	Spill		1	1	0.001	0.1	1	0.005	0.078
18	Southwest corner on floor	13	20	Spill		1	1	0.001	0.1	1	0.001	0.02
18	West wall	11	16	Spill		1	1	0.001	0.1	1	0.001	0.016
19	In TK-19-1	230	340	Internal		1	0.1	0.001	0.1	1	0.002	0.034
20	South end of wall	120	180	Spill		1	1	0.001	0.1	1	0.012	0.18
20	Southwest corner on floor	1000	1600	Spill		1	1	0.001	0.1	1	0.1	1.6
20	Northeast outlet pipe of E-20-2	400	600	Internal		1	0.1	0.001	0.1	1	0.004	0.06
20	Northeast corner on pipes	380	560	Spill		1	1	0.001	0.1	1	0.038	0.56
20	Southeast corner on floor	323	485	Spill		1	1	0.001	0.1	1	0.032	0.485
20	West wall	400	610	Spill		1	1	0.001	0.1	1	0.04	0.61
21	Southeast corner on floor	4	6	Spill		1	1	0.001	0.1	1	4E-04	0.006
22	Outlet pipe of F-22-8-1	24	36	Internal		1	0.1	0.001	0.1	1	2E-04	0.0036
22	Outlet pipe of F-22-5	8	11	Internal		1	0.1	0.001	0.1	1	8E-05	0.0011
23	South wall in pipes	1	2	Internal		1	0.1	0.001	0.1	1	1E-05	0.0002
23	Northwest corner on floor	0.9	1.3	Spill		1	1	0.001	0.1	1	9E-05	0.0013
23	Northeast corner on wall	0.1	0.2	Spill		1	1	0.001	0.1	1	1E-05	0.0002
24	Southwest corner on box	6	8	Spill		1	1	0.001	0.1	1	6E-04	0.008
24	East side on floor of box	16	24	Spill		1	1	0.001	0.1	1	0.002	0.024
25	East side on floor	1	2	Spill		1	1	0.001	0.1	1	1E-04	0.002
25	West side on floor	4	6	Spill		1	1	0.001	0.1	1	4E-04	0.006
26	East side of cell	0.3	0.5	Spill		1	1	0.001	0.1	1	3E-05	0.0005
26	Middle of cell	0.5	0.7	Spill		1	1	0.001	0.1	1	5E-05	0.0007

Table 3.4.2.6-1: Radioactive Contamination in the Cells from the Gamma Cam™ Survey

CELL	LOCATION	MAR Sr (Ci)	MAR Cs (Ci)	TYPE	NOTES	DR	LPF	ARF	RF (Sr)	RF (Cs)	Sr Source Term (Ci)	Cs Source Term (Ci)
27	In TK-27-3	0.4	0.5	Internal		1	0.1	0.001	0.1	1	4E-06	5E-05
28	Northwest corner on wall	0.1	0.2	Spill		1	1	0.001	0.1	1	1E-05	0.0002
28	Outlet pipe of TK-28-3	0.9	1.3	Internal		1	0.1	0.001	0.1	1	9E-06	0.0001
28	Southwest corner on floor	0.7	1.1	Spill		1	1	0.001	0.1	1	7E-05	0.0011
29	South end on floor	38	58	Spill		1	1	0.001	0.1	1	0.004	0.058
29	Pipe leaving east wall	17	26	Internal		1	0.1	0.001	0.1	1	2E-04	0.0026
29	Pipe leaving west wall	51	76	Internal		1	0.1	0.001	0.1	1	5E-04	0.0076
30	South end on floor	7	11	Spill		1	1	0.001	0.1	1	7E-04	0.011
30	Northwest corner on floor	6	8	Spill		1	1	0.001	0.1	1	6E-04	0.008
31	Outlet pipe of TK-31-3	0.3	0.4	Internal		1	0.1	0.001	0.1	1	3E-06	4E-05
31	Outlet pipe from west wall	0.2	0.4	Internal		1	0.1	0.001	0.1	1	2E-06	4E-05
32	Middle of cell	0.1	0.2	Spill		1	1	0.001	0.1	1	1E-05	0.0002
32	Middle of cell	0.2	0.3	Spill		1	1	0.001	0.1	1	2E-05	0.0003
32	Middle of cell	0.2	0.4	Spill		1	1	0.001	0.1	1	2E-05	0.0004
33	Southwest corner on wall	15	23	Spill		1	1	0.001	0.1	1	0.002	0.023
33	South end of box	23	35	Spill		1	1	0.001	0.1	1	0.002	0.035
34	Between TK-34-2 and TK-34-1 on floor	88	132	Spill		1	1	0.001	0.1	1	0.009	0.132
35	Middle of cell on floor	120	180	Spill		1	1	0.001	0.1	1	0.012	0.18
35	South end of cell	57	85	Spill		1	1	0.001	0.1	1	0.006	0.085
36	West side on floor	2.3	3.4	Spill		1	1	0.001	0.1	1	2E-04	0.0034
36	In TK-36-1	4.9	7.3	Internal		1	0.1	0.001	0.1	1	5E-05	0.0007
37	In TK-37-2	3000	4400	Internal		1	0.1	0.001	0.1	1	0.03	0.44
37	Southeast corner on wall	250	370	Spill		1	1	0.001	0.1	1	0.025	0.37
38	Outlet pipes of west wall	330	500	Spill		1	1	0.001	0.1	1	0.033	0.5
38	Northeast corner on floor	160	240	Spill		1	1	0.001	0.1	1	0.016	0.24
39	South end on floor	1800	2700	Spill		1	1	0.001	0.1	1	0.18	2.7
40	Piping	4.9	7.3	Internal	Assume same as Cell 36 internal	1	0.1	0.001	0.1	1	5E-05	0.0007
Canyon Deck		27	41			1	1	0.001	0.1	1	0.003	0.041

Table 3.4.2.6-1: Radioactive Contamination in the Cells from the Gamma Cam™ Survey

CELL	LOCATION	MAR Sr (Ci)	MAR Cs (Ci)	TYPE	NOTES	DR	LPF	ARF	RF (Sr)	RF (Cs)	Sr Source Term (Ci)	Cs Source Term (Ci)
Pipe Trench	Piping	52.5	80.5	Internal	Assume same as Cell 6 internal but 35 times more since pipe trench is 35 cells long	1	0.1	0.001	0.1	1	5E-04	0.0081
Wind Tunnel	Inside perimeter	20000	40000	Contaminated surface	Approximately equal to total cell inventory	0.1	0.1	0.001	0.1	1	0.02	0.4
Waste Cask	On deck	1	2	Internal	Contamination is on the inside of the cask	1	0.1	0.001	0.1	1	1E-05	0.0002
Tank Tk-100	On deck	43	73	Internal		1	0.1	0.001	0.1	1	4E-04	0.0073
Total		**43383**	**80684.4**								**1.001**	**15.696**

As shown above, 15.7 Ci of ^{137}Cs and 1.0 Ci of ^{90}Sr are released from the canyon.

This scenario assumes that the roof collapses. No credit is taken for building wake mitigation because the extent of damage to the walls is unknown.

Taking no credit for building wake atmospheric dispersion factors and using UDEs of Table 3.4.1.4-1 and the relationship Dose = Ci x UDE the doses are as shown in the following table.

Table 3.4.2.6-2: Doses from 221-B roof collapse

Receptor	Isotope	Release (Ci)	UDE (rem/Ci)	Dose (rem)
Onsite	^{137}Cs	15.7×10^{0}	3.59×10^{-1}	5.6×10^{0}
	^{90}Sr	1.0×10^{0}	2.79×10^{0}	2.8×10^{0}
Offsite	^{137}Cs	15.7×10^{0}	2.63×10^{-4}	4.1×10^{-3}
	^{90}Sr	1.0×10^{0}	1.73×10^{-3}	1.7×10^{-3}

The Hanford Site has not experienced a volcanic event; however, because of the Mount St. Helens eruption in 1980, the Hanford Site has experienced mild ash fallout. No problems were experienced from such fallout, but the event did require the evacuation of nonessential personnel and a shutdown of operations. Although a heavy deposition could present health hazards from the respiration of ash and water supply contamination, such an event is not expected to affect B Plant in a manner that would cause a hazard to the public or the environment.

3.4.2.6.4 Frequency Analysis

Damage to the roof from aging that leads to a collapse is not expected, since maintenance to the roof will be performed. The frequency of the roof collapse from aging is judged to be "unlikely", based on the highest frequency of occurrence of the snow and ashfall events. These frequencies are presented in the following paragraphs.

Based on the calculations performed in WHC-SD-HWV-PSAR-001, the frequency of the Design Basis Ashfall (DBA) occurrence is 2.08×10^{-3}/yr.

The probability of a 0.76 m or greater snowfall, based on data over a 34-yr time span referred from the *Multifunction Waste Tank Preliminary Safety Analysis Report*, WHC-SD-W236-PSAR-001, Rev. 0 (WHC 1994c), is 8×10^{-4}, or a frequency of 2.35×10^{-5}/yr. Because the ashfall frequency is more conservative, it is used to assign the "unlikely" event frequency.

3.4.2.6.5 Comparison to Risk Evaluation Guidelines

The doses are compared to the unlikely risk evaluation guidelines in the following table.

Table 3.4.2.6-3: Doses and RGs for Roof Collapse

Receptor	Dose (mSv)[rem]	RG (mSv)[rem]
Onsite	8.4×10^{1} [8.4×10^{0}]	2.5×10^{2} [2.5×10^{1}]
Offsite	6.0×10^{-2} [6.0×10^{-3}]	5.0×10^{1} [5.0×10^{0}]

RG = Risk Evaluation Guidelines (Table 3.4.1.5-1)

The risk evaluation guidelines are not exceeded.

3.4.2.6.6 Summary of Safety SSCs and TSRs

No safety SSCs or TSRs are required, because the roof collapse unmitigated consequences do not exceed the risk evaluation guidelines or the safety class criteria.

3.4.2.6.7 Defense in Depth

It is anticipated that the canyon roofing will be inspected annually through the S&M phase. Maintaining the roof could prevent further degradation to the canyon building. An administrative control to keep facility workers out of and away from the canyon building when snow and volcanic ash is building up to accumulations identified in this analysis.

3.4.2.7 Design-Basis Earthquake

A facility must be designed to withstand the seismic event corresponding to the safety class designated to the facility. As described in Section 1.5, B Plant is a Performance Category 1 (PC-1) facility for meeting seismic requirements. The following table shows the DBE seismic energy that a facility must withstand. In this case, the canyon structure walls must withstand a DBE of 0.09 g. The following sections identify seismic analyses that have been conducted for B Plant, compile the results and assumptions, and analyze a DBE scenario for B Plant.

Table 3.4.2.7-1: Safety Class Earthquake

Safety Class	DBE	Frequency
SC (PC3, existing)*	0.20 g	2×10^{-4}
SS (PC2, existing)*	0.12 g	1×10^{-3}
GS (PC1, existing)*	0.09 g	2×10^{-3}

* HNF-PRO-097
SC = Safety Class SS = Safety Significant GS = General Service

3.4.2.7.1 Structural Integrity Analyses

Structural integrity of the B Plant Complex is examined against the criteria of the DBE in this section.

The original B Plant design was based on the requirements of the *Uniform Building Code* (UBC 1940), which required resistance to a lateral force resulting from a dead load on the structure, but did not require resistance to lateral acceleration forces resulting from an earthquake. *Standard Architectural-Civil Design Criteria Design Loads for Facilities*, Rev. 11 (SDC 4.1); DOE Order 6430.1A, *General Design Criteria*; and *Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards*, UCRL-15910 (LLNL 1980), contain the current seismic criteria for the design of nonreactor facilities at the Hanford Site. As determined in the following sections, some facilities are not seismically qualified for their safety class DBE.

As a minimum, LLNL 1980 specifies that an elastic dynamic analysis should be performed for Safety Class 1 and 2 structures and resulting demand/capacity ratios should be calculated for the structure. If the demand/capacity ratios are below unity for the entire structure, the facility is considered seismically adequate. If the demand/capacity ratios are not below unity for the entire structure, inelastic analysis is necessary to allow redistribution of the local peak demands. Evaluations of Safety Class 3 facilities are based on normal building code seismic provisions. LLNL 1980 also addresses special considerations for existing facilities and emphasizes the need for establishing the as-built condition of the facility and materials of construction. The specified probability of exceedence for maximum ground accelerations noted in LLNL 1980 are as follows:

- 2×10^{-4}/yr for Safety Class 1 (Safety Class)
- 1×10^{-3}/yr for Safety Class 2 (Safety Significant)
- 2×10^{-3}/yr for Safety Class 3 (General Services).

The LLNL 1980 probabilities correspond to current requirements for maximum horizontal ground surface accelerations of 0.2 g, 0.12 g, and 0.09 g. Most of the analyses reviewed were performed when B Plant was considered a Safety Class 1 facility. Maximum ground surface accelerations of 0.2 g and 0.25 g were used in these analyses, depending on when the analyses were performed. Limiting analyses were also performed for a 0.1 g Hanford Regional Historical Earthquake (HRHE). Many of the structures that are overstressed in the original calculations may prove adequate in view of the reduced seismic demands for a Safety Significant facility. Because of the nonlinear nature of many of the analyses, linear scaling of all model results is not possible; however, the calculated stresses that are much larger than the material allowable cannot be justified without further analysis. No such analysis was performed during the publication of this document.

The analyses summarized in the following subsections did not use the larger seismic acceleration values and methods specified in WHC-SD-W236A-TI-002, Rev. 1. That document was issued following the dates the referenced seismic analyses were completed. Instead, the older values of SDC 4.1 were used. If a structural analysis were completed using the newer values and methods of WHC-SD-W236A-TI-002, Rev. 1, then the canyon structure could possibly be found to fail. However, in an informal discussion and review of the structural assessment requirements with a FDNW structural engineer, it was determined that, according to HNF-PRO-097, Engineering Design and Evaluation, seismic analysis for B Plant need not use the WHC-SD-W236A-TI-002, Rev. 1 criteria, because B Plant is a PC-1 facility. Further discussion informally suggested that if the criteria of the WHC-SD-W236A-TI-002, Rev. 1 were used, the analysis results would not likely be impacted. This is so because the methods used in SDC-4.1 are more conservative and less refined, such that the use of the methods prescribed in WHC-SD-W236A-TI-002, Rev. 1 could cancel the impact of the higher acceleration values.

3.4.2.7.1.1 Previous Analyses of 221-B

3.4.2.7.1.1.1 B Plant Canyon Structure

The confinement boundary of the B Plant canyon is comprised of the 221-B walls, floor, and roof. All analyses of the components that define the confinement boundary must meet the criteria discussed in Section 3.4.2.7. The previous analyses conservatively predicted the structure displacements and stresses and therefore, bound current DOE requirements.

The first analysis to seismically qualify the canyon structure to current standards was performed using linear elastic dynamic analysis techniques and is referred from *B Plant Structural Qualification Interim Report*, WHC-SD-WM-SA-001, Rev. 0 (WHC 1991a). This analysis examined the feasibility of demonstrating compliance of the 221-B Canyon structure with DOE requirements for a Safety Class 1 facility. The first step was a detailed, nondestructive inspection of the structural elements of the reinforced concrete facility. A linear elastic dynamic finite element analysis that includes the concrete tension capabilities was conducted for a 0.2 g DBE. Soil-structure interaction effects were included, but inelastic effects were not. The analysis methodology meets current (i.e., 1995) guidelines for a Safety Class 1 facility, but several areas of high stress were identified.

The report concluded that to structurally qualify the 221-B structure, a more detailed nonlinear

evaluation was required. A nonlinear static analysis was also proposed to identify the potential collapse mechanism and the static load capacity.

An analysis with the recommended nonlinearities was conducted in the *B Plant Canyon Structure Seismic Evaluation*, WHC-SD-WM-SA-005, Rev. 0 (WHC 1991b). The analysis planned to first determine the as-built condition and the current condition using standard nondestructive testing techniques. Considerable effort was spent in developing a model that accurately characterizes the nonlinear behavior of the various construction joints. Both static and dynamic analyses were then conducted. The static analyses predicted a positive margin against collapse for the DBE of 0.2 g with a collapse load of approximately 0.4 g.

The nondestructive examination showed that the concrete in the north and south canyon walls was in good-to-excellent condition, with minimal degradation and cracking. The cracks that existed were 15 to 23 cm deep at a maximum. Some of the construction joints were unbonded. Similar findings were made for the roof and galleries.

An elastic analysis was next performed using response spectrum techniques. The initial elastic analysis indicated that there were several locations of local overstress. As a result, it was decided to follow up with an inelastic analysis in order to secure a comprehensive understanding of the potential structural responses during the postulated seismic event.

The inelastic analysis was performed using a nonlinear finite element model. The inelastic dynamic analysis predicted peak plastic strains of less than 2% for the reinforcing bar. The ultimate strain for Grade 40 reinforcing bar is 12%, which indicated a significant margin against failure. Gapping at the construction joints and cracking of the concrete were not precluded; although, no complete through-thickness cracking was predicted. Demand/capacity curves generated for the canyon roof and walls verified compliance with the capacities defined in UCRL-15910.

The results of the inelastic analysis were used to perform a nonlinear time-history analysis. The inelastic time-history analyses indicated that rebar yielding occurs at the crane level. The outer rebar at the north crane wall showed the largest strains. The analysis showed a peak plastic strain of 1.6% against an ultimate strain of 12%. The structure was deemed stable if the north deflections stayed below 1.91 cm and south deflections stayed below 3.18 cm. The analysis showed displacements of 0.56 and 1.22 cm, which indicated that the section strength was not exceeded at any location. This analysis showed seismic adequacy relative to LLNL 1980. Further analyses showed that accelerations of about 0.4 g are necessary for collapse of the building. While the building will not collapse, gapping and yielding at construction joints is expected.

B Plant Canyon Structure Seismic Evaluation Review Documentation, WHC-SD-WM-SA-007, Rev. 0 (WHC 1990a), concluded that the structural analysis of the canyon performed by WHC was thorough and fully complied with all applicable criteria contained in DOE 6430.1A, LLNL 1980, and SDC-4.1 for the specified DBE of 0.2 g. Recommendations from the independent review were noted. The previously described analyses were performed with a two-dimensional plane model of the canyon cross section, so that the end-walls were not modeled. The study recommended that the effect of these end-walls be evaluated. Also, the 271-B Support Building adjoins the canyon north wall, and the interaction of these two structures should be evaluated.

B Plant Canyon End-Wall Study, WHC-SD-WM-SA-013, Rev. 0 (WHC 1995a), determined the effect of the canyon end-walls. The analysis evaluated the end-wall structural integrity and stability and the interaction of the end-wall with the adjacent segment of canyon structure. In the analysis, both linear static and dynamic analysis techniques for a DBE of 0.2 g were used. The shear keys between the end-wall and the canyon structure were found to be overstressed; however, a rocking analysis of the end-wall without considering shear keys showed that the walls were stable. The end-wall analysis predicted stresses in the shear keys that are excessively high. The analysis results did not indicate collapse of the canyon structure; however, the analytical methodology used did not demonstrate compliance with DOE requirements for a Safety Class 1 facility. While a safety significant earthquake is lesser in magnitude, safety significant qualification cannot be concluded from this analysis either.

The two buildings adjacent to the 221-B Canyon structure present potential hazards because of seismic displacements. The *B Plant Building Interface Study*, WHC-SD-WM-SA-014, Rev. 0 (WHC 1996d), evaluated the interaction of the 225-B and 271-B Buildings with the canyon. *Earthquake Analysis of the Waste Encapsulation Facility*, JABE-VITRO-01 (Blume 1971), concluded that the 225-B facility was designed to withstand a 0.25 g seismic event. Also, a 5.1-cm seismic gap isolates the 225-Building from the canyon structure. An evaluation of the calculated displacements proved that no interaction occurs between the 225-B Building and the canyon structure; therefore, no analysis is necessary.

The 271-B Facility adjoins, but is not structurally anchored to the canyon facility. The evaluation of the 221-B/271-B interaction used previous analyses (WHC 1990a) of the 221-B Facility to impose acceleration loads on a combined 221-B/271-B model developed for this study. A true dynamic interaction analysis was not performed, but the study concluded that the 271-B Building would not impose sufficient additional loadings on the canyon to result in failure.

Another area of concern for the 221-B Facility is the relative displacement of the horizontal construction joints on the north and south walls and the vertical expansion joints between 12.2 m segments. During a seismic event, confinement boundary leakage from through-wall cracking or gapping of these joints was postulated. Results from the original analysis (WHC 1990a) of the 221-B Facility were used to evaluate the construction joint. An analysis of these results showed that the horizontal construction joint displacement and rotations were small and would not result in a through-wall leak path. The vertical expansion joints were evaluated separately by using a soil-structure-interaction model to conservatively predict the gapping. The maximum displacements were determined to be insufficient to produce gapping in the expansion joints, as a result of the 0.2 g DBE. The reference contains further hand calculations to determine the impact forces generated between 12.2 m segments during a seismic event. The calculated stresses were found to be within allowable code limits.

The *B Plant Confinement Study*, WHC-SD-WM-SA-012, Rev. 0 (WHC 1996e), defines the canyon confinement boundary to determine whether the existing structures and components will maintain confinement under seismic loading. Previous analyses and evaluations of components not addressed in other analyses were summarized in that document. Various access doors in the canyon were evaluated for the 0.2 g seismic event by using hand calculations and detailed numerical models. The resulting stresses and displacements were low and thereby verified the structural integrity of the access doors during the specified seismic event. The results

indicated the following:

- The canyon confinement boundary will remain in place, including the roof.
- The west wall contains two openings that allow access from 221-B to WESF. The floor frame is displaced less than 0.25 cm and, therefore, survives the earthquake.
- The west wall will not collapse, but gaps will form between the walls and the rest of the structure.
- The 221-B Building and WESF will not impact each other.
- The 10 canyon doors on the south side are not failed or opened by seismic forces. The peak displacement is 0.08 cm.
- The air tunnel will remain intact, but will have some cracking.
- The stair wells on the north side could collapse but the doors will remain closed.

It is assumed the wall movement will cause the crane to fall from the movement of the rail and impact the coverblocks causing some cracking and minor structural damage, but the coverblocks will remain intact during the event. The jumpers to the vessels and wall nozzles have been removed, so there is no impact to the jumpers or nozzles. The vessels may shake or crack, but they are empty, except for minimal heels that could not be removed by existing equipment configuration.

Most Recent Analysis

A technical roofing evaluation was completed in 1998 to evaluate the integrity of the canyon building roofing. While evaluating the roofing, the roof deck was inspected. The *Technical Roofing Evaluation* (FDI 1998) report recommends that the roofing be replaced, but states that if the roofing is not replaced, the concrete roof deck will probably not be adversely affected for decades.

3.4.2.7.1.1.2 221-B Cover Blocks

The cover blocks are assumed to fail from seismic forces and fall into the cells. The structural analysis referred to above demonstrated that the stresses and displacements for the structure at or near the vicinity of the canyon deck were minor. This was determined because the structure is quite massive and well tied together in this location and because the horizontal and vertical accelerations were almost identical to those of the ground (no amplification or differential accelerations). The cover blocks are 1.8 m thick and have a stepped construction. There are four cover blocks per cell, (except for Cell 10) with a cell dimension of 5 m long and 4 m wide. The weight is approximately 57,700 kg for each cover block. As a result, the natural frequency of the cover block is similar to the structure around it and, therefore, the cover block should not fail. The stepped construction also protects against the cover block falling into the cell, because the weight rests on many edges rather than on two edges, as in the case of single-ear cover blocks

used at WESF. It might therefore be possible to qualify the cover blocks against failure. Because this qualification is not yet done, it is assumed that the cover blocks can fall into the cells.

3.4.2.7.1.1.3 Equipment

The equipment in the process cells is supported by a variety of bases, depending on the length of the tank. At the top, the tanks and other equipment were connected to the sides of the process cell via jumpers. The jumpers were removed during deactivation and dropped into the cells. Seismic effects could cause the equipment to fall against the side of the cell (the equipment being typically too large to fall completely over in the process cells). Fracturing of the top of the vessel or sides near the top of the vessel could occur, if any of these vessel walls are weak. However, the fracturing of the vessel is extremely unlikely because the vessels walls, top, and bottom are typically made of 1.27 cm thick stainless steel. If the cover block falls into the cell, vessel fracturing could occur. The extent of the fracturing is dependent on the size of the cover block pieces and distance of the fall. It is expected there could be small openings in the top or bottom of the tank.

3.4.2.7.1.1.4 Cell Drain Header

The *B Plant Cell Drain Header Seismic Analysis*, WHC-SD-W024H-SA-001, Rev. 0 (WHC 1991c), was referred to for this study. In this study, it is evaluated for a 0.12 g lateral acceleration and is assumed to survive a safety significant seismic event.

3.4.2.7.1.1.5 Conclusion for 221-B

The conclusions for the 221-B Facility seismic analysis include the following:

- 221-B structure will not collapse.
- There may be gaps in the construction joints and in the meeting of the east and west walls with the north and south walls.
- The crane will fall from movement of the rail.
- Cover blocks are assumed to fall into the cells.
- Tanks in the process cells can be damaged by cover blocks failures and/or by tipping over.

3.4.2.7.1.2 Previous Seismic Analyses of The Deactivated Canyon Exhaust Ventilation System

B Plant Support Facilities Natural Forces Evaluation, WHC-SD-WM-TA-002, Rev. 0 (WHC 1983), analyzed the filter cells for seismic loads. The maximum seismic demands were determined for the walls of the cell by using a safe shutdown earthquake (SSE). The SSE is an earthquake with a zero period acceleration of 0.25 g with an applicable ground response spectrum. Soil loads were also determined.

The A and B filter cells analysis found that the roof and the roof supports survive the SSE, but the north wall fails because of the soil pressures generated by seismic motion. The results also predicted cracking with possible resultant loss of the water seal. The north wall failure could also result in the collapse of the entire cell. If the cell remains intact, the HEPA filter frames would survive the SSE motions.

The roof and support columns of the C filter cell will survive the SSE. The south wall panels between the pilasters will fail because of soil pressures generated by seismic motions. The pilasters are marginal. Failure of the south wall could cause the loss of the water seal and potentially result in the collapse of the cell. If the cell survives, the filter support frames will survive the SSE intact.

The structure of the D filter cell will survive the SSE loads and motions. The steel in the prefilter will yield, causing the prefilters to leak. The HEPA filters could experience impact loads because of the loosening of the anchor bolt for the center support strut. The strut might also fall away, depriving the frame of its center support. The analysis results also show that if the differential pressure is above 5.8 cm of water, the anchor bolt will not pull out.

WHC 1983 also provided an assessment of the A-D filter cells under the 0.12 g earthquake. The information in the document is not presented clearly; however, it appears that the failures discussed for the 0.2 g earthquake will also occur, as a result of the 0.12 g earthquake.

It is assumed from WHC 1983 that the A, B, and C filter cells collapse. The D filter cell will remain intact.

The *B Plant Canyon Exhaust Ductwork and Filter Study*, WHC-SD-WM-SA-016, Rev. 0 (WHC 1996f), assessed the ability of the canyon exhaust duct and filter system to withstand seismic and other loadings. The study summarized several different analyses performed over the last 15 years. The seismic events used for these analyses (0.20 and 0.25 g) resulted in conservative loadings.

Limited analyses were completed for a 0.10 g HRHE. The stated goal of the study was to collect and evaluate the existing analyses, recommend additional work, and lay the groundwork for future work by providing a concise system description and reference lists. Many of the analyses summarized are taken from an earlier report (WHC 1983). Unfortunately, many of the calculational details of these analyses are not available. The study reached the following conclusions:

- The underground ducts may sustain local cracking but catastrophic failure is unlikely.
- Filter cells A, B, and C will experience partial failure.
- Local cracking could also cause the water seals of out-of-service filters to fail.
- Filter cell D design is acceptable but the HEPA filter bank is suspect.
- Filter cell E design analyses are inadequate.
- Filter cell F design calculations are adequate.
- The sand filter is not adequate for seismic event.
- The exhaust stack is susceptible to seismic events.

An overall conclusion for the exhaust system is not possible on the basis of the information evaluated. Instead, specific conclusions concerning each component can be made. The exhaust duct analysis was thorough and conservative and, therefore, the exhaust duct analysis is considered adequate. Filters A, B, and C are marginal for the 0.2 g DBE. A conclusion cannot be drawn for a 0.12 g DBE without a detailed evaluation. Analysis of the D filter cell predicts the reinforced concrete structure will survive the 0.25 g earthquake, but yielding will occur in the filter frame. This filter uses the same filter support frames as E filter, which is shown in subsequent detailed analysis to be adequate and, therefore, D and E filters are considered to survive the 0.12 g DBE. *B Plant Filter Design Calculations* (ICF KEH 1991) evaluated F filter to the requirements of SDC-4.1, Rev. 10. The details of these calculations are not available, but the requirements of Rev. 10 are generally more severe than those of Rev. 11 and F filter is thus considered adequate for the 0.12 g DBE. The sand filter cannot adequately resist the 0.10 g HRHE, and would probably collapse.

A subsequent analysis of E filter was conducted in the *B Plant Seismic Qualification of E Filter*, WHC-SD-W239-SA-001, Rev. 0 (WHC 1993c). It should be noted that both E and F filters have never been contaminated and B Plant does not intend to use F filter. In the analysis, linear elastic static analysis was used to qualify E filter. An argument was made concerning the use of a static analysis versus the LLNL 1980 for dynamic analysis. It was noted that evaluation of the F filter used dynamic analysis techniques with no significant change in the response. Because of the close proximity of the E and F filters and the similarity in configuration, a dynamic analysis of the E filter is not deemed necessary. Results from the analysis predicted local overstressing for the DBE of 0.2 g. Also, cracking was calculated to occur, but the structural integrity and function of the filter were not expected to be compromised. Linear scaling of the calculated stresses showed that the structure would not be overstressed for the DBE of 0.12 g. As a result of the reduced seismic demand, the E filter housing and frame were considered structurally adequate.

3.4.2.7.1.2.1 Conclusions for the Deactivated Canyon Exhaust Ventilation System

Filter cells A, B, C, and the sand filter are assumed to experience some failure during a DBE of 0.12g. New analyses could demonstrate survival. Filter cells D and E are expected to survive the DBE. Filter Cell F is not considered, because it does not contain filters or contamination.

3.4.2.7.1.2.2 291-B Stack

WHC 1983, analyzed the B Plant stack. This document concluded that the vertical steel reinforcement would yield and that the stack foundation is unstable (overturning possible) at 0.12 g. At 0.25 g, the concrete stresses exceed allowable limits. WHC 1983 also showed that the masonry is incapable of resisting lateral motions and would fail.

AR Vault, AR Stack, and B Plant Stack Seismic Evaluation, internal letter, SA:GRW 89-15 (Conrad and Wagenblast 1989), provided a preliminary assessment of the B Plant stack. The analysis was performed to the requirements of DOE Order 6430.1A and UCRL-15910. The evaluations used static methods and dynamic analyses were to follow later. Engineering experience shows that dynamic analyses usually increase the margin to failure.

The stack was analyzed as a cantilevered beam held at the base. A peak acceleration of 0.33 g

was applied to the entire mass of the stack, assuming it was all at the stack's center of mass. The value of 0.33 g was obtained by using the peak acceleration from a 10% damped response spectrum curve anchored at 0.2 g. The results of this analysis indicated that the stack was unstable and would collapse (topple over) with this load. The analysis also showed that the load would have to be reduced by 50% to demonstrate survival. A preliminary response spectrum evaluation was also performed. This analysis showed that the use of 0.33 g over the entire mass was very conservative. This analysis also showed that only 25% of the mass experiences 0.33 g and the rest experience lower acceleration values. This response spectrum analysis demonstrated that the use of dynamic analysis would most likely demonstrate survival; however, the dynamic analysis has not yet been performed.

Based on WHC 1983, the internal brick of the stack is assumed to fall into a large pile within the stack. The stack itself is also assumed to fall at both 0.12 g and 0.25 g earthquakes; however, based on the response spectra analysis, the entire stack is not assumed to fall (i.e., the damage radius is < 61 m).

The evaluation of the stack in Conrad's and Wagenblast's internal letter determined the stack could survive the 0.12 g earthquake. However, WHC 1983 states that the stack is unstable with regards to overturning motions and the stack is assumed to fall.

The 291-B stack was evaluated for both the HRHE of 0.1 g and the SSE of 0.25 g (WHC 1996f). The results predicted that the stack would likely collapse during the SSE event, but the stack was considered adequate to resist the 0.10 g event with some loss of function because of the masonry liner collapsing. The study is inconclusive with regards to the 0.12 g DBE.

3.4.2.7.1.3 Previous Seismic Analyses of 211-B Chemical Storage Area

WHC 1983, evaluated other components that are not critical for B Plant confinement, including 211-B. The Chemical Storage Areas were classified as Safety Class 3 structures. The 211-B Chemical Storage Area consists of a series of horizontal aboveground tanks, associated piping, and access and support platforms. The vertical tanks have been removed from B Plant. The horizontal tanks are now empty, except for minimal heels, which are dry except for the demineralized water tank.

The equivalent static method was used in WHC 1983 for these tanks. The seismic analysis was based on 0.2 g. The liquids in the tank, as well as the tank, were assumed to be subjected to the peak horizontal response spectra accelerations. The internal pressure caused by the acceleration of the liquid and the forces on the concrete haunch and footing, which support the tanks, were determined and the stresses were combined using existing industry practice.

The results for the horizontal tanks concluded that the dead weight by itself creates excessive soil-bearing pressures with unacceptable factors of safety. These pressures result in movements that would overturn the tank, break the supports and subsequently collapse the tank.

Several upgrades have been made to the 211-B Chemical Storage Area subsequent to this analysis and are documented in *Preliminary Safety Analysis Report, B Plant Environmental Compliance Upgrades 211-B Chemical Tank Farm and 211-B Gallery Scale Tanks*,

WHC-SD-W010H-PSAR-001, Rev. 0 (WHC 1993d). A retention basin to provide secondary containment for each group of tanks has been added. These reinforced concrete basins were designed per Safety Significant seismic criteria. The tank supports, piping, piping supports, and associated equipment have been modified to meet seismic criteria for Safety Class 3 structures; however, the vertical supports were removed, and HNO_3 is not presently stored at 211-B. In light of the reduced seismic resistance requirement and increased structural capacity, the chemical storage area is adequate as a Safety Significant structure. It also should be noted that even if a failure occurred the consequences will not be significant since the tanks and pipes are empty except for small heels. There are no operative SSCs in or near the 211-B area.

3.4.2.7.1.4 Previous Seismic Analysis of 212-B Cask Loading Station

The 212-B Building is inactive and the casks have been removed, but residual contamination remains and thus it is examined.

WHC 1983, analyzed the Cask Loading Station for both 0.1 g and 0.25 g seismic event. The 212-B Cask Loading Station consists of three separate structural components:

- Below grade operating gallery constructed of reinforced concrete.
- Above grade operating gallery constructed of a structural steel frame with siding.
- Above grade enclosure additions.

These above grade and below grade areas were evaluated separately. The stresses for the below grade gallery during the seismic events were within code limitations. A response spectrum analysis of the above grade portions of the Cask Loading Station indicated that the structure was adequate for both seismic events considered. The east-west (two dimensional) structural support member at column line 2 of the cask-handling area was analyzed for earthquake motions. The results of the analysis were that the cask-handling area can survive a 0.2 g seismic event with the stresses remaining within code allowables. The structure was assumed to remain intact with the contamination contained; therefore, the main structural components of the 212-B Cask Loading Station are adequate to resist the 0.09 g seismic event required for a General Services structure.

Only a qualitative appraisal was made for the enclosures on the north and south sides. These enclosures are not part of the main portion of the building (the cask-handling area). The enclosures have no movement-resistant connections; therefore, the siding provides only minimal lateral force resistance. These enclosures were considered inadequate for the seismic events considered; however, the contamination levels of the north and south enclosures are very small, meaning that collapse will result in little or no release.

3.4.2.7.1.5 Seismic Analyses of Other B Plant Support Facilities

The B Plant Complex is composed of a number of small buildings (e.g., compressor buildings, pump houses) that contain minimal or no radiologically contaminated materials and may contain extremely small quantities of hazardous materials. Complete collapse of the buildings during a seismic event would not yield consequences above the risk evaluation guidelines.

3.4.2.7.1.6 Seismic Analysis Conclusions

Several deficiencies, with respect to current DOE requirements, are noted from the previous analyses. The canyon end-wall evaluation predicts excessively high stresses in the shear keys, but the wall is predicted to remain stable after shear-key failure. The analysis provides adequate assurance that the end-walls are structurally stable, but a time-history dynamic analysis would be required to establish that the walls can be classified as a Safety Class 1 structure. The end-wall analyses are also considered inadequate to confirm the structural stability of the end walls to Safety Significant criteria (0.12 g). The organic process cell cover blocks are also assumed to be seismically unqualified. The canyon roof is expected to remain in place.

The sand filter is found to be inadequate for the HRHE of 0.1 g, which indicates that the structure would not survive the 0.12 g DBE. On the basis of the analyses reviewed, filter cells A through C would be expected to fail the 0.12 g DBE. Similarly, the 291-B stack is structurally inadequate for the DBE.

The assumed failures are listed in the following table.

Table 3.4.2.7-2: Summary of Assumed Failures for 0.12 g DBE	
221-B Canyon	
Structure	Structure remains intact. There are gaps in the construction joints and in the area where the east and west wall meet the north and south walls.
Crane	Falls, fails cover block, and falls into cell.
Cover blocks	Falls, ruptures tanks.
291-B Filters	
A and B filters/vaults	North wall fails with a potential collapse. Vault collapse.
C filter/vault	South wall fail with potential collapse. Vault collapse.
Sand Filter	Vault collapse.
Water seals	Could leak as a result of cracking. Water enters vault.
Stack	Brick liner collapses and stack topples onto D Filter. Collapses D Filter.
Passive Vent System	Collapses with the vaults.
ACT Canyon Exhaust System	
HEPA filters housing and duct external to canyon building	1. If it fails, the hole is considered part of the canyon cracks. 2. If it remains intact, filtered or unfiltered ground release.
HEPA Filters and Seals	1. If filters and seals remain intact, release is mitigated. 2. If filters and seals fail, unfiltered ground release.
Fans (one operates at a time)	Whether or not fans fail, total suspended portion of canyon inventory is assumed to be released.
Stack	Ground release whether stack stands or falls.

3.4.2.7.2 Design-Basis Event Source Term and Consequence Analysis

The previous section lists the assumed DBE SSC failures. The following sections describe the source terms and consequences for the affected SSCs and related hazards.

3.4.2.7.2.1 221-B Canyon Scenario Development

As shown in the previous section, the 221-B canyon building is expected to survive a DBE of 0.12 g. The roof is expected to remain in place. The walls are expected to remain standing, but they might crack and gap. The crane and cover blocks are assumed to fall and crush equipment in the cells.

As described in Section 3.4.2.4, a canyon fire is not expected.

Radioactive material can be suspended when the contamination in the cells and equipment in them is impacted by the crane and/or cover blocks. All of the suspended material is assumed to escape from the canyon through the gaps, cracks, and hole of the canyon exhaust system, in case that system is breached and continues to operate. Filtration of the suspended material is not considered.

The existence of the penetration made in the outer stairwell wall for the new ACT duct is considered to be included in the release path for the DBE analysis, where all the suspended canyon contamination is released through gaps and cracks. Whether the new duct remains in place or not, and whether the canyon exhaust system remains operating or not, during the DBE, all of the suspended material is postulated as a ground release. The new stack is not high enough to credit an elevated release, but the ACT stack is close enough to the canyon building to take credit for building wake.

A seismic event could result in some contamination spread from the B Plant canyon into WESF and/or from WESF into the B Plant canyon through the pipes and doorways between these two buildings. This contamination spread is expected to be small compared to the release to the environment.

The new filters and stack could be within the influence of the stack in the 291-B area. If the 291-B area stack were to fall and collapse the ACT filter's and/or stack, the consequences would be bounded by the DBE canyon contamination release, since the ACT will have only a portion of the contamination available for release from the canyon building.

3.4.2.7.2.2 Canyon Consequences Analysis

The impact forces to the contamination in the cells and equipment in the cells for this DBE event are assumed to be less than or equal to the impact forces of the roof collapse scenario. The DR, ARF, RF, and LPF for the roof collapse scenario, Section 3.4.2.6, are used for this DBE scenario. Therefore, the unmitigated DBE consequences will be the same as the unmitigated roof collapse consequences, which do not exceed the onsite or offsite risk evaluation guidelines. As described in the preceeding seismic analyses subsections, the walls are expected to remain standing. Therefore, building wake is credited to demonstrate the expected DBE mitigated consequences.

The amount of contamination released from the canyon, using the results of Section 3.4.2.6-3 are:

15.7 Ci of ^{137}Cs and 1.0 Ci of ^{90}Sr.

Using this release quantity, the UDE for building wake from Table 3.4.1.4-1, and the relationship Dose = Ci x UDE, the DBE consequences from the canyon are as shown in the following table.

Table 3.4.2.7-3: Doses from releases from contaminated equipment and all cells

Receptor	Isotope	Release (Ci)	UDE (rem/Ci)	Dose (rem)
Onsite	^{137}Cs	1.57×10^{1}	1.2×10^{-1}	1.9×10^{0}
	^{90}Sr	1.0×10^{0}	9.33×10^{-1}	9.3×10^{-1}
Offsite	^{137}Cs	1.57×10^{1}	2.60×10^{-4}	4.1×10^{-3}
	^{90}Sr	1.0×10^{0}	1.71×10^{-3}	1.7×10^{-3}

The total onsite and offsite doses and the respective risk evaluation guidelines are shown in the following table.

Table 3.4.2.7-4: DBE Canyon Consequences Comparison to RG

Receptor	Dose mSv (rem)	RG mSv (rem)
Onsite	2.8×10^{1} (2.8×10^{0})	250 (25)
Offsite	5.8×10^{-2} 5.8×10^{-3}	50 (5)

RG = Risk Evaluation Guidelines (Table 3.4.1.5-1)

The releases from the canyon due to a DBE do not challenge the risk evaluation guidelines.

3.4.2.7.2.2.1 Canyon Structural Defense in Depth

Section 3.4.2.7.1.1.1, discussed that there is a "5.1 cm seismic gap" between B Plant and WESF, and there will be no interaction between 221-B and 225-B for displacements that will occur during a DBE. That judgement is applicable as long as both buildings, 221-B and 225-B, maintain their structural ability to withstand the DBE they are rated to withstand.

WESF is considered able to resist a DBE of 0.25 g. B Plant canyon can only resist 0.12 g. The WESF BIO, Section 3.4.2.1.2.4, has analysis that says that if a 0.12 g DBE occurs, the west end wall of the 221-B canyon collapses and falls on the WESF roof, causing it to collapse. WESF would have a release from consequences to A cell. The scenario has a probability of "unlikely". If the B Plant canyon structure, especially the west end wall, degrades such that it fails at a lower energy earthquake, which may have a higher frequency of occurrence, then the WESF safety basis is impacted. The impact is based on having a seismic event that may be of a higher frequency, which could mean that the A cell consequences would have to be compared to risk evaluation guidelines of a lower occurrence frequency. It is expected, in this case, that the risk evaluation guidelines would be exceeded.

Thus, degradation of the canyon structural integrity could have a negative impact to the WESF

safety basis. Maintaining the 221-B canyon roofing will enhance potentially extending the life of the canyon roof and walls seismic structural integrity.

3.4.2.7.2.3 Crane Falls

The fall of the crane could cause a cover block to fail and fall into a cell. In the S&M mode, the crane will be parked over a cell which contains no significant contamination. This failure could result in some suspension of contamination on the canyon floor from the vibration caused by the impact. Suspension of this material is considered enveloped by suspension of the material in the cells because they are more contaminated and the impact area is small compared to all of the surfaces from which contamination was suspended. Thus, the consequences of the crane falling during a DBE are considered to be included in the canyon and equipment contamination consequences.

3.4.2.7.2.4 291-B Filters and Stack Collapse

3.4.2.7.2.4.1 Filters A through E

According to Section 3.4.2.7.1.2, the A, B, and C filter structures are assumed to collapse in a seismic event and the D filter structure is assumed to remain intact, but the filter may be damaged. Therefore, it is assumed that A, B, and C filters structures and the filters themselves collapse resulting in a fraction of the filter inventories being released. The stack can collapse onto more than one of the filter housings at a time; therefore, it is assumed for this evaluation that the stack falls onto the D filter cell. Since the D filter can be damaged, it is assumed that the same fraction of D filter inventory is released through the pathway adjoining the D filter structure, where the C filter structure failed.

Therefore, this DBE analysis covers collapse of all the filter vaults A, B, C, D, and E. Since E filter has been in service for only a short time, it has negligible contamination/inventory as compared to the other filters. For this reason, E filter consequences are not included in this analysis. See Table 3.3-3 for filter inventory.

DOE 3010 provides release fractions for impact testing of enclosed HEPA filters and cites that for 60 tests, ARFs of 5×10^{-5} to 1×10^{-5} were obtained. While the handbook recommends a bounding ARF and RF of 5×10^{-4} and 1.0 (for additional conservatism), since the B Plant filters are located below ground and are postulated to be covered by rubble from the overburden and stack segments, the more realistic results of the actual testing (5×10^{-5}) is appropriate for this scenario.

The collapse of B Filter will be analyzed. With an ARF of 5×10^{-5} and the B Filter inventory from Table 3.3-3, the inventory released from B Filter is:

Table 3.4.2.7-5: Potential Releases from collapse of B Filter			
Isotope	**Inventory**	**ARF**	**Release**
^{137}Cs	4.3×10^{4} Ci	5.0×10^{-5}	2.15 Ci
^{90}Sr	2.9×10^{4} Ci	5.0×10^{-5}	1.45 Ci
Pu (mix)	1 g	5.0×10^{-5}	5.0×10^{-5} g

Since the B Plant building is nearly 61 m north of B filter, and if the surface wind is toward the east (prevailing), no credit for building wake is taken. No credit is taken for plume meander, since the release period is assumed to be short.

Using the UDE's of Table 3.4.1.4-1 and the relationship Dose = Ci x UDE, the doses are as follows:

Table 3.4.2.7-6: Doses from collapse of B Filter				
Receptor	**Isotope**	**Release**	**UDE**	**Dose (rem)**
Onsite	^{137}Cs	2.15 Ci	3.59×10^{-1} rem/Ci	7.72×10^{-1}
	^{90}Sr	1.45 Ci	2.79×10^{0} rem/Ci	4.05×10^{0}
	Pu (mix)	5.0×10^{-5} g	8.59×10^{2} rem/g	4.30×10^{-2}
Offsite	^{137}Cs	2.15 Ci	2.63×10^{-4} rem/Ci	5.65×10^{-4}
	^{90}Sr	1.45 Ci	1.73×10^{-3} rem/Ci	2.51×10^{-3}
	Pu (mix)	5.0×10^{-5} g	4.79×10^{-1} rem/g	2.40×10^{-5}

The total onsite and offsite doses from the collapse on B Filter are therefore:

Table 3.4.2.7-7: Total doses from collapse of B Filter	
Receptor	**Dose mSv (rem)**
Onsite	48.7 (4.87)
Offsite	0.031 (0.0031)

In the same manner, the consequences of A, C, and D filter collapses are analyzed:

Table 3.4.2.7-8: Doses from collapse of HEPA Filters		
Filter Structure	**ONSITE mSv (rem)**	**OFFSITE mSv (rem)**
A Filter	20.4 (2.04)	0.030 (0.0030)
B Filter	48.7 (4.87)	0.031 (0.0031)
C Filter	27.2 (2.27)	0.0173 (0.00173)
D filter	32.5 (3.25)	0.0215 (0.00215)
TOTAL (A,B,C,D)	129 (12.9)	0.083 (0.0083)

The filter collapse consequences are compared to the risk guidelines for the "unlikely" range for frequency of occurrence after the sand filter collapse in the following section.

3.4.2.7.2.4.2 Sand Filter

Using the same ARF used in the DBE analysis for B filter collapse, the sand filter release is:

Table 3.4.2.7-9: Inventory released from Sand Filter collapse			
Isotope	**Inventory**	**Release Fraction**	**Inventory released**
^{137}Cs	2.0×10^{3} Ci	5×10^{-5}	1.0×10^{-1} Ci
^{90}Sr	3.0×10^{3} Ci	5×10^{-5}	1.5×10^{-1} Ci
Pu (mix)	11 g	5×10^{-5}	5.5×10^{-4} g

The doses resulting from the collapse of the sand filter, taking no credit for building wake or plume meander, using Table 3.4.1.4-1 and the relationship Dose = Ci x UDE are:

Table 3.4.2.7-10: Potential Releases from Sand Filter collapse

Receptor	Isotope	Release	UDE	Dose (rem)
Onsite	^{137}Cs	1.0×10^{-1} Ci	3.59×10^{-1} rem/Ci	3.59×10^{-2}
	^{90}Sr	1.5×10^{-1} Ci	2.79×10^{0} rem/Ci	4.19×10^{-1}
	Pu (mix)	5.5×10^{-4} g	8.59×10^{2} rem/g	4.72×10^{-1}
Total				9.27×10^{-1}
Offsite	^{137}Cs	1.0×10^{-1} Ci	2.63×10^{-4} rem/Ci	2.63×10^{-5}
	^{90}Sr	1.5×10^{-1} Ci	1.73×10^{-3} rem/Ci	2.60×10^{-4}
	Pu (mix)	5.5×10^{-4} g	4.79×10^{-1} rem/g	2.63×10^{-4}
Total				5.49×10^{-4}

The following table shows the HEPA and Sand Filters collapse consequences and RGs.

Table 3.4.2.7-11: Doses from Filter collapse

Receptor	Dose mSv (rem)			RG mSv (rem)
	HEPA Filters	Sand Filter	Totals	
Onsite	129 (12.9)	9.3 (0.93)	138.3 (13.8)	250 (25)
Offsite	0.083 (0.0083)	0.0055 (0.00055)	0.089 (0.0089)	50 (5)

RG = Risk Evaluation Guidelines (Table 3.4.1.5-1).

3.4.2.7.2.5 291-B Filters Fire and Explosion

Since the filters are isolated from the canyon by a massive concrete plug, there can be no impact from a canyon fire to the 291-B area underground HEPA filters.

The filters are susceptible to flooding that could lead to hydrogen buildup and deflagration or explosion. A hydrogen explosion in the 291-B filter vaults is analyzed in Section 3.4.2.4. The consequences from the nonseismic filter explosion analysis include a collapse release, which would be expected during a DBE. The unmitigated hydrogen explosion consequences are much greater than the filter collapse consequences. Hydrogen accumulation in the vaults is prevented by the defense in depth features described in Section 3.4.2.4.7, thereby preventing the hydrogen explosion, even during a DBE. Therefore, the hydrogen explosion consequences are not considered to be part of the total DBE consequences.

Section 3.4.2.6 analyzes a postulated nonseismic fire scenario in B and D filters, which is not

expected to occur during a seismic event due to the low volume and type of combustible materials in the vaults and the absence of ignition sources. The nonseismic fire analysis involves a scenario where a significant fuel source is introduced to the vaults by the accident initiator; fuel leaking from a vehicle. Vehicles are not allowed on or near the vaults.

3.4.2.7.2.6 Canyon Fire

As explained in Sections 3.4.2.4 for the nonseismic canyon fire analysis, there are limited combustible hazards and there is no expectation of a canyon fire.

If a fire is ignited in the canyon by a seismic event, additional radioactive material could be suspended by the fire. However, for the following reasons, consequences of a seismic initiated fire will not be added to the seismic resultant consequences:

- The remaining low volume of combustibles in the canyon are described in the FHA. The remaining combustibles consist mostly of wood products. There is some paper, cardboard, plastics and electrical components materials. There are no known flammable fluids or gases, including hydrogen.

- In Cell 10, there is an electrical circuit for the liquid level detection. This system is designed to be "intrinsically safe", so as to not produce an arc or ignition source.

- It is unlikely that a fire would occur. If one were to occur, it would be localized so only a portion of the canyon contamination would be involved.

- The seismic consequences for materials suspended by impact are adequately conservative so that the suspension from a localized fire is negligible. All of the canyon contamination is considered in the seismic analysis.

3.4.2.7.2.7 Spray Leak (Aqueous Solution)

A spray release with significant consequences will not occur during B Plant S&M operations, since no transfers of liquids under pressure will occur. Pumping of water that is leaked into the canyon might occur, but this water will contain only small levels of contamination.

3.4.2.7.2.8 Hydrogen Explosion in Canyon Vessel

The hydrogen explosion in a canyon vessel is not credible during S&M operation as vessels have been drained and are open to the canyon. Flammable gas concentrations will not reach lower flammability limits due to negligible generation components and the massive air space. There are no credible ignition sources.

3.4.2.7.2.9 Other

The toxic releases are considered to be the same as for the beyond design basis earthquake. Except for the potential of negligible volumes of chemicals, all chemicals have been removed from B Plant.

3.4.2.7.2.10 Comparison to Risk Evaluation Guidelines

The following table presents the postulated consequences of a DBE and the appropriate risk evaluation guidelines for an unlikely event.

Table 3.4.2.7-12: Design-Basis Earthquake Doses

Source	Onsite	Offsite
	Dose mSv (rem)	Dose mSv (rem)
Canyon contamination	28 (2.8)	0.058 (0.0058)
Sand filter collapse	9.3 (0.93)	0.0055 (0.00055)
A, B, C and D filters collapse	129 (12.9)	0.083 (0.0083)
Total	166 (16.6)	0.15 (0.015)
RG mSv (rem)	250 (25)	50 (5)

RG = Risk Evaluation Guidelines (Table 3.4.1.5-1)

The risk evaluation guidelines and safety class criteria are not exceeded.

3.4.2.7.2.11 Summary of Safety SSCs and TSRs

Since the risk evaluation guidelines and safety class criteria are not exceeded, no TSRs or safety class/safety significant equipment is required for the DBE.

3.4.2.7.2.12 Defense in Depth

The onsite and offsite radiological consequences are well below the risk evaluation guidelines. Therefore, there are no safety significant SSCs/features required to protect the onsite and offsite receptors and the environment. However, there is a potential hazard to facility workers following seismic events of a magnitude close or exceeding the DBE of 0.12g. Facility workers could face radiological exposures and occupational hazards associated with weakened and/or falling structures, such as the canyon building and the retired vaults and retired stack. Therefore, it is necessary to establish and implement a worker protection feature to keep workers away from the B Plant structures during and following seismic events of this magnitude, until the hazards are understood. An administrative control could direct this worker protection feature.

3.4.2.8 Wind

Previous wind analyses of B Plant facilities are contained in *B Plant Support Facilities Natural Forces Evaluation*, WHC-SD-WM-TA-002 (Chen et al. 1983). The following facilities were analyzed:

- 211-B Chemical Storage Area
- 212-B Cask Loading Station
- 291-B Exhaust ventilation system including filter cells 291-BC, 291-BD, 291-BF, and 291-BG
- 292-B Stack Effluent Monitoring Building.

The wind analyses evaluated the effects of tornados having a maximum wind speed of 241 kph plus a 40 kph translational wind speed for a resultant maximum wind speed of 281 kph and a negative pressure of 5.17 kPa. The effects of tornado-generated missiles were also analyzed. Forces on the structures were analyzed, in accordance with the guidelines of the *American Society of Civil Engineers Task Committee on Wind Forces* (ASCE 1961), and tornado-generated missiles were evaluated, in accordance with SDC-4.1, *Standard Architectural-Civil Design Criteria: Design Loads for Facilities Hanford Plant Standard*, Rev. 11 (SDC-4.1 1989), and Chen et al. 1983.

Current wind analysis requirements for the Hanford Site are found in U.S. Department of Energy (DOE) Order 5480.28, *Natural Phenomena Hazards Mitigation*, DOE Order 6430.1A, *General Design Criteria*, and HNF-PRO-097. Evaluation of tornado resistance for nonreactor facilities is no longer required; however, depending upon the performance category of the structure, facilities are required to resist straight winds (fastest km wind speed) up to 144 kph in accordance with HNF-PRO-097. Based on the new requirements, the analyses of tornado winds in Chen et al. 1983 are conservative and B Plant facilities containing hazardous materials (canyon and isolated filters) would survive a straight wind; however, a more rigorous analysis is required to determine structure demand/capacity ratios for the design-basis wind event.

The criterion used in Chen et al. 1983 to evaluate the survivability of the structures was based on results of stress analysis and engineering judgement. The structural safety/survivability of facilities was evaluated and categorized into the five levels shown in the following table. The results of the analyses are summarized in the following subsections.

Table 3.4.2.8-1:Qualitative Rating of Building Integrity (WHC 1994c)

Rating	Definition	Percent range
Safe	Meets all present code requirements — high safety factor against failure.	100%
High	Barely meets code requirements — may result in local failure, total structural failure not expected.	75-99%
Medium	Cannot meet code requirements — localized failure will occur, total structural failure is not expected, may still be partially functional.	50-74%
Low	Cannot meet code requirements — structural survivability is low, expected to lose function.	25-49%
Unsafe	Safety factor is very low — structural survivability and functioning is lost.	< 25%

3.4.2.8.1 221-B Canyon Structure

The massive 221-B Canyon is constructed of steel reinforced concrete. The ability of the 221-B Canyon structure to survive a tornado was analyzed and noted in WHC-SD-WM-SAR-013, Rev. 2 (WHC 1993e).

The 221-B Canyon Building is expected to survive high winds based on the results of Chen et al. 1983. That analysis concludes that less structurally massive buildings (212-B, 291-B, and 292-B) will survive high winds. Building 212-B is a steel structure with sheetmetal siding panels. Buildings 291-B and 292-B are concrete filled masonry block structures. The canyon walls are constructed of concrete. The walls are credited to withstand a DBE of SS criteria (Table 3.4.2.7-1, magnitude: 0.12g). The discussion above supports the conclusion that the canyon structure will survive a straight wind.

3.4.2.8.2 271-B Support Building Collapse Analysis

The ability of 271-B to survive a 113 kph straight wind (fastest km wind speed) has not been analyzed and it is assumed to fail.

The 271-B building is assumed to collapse from a 113 kph straight wind. Because the building contains no significant chemical or radioactive material, there are no dose consequences.

3.4.2.8.3 Chemical Storage Area

The 211-B Chemical Storage Area is a series of six above ground horizontal tanks with associated pipes and support structures. The tanks and associated piping have been emptied to minimum heels. The tanks are expected to remain stable and not overturn from high winds. Wind-generated missiles could penetrate the tanks. However, after Chen et al. 1983 was published, upgrades were made to 211-B that enhanced the resistance of these vessels and structures to a

wind event. The upgrades were noted in *Preliminary Safety Analysis Report, B Plant Environmental Compliance Upgrades 211-B Chemical Tank Farm and 221-B Gallery Scale Tanks*, WHDD-SD-W010H-PSAR-001, Rev. 0, (WHC 1993b). These upgrades include horizontal tank supports and additional supports for equipment and pipes.

These additions were made to meet applicable seismic criteria specified in SDC 4.1 1989. The conclusion is made that the tanks and associated pipes and their supports will survive a high wind event. Because the tanks and area have been emptied to minimum heels, the consequences of a wind induced event will not be significant.

3.4.2.8.4 212-B Cask Loading Station

The 212-B Cask Loading Station consists of three separate structural components. These structures include the below grade operating gallery area and hot cell (reinforced concrete structure), the above grade truck port and handling area (structural steel frame with insulated and non-insulated siding and roofing), and the above grade enclosure additions for maintenance and equipment.

The below grade structures would survive the high-wind event without damage. The steel structure and metal siding would likely survive high winds; although, wind-generated missiles might penetrate the metal skin causing localized damage. If the structures were postulated to fail, any resulting release is minimal because the facility is inactive and the aboveground portion is not contaminated (WHC 1993c). There is also the possibility that portions of the metal skin could become wind-generated missiles that could impact other structures. The 212-B station and systems have been deactivated.

3.4.2.8.5 291-B Area Exhaust Ventilation System

The exhaust ventilation system consists of the following structural components:

- 291-B exhaust ventilation stack
- 291-BC (A and B filters instrument building)
- 291-BD (C filter instrument building)
- 291-BF (D filter instrument building)
- 291-BG (E filter instrument building)
- Duct from canyon to filters, fans and stacks
- Exhaust air tunnels
- Sand filter cell and exhaust ducts
- Filters/vaults A, B, C, D, E.

The 291-B exhaust ventilation stack is a reinforced-concrete structure that has a cylindrical cross section and is tapered along its length. Engineering judgement has concluded that the stack would have a high probability of surviving straight winds in the range of 113 to 144 kph (WHC 1993b). Based on this conclusion, no penetration by wind-generated missiles is expected.

Below grade structures associated with the filter cells are not impacted by straight winds. The above grade structures analyzed include the metal-frame buildings located over the filters and the

small metal-skinned instrument houses. The survivability of a metal frame building depends on the metal skin. If the skin remains attached to the frame, stresses are much higher in the frame. The structure is rated as having a high probability of surviving; however, wind-generated missiles could possibly penetrate the metal skin causing localized damage.

Structure 291-BH is an aboveground, 1.2 m by 1.5 m by 2.4 m concrete housing for the duct plug operating mechanism. This building is likely to survive high-wind conditions; however, the metal skinned instrument houses could suffer localized damage from wind-generated missiles.

No significant release of radioactive or hazardous materials is expected from localized wind damage to these aboveground structures, because they contain no or very low levels of radioactive or hazardous materials.

3.4.2.8.6 292-B Stack Effluent Monitoring Building

The 292-B Stack Effluent Monitoring Building is an aboveground, unreinforced concrete block structure approximately 4.9 m tall. The roof is a concrete slab 10 cm thick supported by block walls and two reinforced concrete beams. This structure would likely survive a high-wind condition. Penetration of the structure by wind-generated missiles is unlikely and even if damage occurred, no release of radioactive materials is expected because only very low quantities of radioactive contamination are contained in the building.

3.4.2.8.7 Canyon Exhaust System

The portions of the new system that are exterior to the 221-B canyon building consist of ductwork, the Air Cleaning Train (ACT), and the stack. The system is attached to large concrete pads and the canyon structure. The ACT consists of the HEPA filters and filter housings. This system is designed to withstand 113 kph winds in accordance with Hanford design criteria of GC-LOAD-01 (HNF 1997a).

The potential does exist for a missile generated from older buildings to damage the ACT. The consequences of this event are bounded by the analysis given in Section 3.4.2.1 for vehicle impact.

3.4.2.8.8 Wind Analysis Conclusion

With the exception of 271-B, which has not been structurally analyzed, the major structures within the B Plant complex would likely survive wind conditions up to 144 kph with no release of radioactive or hazardous materials and no adverse consequences are expected. Wind generated missiles that could be generated from the smaller buildings near B Plant are not expected to damage the major B Plant structures that contain significant radiological material inventories.

The B Plant complex also includes a number of uncontaminated support buildings that contain hazardous materials, such as asbestos. Building 217-B is sided with a material containing asbestos. It is not expected that high winds will damage the building or the siding. Wind driven missiles could damage the siding.

Consequences from damage to the ACT filters from wind are enveloped by the consequences from a vehicle collision. A postulated collapse of the smaller buildings under high winds would not produce consequences exceeding the RG. Buildings 221-BB and 221-BF contain internal radiological contamination. These are concrete structures that are expected to survive high winds. The major portion of 221-BF is a below grade vault. Building 221-BB is above ground.

3.4.2.9 Flood

The climate at the Hanford Site is arid to semiarid with an average rainfall of 15.9 cm (WHC 1993e). Neither the maximum expected rainfall over the next 1,000 years, nor the effect of the 100-yr probable flood of the Columbia River would pose any added hazards to operations in the 200 Areas (WHC 1993b).

A calculation of the effect a Columbia River flood would have on waste management operations has been performed. The frequency is 1 in 1,000 years. This dam-regulated probable maximum flood (PMF) is one previously predicted by the U.S. Army Corps of Engineers. This projection was derived by using extensive data and computer modeling techniques, and by incorporating assumptions for a combination of conditions that are the most severe and are considered reasonably possible for the Columbia River Basin. Contributing factors of winter snow accumulation, spring melting, and runoff-season rainstorms were maximized (WHC 1993e).

The cause of the PMF is an assumed spring snow melt runoff in the mountains of the Columbia River watershed, following exceptionally cold and wet weather during the October to April snow accumulation season. In the Columbia River Basin as a whole, the October to April precipitation is assumed to equal 1.3 times the normal annual precipitation (WHC 1993e). Unusually rapid melting, as a result of meteorologic conditions, is predicted based on the assumption of extreme seasonal values for air temperatures, dewpoint, solar radiation albedo, and wind speed. In addition, two hydrologically significant basin-wide rainstorms were assumed — the most severe is considered reasonably possible. Rain contributions to the PMF were also assumed to fall entirely during two 5-day periods of the snow melt season. Mid-May was arbitrarily chosen for the first storm and the second was timed to maximize the natural peak discharge of the lower Columbia River. The calculation shows that, even under these circumstances, B Plant and other operations in the 200 Areas are not affected. The maximum recorded 24 h precipitation is 4.9 cm. A 28 cm, 24 h downpour will not cause flooding in the 200 Areas.

A worst-case flood would result from a postulated 50% breach of Grand Coulee Dam. The ensuing flood of 2.27×10^5 m^3/s would crest at about 140 m above mean sea level (amsl) in the channel between 200 East Area and Gable Mountain. B Plant is at approximately 215 m amsl, and well above the crest of the flood, but normal operations could not continue. The export water line and certain electrical transmission lines would be affected by the flood and would thereby necessitate the use of backup services. Aside from the hypothetical breach of Grand Coulee Dam, surge- or seiche-type flooding will not occur in the 200 Area (WHC 1993e).

3.4.2.10 Neighbor Facilities Events

External events are accidents at other facilities that may affect B Plant. The nearest facility to B Plant is the Waste Encapsulation and Storage Facility (WESF), which is located directly adjacent to B Plant. There are other facilities in the 200 East Area, such as tank farms, that contain radioactive or toxic materials. There are no potential accidents identified at these facilities that could significantly physically damage the B Plant facility. Radiological or toxic releases from other facilities could affect surveillance and maintenance personnel. Hanford Emergency Response procedures will result in site alarms being activated in case of an accident at other facilities. Surveillance personnel would also likely be alerted by alarms from WESF.

3.4.2.11 Previous Safety Basis Scenarios

Several scenarios that are discussed in the B Plant BIO (previous authorization basis) are not developed into accidents in this SAR, since the scenarios do not result in significant releases during the S&M phase, according to the hazards analysis for this phase. These scenarios are discussed below.

3.4.2.11.1 Crane Drop

An electrically operated, overhead bridge crane spans the entire width of the B Plant canyon. The crane will not be used during S&M, therefore drops of the crane loads are not considered. A drop of the crane is considered in the DBE analysis.

3.4.2.11.2 Total Loss of Electric Power to B Plant

Loss of electrical power (LOEP) to B Plant during the S&M phase will result in loss of building surveillance lighting, the canyon exhaust system, and the liquid monitoring in Cell 10 and in the retired filter vaults. During this power loss scenario, there will be no threat of hydrogen generation in the canyon building or in the vaults, since water is not stored in the canyon vessels or the filter seals systems piping. Loss of electric power during the S&M phase may preclude entrance to the 221-B and 271-B buildings due to the potential that contamination may spread from the canyon, but without an additional accident, there is no threat of significant consequences to the environment, or onsite and offsite receptors.

To be compliant with life safety codes, personnel will not be allowed to enter a building with surveillance lighting if there is no electrical power available to the lighting system. The surveillance personnel are required to carry flashlights while inside the building, so they will be able to safely exit the building in the event of a LOEP. There is no limit for a duration of electric power loss to the facility, based on accident analysis results.

3.4.2.11.3 Spray Leak

No pressurized transfers of radioactive liquids will occur during the S&M phase, except for possibly removal of water that has leaked into the facility. While this water might contain small amounts of contamination, a spray leak of this water will not produce significant onsite or offsite consequences. Spray leaks are therefore not considered.

3.4.2.11.4 In-Tank Explosion in Cell

3.4.2.11.4.1 Cause and Source

Residual contamination is present in the cells and tanks in the B Plant canyon, (Section 2.5.2). There may be small liquid heels in tanks, or it is possible that water could leak into the canyon. The radiation could interact with the water to produce hydrogen which, if allowed to accumulate, could result in flammable concentrations. However in the S&M phase the amount of liquid will be highly limited and the tanks are open to the canyon. The canyon has a large open volume and there are paths for hydrogen to diffuse from the building. Hydrogen accumulation in a cell leading to a detonation is not credible in the S&M mode of operation.

3.4.2.11.4.2 Red Oil Explosions

B Plant Organic Process: Red Oil Explosion Scenario, WHC-SD-WM-RA-001, Rev. 0 (WHC 1994e), examined the current facility configuration/ operation using fault-tree analysis and concluded that the creation of red oil in the B Plant organic process cells is not credible. The following three sections describe why a red oil explosion is not credible in the canyon. Red oil explosion is not a concern for other areas of B Plant, because of the absence of organics, nitric acid, and heat sources.

3.4.2.11.4.3 Potential for Explosion in a Canyon Process Cell Vessel

The original design configuration of B Plant provided piping between the AMU in 271-B and the tanks formerly used to store organic solutions in the canyon for process purposes. The system is now configured so that the interconnecting piping, between the HNO_3 tanks and the organic tanks has been removed and, therefore, there is no credible way to introduce HNO_3 into the organic tanks. Furthermore, the organics and all chemicals have been removed from the facility. The steam lines to the organic process tanks have also been removed there by eliminating the heat source.

Assuming one chemical were to leak from one vessel/cell and another chemical were to leak from another vessel/cell, and the two could come together in cells drain header, there could be a reaction in the header, but it would be vented from where the chemicals just came. There are no known quantities of HNO_3 in the canyon.

All the vessels in the canyon are vented because all the jumpers were removed, thereby leaving the vessels open to the process cell atmosphere. The process cells atmospheres are common with the canyon atmosphere via the ventilation gaps between the cover blocks and the deck, and via the duct ports between the process cells and the wind tunnel.

Tk-10-1 is a rectangular tank in the bottom of the cell. The tank is completely open at the top. Thus, the tank is vented and filtered by the canyon exhaust system.

3.4.2.11.4.4 Potential for Explosion in Tank TK-10-1

Tank TK-10-1 serves as the drain tank to collect liquids from the canyon cells. As such, it is possible that a potentially energetic chemical reaction could occur in the tank because of the collection of incompatible chemicals (i.e., HNO_3 and NaOH) or as the result of the occurrence of an energetic reaction between the degraded organic phase (i.e., NPH/TBP and HNO_3). Of the two reactions, the organic/HNO_3 reaction is the most vigorous and is evaluated in this subsection. The organic and chemical materials have been removed from all vessels and pipes. There is a remote possibility that very small volumes of organic and chemical materials might remain in pipes and leak out or remain on cell floors or in the cell drain line and be washed out to Tk-10-1 if water leaked into the cells. All water has been drained and the building weatherization is to be maintained.

Tank TK-10-1 is a large, rectangular tank that is open at the top. Studies by Nichols (1960) and WHC-EP-0737 indicate that explosive reactions involving degraded organics and HNO_3 can only occur in closed systems. Open systems (tanks) allow for the rapid venting of reaction products. There is no steam or other heat source in B Plant; superheating cannot occur.

3.4.2.11.4.5 Explosions in Cell Drain Line to Tank TK-10-1

The cell drain line is a 15.25 cm diameter concrete-encased, stainless steel line that drains any liquids spilled to the cell floor by gravity to tank TK-10-1. There is a remote possibility that residual degraded organic could spill to the cell floor and drain to tank TK-10-1 at the same time that concentrated HNO_3 spilled from the heels from another tank/pipe resulting in a mixing of the two materials in the drain line. Even in this improbable case, an explosion could not occur because there is no source of heat to raise the temperature of the mixture, the pipe would vent any reaction gases in both directions so pressurization could not occur, and the mixture would be traveling down the pipe in continuous contact with cold surfaces.

3.4.3 Beyond Design Basis Accidents

Beyond Design Basis Accidents (BDBA) are analyzed for information only. Controls are not required for BDBAs.

DOE 5480.23 requires the evaluation of accidents beyond the design basis to provide a perspective of the residual risk associated with the operation of the facility (see Attachment 1, paragraph 4.f(3)(d)11c, of the Order). Such beyond DBAs are not required to provide assurance of public health and safety. Accordingly, they serve as bases for cost-benefit considerations if consequences exceeding risk evaluation guidelines are identified in the beyond DBA range. However, such cost-benefit analysis would be performed outside the SAR with concurrence of DOE.

3.4.3.1 Beyond Design Basis Earthquake

This section calculates the unmitigated consequences of a beyond DBE (BDBE). For this analysis, it is assumed that the earthquake is greater than 0.2 g and subsequent failure of all pertinent facilities occurs. In these analyses, no credit is taken for holdup within the facility, plateout, or other removal terms. What is suspended is released.

The facilities analyzed include the following:

- 221-B building, including the galleries and canyon
- 271-B support building
- 291-B filter cells A-E and the sand filter
- 291-B stack
- 212-B Cask Loading Station.

The potential failures are listed in the following table:

Table 3.4.3.1-1: Summary of Potential Failures

Structure	Failure mode
Stack	Stack topples over, contributes to filters release
A through D filter cells, and the sand filter	Collapse of filter buildings.
A through D filters	Fire and/or flooding and potential hydrogen generation.
271-B	Building collapses.
221-B canyon facility, canyon structure, and cover blocks	Structure fails resulting in the facility caving in on itself creating rubble and dust. The cover blocks fall into cells as building crumbles.
212-B building and hot cell	Collapses into rubble.

The B Plant facility also includes a number of small buildings which are not contaminated or contain negligible quantities of hazardous materials compared to the structures listed in Table 3.4.3.1-1. Complete collapse of these buildings during a seismic event would not yield applicable consequences and is not further analyzed.

3.4.3.1.1 Consequence Assessment - No Controls

The release of radioactive material, as a result of each of the Seismic accidents listed below, is included in this subsection.

- Canyon fire and hydrogen explosion
- Suspension of canyon contamination by seismic impacts and spray releases
- 212-B Cask Loading Station contamination
- Stack failure
- Retired HEPA filters structures and sand filter structure collapse
- Hydrogen explosion in retired filters vaults

3.4.3.1.1.1 Canyon Fire

The canyon fire analysis addressed in Section 3.4.2.3 concluded that there are no dose consequences from a canyon fire for B Plant during normal S&M operations.

During the BDBE, the exhaust fans could remain operable. If the combustibles in the canyon or process cells were to ignite, the fire could generate smoke and fumes of a high temperature. The exhaust system could carry the smoke and fumes to the ACT filters, which could destroy the filters if the heat is high enough and lasts long enough. However, the FHA fire modeling demonstrated the filters would not be breached. The fuel load modeled in the analysis was significantly greater than the actual fuel load available to burn in the canyon. Regardless, for an event of this magnitude a worst case assumption would be the filters would be shaken loose, so their seals would be breached. The contamination on the ACT filters and contamination drawn from the canyon could be released through the stack or at ground level if the filter or fan housings or the duct or stack are breached. In the event of a stack collapse, the contaminants would be released at ground level. Even if the stack does not collapse, the release is considered to be a ground release, since the stack is too low to credit an elevated release.

Since it is assumed for this BDBE analysis that the canyon structure could totally collapse, then the seismic impact fire and consequences would be a ground release whether or not the canyon exhaust system continued to operate.

As with the DBE canyon fire analysis, and for the same reasons stated in that analysis, the BDBE seismic forces are credited to cause conservative suspension and release, so that canyon fire contribution is considered negligible.

3.4.3.1.1.2 Spray Releases

There are no anticipated pressurized transfers for solution containing significant quantities of radioactive or toxic materials during B Plant S&M operations.

3.4.3.1.1.3 Hydrogen Accumulation In Canyon Vessels

The S&M configuration has the facility fully deactivated, the old ventilation system shut down and isolated, and the new canyon exhaust system operating. During the S&M phase there may be liquid in cell 10, but the vessel in cell 10 is not covered and will not accumulate hydrogen. There will be no hydrogen generating solutions in the other vessels, except for tank heels. Those vessels are be opened/vented to the cells. With the minimal heels, the tanks vented, and the large volume of airspace surrounding the vessels, there is no hazard of hydrogen accumulation in the canyon building. Furthermore, there is electrical energy in only Cell 10, which is low voltage for the liquid level detection. This energy is intrinsically arc proof.

3.4.3.1.1.4 Canyon and Equipment Contamination

It is assumed the roof and most of the walls will collapse. The overhead crane will fall and cover blocks will collapse into the cells crushing vessels, waste drums and jumpers.

The canyon and process cells contamination (Table 3.3-3) could be liberated by surface impact or vibration. The contamination in the 221-B Canyon is 8.1×10^4 Ci of cesium and 4.4×10^4 Ci of strontium. The BDBE scenario is the same as the design basis roof collapse analysis of section 3.4.2.6, except no DR, RF, and LPF reductions are credited. Using ARF = 1×10^{-3}, DR = 1.0, RF = 1.0, and LPF = 1.0, the releases are 81.0 Ci of ^{137}Cs and 44.0 Ci of ^{90}Sr. Since the building could potentially collapse from a BDBE, no credit for building wake is taken. The doses from the 221-B structure are calculated using the UDEs from Table 3.4.1.4-1 without building wake or plume meander, and the relationship Dose = Ci x UDE.

Table 3.4.3.1-2: BDBE Releases from Canyon and Equipment Contamination

Receptor	Isotope	Release (Ci)	UDE (rem/Ci)	Dose (rem)
Onsite	^{137}Cs	8.1×10^1	3.59×10^{-1}	2.91×10^1
	^{90}Sr	4.4×10^1	2.79×10^0	1.23×10^2
Total				1.51×10^2
Offsite	^{137}Cs	8.1×10^1	2.63×10^{-4}	2.13×10^{-2}
	^{90}Sr	4.4×10^1	1.73×10^{-3}	7.61×10^{-2}
Total				9.74×10^{-2}

Table 3.4.3.1-3: BDBE Doses from Canyon and Equipment Contamination

Receptor	Dose mSv (rem)	RG mSv (rem)
Onsite	1,510 (151)	250 (25)
Offsite	0.97 (0.097)	50 (5)

RG = Risk Evaluation Guidelines (Table 3.4.1.5-1)

3.4.3.1.1.5 212-B Cask Loading Station

With the exception of the underground hot cell in 212-B, the Cask Loading Station contamination has been cleaned out. All the existing systems in the building have been shut down. A new lighting system was installed for a portion of the building in 1998, to support surveillance for water intrusion and radiological monitoring during the S&M phase. The hot cell has ≈100 to 1,000 Ci of contamination (Table 3.3-3). The hot cell atmosphere has a negative

pressure due to the interface with the 221-B building canyon exhaust system. Because the contamination is unknown, the contamination is conservatively assumed to be entirely from strontium.

Based on Section 3.4.3.1.1.4, the ARF of 1×10^{-3} is used for the release fraction. Using the UDE's for a ground release (Table 3.4.1.4-1) and the relationship Dose = (Total Ci)(release fraction)(UDE), the resultant releases out of the facility are:

Table 3.4.3.1-4: Potential Releases and Doses from 212-B Cask Loading Station

Receptor	Isotope	Total Ci	Release Fraction	UDE (rem/Ci)	Dose (rem)
Onsite	^{90}Sr	10^3	1.0×10^{-3}	2.79×10^0	2.79×10^0
Offsite	^{90}Sr	10^3	1.0×10^{-3}	1.73×10^{-3}	1.73×10^{-3}

Table 3.4.3.1-5: 212-B Doses Comparison to Guidelines

Receptor	Dose mSv (rem)	RG mSv (rem)
Onsite	2.8×10^1 (2.8×10^0)	250 (25)
Offsite	1.7×10^{-2} (1.7×10^{-3})	50 (5)

RG = Risk Evaluation Guidelines (Table 3.4.1.5-1)

3.4.3.1.1.6 Chemical Releases

There are no hazardous chemicals stored in B Plant other than small heels in tanks. There will no significant releases during a seismic event.

3.4.3.1.1.7 291-B Filters

Different scenarios can occur involving the underground filters during a seismic event. This analysis considers the deactivated configuration, the underground filters are isolated from the canyon building and the 291-B fans and stack.

3.4.3.1.1.7.1 291-B Filter and Stack Collapse

All the underground filter cells structures are assumed to collapse from a beyond design basis seismic event. The old stack is assumed to collapse on top of one or more of these buried structures.

3.4.3.1.1.7.1.1 A-E Filters

The rubble from the vault ceilings would crush the filters and suspend the radioactive inventory. The possibility exists that the stack could fall on the collapsing filter, generating an even higher percentage of airborne radioactive particles. From the DBE analysis for the 291-B filters, the total dose consequences for the unmitigated release (not elevated) collapse of A, B, C and D filters is:

Table 3.4.3.1-6: Doses from collapse of A - D Filters

Receptor	Dose mSv (rem)	RG mSv (rem)
Onsite	129 (12.9)	250 (25)
Offsite	8.3×10^{-2} (8.3×10^{-3})	50 (5)

RG = Risk Evaluation Guidelines (Table 3.4.1.5-1)

3.4.3.1.1.7.1.2 Sand Filter

The sand filter is assumed to collapse from a BDBE with the same assumptions used in the DBE analysis, taking no credit for building wake or plume meander, the doses are:

Table 3.4.3.1-7: Doses from collapse of Sand Filter

Receptor	Dose mSv (rem)	RG mSv (rem)
Onsite	9.3 (0.93)	250 (25)
Offsite	0.0055 (0.00055)	50 (5)

RG = Risk Evaluation Guidelines (Table 3.4.1.5-1).

3.4.3.1.1.7.2 291-B Filters Fire

As determined for the DBE, fires are not expected to be initiated in any of the retired HEPA filters (291-B area and new exhaust system) from a seismic event due to the low volume and type combustible materials in the vaults and the absence of ignition sources that could ignite combustibles. The nonseismic fire analysis involves a scenario where a significant fuel source is introduced to the vaults by the accident initiator; fuel leaking from a vehicle.

3.4.3.1.1.7.3 291-B Filters Explosion

The scenario considered is an explosion in the underground filters. This consequence is postulated to be caused by an earthquake that creates an ignition source in the vaults while up to 10% hydrogen gas is in the vault. The scenario is identical to the scenario of Section 3.4.2.4 for the nonseismic hydrogen explosion.

3.4.3.1.1.7.3.1 Source Term Analysis

The source term is as shown in Section 3.4.2.4 for the nonseismic hydrogen explosion.

The resulting respirable releases, using the relationship
Respirable release = (Inventory)(0.5)(1.0E-02), are shown in the following table.

Table 3.4.3.1-8: Respirable releases due to hydrogen deflagration in HEPA filter vaults

Isotope	Inventory	Release
^{137}Cs	1.56×10^5 Ci	7.8×10^2 Ci
^{90}Sr	7.10×10^4 Ci	3.55×10^2 Ci
Pu (mix)	4 g	2.0×10^{-2} g

3.4.3.1.1.7.3.2 Consequence Analysis

The consequences are identical as shown in Section 3.4.2.4 for the nonseismic hydrogen explosion. This release was assumed to have a duration of less than 1 hour so credit is not taken for plume meander or building wake. The unit dose equivalents from Table 3.4.1.4-1 for a ground release were used to calculate the resulting radiological doses shown below. There are no significant toxic materials on the filters. Using the relationship: Dose = Ci x UDE, from section 3.4.1.4, the consequences are:

Table 3.4.3.1-9: Doses from hydrogen deflagration in HEPA filter vaults

Receptor	Isotope	Release	UDE	Dose (rem)
Onsite	^{137}Cs	7.8×10^2 Ci	3.59×10^{-1} rem/Ci	2.80×10^2
	^{90}Sr	3.55×10^2 Ci	2.79×10^0 rem/Ci	9.90×10^2
	Pu (mix)	2.0×10^{-2} g	8.59×10^2 rem/g	1.72×10^1
Total				1.29×10^3
Offsite	^{137}Cs	7.8×10^2 Ci	2.63×10^{-4} rem/Ci	2.05×10^{-1}
	^{90}Sr	3.55×10^2 Ci	1.73×10^{-3} rem/Ci	6.14×10^{-1}
	Pu (mix)	2.0×10^{-2} g	4.79×10^{-1} rem/g	9.58×10^{-3}
Total				8.29×10^{-1}

3.4.3.1.1.7.3.3 Comparison to Risk Evaluation Guidelines

Radiological doses due to a hydrogen deflagration in the HEPA filter vaults compared to the risk evaluation guidelines are:

Table 3.4.3.1-10: Comparison of hydrogen deflagration doses to RGs

Receptor	Dose mSv (rem)	RG mSv (rem)
Onsite	12,900 (1290)	250 (25)
Offsite	8.3 (0.83)	50 (5)

RG = Risk Evaluation Guidelines (Table 3.4.1.5-1).

3.4.3.1.1.7.3.4 Retired Filters Aging and Seal Failure

Filter aging failure is due to aging of the filter housings and seals. The filters are isolated. The seals have been intentionally abandoned. Aging of the concrete is expected to be very minimal, but could result in the vaults eventually leaking and/or collapsing.

3.4.3.1.2 Unmitigated BDBE Results

The following table presents a summary of the doses caused by an unmitigated BDBE.

Table 3.4.3.1-11: Summary of Beyond DBE Doses and Exposures		
Radiological Source	**Onsite Dose mSv (rem)**	**Offsite Dose mSv (rem)**
221-B Canyon		
Canyon contamination (Table 3.4.3.1-3)	1,510 (151)	0.97 (0.097)
291-B Filters		
A, B, C, and D filter collapse (Table 3.4.3.1-6)	129 (12.9)	0.083 (0.0083)
Hydrogen Explosion in the 291-B Filter Vaults (Table 3.4.3.1-9)	12,900 (1,290)	8.3 (0.83)
Sand filter collapse (Table 3.4.3.1-7)	9.3 (0.93)	0.0055 (0.00055)
Total: 291-B (excluding the hydrogen deflagration in the 291-B Filter Vaults)*	138 (13.8)	0.089 (0.0089)
212-B Cask Loading Station		
212-B Hot Cell (Table 3.4.3.1-5)	28 (2.8)	0.017 (0.0017)
Overall Total		
Total (221-B Canyon, 291-B Filters (excluding hydrogen deflagration)*, 212-B Station)	1676 (167.6)	1.1 (0.11)

* Deflagration consequences are not included in the totals, because those doses already vastly exceed the total of the other contributors and to prevent combining the fire and the explosion, which would account for the filter contamination twice.

AMU = aqueous makeup unit

3.5 Summary of Analysis of Selected Hazards

The following table lists the hazardous conditions that were selected (Table 3.3-4) from the hazards analysis to be further analyzed. All the accidents are either analyzed in the SAR or concluded to be bounded by analyzed accidents. The table lists the SAR section which contains the analysis of the specific accident or bounding accident.

Controls required for each specific accident are listed if the unmitigated consequences exceed the guidelines. There were no postulated offsite consequences that exceed the offsite evaluation guidelines or the offsite criteria of Table 3.4.1.5-1 for designating a Safety Class SSC. The controls identified in the table are for onsite consequences mitigation.

Table 3.5-1: Analysis and Controls

Bin	Designator	Accident Description	FSAR Accident Analysis	Controls
1	221B-Sei-01 291B-Sei-02	Release due to BDB Seismic failure of 221B and 291B Structures	Analyzed in Section 3.4.3, BDBE	Controls not determined by BDB accidents
1	221B-Sei-02 291B-Sei-01	Release due to design basis earthquake	Analyzed in Section 3.4.2.7, DBE	Onsite and offsite risk evaluation guidelines met without controls
2	221B-Load 221B-Rain	Release due to structural degradation by rain, aging volcanic ash or snow	Analyzed in Section 3.4.2.6 Canyon Roof Collapse	Onsite and offsite risk evaluation guidelines met without controls
3	291B-Wind-01	Release due to high wind driven missile damage to isolated filters risers or passive vent system	Consequences enveloped by fire in filter event, Section 3.4.2.5	Onsite and offsite risk evaluation guidelines met without controls
3	221B-Ehst-03	Release due to wind driven missile damage to ACT	Consequences enveloped by damage to filter by vehicle, Section 3.4.2.1	Onsite and offsite risk evaluation guidelines met without controls
3	B-Plant-02	Release due to wind driven missile	Analysis of roof collapse envelopes releases, Section 3.4.2.6	Onsite and offsite risk evaluation guidelines met without controls
4	221B-Ehst-02	Release due to filter failure in ACT	Analyzed in Section 3.4.2.2, bounded by roof collapse	Onsite and offsite risk evaluation guidelines met without controls.
4	221B Ehst-06	Release due to seal failure in ACT	Enveloped by analysis in Section 3.4.2.2, bounded by roof collapse	Onsite and offsite risk evaluation guidelines met without controls
5	291B-Rain-01	Release due to hydrogen explosion in A-E filters	Analyzed in section 3.4.2.4	Administrative control for surveillance monitors conditions and prevents accident.
5	291B-Impact-03	Release from A-E filter due to vehicle impact	Analyzed in Section 3.4.2.5, Fire in Retired Filters	Onsite and offsite risk evaluation guidelines met without controls
5	221B-Ehst-07	Release from ACT due to vehicle impact	Analyzed in Section 3.4.2.1, ACT Vehicle Impact and Fire	Onsite and offsite risk evaluation guidelines met without controls
5	221B-Ehst-09	Release from ACT filter due to external fire	Analyzed in Section 3.4.2.1, ACT Vehicle Impact and Fire	Onsite and offsite risk evaluation guidelines met without controls

Table 3.5-1: Analysis and Controls				
Bin	**Designator**	**Accident Description**	**FSAR Accident Analysis**	**Controls**
6	B-Plant-03	Dose consequences from accidents at other facilities	Discussed in Section 3.4.2.10, Neighbor Facility Events	Hanford sitewide emergency response action.

3.6 References

29 CFR 1910, *Occupational Safety and Health Standards, Code of Federal Regulations*, as amended

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4.0 SAFETY STRUCTURES, SYSTEMS AND COMPONENTS

4.1 Introduction

The accident analyses presented in Chapter 3 consider natural phenomena events (e.g., earthquakes, floods, high winds, snowfall, and ashfall) and operational accidents, such as fires, explosions, mechanical failures, human errors, construction activities and vehicle accidents. The accident analyses predict the "worst-case" probabilities and consequences of each postulated accident by making realistic, conservative assumptions and employing sound engineering and empirical models. The analyst then applies a graded approach to evaluate the risk to the public, onsite personnel and facility workers. The accident analysis in conjunction with the controls selection process provides the basis for the classification of safety SSCs.

The following tables are in chapter 3:

- Table 3.3-4 displays the hazardous conditions, selected from the hazards analysis, for further analysis.
- Table 3.4.2-1 displays the postulated consequences of the accident scenarios developed to analyze the hazardous conditions selected for further analysis.
- Table 3.5-1 displays which scenarios are credited with controls to prevent the postulated consequences from challenging the risk evaluation guidelines and/or safety class criteria.

Design features relied on to prevent accidents and/or mitigate consequences are identified in the accident analyses of Chapter 3.

The design features which are relied on as safety SSCs are listed in this chapter. The safety SSCs and their safety functions are described. When a safety SSC relies on a support system to protect the safety SSC, the support system and its function are described. The safety SSCs and associated support systems' functional requirements are described, as are the general conditions under which the SSCs and support systems must operate, as postulated in the respective analyses. Performance criteria necessary to provide reasonable assurance that the functional requirements will be met are described.

When operational controls are necessary to ensure that safety SSCs and associated support systems and their functions are maintained operational or to ensure worker protection for other than standard industrial safety issues is maintained, then the operational controls are described. These operational controls are candidate administrative controls and will be further addressed in Chapter 5.

4.2 Requirements

This chapter demonstrates the designation of safety SSCs in accordance with DOE Order 5480.23, *Nuclear Safety Analysis Reports* using the guidelines of DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, (DOE 3009) and in accordance with Project Hanford Management Contract procedure HNF-PRO-704, Rev 0, *Hazard and Accident Analysis Process* (HNF-PRO-704).

4.3 Safety Class Structures, Systems, and Components

There are no safety class SSCs designated for B Plant during the S&M Phase. One of the postulated accidents has postulated offsite radiological dose consequences that exceed the criteria used by the PHMCs to establish safety class preventive and/or mitigative controls. The hydrogen explosion accident of Section 3.4.2.4 for the deactivated filter vaults has postulated offsite dose consequences that exceed the PHMC safety class criteria of 0.5, in accordance with Table 3.4.1.6-1 in Chapter 3. However, a safety class SSC is not assigned to prevent the hydrogen explosion, because the initiators for the explosion are prevented by the existing passive design features and by implementation of administrative controls. The passive design features prevent water intrusion into the vaults and provide a path for any hydrogen that may be generated to diffuse out of the vaults, so that the hydrogen concentration will not challenge the lower flammability limit. Administrative controls are established to monitor the hydrogen concentration and water in the filter vaults at a conservative frequency, which allows sufficient time for recovery if hydrogen is detected. This level of control is acceptable, because of the extremely unlikely occurrence of a massive volume of water (600,000 gallons) getting into the vaults, and the long duration required for water and/or hydrogen to accumulate, with sufficient time to detect and resolve the condition before it develops into a dangerous condition. The configuration characteristics are described in detail in the facility description of Chapter 2. The defense in depth features credited to prevent the hydrogen explosion are described in Section 3.4.2.4.7.

4.4 Safety-Significant Structures, Systems, and Components

There are no safety significant SSCs designated for B Plant during the S&M Phase. The hydrogen explosion scenario of Section 3.4.2.4 for the deactivated filter vaults is the only postulated that has onsite and offsite radiological dose consequences that exceed the onsite and offsite risk evaluation guidelines of Table 3.4.1.5-1. However, as described in Section 4.3, the accident is prevented with administrative controls and passive design features. As described in Section 4.3, this is an adequate level of control to prevent a hydrogen explosion in the deactivated filter vaults.

5.0 DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

5.1 Introduction

Technical Safety Requirements (TSR) 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 and Chapter 4 provide information sufficient to support the derivation of TSRs.

5.2 Requirements

The primary requirements specific for this section are included in DOE Orders 5480.22, *Technical Safety Requirements*, and 5480.23, *Nuclear Safety Analysis Reports*.

5.3 Technical Safety Requirement Coverage

As shown in Chapter 4, there are no Safety Class or Safety Significant structures, systems, or components designated for B Plant during the S&M Phase.

There are several candidate hazards that warrant administrative controls to ensure:

- the safety analysis assumptions and defense in depth prevention and mitigation features are maintained as considered in this document,
- the facility workers are protected from occupational hazards, whether or not the hazards are covered by institutional safety programs,
- the safety and administration programs are maintained to ensure the safety of the facility and onsite workers, the onsite and offsite public, and the environment are protected.

5.4 Derivation of Facility Modes

Based on the scope of activities, there are two facility modes.

Normal Operations: S&M activities, as defined in Section 2.5, are being performed. The radioactive material inventory places this facility within Hazard Category 2 as defined in DOE-STD-1027-92 (DOE 1027).

Restricted Operations: Operations authorized other than normal operations, i.e., JCO.

5.5 Technical Safety Requirements Derivation

This section describes the derivation of TSRs for three categories. There are no Safety Limits, Limiting Control Settings, Conditions for Operations, or Surveillance Requirements designated for controlling the safety basis. The three categories are administrative control topics covering several controls that shall be implemented.

5.5.1 Worker Protection

There needs to be administrative controls to protect the facility workers. The administrative controls need to address

- life safety code requirements,
- occupational hazards identification and prevention,

particularly for hazard identification and controls; and facility and/or building access controls during hazardous conditions, such as;

- loss of ventilation and/or illumination in deactivated buildings that are entered for S&M activities,
- the occurrence of natural phenomena that could present occupational hazards, such as earthquake or buildup of snow or volcanic ash on the building roofs.

5.5.2 Management Programs

There needs to be administrative controls to ensure sufficient emphasis is directed to maintaining safety and management programs instrumental to quality mission implementation and accomplishment.

The management programs shall ensure the institutional safety programs, nuclear safety programs, and quality conduct of operations are thoroughly instituted. Special attention shall be directed to establishing administrative controls for implementing the following programs and themes:

- fire protection,
- radiological protection,
- occupational safety,
- nuclear safety,
- configuration control,
- surveillance and maintenance of the SSCs, particularly addressing degradation monitoring,
- excavation control, and
- work control, particularly addressing hazards identification and controls.

5.5.3 Specific S&M Operational Controls and Programs

Specific surveillance and maintenance activities must be implemented through established administrative controls to ensure the hazards are continually understood and controlled, and operational expectations are known and implemented.

Programs shall be instituted to monitor the operative and passive SSCs to ensure the operational risk represented by this safety basis document is not challenged. Of particular concern is monitoring of the facility SSCs and reporting certain conditions to the U. S. Department of Energy (DOE) project representative assigned to B Plant. The particular concerns are associated with degradation of the SSCs, water detection in Cell 10, and extended failure of the canyon exhaust system operation.

5.5.3.1 S&M for the Facility SSCs

There are five S&M activity themes that are to be addressed with administrative controls. They are:

- Surveillance and maintenance of the retired filters configuration, particularly the prevention of water intrusion to the underground vaults, surveillance for hydrogen buildup in vaults, and functional test of the passive vent system.

- Surveillance and maintenance of the canyon exhaust system, particularly maintaining the system operable, ensuring radiological loading controls are maintained to protect facility workers during filter changes, and notifying the DOE facility representative if the system will be inoperable for an extended duration of 96 hours.

- Surveillance and maintenance of the SSCs, particularly the canyon and other structures that can/may contain radiological and/or toxicological materials. This includes the roof membranes of these structures for water intrusion prevention.

- A control shall be established to prohibit movement of the canyon process cells cover blocks, unless prior DOE authorization is obtained.

- Maintain authorization basis interfaces with associated organizations and nearby facilities.

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6.0 PREVENTION OF INADVERTENT CRITICALITY

Policies and procedures governing this subject are maintained on the Hanford Intranet for companies, such as BWHC, that are under contract with the Project Hanford Management System (PHMS). B Plant administrates health and safety programs in accordance with the PHMS and facility programs and procedures. Facility programs are described in the Waste Encapsulation and Storage Facility (WESF) Project Administration manual, FSP-WESF-001 (FSP-WESF-001).

As stated in the Executive Summary, Section E.5, B Plant will be operated under FDH by BWHC until the facility is transferred to BHI. The transfer is anticipated to occur by March 31, 1999. Upon transfer, this chapter will be void and the respective sections of Appendices B and C become active.

There is no fissile material in the B Plant facility complex, therefore, the B Plant facility is exempt from Criticality prevention requirements. (Reed 1994a).

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7.0 RADIATION PROTECTION

7.1 Introduction

Policies and procedures governing this subject are maintained on the Hanford Intranet for companies, such as BWHC, that are under contract with the Project Hanford Management System (PHMS). B Plant administrates health and safety programs in accordance with the PHMS and facility programs and procedures. Facility programs are described in the Waste Encapsulation and Storage Facility (WESF) Project Administration manual, FSP-WESF-001 (FSP-WESF-001).

As stated in the Executive Summary, Section E.5, B Plant will be operated under FDH by BWHC until the facility is transferred to BHI. The transfer is anticipated to occur by March 31, 1999. Upon transfer, this chapter will be void and the respective sections of Appendices B and C become active.

This chapter outlines the radiation protection program administrated for B Plant. The purpose of the radiation protection program is to provide essential services and expertise necessary to ensure the radiological safety of personnel who work in the facility. The technical content of this chapter 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 for B Plant personnel.

7.2 Requirements

All activities performed at B Plant are subject to the requirements of 10 CFR 835, *Occupational Radiation Protection* (10 CFR835) without exception or deviation. Approved changes to 10 CFR 835, as published in the Federal Register, are applicable to B Plant in accordance with the implementation processes and implementation schedules allowed by the Department of Energy (DOE) and as specified in 10 CFR 835.

10 CFR 835, Section 835.101 requires that DOE activities are conducted in compliance with a documented radiation protection program (RPP) that is DOE approved. The documented radiation protection program for B Plant is HNF-SP-1145, *Fluor Daniel Hanford Radiation Protection Program, Implementation of Title 10, Code of Federal Regulations*, Part 835 (HNF 1145), describes how each requirement of 10 CFR 835 is implemented at a program level.

Technical requirements and standards for the radiation protection program plan are mandated by the *Hanford Site Radiological Control Manual (HSRCM-1)*. Deviations from HSRCM-1 technical standards are permissible if approved in accordance with the Technical Equivalency Determination (TED) process described in HSRCM-1. The TED process is designed to ensure that all technical equivalent determinations are consistent with the minimum requirements of 10 CFR 835.

All additional standards and requirements that apply to the radiation protection program at B Plant are detailed in HSRCM-1 and are subject to change in accordance with the HSRCM-1 change control and approval process.

7.3 Radiation Protection Program and Organization

The radiation protection program provides services specified by HSRCM-1 including, but not limited to:

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

The radiation protection manager administrates the radiation protection program that may service several facilities simultaneously. The radiation protection manager is responsible for ensuring that the radiation protection program meets HSRCM-1 mandated technical criteria. He/she has direct access to the senior facility manager and has approval authority over all radiological work performed at the facility.

Radiation protection supervisors provide direction and guidance to radiological control technicians. 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.

Radiological control technicians perform radiological surveillance activities, provide radiological access control, and provide radiological work monitoring. In addition, radiological control technicians provide work practice guidance to field crews and encourage implementation of HSRCM-1. Radiological control technicians 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 radiological control technicians are specified in HSRCM-1. Qualification programs for radiological control technicians include classroom and applied training commensurate with 10 CFR 835.

7.4 ALARA Policy and Program

The ALARA Policy for B Plant is:

"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."

ALARA programs and procedures are subject to the standards established by Hanford procedures that are recognized by HNF-SP-1145 as implementation mechanisms for 10 CFR 835 requirements. 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 radiological control technicians are governed by 10 CFR 835 and HSRCM-1.

All general employees are trained in radiation safety prior to receiving occupational exposure during access to controlled areas. Allowance is made for previous DOE training on generic radiation safety topics provided the training was received at another DOE facility within the past 2 years. Documentation of the previous training clearly identifies the individual's name, date of training, topics covered, and name of the certifying individual. The 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 is 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. The knowledge of radiation safety possessed by radiological workers is verified by examination prior to assigning workers to perform radiological work.

Training for radiological control technicians is established and conducted at intervals not to exceed 2 years 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 radiological control technicians. The required level of knowledge of radiation safety possessed by radiological control technicians is verified by examination to include demonstration prior to unsupervised work assignment. The training is commensurate with the technician's assignment and includes procedures specific to the facility where the technician is assigned. Training documentation clearly identifies the individual's name, date of training, topics covered, and name of the certifying individual.

7.6 Radiation Exposure Control

Occupational exposures at B Plant are maintained ALARA by limiting access to the major radiological source term at the facility. The major source term is comprised of radioactive materials/systems located in the B Plant canyon and access to the canyon is controlled by physical and administrative barriers that include locked doors and radiological access requirements.

The canyon has been deactivated and (under the deactivated facility mission role) is rarely occupied. Entries into the canyon are evaluated in advance for ALARA considerations and exposure control measures are incorporated into job-specific work instructions.

The canyon is surrounded by shield walls as part of the facility design. The shielding is effective in maintaining dose rates in work areas adjacent to the canyon to levels that are generally below 5 mrem/hr. Entries into the work areas adjacent to the canyon are evaluated in advance for ALARA considerations and exposure control measures are incorporated into job-specific work instructions.

Removable contamination is controlled in accordance with HSRCM-1 criteria that include, but are not limited to:

- 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 by:

- 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 airborne contamination.

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

B Plant is serviced by a continuously operating ventilation system that provides directed airflow to prevent the migration of radioactive contamination. The filtration system utilizes several banks of HEPA filters that are monitored for the buildup of radioactive particulate and are changed as needed to maintain the effectiveness of the system.

7.6.1 Administrative Limits

The facility objective 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 (TEDEs), 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 by HSRCM-1.

Planned special exposures are administrated in accordance with HSRCM-1. Events involving the use of the planned special exposure processes are not anticipated over the life of the facility.

7.6.2 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 radiological work permits specify the types and amount of respiratory protection equipment, protective clothing, and shielding necessary to complete activities ALARA. HSRCM-1 specifies general criteria against which job-specific applications are evaluated to minimize personnel exposure.

Radiological posting, labeling, and radiological boundary control criteria are specified in HSRCM-1. In general, radiological areas are classified according to the degree and nature of the radiological hazards present. Entry and exit control requirements are established in accordance with HSRCM-1 and are commensurate with the degree of risk associated with the area to be entered.

The radiological work permit (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 HSRCM-1.

HSRCM-1 provides definitions for radiological areas. The definitions for radiological areas are subject to change in accordance with the HSRCM-1 approval and change control process. The current definitions for radiological areas, as provided by HSRCM-1, are applicable to B Plant.

7.6.3 Dosimetry

Dosimetry is required for all B Plant personnel for whom 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 percent of the corresponding administrative control limits specified by HSRCM-1
- Declaration of pregnancy and an expected external dose equivalent of 50 mrem or more during the gestation period.

HSRCM-1 specifies dosimetry requirements for minors, students, visitors, and members of the public.

The types of Dosimetry utilized at B Plant to monitor radiological workers includes:

- Hanford Standard Dosimeters (HSDs)
- Pocket and electronic dosimeters
- Extremity dosimeters including finger rings and/or thermoluminescent (TLD) 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 radiological work permits and are based on the radiological hazards associated with the 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.

Hanford Standard Dosimeters (HSDs) provide the primary basis for employee legal record exposure history files. The site Dosimetry organization issues HSDs and HSD exchanges are coordinated through line management and supervision contacts at the facility. Exchange frequencies are based on the anticipated annual exposure for the personnel who are issued dosimeters.

Internal exposure is controlled by air sampling and contamination control. Internal exposure is monitored by annual whole body (in vivo) counting and/or strontium urinalysis as required by HNF-PRO-423, Radiological Work Permits. Radiological work permits specify the activities that require annual whole body counting as part of the access control requirements. Instrumentation, procedures, processes, and methods for performing whole body counts are administrated by the Dosimetry department in accordance with HSRCM-1 mandated criteria.

7.6.4 Respiratory Protection

Respiratory protection equipment includes respirators with particulate or gas-filtering cartridges, supplied air respirators, self-contained breathing apparatus and airline supplied-air suits and hoods. The most common type of respirators used at B Plant are air purifying respirators and supplied air respirators.

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 HSRCM-1 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 for the training programs they provide.

Respirator maintenance and cleaning is contracted to site service organizations that have obtained DOE approval for providing equipment cleaning/testing/maintenance programs. The site service organizations that provide the services maintain all respiratory protection historical records required by DOE.

7.7 Radiation Monitoring

Radiological monitoring of dose rates, contamination levels, and airborne radioactivity levels is performed by radiological control technicians in accordance with site procedures and facility-specific radiological surveillance task descriptions. The radiological control organization establishes the frequency and scope of radiological surveillance in accordance with HSRCM-1 criteria. Regions of B Plant 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.

7.8 Radiological Instrumentation

Radiological instrumentation includes a variety of portable and semi-portable instruments designed to detect the types and energies of radiation present in the B Plant source term. The instrument descriptions provided in this section are intended to provide an overview of the

radiological instrumentation typically available to Radiological Control Technicians at B Plant. 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:

- Cutie Pie (CP) dose rate meters
- Micro-rem meters
- Geiger-Muller counters
- Portable Alpha Meters (PAMs).

Typical dose rate meters are air-filled ionization chambers used to detect beta, gamma and x-ray radiation. Portable dose rate instruments normally measure dose rates between 0.5 mr/hr to 5,000 mr/hr. The typical dose rate instrument responds to photons with energies above 10 keV and beta particles with energies greater than 1 MeV. Field adjustments (made by the Radiological Control Technician) enable the instrument to respond to beta particles with energies greater than 65 keV and photons with energies greater than a few keV.

Pancake Geiger-Muller (GM) contamination survey instruments consist of a count rate meter and a pancake GM detector. Count rate meters typically have three linear ranges calibrated in counts per minute (cpm): 0 to 1,000 cpm, 0 to 10,000 cpm, and 0 to 100,000 cpm. A typical efficiency for the pancake GM detector is about 8% for Th-230 and the instrument is primarily used to detect beta-gamma emitters.

Portable alpha emitters (PAMs) normally consist of count rate meters attached to an alpha scintillation detector. Nominal efficiency for PAMs is approximately 7% and they are sensitive to alpha emitters over a range of 0 to 100,000 counts per minute.

Air sampling instrumentation includes continuous air monitors designed to detect and measure airborne particulate concentrations of beta-emitting radionuclides in the presence of ambient gamma fields. The air monitors are equipped with visual and audible annunciators that warn personnel of a rise in airborne concentrations. Beta efficiencies range from 20% to 25% for Tc-99, Cs-137, Cl-36, and Sr-90.

B Plant is a deactivated facility that is not normally occupied. Therefore, there are no fixed-building occupational radiation protection instruments (area monitors, air monitors) in service.

Maintenance and calibration of radiological instrumentation is contracted to site service organizations that administrate DOE approved maintenance/calibration programs. The site service organizations maintain all required records as part of their service contract. Field source checks and function checks (performed by radiological control technicians and instrument technicians) are performed by established procedures and are documented in accordance with HSRCM-1 criteria.

7.9 Radiological Protection Record Keeping

Radiological control records are maintained as necessary to document compliance with the requirements of 10 CFR 835. Record keeping standards are specified by HSRCM-1 and are

administrated in accordance with DOE 1324.2A Records Disposition (DOE 1324.2A) retention criteria. The radiological control organization provides records management services for records directly applicable to occupational radiation protection.

7.10 Occupational Radiation Exposures

B Plant is a deactivated facility that is rarely occupied. Most entries into B Plant are restricted to surveillance activities in the B Plant galleries where dose rates average less than 0.5 mrem/hr. Annual collective exposure for personnel performing surveillance and maintenance activities in the B Plant galleries is expected to be at or below 500 mrem.

Entries into the High Radiation Areas within the B Plant canyon are not anticipated over the course of the surveillance and maintenance mission. Therefore, no exposure is anticipated for entries into the canyon.

The only significant dose-intensive activity under the surveillance and maintenance mission at B Plant is the building ventilation filter change. Collective dose rates for the filter exchanges may vary depending on a number of variables including the Curie content in the filters at the time of exchange. Reasonable exposure estimates for the filter exchanges is approximately 700 mrem collective exposure per filter change. Approximately two filter changes per year are anticipated.

Based on the information provided above, the estimated annual collective exposure for B Plant is 1.2 rem/year. Historical data (i.e, prior to 10/01/98) is not an accurate guide in estimating exposure for B Plant because the historical data include exposures from work in the B Plant canyon where the dose rates are in excess of 100 mrem/hr. Therefore, the annual exposure estimate is based entirely on known dose rates in/around the galleries and filter banks. The estimate assumes no entries into the B Plant canyon and minimum activities in radiation areas during surveillance and maintenance of B Plant as a deactivated facility.

8.0 HAZARDOUS MATERIAL PROTECTION

8.1 Introduction

Policies and procedures governing this subject are maintained on the Hanford Intranet for companies, such as BWHC, that are under contract with the Project Hanford Management System (PHMS). B Plant administrates hazardous material protection programs in accordance with the PHMS and facility programs and procedures. Facility programs are described in the Waste Encapsulation and Storage Facility (WESF) Project Administration manual, FSP-WESF-001 (FSP-WESF-001).

As stated in the Executive Summary, Section E.5, B Plant will be operated under FDH by BWHC until the facility is transferred to BHI. The transfer is anticipated to occur by March 31, 1999. Upon transfer, this chapter will be void and the respective sections of Appendices B and C become active.

This chapter describes the essential elements of the Hazardous Material Protection program as it relates to the operation of B Plant. Hazardous material protection for B Plant is obtained through implementation of site and facility specific environment, safety and health protection programs. The goal is to protect workers and the environment from uncontrolled exposure to hazardous materials.

Hazardous substances or materials referred to in this section are those materials that pose a hazard to workers, the public, or the environment, because of their chemical properties.

8.2 Requirements

DOE Orders and Titles pertaining to Hazardous Material Protection are given in the following:

DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards*

DOE Order 5483.1A, *Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities.*

Requirements pertaining to occupational exposure to chemicals are addressed in the American Conference of Governmental Industrial Hygienists Threshold Limit Values [ACGIH-TLVS]).

8.3 Hazardous Material Protection and Organization

There is no chemical processing in the B Plant S&M Phase mission. The known chemicals have been removed or stabilized. If unexpected chemicals are found during the S&M phase, removal, stabilization or treatment may be performed.

Hazardous material control is implemented at B Plant in accordance with the Safety Program, the Hazard Communication Program and a hazardous material procurement procedure. These are found in FSP-WESF-001, *B Plant/WESF Project Administration.*

B Plant operations involving hazardous material management will be reviewed by an Industrial Hygienist. The hygienist is responsible for evaluating potential facility hazards; identifying

appropriate monitoring procedures to ensure compliance with all pertinent exposure limits, and ensuring that areas with such hazards are properly posted and that access is controlled appropriately.

Industrial Hygiene responsibilities relevant to hazardous materials protection include the following:

- Hazard evaluations
- Job hazards analyses
- Hazardous material identification, monitoring, and control
- Hazardous material assessments (under emergency conditions)
- Facility program implementation/administration.

B Plant personnel are responsible for safe facility operation. The B Plant 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 B Plant organizational structure is described in Chapter 17.

8.4 ALARA Policy and Program

The Radiological ALARA Program principles (see section 7.4) are applied to hazardous material activities.

8.5 Hazardous Material Training

Safety training is provided to B Plant employees in accordance with the PHMC safety training program. The safety training program consists of courses in general safety awareness, nuclear safety, and courses dealing with hazardous materials and waste.

Employees who routinely work with hazardous chemicals or materials and/or who may contact hazardous material during a foreseeable emergency receive general classroom training (i.e., hazard communication and waste management awareness training) as well as facility- or job-specific hazard training.

Facility- or job-related hazard training is provided by the manager, supervisor, safety trainer, or other qualified individual. Employees receive on-the-job, area-specific training for the chemical hazards they work with or that are present in their work area. Chapter 12 describes procedures and training aspects that are applicable to this subject.

8.6 Hazardous Material Exposure Control

8.6.1 Hazardous Material Identification Program

The WESF Project Administration manual, FSP-WESF-001 and the PHMS contain policies and procedures for identifying and evaluating hazardous materials.

8.6.2 Administrative Limits

Requirements pertaining to occupational exposure to chemicals are addressed in the PHMC policies and procedures and in the WESF Administration manual, FSP-WESF-001. These documents define management and personnel requirements and responsibilities for safe handling of these chemicals, including information on training, safe handling, concentration and contamination limits, medical surveillance programs, personal protective equipment and emergency procedures.

8.6.3 Occupational Medical Programs

The PHMS procedure HNF-PRO-111, *Occupational Medical Qualification and Monitoring* establishes the requirements for a medical program at Hanford. This program defines the process for determining and obtaining necessary employee medical qualifications and monitoring based on the job requirements, hazards, exposures, and overall risk associated with their assigned workscope. This program also introduces and directs the use of an automated employee job task analysis (EJTA) which supports the collection of the data necessary for a risk based approach to medical qualification and monitoring. Records of worker toxicological material exposure, including the results of lab analyses from personal monitoring, are kept as part of the Medical Records Program.

The Occupational Medical Contractor is responsible for the following:

1. Schedule medical qualification examinations and medical monitoring based on the data provided through the EJTA.
2. Remove employees from medical program placement when warranted based on EJTA information and other relevant medical information.
3. Report results of medical examinations and monitoring to employees and line management including the following:
    - Occupationally related information such as medical qualification and monitoring results, medical opinions, and other information regarding medical conditions that would place the employees's health at risk from working in the occupational environment.
    - Determinations regarding the employee's physical and mental health and their ability to safely and reliably perform the assigned job tasks and physical job requirements in accordance with the Americans with Disabilities Act of 1990 and Fitness For Duty.
    - The adequacy of hazard control measures based on individual employee health data and populations based health data.
4. Maintain medical records in accordance with the applicable OSHA and DOE requirements.

8.6.4 Respiratory Protection

The B Plant respiratory protection program requires that the use of respiratory protection be

planned in advance of an activity to protect employees against the inhalation of harmful air contaminants and against oxygen deficient atmospheres. Only respirators approved by the National Institute for Occupational Safety and Health and/or the Mine Safety and Health Administration are used. Employees are medically screened, fit-tested, and trained before using respirators. Respirator and cartridge selection for non-radiological hazards is performed by the B Plant industrial hygienist. An independent annual appraisal of the respiratory protection program is conducted to assess compliance with DOE-mandated standards. Respiratory protection is covered in Section 7.6.4.

8.7 Hazardous Material Monitoring

The known hazardous materials remaining in B Plant have been stabilized as documented in the deactivation end points files. The files include information about storage location, product name, manufacturer, chemical constituents, physical state, container description, and total quantity for all hazardous chemical products stored in the facility.

Surveillance will be conducted to monitor the facility for evidence of uncontrolled hazardous materials. The surveillance program is described in Chapter 10.

8.8 Hazardous Material Protection Instrumentation

Hazardous material instrumentation may be needed during S&M activities. Industrial Hygienists trained to use the instruments ensure that appropriate instruments are used and that the instruments meet the control, use, and calibration requirements of institutional standards and PHMS policies and procedures.

8.9 Hazardous Material Protection Record Keeping

Hazardous materials records and reports are developed, approved, and dispositioned in accordance with the PHMS policies and procedures and FSP-WESF-001. The records and reports are used in work planning, configuration management, and job hazard analyses when needed.

8.10 Hazard Communication Program

A written facility specific Hazard Communication (HazCom) procedure in FSP-WESF-001 has been implemented and is maintained for the work areas in the B Plant facility. The HazCom and waste management awareness training introduces personnel to worker rights and to requirements governing chemical safety in the workplace.

8.11 Occupational Chemical Exposures

There are no occupational chemical exposures anticipated during the S&M phase. The known chemical hazards were removed or stabilized when the facility was deactivated. Industrial Hygienists will participate in the S&M activities in case unknown chemicals are encountered.

9.0 RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

9.1 Introduction

Policies and procedures governing this subject are maintained on the Hanford Intranet for companies, such as BWHC, that are under contract with the Project Hanford Management System (PHMS). B Plant administrates health and safety programs in accordance with the PHMS and facility programs and procedures. Facility programs are described in the Waste Encapsulation and Storage Facility (WESF) Project Administration manual, FSP-WESF-001 (FSP-WESF-001).

As stated in the Executive Summary, Section E.5, B Plant will be operated under FDH by BWHC until the facility is transferred to BHI. The transfer is anticipated to occur by March 31, 1999. Upon transfer, this chapter will be void and the respective sections of Appendices B and C become active.

This chapter provides a general overview of the radioactive and hazardous waste management program in place at B Plant.

Radioactive and hazardous waste management involves various aspects of environmental protection, radiation protection, ALARA, occupational safety and health. The programmatic approach to radioactive and hazardous waste management is contained in the policies and procedures of the PHMS.

Radioactive and hazardous waste programs specifically applied at B Plant are presented in FSP-WESF-001.

9.2 Requirements

Requirements pertaining to Radioactive and Hazardous Waste Management are given in the following DOE Orders and Titles:

DOE Order 5400.1, *General Environmental Protection Program*

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 Protection Standards*

DOE Order 5820.2A, *Radioactive Waste Management.*

9.3 Radioactive and Hazardous Waste Management Program and Organization

A Fluor Daniel Hanford procedure, *Hanford Site Solid Waste Acceptance Criteria*, HNF-EP-0063, sets forth the baseline criteria for acceptance of radioactive waste at treatment, storage, and/or disposal (TSD) facilities that manage low-level or transuranic waste. Because B Plant may generate waste that would be sent to a TSD facility, B Plant must comply with the criteria in HNF-EP-0063.

The programs for managing radiological and hazardous waste at B Plant are a compilation of

nuclear safety, occupational safety and health, and environmental protection, programs, policies, and procedures. These programs, policies and procedures are established and maintained as PHMS, and B Plant specific documents.

The B Plant organizational structure is provided in Chapter 17.

9.4 Radioactive and Hazardous Waste Streams and Sources

9.4.1 Waste Management Process

B Plant is in the S&M phase. During this phase surveillance and maintenance will monitor the remaining inventories and hazards to ensure the hazards remain stabilized.

9.4.2 Waste Sources and Characteristics

There are solid, liquid and gaseous wastes expected from B Plant during the S&M phase. These wastes may be radioactive, hazardous, and/or mixed waste.

Waste sites associated with B Plant are listed in Table 2-1. The waste sites will be monitored during the S&M phase to ensure contamination containment is maintained.

9.4.2.1 Solid Waste

B Plant personnel may generate small quantities of low-level radioactive waste during S&M activities at B Plant. Solid wastes generated during normal S&M activities are expected to be minimal, such as radiation protection clothing (e.g., tape), or HP contamination sampling swabs.

Canyon Exhaust System HEPA filters may require a change-out if dose rates or differential pressure reach operating procedure set points. This operation is expected to occur infrequently, as loading of these filters is expected to be minimal.

Used lamps from the surveillance lighting systems will be disposed. There may be asbestos clean up if asbestos becomes friable. There may be used batteries from flashlights. There may be dead animals and animal excrement that may need to be cleaned up.

9.4.2.2 Liquid Waste

There are no liquid effluent discharges from the facility. There are no expected significant liquid wastes from B Plant. There may be small leaks in the galleries from pipes if liquids were overlooked during deactivation. There may be some accumulation in Cell 10 in the canyon, but it is unexpected that the accumulation will need to be mitigated.

There may be chemicals and fluids that leak from pipes, vessels, gauges, or equipment, if these materials were overlooked during deactivation and are found during S&M activities. Rainwater may leak into the buildings.

All gauges known or suspected of containing "red oil" have been drained.

9.4.2.3 Gaseous Waste

There is an active HEPA filtered air exhaust from the canyon exhaust system. There is a passive vent from the retired filters. These are permitted discharges. The radiological inventory is shown in Table 3.3-3.

9.4.3 Waste Handling or Treatment Systems

Solid and liquid wastes will be packaged and dispositioned in accordance with PHMS and facility waste disposition procedures. The air discharges from the canyon and retired filters' vaults are HEPA filtered and monitored in accordance with PHMS and facility procedures. While B Plant is operated by BWHC, WESF waste handling procedures and areas will be used.

Waste minimization is integrated into all S&M activities by minimizing use of hazardous materials, preventing further generation of radiologically contaminated materials, and segregating hazardous waste from radioactive waste to minimize mixed wastes.

If liquid wastes are generated, special means of transferring liquid waste will be provided, because all transfer pipe routes from B Plant were isolated during facility deactivation.

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10.0 IN-SERVICE SURVEILLANCE AND MAINTENANCE

10.1 Introduction

Policies and procedures governing this subject are maintained on the Hanford Intranet for companies, such as BWHC, that are under contract with the Project Hanford Management System (PHMS). B Plant administrates health and safety programs in accordance with the PHMS and facility programs and procedures. Facility programs are described in the Waste Encapsulation and Storage Facility (WESF) Project Administration manual, FSP-WESF-001 (FSP-WESF-001).

As stated in the Executive Summary, Section E.5, B Plant will be operated under FDH by BWHC until the facility is transferred to BHI. The transfer is anticipated to occur by March 31, 1999. Upon transfer, this chapter will be void and the respective sections of Appendices B and C become active.

This chapter describes testing, in-service surveillance, and maintenance programs and procedures designed and implemented to support defense in depth protection of the workers, onsite personnel, the public, and the environment.

10.2 Requirements

Requirements pertaining to In-Service Surveillance and Maintenance are given in DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*.

In-Service Surveillance and Maintenance requirements are also given in Site Programmatic documents: Maintenance and Operations Procedures and policies in the PHMS System.

10.3 Initial Testing Program

The B Plant initial testing program ensures operability of facility modifications prior to service and ensures that adequate testing is conducted to support facility safety management.

When a new system or a significant modification to an existing system is installed, testing is planned, controlled, and documented through the engineering process and the test control procedure, HNF-PRO-446, *Testing Requirements*. The content of the test program is determined by the size, complexity and technical risk associated with the test. Upon identification and training of the test team and execution of the test, the program requires documented review and analysis of the written test results to verify acceptability of the SSCs.

The site program and procedure for operational readiness reviews or readiness assessments will be implemented prior to the startup or restart of the facility.

10.4 In-Service Surveillance Program

Operational surveillance and maintenance programs are controlled through the facility's Job Control System (JCS).

The B Plant in-service surveillance program relies primarily on an automated recall system for identifying, changing, reporting and closing out in-service surveillance activities. The JCS recall

system is a computerized automated database processing system that includes a module designated "preventive maintenance and surveillance."

Information is entered into the recall system through a system-specific form which is completed by appropriate B Plant staff. All technical changes require approval of the system engineer. Reports are generated on a regularly scheduled basis and work is planned in advance. Upon completion of the surveillance, the recall system is updated to contain evidence of the completed activity.

10.5 Maintenance Program

The B Plant in-service preventative maintenance program relies primarily on an automated recall system for identifying, changing, reporting and closing out maintenance activities. The JCS recall system is a computerized automated database processing system that includes a module designated "preventive maintenance and surveillance."

Information is entered into the recall system through a system-specific form which is completed by appropriate B Plant staff. All technical changes require approval of the system engineer. Reports are generated on a regularly scheduled basis and work is planned in advance. Upon completion of the maintenance, the recall system is updated to contain evidence of the completed activity.

11.0 OPERATIONAL SAFETY

11.1 Introduction

Policies and procedures governing this subject are maintained on the Hanford Intranet for companies, such as BWHC, that are under contract with the Project Hanford Management System (PHMS). B Plant administrates health and safety programs in accordance with the PHMS and facility programs and procedures. Facility programs are described in the Waste Encapsulation and Storage Facility (WESF) Project Administration manual, FSP-WESF-001 (FSP-WESF-001).

As stated in the Executive Summary, Section E.5, B Plant will be operated under FDH by BWHC until the facility is transferred to BHI. The transfer is anticipated to occur by March 31, 1999. Upon transfer, this chapter will be void and the respective sections of Appendices B and C become active.

This chapter describes Conduct of Operations provisions and Fire Protection capabilities at B Plant.

11.2 Requirements

Requirements pertaining to Operational Safety are given in the following DOE Orders and Titles:

DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*

DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards*

DOE Order 5480.7A, *Fire Protection*

DOE RLID 5480.7, *Fire Protection*

Operational Safety requirements are also given in Site Programmatic documents: Operational Safety, Fire Protection, and Conduct of Operations Procedures and policies in the PHMS System.

11.3 Conduct of Operations

Conduct of Operations at B Plant are governed in accordance with the FASTER Facilities Conduct of Operations Graded Approach Applicability Summary, BWHC-9856618 (Smith 1998). The summary is a matrix which identifies which chapters of 5480.19 are applicable to B Plant and which PHMS or facility procedures implement the 5480.19 chapters. Aspects of operations conduct are managed and controlled through the B Plant/WESF Project Administration manual, FSP-WESF-002 and PHMS procedures.

Safe S&M operations are achieved through the integration of safety into every operation. Each member of the B Plant teams is accountable for safety performance and is responsible for ensuring compliance with established procedures, practices, and planning documents. The B Plant team is required to monitor and maintain the facility in compliance with appropriate federal, DOE, state, and local statutes, regulations, orders and contractual obligations.

The B Plant organizational structure is described in Chapter 17. Other organizations outside the

B Plant facility teams provide safety related support to the B Plant S&M activities. This support includes the following: safety analysis and risk assessments for the facilities including radiological dose consequence analyses, criticality analyses, and shielding analyses; interpreting DOE orders and developing guidance for compliance with applicable regulatory requirements; providing guidance, direction, assessments and audits of facility-specific quality assurance programs and program implementation.

Development and implementation of the conduct of operations program is the responsibility of the B Plant team. The B Plant team is tasked with monitoring and assessing work performance. The B Plant employees are responsible for managing, operating, and maintaining the facility in a safe and efficient manner within the framework of the conduct of operations program.

The B Plant conduct of operations program provides effective implementation and control of operating activities through the establishment and communication of written standards and goals in operations; through the performance and communication of periodic inspections, reviews, investigations and self-assessments of operating performance; and by establishing a process for enforcing personnel accountability for performance.

Shift routines, operations turnover, control area activities, aspects of unique operations or processes, and operating practices (including response to emergencies) are specified and communicated to facility personnel.

Communications to personnel is performed by pager, meetings, distributions, postings, phone, or over the public address system. All areas have adequate coverage for alarms ensuring that employees are notified in case of an emergency.

Procedures are documented and implemented for independent verification, control of equipment and system status, lockouts and tagouts, equipment and piping labeling, and log keeping and recording of operational activities. A system is in place for communicating timely orders to operations personnel.

Additional skill development is provided to facility personnel through operator aid postings, ongoing training, and required reading notifications.

11.4 Fire Protection

Fire protection is mandated by DOE Order 5480.7A, *Fire Protection* and in RLID 5480.7, *Fire Protection*. The DOE fire protection requirements are implemented on the Hanford site by compliance with the fire protection requirements in the policies and procedures identified in the PHMS system, which is maintained current on the Hanford Intranet.

B Plant maintains a fire hazards analysis (FHA) for the facility (BWHC 1999a). The FHA has been prepared specifically for S&M phase. The FHA describes the current fire hazards present in B Plant; the postulated potential extent of fire damage; and the impact of candidate fires on safety SSCs.

11.4.1 Fire Hazards

The FHA evaluated worst case postulated fires using qualitative analysis and quantitative modeling. The FHA conclusions show that there are no significant fire hazards and no expected radiological or toxicological releases to the environment. The deactivated facility contains no significant combustible loads or fire hazards.

The hazards and accident analyses of Chapter 3 also conclude that there is no significant risk of radiological release consequences or hazards to workers from fire hazards at B Plant.

11.4.2 Fire Protection Program and Organization

Fire Protection for the B Plant Complex is addressed in HNF 1999a.

The fire hazards at B Plant were reduced as much as possible to minimize fire potential and reliance on active fire prevention systems and departments.

The Hanford Fire Marshall and Fire Department (HFD) were intricately involved during B Plant deactivation. Through the HFD and the Department of Energy - Richland Operations (RL), the B Plant facility was devalued and all fire systems, except external fire hydrants, were deactivated (HNF 1999a). All B Plant fire prevention activities are conducted in accordance with PHMS and facility fire program procedures. When required, the HFD is involved in fire protection activities.

11.4.3 Combustible Loading Control

Combustible loading in deactivated facilities is managed to remain compliant with the PHMS policies and procedures, facility specific procedures and the facility FHA. Work activities involving combustibles will ensure the combustible loading configuration, if changed, is compliant with these policies, procedures, and the FHA.

11.4.4 Fire Fighting Capabilities

The Hanford Fire Department (HFD) is responsible for fire system inspection, testing, maintenance, and repair activities of fire suppression systems, hazardous material (HAZMAT), emergency rescue and medical response for the Hanford Site, and administering the fire prevention program.

11.4.5 Fire Fighting Readiness Assurance

The HFD has stations located strategically across the Hanford Site. The main fire station is located between the 200 East and 200 West Areas. The other stations are located at the 100, 300, and 400 Areas. The department is staffed on a 24-hour, 7-day basis. The HFD Marshal is available to assist in resolving fire prevention concerns.

B Plant personnel do not have work locations in any deactivated buildings, only in office buildings. B Plant personnel participate in WESF fire drills conducted by the WESF administration. The HFD is responsible for frequency and testing of the fire hydrants, which are the only active fire systems. The HFD maintains those records.

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12.0 PROCEDURES AND TRAINING

12.1 Introduction

Policies and procedures governing this subject are maintained on the Hanford Intranet for companies, such as BWHC, that are under contract with the Project Hanford Management System (PHMS). B Plant administrates health and safety programs in accordance with the PHMS and facility programs and procedures. Facility programs are described in the Waste Encapsulation and Storage Facility (WESF) Project Administration manual, FSP-WESF-001 (FSP-WESF-001).

As stated in the Executive Summary, Section E.5, B Plant will be operated under FDH by BWHC until the facility is transferred to BHI. The transfer is anticipated to occur by March 31, 1999. Upon transfer, this chapter will be void and the respective sections of Appendices B and C become active.

This chapter describes the B Plant programs for developing and maintaining administrative and operating procedures. Through implementation and continued use of these programs, consistent and compliant S&M activities protect the workers, the public, and the environment.

The B Plant programs supporting procedures and training control are detailed in FSP-WESF-001. Brief descriptions of the programs are contained in the following subsections.

12.2 Requirements

Requirements pertaining to Procedures and Training are given in the following DOE Orders and Titles:

DOE-STD-1029-92, *Writer's Guide For Technical Procedures*

DOE Order 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*

DOE-HDBK-1078-94, *Training Program Handbook: A Systematic Approach to Training*

DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities.*

Procedure and Training requirements are also given in Site Programmatic documents: Quality Assurance and Conduct of Operations Procedures and policies in the PHMS.

12.3 Procedure Program

Administrative procedures are implemented at B Plant for developing and maintaining administrative and operating procedures.

The B Plant technical procedures include, but are not limited to the following:

- Administrative
- Operational
- Surveillance
- Maintenance
- Emergencies

Development and maintenance of the procedures is provided through identification of new activities, periodic reviews of current procedures, and field-identified changes needed to existing procedures. Responsibility for the implementation of the procedure program resides with the B Plant team. A structured review and approval process is used by the B Plant organization for completing new procedures and for revising or upgrading procedures.

Facility administrative and operating procedures are required for all aspects of activities at B Plant. Procedure compliance is mandatory for safe and compliant operations. Safety is the highest priority in facility operations, so safety aspects are incorporated into facility procedures to ensure all hazards are identified, evaluated and controlled. All personnel have Stop Work authority if there is any doubt as to the safety or hazardous conditions of the work to be performed.

12.3.1 Development of Procedures

Procedures are selected for development based on a need to administrate a program, or to monitor, maintain and operate a SSC that supports the safety basis.

Administrative procedures describe the management of non-process functions and activities. All WESF administrative procedures are prepared and processed in accordance with FSP-WESF-001 and PHMS policies and procedures.

Plant operating procedures provide instructions for conducting all S&M related functions. Plant operating procedures are controlled per Chapter 16 of FSP-WESF-002. Chapter 16 describes the processes for development, verification, validation, and approval of operating procedures. Operating procedures cover maintenance, operations, surveillance and emergencies.

FSP-WESF-002, *WESF Conduct of Operations*, Chapter 16, "Operations Procedures" provides guidelines for the preparation of plant S&M procedures, temporary and one-time procedures, and work procedures and work plans. Chapter 16 provides guidance and requirements for writing operating procedures. The chapter assigns responsibilities and provides guidelines. Guidelines include document preparation and document review, including validation and verification, and document approval. The guide also provides guidance for the first use of a procedure.

12.3.2 Maintenance of Procedures

Procedures are maintained and controlled to ensure the latest revisions are used in the field. New and revised procedures are formally presented to the procedure users. All procedure users are trained to the latest revision and new procedures.

12.4 Training Program

The B Plant training program specifies qualifications, experience, and training requirements for personnel, and the records system necessary to document that each individual has and maintains the necessary skills to perform their assignments safely, accurately, and efficiently.

On shift and classroom training is provided in the following areas as appropriate to an employee's assigned duties:

- Training on safety class and safety significant systems, structures and components (SSC)
- Conduct of normal, abnormal, and emergency operations
- Radiation and hazardous material protection
- Surveillance, testing, and maintenance procedures
- Fire protection
- Quality assurance
- Emergency preparedness, including drill programs
- Unreviewed Safety Question (USQ) training.

The B Plant training program provides a method of documenting and maintaining records of an individual's training through the use of qualification cards and/or training completion records.

12.4.1 Development of Training

To assure effective training and qualifications, B Plant Training courses are developed using the Systematic Approach to Training (SAT) model as described in DOE-HDBK-1078-94, *Training Program Handbook: A Systematic Approach to Training* (DOE HDBK 1078), and the requirements of HNF-PRO-172, *Developing Training*.

The training program and materials are developed, verified, and validated in accordance with FSP-WESF-001. The following PHMS procedures are used to analyze, design, develop, implement and evaluate, respectively, the training program.

- HNF-PRO-170, *Analyzing Training Requirements*,
- HNF-PRO-171, *Designing Training*
- HNF-PRO-172, *Developing Training*
- HNF-PRO-173, *Implementing Training*
- HNF-PRO-174, *Evaluating Training*

12.4.2 Maintenance of Training

System subject matter experts and facility operations personnel are involved in the development and validation of the training materials, which ensures the materials reflect actual plant conditions and current procedures.

Training records are maintained in accordance with FSP-WESF-001.

12.4.3 Modification of Training Materials

As procedure deficiencies are recognized during procedure use, they are noted and the deficiency is corrected or scheduled for correction. Periodic procedure assessments also detect deficiencies in the training program and/or materials. Modification of training materials and content is controlled through the implementation of change control procedures covering training programs and methodology (TN-1, subsection 7 in FSP-WESF-001).

13.0 HUMAN FACTORS

13.1 Introduction

Policies and procedures governing this subject are maintained on the Hanford Intranet for companies, such as BWHC, that are under contract with the Project Hanford Management System (PHMS). B Plant administrates health and safety programs in accordance with the PHMS and facility programs and procedures. Facility programs are described in the Waste Encapsulation and Storage Facility (WESF) Project Administration manual, FSP-WESF-001 (FSP-WESF-001).

As stated in the Executive Summary, Section E.5, B Plant will be operated under FDH by BWHC until the facility is transferred to BHI. The transfer is anticipated to occur by March 31, 1999. Upon transfer, this chapter will be void and the respective sections of Appendices B and C become active.

As stated in the guidance of DOE-STD-3009-94 for application of the graded approach for this chapter, the discussion in this chapter is limited to those areas in which human performance plays an important role in ensuring the performance of safety SSCs.

There is only one safety SSC, as shown in Chapter 4.0. The canyon walls are a SS structure to mitigate onsite consequence by providing a building wake function.

Therefore, this chapter will demonstrate human factors that could adversely impact the SS structure designated function and human factors that will protect that function in order to the enhance long term effectiveness of the SS structure.

13.2 Requirements

U. S. Department of Energy 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 5480.22, *Technical Safety Requirements*
- DOE 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 Process,* (DOE 1997a).
- DOE-STD-3009-94, *Preparation Guide for U. S. Department of Energy Nonreactor Facility Safety Analysis Reports,* (DOE 1994a).

Definitions of the site boundary, risk guidelines and other analysis details are taken from Hanford procedures. Specific procedures referenced are:

- HNF-PRO-700, Rev 1, *Safety Analysis and Technical Safety Requirements*
- HNF-PRO-701, Rev 0, *Safety Analysis Process - Existing Facilities*

- HNF-PRO-702, Rev 0, *Safety Analysis Process - Facility Change or Modification*
- HNF-PRO-704, Rev 0, *Hazard and Accident Analysis Process*
- HNF-PRO-517, Rev, 0 *Safety Analysis Program Glossary*.

13.3 Human Factors Process

Whenever possible passive design features are the first level of defense for reliance on significant prevention and/or mitigation. If an active system is relied upon, then fail safe features are incorporated whenever possible. As a lower level of defense, human interaction can be incorporated. When human interaction is relied upon to respond to an emergency, then human factors are considered in the system design. Human factors are also incorporated into non-emergency operating systems design.

Consideration of the operator's ability to reliably operate B Plant systems and equipment, and how operator actions may affect facility safety, is integrated into the processes that guide engineering, safety, and operations functions at B Plant. B Plant engineering organizations ensure that operator capabilities and limitations are considered in the design, modification, and operation of B Plant facilities and equipment.

13.4 Identification of Human-Machine Interfaces

Section 3.4.2.6 contains analysis of the canyon roof collapse due to excessive loading on the roof. The loading is postulated to be caused by buildup of volcanic ash or snow. The roof collapses, but the walls are credited to remain standing, thus providing building wake. The walls are designated as SS structures. There are no human machine/structure interfaces involved with the scenario or prevention or mitigation.

During the S&M phase, personnel are to inspect the walls to detect structural degradation and prevent or mitigate the degradation to maintain the walls and structural integrity as much as possible.

13.5 Optimization of Human-Machine Interfaces

Personnel will be best able to detect structural degradation given sufficient baseline conditions material, training and appropriate inspection tools.

14.0 QUALITY ASSURANCE

14.1 Introduction

Policies and procedures governing this subject are maintained on the Hanford Intranet for companies, such as BWHC, that are under contract with the Project Hanford Management System (PHMS). B Plant administrates health and safety programs in accordance with the PHMS and facility programs and procedures. Facility programs are described in the Waste Encapsulation and Storage Facility (WESF) Project Administration manual, FSP-WESF-001 (FSP-WESF-001).

As stated in the Executive Summary, Section E.5, B Plant will be operated under FDH by BWHC until the facility is transferred to BHI. The transfer is anticipated to occur by March 31, 1999. Upon transfer, this chapter will be void and the respective sections of Appendices B and C become active.

QA encompasses all those planned and systematic actions and controls necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily in service. QA includes *quality control*, which includes actions needed to ensure that the physical characteristics of a material, structure, component, or system meet predetermined requirements.

Title 10, Code of Federal Regulations, Part 830.120 (10 CFR 830.120), *Quality Assurance Requirements*, applies to B Plant. The PHMC Quality Assurance Program is described in HNF-MP-599, *Project Hanford Quality Assurance Program Description*. Each major subcontractor (MSC) describes their QA program in Quality Assurance Program Plans (QAPP), specific to the MSC scope of work that are compliant to the PHMC QAPD. Implementation is achieved through PHMC procedures, MSC implementing procedures, and work control documents.

The *Facility Stabilization Project Quality Assurance Program Plan* (QAPP), FSP-MP-004, Rev. 0 (FSP-MP-004) defines the application of the QAPD to the BWHC scope of work.

B Plant does not have a facility specific QAPP, but uses the Waste Encapsulation and Storage Facility (WESF) approved QAPP that implements the PHMC QAPD.

14.2 Requirements

Quality Assurance Program requirements applicable to B Plant include:

10 CFR 830.120, *Quality Assurance Requirements*.

FSP-MP-004, *Facility Stabilization Project Quality Assurance Program Plan*.

HNF-MP-599, *Project Hanford Quality Assurance Program Description*.

HNF-SD-WM-QAPP-037, *Quality Assurance Program Plan Waste Encapsulation and Storage Facility*

14.3 Quality Assurance Program and Organization

In compliance with the requirements of QAPD, Part 2, Section 1, QA Program, FSP-MP-004 documents the BWHC Quality Assurance Program, including the BWHC organization, functional responsibilities, and interfaces for implementing the Program. In addition, it identifies procedures and management systems used to implement the program. The B Plant organizational structure is described in Chapter 17.

14.4 Quality Improvement

The quality improvement processes established by BWHC meet the requirements of the QAPD, Part 2, Section 3.0, Quality Improvement.

Processes to detect and prevent quality problems have been established and implemented. Items, services, and processes that do not meet established requirements and are categorized as deficiencies, are identified, tracked and controlled, and corrected in accordance with the graded approach. Correction includes identifying the root cause of the problem and providing measures to prevent recurrence. Quality related information and trends are reviewed and the data analyzed to identify items, services, and processes needing improvement.

Deficiency identification, response, and action verification are documented and tracked in the PHMC deficiency tracking system managed by FDH. Nonconforming items are controlled using documented and approved procedures to prevent their inadvertent installation or use. The status of nonconforming items is tracked to closure.

14.5 Documents and Records

B Plant management is responsible for ensuring that documents and records are generated and maintained in compliance with the requirements of the PHMC QAPD, Part 2, Section 4.0, Documents and Records. This includes ensuring that:

- documents that define processes, specify requirements, or establish design are identified, prepared, reviewed, approved, issued, used, and revised when needed.
- records are specified, identified, prepared, reviewed, approved, controlled, and maintained.

14.6 Quality Assurance Performance

14.6.1 Work Processes

Work processes are performed in accordance with established technical standards and administrative controls using approved instructions, procedures, or other appropriate means. Items are identified and controlled to ensure their proper use and items are maintained to prevent their damage, loss, or deterioration. Equipment used for process monitoring or data collection is calibrated and maintained. Work management process for B Plant is defined in FSP-WESF-001.

The work process established at B Plant incorporates quality assurance and safety policies and procedures to ensure all hazards during installation and operation are recognized and resolved.

An automated job hazards analysis (AJHA) process is used. The AJHA integrates hazard analysis into the work planning process. Work process administrative procedures and maintenance procedures are established to ensure appropriate approvals and processes are maintained. This program ensures tasks are performed, under controlled conditions, with applicable tools and calibrated instruments, in accordance with established technical standards and administrative controls. The work processes established by BWHC meet the requirements of the QAPD, Part 2, Section 5.0, Work Processes.

14.6.2 Design

Control mechanisms are established to ensure that:

- design inputs are correctly translated into design documents in a timely manner
- organizational and physical interfaces are identified and controlled
- changes to design are controlled in a manner commensurate with the original design
- the design is independently verified to be adequate
- documentation and records of the design and design verification processes are maintained in accordance with the QA program.

Quality assurance is integrated into design activities. Design standards and impacts are specified and incorporated into the products. Designs are reviewed, verified/validated, and approved prior to implementation. Design changes are controlled to ensure the results meet the specifications of the design, or the specifications must be changed and approved. Depending on the complexity and safety significance of SSCs, a graded approach of quality assurance is applied. Design control process for B Plant as defined in FSP-WESF-001, meet the requirements of the QAPD, Part 2, Section 6.0, Design.

14.6.3 Procurement

Quality Assurance is integrated into the procurement process using a graded approach commensurate with the safety classification of SSCs. Procured items and services must meet established requirements and perform as specified. Prospective suppliers are evaluated and selected based on their ability to comply with specified criteria. Processes to ensure that approved suppliers continue to provide acceptable items and services are established and implemented. Procurement activities are conducted in accordance with applicable PHMC and FSP-WESF-001 procedures that are in compliance with PHMC QAPD, Part 2, Section 7.0, Procurement.

14.6.4 Inspection and Testing for Acceptance

Inspection and testing of specified items, services, and processes are conducted using established acceptance and performance criteria. Equipment used for inspections and tests are calibrated and maintained. Inspection and testing are conducted in accordance with applicable PHMC and FSP-WESF-001 procedures that are in compliance with PHMC QAPD, Part 2, Section 8.0, Inspection and Acceptance Testing.

14.6.5 Management Assessment

Management assessment processes are established and implemented by FDH and its

subcontractors. Facility management is responsible for planning, scheduling, and conducting assessments of their management systems and processes to identify, track, and correct problems. FDH and the subcontractors are responsible for implementing assessments compliant with the PHMC QAPD, Part 2, Section 9.0, *Management Assessments*.

14.6.6 Independent Assessment

Independent assessments are planned and conducted by FDH. External assessments, including independent assessments are performed to measure adequacy of work performance, evaluate item and service quality, and promote improvement. The groups performing these assessments at B Plant are sufficient authority and freedom from the MSC to carry out their responsibilities. FDH is responsible for implementing, and FDH subcontractors are responsible for supporting, independent assessments in accordance with the PHMC QAPD, Part 2, Section 10.0, *Independent Assessments*.

15.0 EMERGENCY PREPAREDNESS PROGRAM

15.1 Introduction

Policies and procedures governing this subject are maintained on the Hanford Intranet for companies, such as BWHC, that are under contract with the Project Hanford Management System (PHMS). B Plant administrates health and safety programs in accordance with the PHMS and facility programs and procedures. Facility programs are described in the Waste Encapsulation and Storage Facility (WESF) Project Administration manual, FSP-WESF-001 (FSP-WESF-001).

As stated in the Executive Summary, Section E.5, B Plant will be operated under FDH by BWHC until the facility is transferred to BHI. The transfer is anticipated to occur by March 31, 1999. Upon transfer, this chapter will be void and the respective sections of Appendices B and C become active.

This section provides a summary of the emergency preparedness and response program, including descriptions of the major features of the program.

The emergency preparedness program consists of the PHMC emergency program and the facility emergency preparedness program.

15.2 Requirements

Emergency planning is required by:

DOE Order 151.1, *Comprehensive Emergency Management Program,*

DOE/RL-94-02, *Hanford Emergency Response Plan*, as amended (DOE/RL-94-02).

15.3 Scope of Emergency Preparedness

The hazards at B Plant are identified in the BPC, the B Plant/WESF Hazards Assessment Chapter 3. Hazardous events are grouped as operational events, natural phenomena, and security events. The primary operational hazards of concern are: (1) fire and/or explosion in the underground HEPA filters and, (2) natural phenomena. The primary natural phenomena are seismic, volcanic, high winds/tornados, floods, range fire, and aircraft crash. The primary security events are bomb threat, hostage situation, and suspicious object events.

For the primary operational and natural phenomena events, postulated accidents are analyzed in Chapter 3 to identify dose consequences to the onsite worker and the offsite general population. The worst case accidents at B Plant are canyon roof collapse (3.4.2.6) and a design basis earthquake (3.4.2.7), both accidents could have onsite radiological releases.

15.4 Emergency Preparedness Planning

The Hanford site emergency preparedness program is documented in the PHMS system, particularly procedure HNF-PRO-424, *Emergency Preparedness Program*.

The DOE Orders require an emergency planning hazards assessment document for each facility

that has the potential to reach or exceed the lowest level of emergency classification. The *B Plant/WESF Hazards Assessment*, HNF-SD-PRP-HA-008 (HNF 1997b) provides the required assessment. The assessment recognizes the hazards and accident scenarios of the facility authorization basis documents, compares the hazards/scenarios consequences to the emergency classification criteria and designates the appropriate Emergency Action Level (EAL). There are three levels of classified emergencies. In the order of least to most severe, they are Alert Emergency, Site Area Emergency and General Emergency. After designating the EALs, an Emergency Planning Zone (EPZ) is established for the facility. The B Plant/WESF complex EPZ is within the EPZ for the Hanford 200 Area, which has a 16.1 km (10 mi.) radius. Therefore, the 200 Area EPZ is designated to be the B Plant/WESF EPZ. This is explained in the *B Plant/WESF Hazards Assessment*.

The *B Plant Complex Emergency Plan*, HNF-IP-0263-BPC (BPC), (WHC 1994d), documents the B Plant-specific emergency plan. The emergency plan provides employees and visitors information necessary to react to emergency situations in order to do the following:

- Maximize employee safety, minimize risk to life, and provide prompt and efficient treatment for injured persons
- Ensure continuity of leadership at all times and in all emergency situations
- Minimize the effects of an accident on the health and safety of the general public and the environment
- Minimize property damage
- Ensure prompt internal and external communications with responsible authority.

The BPC addresses building evacuation routes, employee requirements, potential emergency conditions, emergency plan implementation, emergency resources, emergency response plans, termination of emergency, accident recovery, post-event analysis, and reporting requirements.

15.4.1 Emergency Response Organization

The Hanford Site emergency response organization has been developed to allow the facility contractors to continue their management and operational roles in the event of an emergency.

The Hanford Site emergency response organization and the roles and responsibilities of the organization are described in DOE-0223. Section 1.1 of DOE-0223 describes the Hanford Incident Command System (ICS) and defines the roles and responsibilities of the ICS functions, including requirements for emergency response actions, communications and notifications. Section 2.0 of DOE-0223 describes the function of the RL Emergency Operation Center.

The B Plant emergency preparedness program is developed, implemented and maintained in coordination with the Hanford Site emergency response organization. The program requires the identification of a Building Emergency Director (BED) and designated alternates. The BED or alternates have overall responsibility for implementing the B Plant emergency response plan. The BEDs have the authority to commit all necessary resources (both equipment and personnel) to respond to any emergency. The HFD personnel have the authority to commit all necessary resources (both equipment and personnel) to respond to any emergency. The BED is also supported by designated staging area managers and personnel accountability aides. In the event of an emergency on any shift, the BED has support from the Hanford Site emergency response organization.

15.4.2 Assessment Actions

An emergency response is activated when the BED has determined that a radiological or hazardous release, fire, or explosion that could threaten human health or the environment has occurred at the facility. An incident requiring evacuation of personnel or the summoning of emergency response units will not necessarily indicate that the plan has been activated.

The emergency response plan is implemented whenever the BED determines that the severity of the incident is or will be a potential to endanger human health or the environment. The B Plant organization implements the emergency response plan through specific implementing procedures identified for each postulated incident.

The BED must assess each incident to determine the response necessary to protect personnel, the facility, and the environment. If assistance from patrol, fire, or ambulance units is required, the Hanford emergency response number (911) is used to contact the Patrol Operations Center and request the desired assistance. To request resources or assistance from off-site or with a cellular phone, the Patrol Operations Center business number is used (373-3800).

The initial response for any emergency is to protect the health and safety of persons in the immediate area. Identification of released radiological or hazardous material is essential to determine appropriate protective actions. Containment, treatment, and disposal assessment are secondary responses.

The B Plant/WESF Hazards Assessment (HNF 1997b) provides a description of generic incident responses, describes the process for assessing and identifying the hazardous materials and/or dangerous waste, and describes the process for categorizing and classifying an incident. The assessment and event classifications are further described in Section 5.12.2.

Consequence assessments evaluate and interpret radiological or other hazardous materials measurements or other information during a declared emergency to provide a basis for decision making. The Unified Dose Assessment Center has the primary responsibility for overall onsite and offsite consequence assessment for the Hanford Site.

15.4.3 Notification

The DOE and site contractor will respond to all emergencies within the Hanford Site boundary. The DOE and its contractors have established arrangements to coordinate responses to emergencies. The DOE identifies the planning and responsibilities for notification and interface with other organizations for an emergency or other incident at the Hanford Site. The DOE has established a number of coordination agreements, or memoranda of understanding, with various agencies to ensure proper response resource availability for incidents involving the Hanford Site. The DOE has also established interface understandings with other federal, tribal, state, local and private organizations.

Notification of an emergency event may be initiated by a B Plant staff person who becomes aware of a condition that may affect operations. In some instances the automatic or manual actuation of a facility alarm might be the alerting mechanism. If an alarm is not the initiating action, a staff person calls 911 (373-3800 if from offsite or if using a cellular phone) and provides his/her name, the nature of the emergency, and exact location of the emergency.

Section 1.1 of DOE-0223 describes the responses and notifications for declared and non-declared emergencies. Declared emergencies are emergencies that meet the EAL criteria and require an Incident Command Post to coordinate the responses. For declared emergencies, the Patrol Operations Center is notified of the emergency by phoning 911 (373-3800 if by cellular phone). The Patrol Operations Center makes onsite notifications; the Occurrence Notification Center makes offsite notifications. Declared emergency responses include preplanned protective actions. Non-declared emergencies are emergencies that do not meet the EAL criteria, but require additional resources to respond to the emergency, which must also be coordinated at an Incident Command Post. For non-declared emergencies, notifications are made to the Patrol Operations Center by phoning 911 (373-3800 if using a cellular phone).

Occurrence reporting requirements are presented in RLID 232.1, *Occurrence Reporting and Processing of Operations Information.*

15.4.4 Emergency Facilities and Equipment

The following table provides a summary description of the emergency communications equipment available at B Plant for personnel who are at B Plant performing S&M activities.

Table 15.4-1: B Plant Communications Equipment

Type	Location	Capability
Hanford Site standard emergency signals	WESF complex	Emergency notification to personnel
Two-way radios	Key personnel	Internal communications
Cellular phones	On-call manager	External communications

15.4.5 Protective Actions

Protective actions are taken during an emergency to prevent or minimize actual and/or projected exposure to releases of radioactive and/or nonradioactive hazardous materials. Specific actions are typically in the form of sheltering and/or evacuation, or the use of time, distance, and shielding to reduce exposure to hazardous materials by emergency workers and the public.

Protective action guides are used to determine the appropriate protective actions as identified in DOE/RL-94-02. The B Plant BED classifies an event as an operational emergency, using facility emergency action levels. Based on the classification and event, the BED implements initial onsite protective actions and, if necessary, makes initial offsite protective action recommendations. Protective actions at B Plant are designed to minimize exposure to workers and the public. The B Plant emergency response program provides procedures that describe responses to those operational emergencies that are considered to be potential events that could occur during operation of the facility and in particular those events that have radiological or chemical dose consequences that exceed guidelines.

For the declared emergencies; Alert, Site Alert, and General, there are preplanned protective actions that are to be implemented. Those preplanned protective actions are discussed in DOE-0223. For General emergencies, there are automatic protective recommended actions made to offsite agencies through the notification process.

15.4.6 Training and Exercises

The Hanford Site and B Plant emergency preparedness planning program incorporates emergency response training which is conducted at all levels (i.e., the facility, area, northern area RL Emergency Operations Center, and DOE Emergency Control Center). Specialized individual training programs are provided for B Plant, Hanford Site contractors, DOE staff, and non-DOE emergency personnel. Emergency drills and exercises are conducted to test workers and evaluate the adequacy of the emergency facilities, equipment, procedures, communication channels, actions of emergency response personnel, and coordination between the organizations.

15.4.7 Recovery and Reentry

A B Plant operations recovery plan is developed when necessary. A recovery plan is needed following an event when further risk could be introduced to personnel, the facility, or the environment through recovery actions and/or to maximize the preservation of evidence. Depending on the magnitude of the event and the effort required to recover from it, recovery planning may involve personnel from DOE and other contractors. If a recovery plan is required, it is reviewed by appropriate personnel and approved by management before facility restart. Restart of operations is performed in accordance with the approved plan.

For emergencies not involving activation of the RL Emergency Operations Center, the B Plant BED ensures that conditions are restored to normal before operations are resumed. If the Hanford Site emergency organization was activated and the emergency required evacuation from a facility and/or the Hanford Site, the actions that follow fall into three processes when the emergency has been stabilized. These three processes or activities are emergency event termination, reentry, and recovery.

Termination occurs after all the applicable criteria has been met and concurrence between the Incident Command Post and RL Emergency Operations Center has been obtained. Notification of termination of an event is made to all relevant onsite entities as well as DOE Headquarters and relevant state, county, and offsite agencies.

Reentry is the act of reentering an evacuated area for the purpose of performing emergency activities or to assess facility damage for the purpose of determining if the emergency can be terminated and/or for determining the extent of required recovery activities. Reentry can be performed at any time before termination of the emergency and during recovery activities.

Upon termination of the emergency event, plans are developed to return the affected facility and surrounding areas to normal. Upon completion of the initial reentry team assessment and evaluation activities, the RL Emergency Manager will designate a manager of recovery operations. The Site Emergency Director appoints an Onsite Recovery Manager. The manager of recovery operations will assess the extent of recovery operations necessary and determine the organization needed to implement those operations. Recovering actions include a formal investigation and report.

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16.0 PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

16.1 Introduction

Policies and procedures governing this subject are maintained on the Hanford Intranet for companies, such as BWHC, that are under contract with the Project Hanford Management System (PHMS). B Plant administrates health and safety programs in accordance with the PHMS and facility programs and procedures. Facility programs are described in the Waste Encapsulation and Storage Facility (WESF) Project Administration manual, FSP-WESF-001 (FSP-WESF-001).

As stated in the Executive Summary, Section E.5, B Plant will be operated under FDH by BWHC until the facility is transferred to BHI. The transfer is anticipated to occur by March 31, 1999. Upon transfer, this chapter will be void and the respective sections of Appendices B and C become active.

This authorization basis document establishes the B Plant safety controls during the S&M phase of activities. The facility was deactivated in 1998. The deactivated configuration does not inhibit a decontamination and decommission phase. Hazards are either removed or stabilized. Most equipment has been deactivated; some is left in place, providing the option for future use, such as the canyon crane.

16.2 Requirements

There is no anticipated design activity associated with the B Plant Complex S&M phase of operation.

16.3 Description of Conceptual Plans

Plans for eventual Decontamination and Decommissioning of the B Plant Complex have not yet been formulated. The S&M Phase of the B Plant Complex may extend for decades before actual D&D operations will occur.

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17.0 MANAGEMENT, ORGANIZATIONAL, AND INSTITUTIONAL SAFETY PROVISIONS

17.1 Introduction

Policies and procedures governing this subject are maintained on the Hanford Intranet for companies, such as BWHC, that are under contract with the Project Hanford Management System (PHMS). B Plant administrates health and safety programs in accordance with the PHMS and facility programs and procedures. Facility programs are described in the Waste Encapsulation and Storage Facility (WESF) Project Administration manual, FSP-WESF-001 (FSP-WESF-001).

As stated in the Executive Summary, Section E.5, B Plant will be operated under FDH by BWHC until the facility is transferred to BHI. The transfer is anticipated to occur by March 31, 1999. Upon transfer, this chapter will be void and the respective sections of Appendices B and C become active.

This chapter presents an overview of the organizational structures, policies, and programs which ensure that safety is the fundamental principle guiding all B Plant operations. This overview gives a basic outline of the organization structures, responsibilities, and interfaces of the contractors responsible for management of B Plant in surveillance and maintenance phase. Safety management policies and programs in place for (1) assessing and controlling safety performance and (2) integrating safety consciousness.

17.2 Requirements

The following federal regulations and U.S. Department of Energy (DOE) orders contain requirements for establishing the management, organization, and institutional aspects of the B Plant Authorization Basis:

- 10 CFR 830, "Nuclear Safety Management"
- DOE O 232.1, *Occurrence Reporting and Processing of Operations Information* Change 0 (1995)
- DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities*, Change 1 (1992)
- DOE 5480.20A, *Personnel Selection, Qualification and Training Requirements for DOE Nuclear Facilities*, Change 0 (1994)
- DOE 5480.21, *Unreviewed Safety Questions*, Change 0 (1991)
- DOE 5480.22, *Technical Safety Requirements*, Change 2 (1996)
- DOE 5480.23, *Nuclear Safety Analysis Reports*, Change 1 (1994)
- DOE 5480.26, *Trending and Analysis of Operations Information Using Performance Indicators*, Change 0 (1993)
- RLP 5480.23, *Review and Approval of Nuclear Safety Documents*, Change 1 (1996).

17.3 Organizational Structure, Responsibilities, and Interfaces

Fluor Daniel Hanford, Inc. (FDH), is responsible to the DOE, Richland Operations Office (RL) for planning, integrating, and managing Hanford site activities such as the surveillance and maintenance of B Plant. FDH is supported by subcontractors, collectively referred to as the Project Hanford Management Contract (PHMC) Team, and other companies referred to as enterprise companies. In addition, other onsite contractors (e.g., Pacific Northwest National Laboratory [PNNL] and Hanford Environmental Health Foundation) provide support and have existing contracts with RL for certain site services. The PHMC Team and project activities are directed by FDH project directors.

17.3.1 Organizational Structure

The B&W Hanford Company (BWHC), under contract with the Project Hanford primary contractor, Fluor Daniel Hanford (FDH), Inc. manages operations at various Hanford facilities. In the BWHC organization, the FASTER/WESF Project organization manages the FASTER Facilities (FF) organization. The FF organization will manage the B Plant S&M Phase operations.

17.3.2 Organizational Responsibilities

The BWHC will manage B Plant operations in accordance with the Project Hanford Management System (PHMS). The PHMS contains the FDH contractor and subcontractor management and operations policies and procedures; these are accessible on the Hanford Intranet. The PHMS policies and procedures provide requirements and responsibilities for compliance of environment, health, safety, and quality rules and regulations. BWHC policies and procedures for compliance of the PHMS policies and procedures are also accessible on the Hanford Intranet.

The FF organization will interface with various FDH contractors and subcontractors, who manage other Hanford facilities and the FDH infrastructure. For example, BWHC and the FASTER/WESF organizations interface with contractors who manage and operate fire protection, emergency protection, the tank farms, health, safety and quality oversight, construction contractors, and other FDH subcontractors.

The FF organization will interface with other BWHC and FASTER/WESF organizations to provide standard and effective management of the facilities managed by BWHC; including B Plant.

BWHC organizations also interface with the Hanford Environmental Restoration Contractor (ERC). The Hanford ERC is Bechtel Hanford Inc. (BHI). It is anticipated that the B Plant facility and its stewardship responsibilities will eventually be transferred to BHI for the long term S&M phase operations and/or the life-cycle stage for the facility. This transfer is expected to occur by March 31, 1999. At that time, this chapter is void and respective sections of Appendices B and C are applicable.

BWHC 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 engineering is conducted in accordance with program requirements and the safety authorization basis.

The following subsections summarize the organizational responsibilities of Project Hanford contractors that support B Plant Surveillance and Maintenance (S&M).

17.3.2.1 Fluor Daniel Hanford, Inc.

As management contractor FDH is ultimately responsible for (1) contract performance, which includes protecting the public, workers, and environment from anticipated hazards associated with Hanford Site operations; and (2) providing a focal point for interaction with DOE and the stakeholders.

17.3.2.1.1 Environment, Safety and Health Organization

To ensure an integrated approach to safety, FDH has created an ESH&Q organization that is responsible for the development, incorporation, and implementation of environmental safety and health requirements into sitewide programs. The environmental safety and health requirements are incorporated, as appropriate, into major subcontractor programs and specific safety and health programs associated with specific projects and activities.

17.3.2.1.2 Project Direction

Project Direction provides leadership, oversight, direction, and control in the execution of projects. The Office of Project Direction monitors and is accountable for the FDH subcontractor's performance to ensure technical, cost, and schedule baseline conformance; integrating interfaces; evaluating, forecasting, and reporting performance for all performance factors including safety, QA, and project progress; and facilitating PHMC Team support to the projects.

The Project Director is the key point of contact for FDH subcontractors and is the designated FDH Contracting Officer's Representative. The Project Director is responsible for the conduct of all aspects of a project, including safety, health, and environmental issues. FDH ES&H consults and advises the Project Director and develops guidance for the subcontractors. The Project Director has a staff of managers and supervisors delegated to assist in ensuring all mission activities are conducted safely and in compliance with regulations and commitments.

17.3.2.1.3 Quality Assurance Organization

The FDH QA organization is in place to develop sitewide QA programs and policies and to communicate those programs and policies to the major subcontractors. The purpose of FDH QA programs is to establish an integrated approach to quality that ensures performance of all Hanford Site activities meets contract expectations.

17.3.2.1.4 Training Organization

The FDH Training Director establishes the standards for all PHMC Team training to ensure that all training programs meet RL training requirements and to prepare the workforce to perform work safely and effectively. These standards, in conjunction with implementing procedures and supporting documents that govern training under the PHMC, establish a graded, systematic approach to training that is designed to ensure that the qualification and training program meets DOE and federal requirements. B Plant has a training staff to ensure B Plant personnel are trained and qualified to perform their responsibilities effectively and safely.

17.3.2.2 B Plant BWHC

BWHC is responsible for the day-to-day operation of B Plant. BWHC responsibilities for B Plant include, but are not limited to, the following activities:

- Ensure that the B Plant facility operations meet applicable federal, state, and local laws and regulations and comply with sitewide standards and procedures
- Provide implementation and compliance guidance and direction to B Plant for applicable environmental laws, regulations, permits, and consent orders/agreements
- Establish a self-assessment strategy to determine the effectiveness of each organization and to ensure that senior management is involved in the assessment process
- Manage the B Plant facility during the Maintenance and Surveillance phase.

Responsibilities of the BWHC divisions are summarized in the following subsections.

17.3.2.3 Other Project Hanford Management Contract Team Companies

At present, with the low level of activity at B-Plant, no other companies besides BWHC are required to directly support the S&M mission. Other contractors do provide support services to the site as discussed below.

17.3.2.4 Hanford Fire Department

The Hanford Fire Department jurisdiction encompasses all of the Hanford Site. The department is managed by DynCorp Tri-Cities Services, Inc., an FDH subcontractor. The Hanford Fire Department is responsible for providing the following fire protection response functions:

- Maintain command of emergency response forces to control and terminate fire-related incidents; provide emergency medical patient care; act as the incident command agency for emergency incidents involving hazardous materials
- Conduct functional testing of remaining fire protection systems and maintain self-contained breathing apparatus at all Hanford Site facilities
- Maintain an active fire prevention program through facility tours and inspections of all flammable and reactive waste sites

- Maintain a highly trained emergency response team certified under a 3-yr Washington State-approved firefighter apprenticeship program

- Maintain a modern fleet comprised of emergency response vehicles including pumper trucks, aerial ladder units, modular ambulances, command vehicles, wild land brush tankers, hazardous materials response vehicles, and specialized equipment designed to deal with the unique requirements of the Hanford Site.

The Hanford Fire Department works closely with the BWHC ESH&Q division to support related inspection, compliance, and design-review activities.

17.3.2.5 Emergency Preparedness

See Chapter 15.0 for a description of the emergency preparedness organization responsibilities that apply to B Plant safety.

17.3.2.6 Safeguards and Security

The Safeguards and Security organization, managed by Protection Technology Hanford, is responsible for providing protection of government property. The Security Applications Center, operated by Safeguards and Security personnel, provides analytical and systems engineering support for cost-effective and uniform safeguards and security systems. Physical security entails command, control, and notification activities for all emergency conditions and 24-h enforcement of applicable federal, state, and local laws. The security organizations conduct their activities in compliance with Protection Technology Hanford policies and procedures.

17.3.2.7 Procurement and Materials Management

The Procurement and Materials Management organization, managed by FDH with support from Fluor Daniel Northwest, Inc., is responsible for the procurement of goods and services that meet established standards and requirements. Prospective suppliers are evaluated and selected from specified criteria. Established processes ensure that approved suppliers continue to provide acceptable items and services. Inspection and testing of specified items, services, and processes are coordinated to ensure that established acceptance and performance criteria are used. B Plant procurement is performed following approved procedures and processes with graded levels of management controls.

17.3.2.8 Lockheed Martin Services, Inc

Lockheed Martin Services, Inc., provides information resource management services. These services include planning and information resource management in the areas of computing; telecommunications; records management; photography and audiovisual equipment and capabilities; printing, duplicating, and engineering reproduction; document processing, storage, and retrieval; and graphics illustration.

17.3.2.9 Transportation and Packaging Services

The Transportation and Packaging Services organization, managed by Waste Management Federal Services, Inc., Northwest Operations, provides site wide policies and procedures governing hazardous materials transportation and packaging, qualification requirements and shipper training, preparation and maintenance of required shipping container safety documentation, hazardous materials packaging, design procurement support, analysis and testing, field support to the DOE Headquarters transportation management program, and all other transportation management activities.

17.3.3 Staffing and Qualifications

Since the B Plant facility is deactivated and in the S&M Phase, there are few activities at the facility. Therefore, a large staff is not required and more effective management will be provided by utilizing infrastructure in the FASTER/WESF Project organization, such as the FASTER/WESF Baseline Control, Radiological Control, and Compliance and Integration organizations and the WESF operations and maintenance organizations.

17.4 Safety Management Policies and Programs

This section identifies safety programs and procedures implemented by the Project Hanford Management System (PHMS) to enhance safe operations. The PHMS provides managing and operating plans, policies, and procedures for the major subcontractors use in conducting safe operations.

17.4.1 Safety Review and Performance Assessment

The PHMS policies and procedures provide requirements for a nuclear safety program and management of the program. The procedures address independent oversight, safety review, USQ determinations, and appraisal of the safety performance of all the organizations involved in the management of safety, such as operational safety, nuclear safety, industrial safety, criticality protection, fire protection, radiological protection, hazardous material protection, and radioactive and hazardous waste management, quality assurance, emergency preparedness, and other conduct of operations themes.

The BWHC Managing Directives identify BWHC requirements for compliance with the PHMS policies and procedures.

17.4.2 Configuration and Document Control

Configuration and document control are specifically addressed in the PHMS policies and procedures described above. The inter-related programs are addressed in the policies and procedures, so that all associated safety and technical basis programs work together to provide quality conduct of operations. Appropriate safety programs are addressed in configuration and document control procedures. For example, nuclear safety topics, such as the USQ review process, are mandated in procedures directing the configuration modifications process.

17.4.3 Occurrence Reporting

Occurrence reporting requirements are specifically addressed in the PHMS policies and procedures described above. 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

The following discussion represents the safety culture that the Hanford prime contractor and subcontractors promote. The programs described are all presented on the FDH and BWHC webpages on the Hanford Intranet. These programs are continually being actively promoted to and by the B Plant management staff and workforce.

FDH and BWHC regard safety as the highest priority concern for conducting all activities at work. FDH and BWHC strive to maintain a management staff and workforce that voluntarily believe that it is their responsibility and best interest to "own" a "ZERO ACCIDENT" safety culture at Hanford and at home.

The FDH Presidents and Employee Zero Accidents Council charter states that "The President's Zero Accident Council (PZAC) and Employee Zero Accident Council's (ZAC's) will work to improve the health and safety of Project Hanford employees and visitors by demonstrating commitment to affect positive change within the five elements of the U.S. Department of Energy's Voluntary Protection Program (DOE-VPP), jointly strive to achieve a single Project Hanford safety program, and provide the leadership to influence positive behavior and continual improvement toward the achievement of zero accidents."

BWHC actively supports the FDH Integrated Environment, Safety and Health Management System (ISMS). This system embraces the five elements of the DOE-VPP. The ISMS is implemented by the PHMS with the Integrated Environment, Safety and Health Management System Plan, HNF-MP-003. This plan establishes a single safety and environmental management system that integrates environmental, safety, and health (ES&H) requirements into all aspects of work planning and execution to effectively protect the workers, public, and environment.

In addition, BWHC promotes a "Target Zero" safety philosophy with the doctrine that:

- all accidents can be prevented
- the company is committed to preventing accidents
- management is responsible for providing a safe workplace
- employees are responsible for preventing injuries to themselves and their co-workers
- working safely is a condition of employment
- all operations must be performed safely
- training is essential to a successful safety program
- prevention of accidents is good business.

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APPENDIX A
B PLANT S&M PHASE HAZARD IDENTIFICATION AND EVALUATION

LIST OF TERMS

ACT	Air Cleaning Train
AB	Authorization Basis
BIO	basis for interim operation
DOE	U.S. Department Of Energy
HI&E	Hazard Identification and Evaluation
IE	initiating event
PHA	preliminary hazards assessment
S&M	surveillance and maintenance
UPR	unplanned release sites

A 1.0 INTRODUCTION

A 1.1 Purpose

The purpose of this document is to document the process of the identification and evaluation of hazards (HI&E) associated with B Plant in a surveillance and maintenance phase. This document is not intended to authorize activities or define or determine the adequacy of controls or mitigative features associated with this mode of operation.

This hazard identification team identifies hazards which may lead to unsafe conditions and evaluates those hazards for potential events that could lead to the release of radiological and toxicological material specific to the surveillance and maintenance (S&M) phase of B Plant. The main purpose of this hazard evaluation is to identify hazardous conditions which have a potential for impacting personnel at the facility, onsite, or offsite. This hazard evaluation does not constitute an accident analysis.

A 1.2 Scope

This hazards evaluation addresses activities associated with B Plant in the Surveillance and Maintenance phase. The deactivation of Hanford excess facilities is intended to achieve significant risk reduction and cost savings for the operation of the Hanford site by the Department of Energy. The hazards analysis documented in this report was performed to identify hazards to the public, workers, and environment associated with B Plant being in the S&M phase. These hazardous conditions then can be compared to existing accident analyses to determine if they are bounded and, if not, what new accident analyses need to be developed.

A 1.3 Background

Operational Phase

The B Plant Complex at the U.S. Department of Energy, Hanford Site is located in the south central region of Washington State. B Plant was constructed between 1943 and 1945 to process spent nuclear fuels in support of the Manhattan Project. After its original mission was completed in 1952, the plant was modified between 1961 and 1967 for the recovery, separation, and purification of strontium (Sr) and cesium (Cs) contained in the mixed fission product waste stream generated during fuel reprocessing operations. At first, the cesium and strontium products were shipped from B Plant in casks through the 212-B facility for further processing and testing at other facilities. During 1970-73, while the Waste Encapsulation and Storage Facility (WESF) was being constructed on the west end of B-Plant, cesium and strontium were stored in B-Plant canyon cells vessels. The recovered, purified, and concentrated Sr and Cs solutions were then transferred to the newly constructed (1974) WESF for conversion, encapsulation, and storage. These Sr and Cs separation campaigns were conducted at B Plant from 1968 to 1985.

In May 1991 the U.S. Department of Energy, Richland Operations Office (RL) eliminated B Plant from any future processing missions due to the difficulties of bringing a 46 year old plant up to current environmental standards. Between 1991 and 1995, B Plant was maintained to ensure safe storage and management of substantial radioactive contamination and residual inventory from past operations, as well as supporting safe storage of approximately 150 megacuries of encapsulated Sr and Cs in WESF.

Deactivation Phase

In September 1995, the Department of Energy directed FDH to deactivate the B Plant facility, place it in a S&M Phase and decouple B Plant from WESF. WESF will continue its mission of providing safe storage and management of Hanford's Sr and Cs capsule inventory.

Deactivation activities were designed to isolate the facility to prevent contamination migration to the environment, and achieve facility hazards stability through the removal, stabilization, disposal, or excessing of major radioactive sources, hazardous materials and waste. Activities included removal of stored radioactive and hazardous materials, shutdown of all process and support systems such as the electrical power distribution system and heating, ventilation, and air conditioning (HVAC), and installation of operational systems required to support S&M. Operational installed systems included a new canyon exhaust system, a passive vent system for the retired filters of the old ventilation system, an electrical power and lighting system in the surveillance routes, and a liquid level detection system in cell 10 of the 221-B canyon and in the deactivated filter vaults.

An end point criteria process was utilized for deactivating B Plant. The endpoints are documented in WHC-SD-WM-TPP-054, *B Plant End Point Document*. This method ensured a safe, stable, and environmentally sound facility, suitable for long-term surveillance and maintenance.

B Plant is unoccupied and locked. Deactivation of B Plant resulted in a vast reduction of the hazards and risks associated with this facility and greatly reduce the costs of surveying and maintaining the facility until the final disposition phase is initiated.

Surveillance and Maintenance Phase

The S&M Phase is the time period between completion of B Plant facility deactivation and initiation of final disposition. The S&M Phase duration is presently unknown; it could exist for decades. During this time, the operating contractor will perform surveillance and maintenance of the facility structures and operational systems. The contractor must ensure efficient, cost effective maintenance of B Plant to keep it in a safe condition that presents no significant threats of release of hazardous substances into the environment and no significant risk to human health and the environment.

A 2.0 EXECUTIVE SUMMARY

The most significant hazards at B Plant involve the remaining radiological inventory in the canyon building and the retired filters. There are no significant hazards associated with chemicals since the liquid chemical inventories have been removed and the dry chemical that remains in the canyon is stable Tri-Sodium Phosphate.

The most significant risks associated with the remaining radiological inventories in the canyon and the retired filters are postulated to be initiated by natural phenomena (seismic event, ash/snow load causing roof collapse, stack collapse on the retired filters) and explosion (hydrogen explosion in the retired filters).

Less consequential hazards resulting in potential releases from the canyon and/or the retired filter

vaults were identified. These hazards are due to impacts to the new canyon exhaust system from missiles or vehicles, the retired filter risers by vehicles and passive vent system, or by fires in or adjacent to the structures.

Aging of the structures by natural phenomena (rain, freeze/thaw cycles) could cause degradation to the structures which are relied on to contain their radiological inventory. The degradation of structural integrity could eventually lead to release of radiological inventory due to structural collapse.

A 3.0 B PLANT DESCRIPTION

A 3.1 Physical Property in S&M Scope

The scope of property in the B Plant S&M Phase includes

- active and passive operative structures, systems, and components (SSC)s
- buildings that contain deactivated and operative systems, including vessels, electrical equipment, process equipment, and minimal residual radiological and chemical materials
- underground pits and tanks
- underground vaults containing retired high efficiency particulate (HEPA) filters and vessels
- underground isolated pipes that were used for transferring of radiological, chemical, sanitary, and nonsanitary effluents
- unplanned release sites (UPR)s and waste sites
- a fence surrounding the deactivated facilities
- and the grounds inside the fence.

Nearly all the SSCs to be transitioned to the S&M Phase are inside the fence shown in Figure A-1, but some are located outside the fence. Table A 3-1 lists all the SSCs that are to be transitioned to the S&M Phase. There are 27 buildings, 3 basins, 1 railroad tunnel, 6 underground filter vaults (only 5 contain abandoned HEPA filters), 1 underground vault containing the sand filter, 2 underground tanks, 3 stacks (2 deactivated, 1 active), 2 electrical substations, 19 UPRs, 3 waste sites, 1 reverse well, 1 french drain, the yard area inside the fence, and the fence. The UPRs listed in Table A 3-1 that are outside of the fence can be located by acquiring data from the Waste Information Data System (WIDS). This information is available to the Hanford Site contractors.

A more complete description of B Plant and its operational and nonoperational SSCs can be observed in the B Plant safety analysis report for which this HI&E is developed.

A 3.2 Operational

All the items listed in Table A 3-1 are deactivated, except for the following operational systems:

1) The canyon exhaust system, which includes:

- the duct from Cell 10 within the 221B canyon to the new 296-B-1 stack
- the two parallel HEPA filter banks and housings, called the air cleaning train (ACT)
- two electric motor driven exhaust fans
- the 296-B-1 stack.

2) The S&M Phase surveillance lighting systems in 271-B, 221-B and 212-B

3) The liquid level monitoring system in Cell 10 of building 221-B

4) The passive vent system and the liquid level monitoring system for the retired underground HEPA filters vaults in the 291-B area.

Deactivated means the SSCs are isolated from all utilities; the hazards are reduced and/or stabilized; and the structures are closed, sealed, and locked. Operational means the SSCs are in service, whether active or passive.

A 3.3 Surveillance

Surveillance activities will include surveillance and monitoring of the 221-B building pipe and electrical galleries and canyon exhaust system, the retired filters in the 291-B area, buildings 271-B, 212-B, 222-B, ancillary buildings, and the yard and fence around B Plant. Particular concern will be focused on the roofs of structures containing radio radioactive materials contamination.

A 3.4 Maintenance

Maintenance activities will include a preventative maintenance program, calibrations, high efficiency particulate air (HEPA) filter change outs, equipment condition inspections, maintenance history, cold weather protection, and modification work.

A 3.5 Administration

B Plant will be managed by a S&M contractor in accordance with the B Plant safety analysis report.

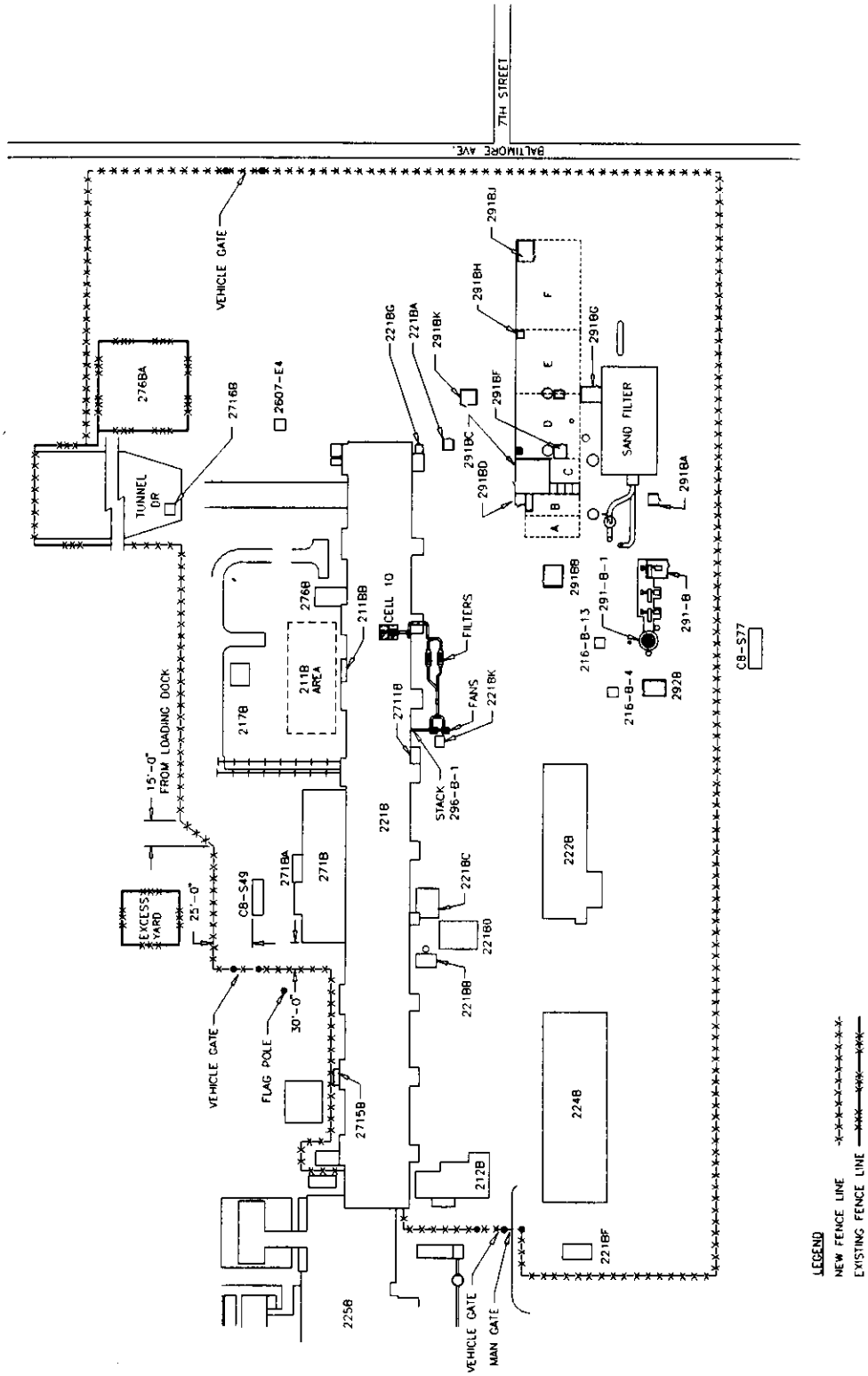

Figure A-1: B Plant S&M Phase Facility Layout

Table A 3-1: B Plant Complex Facilities and Waste Sites		
Building ID	**Building Description / Components**	**Location**
207-BA	CBC Sampling Building	Northwest of Facility, east of Baltimore St.
211-B	Chemical Tank Farm Area	North of 221B Bldg.
211-BB	MCC Building for 211B Area	Between 211B and 221B
212-B	Cask Transfer Building	South of West End of 221B
217-B	Demineralized Water Building	North of 221B and 211B Area
221-B	B Plant Canyon Building: • Canyon and process cells • Electrical gallery • Pipe gallery • Operating gallery • SWP Change Room • Railroad tunnel	Inside 221B Bldg
221-BA	15-inch Cooling Water Monitor Building	South of East End of 221B Bldg.
221-BB	Condensate Building for LLW Concentrator	South of 221B Bldg.
221-BC	SWP Change Building	South of 221B Bldg.
221-BD	Laundry Storage Building	South of 221B Bldg.
221-BF	BCP Diversion Pit Building	South of West End of 221B Bldg.
221-BG	24-inch Cooling Water Monitor Building	SE Corner of 221B Bldg.
221-BK	Canyon Exhaust System Instrumentation Building and Canyon Exhaust System: • Duct • Filters • Fans	South Side of 221B Bldg.
222-B	Office Building	South of 221B Bldg.
271-B	B Plant Support Building: • Basement • First Floor • Second Floor • Third Floor	North Side of 221B Bldg.
271-BA	Laundry Storage Building	North Side of 221B Bldg.
2711-B	Breathing Air Compressor Building	South Side of 221B Bldg.
2715-B	Paint and Oil Storage Building	North Side of 221B Bldg.
2716-B	Storage Bldg - RR Cut	North of RR Tunnel Door
276-B	Paint Shop	North of 221B Bldg.
276-BA	ISO Tank Area	Northeast of 221 B Bldg.
291-B	Exhaust Fans Control/Turbine Building	South of 221B Bldg.
291-BA	Exhaust Air Sample Building	South of 221B Bldg.
291-BB	Instrument Building - A and B filters	South of 221B Bldg.
291-BC	C Filter Building	South of 221B Bldg.
291-BD	C Filter Instrument Building	South of 221B Bldg.

Table A 3-1: B Plant Complex Facilities and Waste Sites		
Building ID	**Building Description / Components**	**Location**
291-BF	D Filter Instrument Building	South of 221B Bldg.
291-BG	E Filter Instrument Building	South of 221B Bldg.
291-BJ	F Filter Instrument Building	South of 221B Bldg.
291-BK	E Filter Monitoring Control Building	South of 221B Bldg.
292-B	Stack Monitoring Building	South of 221B Bldg.
291-B-1	Retired Canyon Ventilation Stack	South of 221B Bldg.
296-B-1	Canyon Ventilation Stack	South Side of 221B Bldg.
296-B-2	Filter Vault Passive Vent Stack	Above Vault E
296-B-5	Retired 221-BB Stack	Adjacent to 221 BB
296-B-13	Retired 221-BF Stack	Adjacent to 221 BF
296-B-21	Retired Pipe Gallery Exhauster	North Side of 221 B Bldg.
296-B-22	Retired Pipe Gallery Exhauster	North Side of 221 B Bldg.
296-B-23	Retired Pipe Gallery Exhauster	North Side of 221 B Bldg.
296-B-24	Retired Pipe Gallery Exhauster	North Side of 221 B Bldg.
296-B-25	Retired Pipe Gallery Exhauster	North Side of 221 B Bldg.
296-B-26	Retired Pipe Gallery Exhauster	North Side of 221 B Bldg.
296-B-27	Retired Pipe Gallery Exhauster	North Side of 221 B Bldg.
C8-S49	Main B Plant Substation (271-B/221-B)	North of 221B Bldg.
C8-S77	B Plant 291-B Area Substation	South of 221B Bldg. And 291B Area
A-F Filters	A-F Filter Vaults	South of 221B Bldg.
Yard	Total area inside the fence	Fence surrounds B Plant
Unplanned Release Sites	B Plant Unplanned Release Sites • UPR-200-E-1 • UPR-200-E-2 • UPR-200-E-3 • UPR-200-E-7 • UPR-200-E-32 • UPR-200-E-41 • UPR-200-E-44 • UPR-200-E-52 • UPR-200-E-64 • UPR-200-E-69 • UPR-200-E-80 • UPR-200-E-85 • UPR-200-E-90 • UPR-200-E-95 • UPR-200-E-103 • UPR-200-E-112 • UPR-200-E-140	Inside and outside the B Plant fence. See Waste Information Data System (WIDS) map.

Table A 3-1: B Plant Complex Facilities and Waste Sites		
Building ID	**Building Description / Components**	**Location**
Waste Sites	B Plant Waste Sites • 200-E-6, Septic Tank • 200-E-16, LLW Concentrator (in Canyon) • 200-E-25, Miscellaneous Stream #659 • 200-E-28, 221-B Steam Condensate Release • 200-E-30, 291-B Sand Filter • 200-E-55, Miscellaneous Stream #322 • 200-E-88, Miscellaneous Stream #3 • 200-E-89, Miscellaneous Stream #4 • 200-E-90, Miscellaneous Stream #5 • 200-E-91, Miscellaneous Stream #6 • 200-E-92, Miscellaneous Stream #7 • 200-E-93, Miscellaneous Stream #8 • 200-E-94, Miscellaneous Stream #9 • 200-E-95, Miscellaneous Stream #308 • 200-E-97, Miscellaneous Stream #470 • 200-E-98, Miscellaneous Stream #490 • 200-E-99, Misc Stream #570/#1 (Duplicate) • 200-E-100, Misc Stream #571/#2 (Duplicate) • 207-B, Cooling Water Retention Basin • 216-B-4, Dry Well • 216-B-13, Crib • 216-B-59, Trench • 216-B-59B, Retention Basin • 216-B-64, Retention Basin • 217-B NU, 217-B Bldg Emergency Neut Unit • 221-B-26-1, Radioactive Organic Waste Solvent Tank 1 • 221-B-27-2, Tank TK-27-2 • 221-B-27-3, Radioactive Organic Solvent Tk 2 • 221-B-27-4, Radioactive Organic Waste Solvent Tank 3 • 221-B-28-3, Radioactive Organic Solvent Tk 4 • 221-B-28-4, Radioactive Organic Solvent Tk 5 • 221-B-29-4, Radioactive Organic Solvent Tk 7 • 221-B-30-3, Radioactive Organic Solvent Tk 6 • 221-B NANU, 221-B Nitric Acid Neut Unit • 221-B SDT, 221-B Plant Settle & Secant Tank • 221-B SHNU, 221-B Sodium Hydroxide Elementary Neutralization Unit • 221-B-WS-1, B Plant Storage • 221-B-WS-2, B Plant Waste Pile • 270-E-1, Condensate Collection Tank • 2607-E3, Septic Tank • 2607-E4, Septic Tank • B Plant Filter, F-34-4 Filter	Inside and outside the B Plant fence. See Waste Information Data System (WIDS) map.

AMU = Aqueous Makeup Unit
BCP = B Plant Process Condensate
CBC = B Plant Cooling Water
LLW = Low Level Waste
MCC =Motor Control Center
SWP = Special Work Permit (protective clothing)
UPR = Unplanned Release Site
WESF = Waste Encapsulation and Storage Facility

A 4.0 HAZARD IDENTIFICATION AND EVALUATION METHODOLOGY

This section describes the methodology used in identifying and evaluating the hazards for the surveillance and maintenance phase of the Hanford B Plant after deactivation. The types of events considered in the hazard evaluation are internal, external, and natural phenomena associated with B Plant. These events could result in an uncontrolled release of radioactive or hazardous materials that could potentially affect the public, workers, or the environment. DOE Orders and standards that provide requirements and guidance for performing hazards analyses to establish the safety basis of nuclear facilities include the following:

- DOE 5480.23, 1994, *Nuclear Safety Analysis Reports,* Change 1
- DOE-STD-3009-94, 1994, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports.*

The methodology used in performing the B Plant PHA and evaluating the resultant hazardous conditions is provided in the following document:

- HNF-PRO-704, Rev 0, *Hazard and Accident Analysis Process.*

Sabotage and terrorism events were not considered in this hazards assessment.

A 4.1 PHA Methodology

Hazard Identification and Evaluation (HI&E) is the process of highlighting natural phenomena, material, system, process, and facility characteristics with the potential to initiate accidents having undesirable consequences. The method of HI&E used for B Plant S&M was a Preliminary Hazards Analysis (AICHE 92) that uses a form-driven approach to ensure that standardization and completeness occur. A preliminary hazards analysis (PHA) focuses on the basic elements of a facility or system and identifies the hazards of interest, evaluates potential causes and effects, and proposes potential mitigative measures. The PHA form used is presented in Figure 4.1.

The hazards evaluation was performed by a small team, since B Plant personnel were not available on a full time basis to participate in the evaluation. The team consisted of the hazards analyst, a safety analyst familiar with B Plant, and a B Plant engineer familiar with the plant and the safety basis process. The hazard evaluation team members and their qualifications are provided in Appendix A. Participation of B Plant engineers and operations personnel was achieved as needed to answer questions and understand the S&M Phase configuration and inventory through telephone interviews and reporting the information to the team. B Plant personnel interviewed by telephone were Fen Simmons, Mitch Baron, Mike Gunderson, Kari McDaniel, and Ron Weissenfels.

An independent hazards analyst peer review of the HI&E was performed and the resulting checklist is provided in Attachment D of this report.

PHA studies are considered a thorough method of hazards identification. However, two criticisms of this technique are 1) that the technique is not implicitly designed to highlight accidents initiated by natural phenomena or external events and 2) that the technique does not

necessarily pick up standard industrial safety hazards. This PHA study addresses the effects of natural phenomena and external events in at least two ways. First, because the effects on process parameters initiated by natural phenomena and external events are generally of the same type as those that can be initiated by equipment failures, natural and external phenomena are included in the "Causes" column of the PHA form as deemed applicable by the team. Second, since external events can add hazardous material to the system (such as fuel from a truck crash) which might initiate accidents, they are addressed under their own separate categories. Similarly, the confinement barrier deterioration potentially caused by external events or natural phenomena is also included specifically under the "Hazardous Condition" column in the PHA form. The second criticism is also not applicable to this hazard evaluation, since standard industrial safety hazards were considered within the work scope. This is addressed as a standard hazard which covers the entire B Plant facility which applies to the surveillance and maintenance personnel.

To provide consistency in identifying potential hazards that could lead to accident initiating events the PHA study utilized a hazard/energy identification checklist. A blank hazard/energy identification checklist is presented in Figure 4.2. The checklists completed for this PHA are presented in Attachment B of this report.

The PHA team used, in an ordered manner, the hazards identified through the use of the hazard/energy identification checklist to postulate undesired events, identify causes, and estimate potential consequences. This information was recorded on the PHA data sheets and is presented in Attachment C of this report.

A 4.1.1 Assessment of Likelihood and Consequence

Each hazardous condition identified by the analysts was assessed for likelihood and consequence from the categories summarized in Table A 4-1 and Table 4-2. Existing preventive and mitigative features for each hazardous condition were identified during the analyses.

The assessment of likelihood and consequence for each hazardous condition was a collective, qualitative judgment of the hazards evaluation team. The assessment was made without considering preventive or mitigative features or controls. This permits a clearer understanding of the underlying significance of the hazardous condition, which leads to a better understanding of the importance of preventive or mitigative features or controls.

The frequency category of a postulated hazardous condition is also designated with an alphanumeric system. An F is used to indicate that the category being specified is frequency. The frequency is a range rather than a point value. A number from zero to three is used to indicate the range; zero being the lowest frequency and three the highest frequency.

The consequence category of a postulated hazardous condition was designated with an alphanumeric system. An S indicates safety consequence and an E indicates environmental consequence. A number from zero to three is used to show severity with zero being the lowest severity and three being the highest severity.

A 4.1.2 PHA Form

In the PHA form (Figure 4.1) the first column, designated "ID," is intended to capture the unique alphanumeric identifier for the line of information in the table. The second column, designated

"Location/Activity" is used to record the location or activity associated with the unique ID code. The third column, designated "Hazardous Condition" is used to record a description of the Hazardous Condition associated with the unique ID code and the particular location/activity. In general, Hazardous Conditions are related to uncontrolled releases of hazardous or radioactive material. The fourth column, labeled "Causes," lists the potential cause or causes of the hazardous event or failure. The fifth column, "Material at Risk" describes the type and quantity (if known) of hazardous material that may be involved in the Hazardous Condition. The sixth column, labeled "Consequences," lists the potential consequences of the Hazardous Condition. The seventh column, "Engineered Features" is used to list the potential hardware design features that may/could mitigate or prevent the considered event. The eighth column is labeled "Administrative Features" and lists the potential administrative controls such as procedures, training, practices, etc., that could mitigate or prevent the event.

The ninth column is labeled "Freq Cat" The Frequency column is a "first cut," qualitative consensus estimate of the frequency of the event assuming that no engineered or administrative safety features are present. However, existing physical constraints or conditions that limit the frequency of an event are assumed to be applicable. The tenth column is labeled "Cons Cat" The Consequence column contains a qualitative estimate of the result of the event, assuming that no controls, engineered or administrative, are present. However, as with the "Freq Cat" column, existing physical constraints or conditions that limit the consequence of an event are assumed to be applicable. The Consequence Ranking column is a "first cut," qualitative consensus estimate of the consequence severity.

The "Remarks" column contains information that the team judges important enough to require documentation. This includes (but is not limited to) assumptions about system or facility operation or design or factors which impacted the frequency or consequence category designation.

A 4.2 Hazard Evaluation Methodology

After identifying the hazardous conditions using the above PHA methodology, the hazardous conditions were binned to facilitate the selection of candidate accidents for detailed quantitative analysis. This binning process is comprised of the following steps:

1. Initial Screening, which screens out all hazardous conditions, not assessed as S2 or S3 consequence level, and frequency condition assesed as F0.

2. Assignment of Accident Release Attributes that describe each accident using its accident release attributes as related to the uncontrolled release of the material at risk.

   The Accident Release Attributes are:

   A. Initial energy available to release the hazardous material. The attributes related to energy level have three designations: high, moderate, and low.

      High energy level, designation "A" assigned to energetic events such as explosions, fires and nuclear criticality.

      Moderate energy level, designation "B" assigned to events such as

ventilation system breach while the fans are running, liquid sprays from pressurized line, and dropping hardware or equipment into a dispersable material.

Low energy level, designation "C" assigned to events such as leaks from non-pressurized liquid containers and breach or leak of a passive ventilation system.

B. Initial release location. The attributes related to the initial release location have three designations: (1) atmospheric, (2) ground surface, and (3) subsurface. Sometimes, the accident may result in release to more than one destination. The destination of the most severe consequence is assigned.

C. Initial form of the release. Three attributes are related to the initial form of the release: a) vapor/gas/aerosol, b) liquid/slurry, c) and solid/sludge. If the accident results in the release of more than one form of material, the attribute associated with more severe consequence is assigned.

Step two was performed as described in Section A 6.1 with the results shown in Table A 6-1.

3. Accident Release Categories. Once the release attributes are assigned to the hazardous conditions, an accident release category identifier is assembled by grouping the Accident Release Attributes. See Table A 6-1, Accident Release Category column.

4. Binning Hazardous Conditions by Cause and Accident Release Category. Examination of the causes supports selection of representative sets of accidents for each Accident Release Category. After identifying the hazardous conditions causes from the PHA tables, the hazardous conditions are binned by grouping the conditions that have both a common cause and a common Accident Release Category. The bins selected for this analysis are shown in Tables A 6-1 and A 6-2.

The results of these steps is a list of hazardous conditions in a binned and tabular format. After the hazardous conditions have been binned, representative bounding accidents can then be developed for consequence analysis. This last step is covered in an accident analysis.

Table A 4-1: Likelihood (Frequency) Descriptions and Definitions		
Frequency Assessment Code	**Estimated Annual Frequency**	**Operational Definition**
F3	Anticipated 10^{-2}/yr ≤ F3 < 10^{-1}/yr	Has occurred or is likely to occur during the lifetime of the facility
F2	Unlikely 10^{-4}/yr ≤ F2 < 10^{-2}/yr	Is foreseeable, but unlikely to occur during the lifetime of the facility
F1	Extremely Unlikely 10^{-6}/yr ≤ F1 < 10^{-4}/yr	Is perhaps possible, but extremely unlikely to occur during the lifetime of the facility
F0	Beyond Extremely Unlikely F0 < 10^{-6}/yr	Is considered too improbable to warrant further consideration

Table A 4-2: Safety and Environmental Consequence Categories	
Consequence Assessment Code	**Definition**
S3	There is sufficient material and energy available to cause a high or moderate impact to the maximum offsite individual
S2	There is sufficient material and energy available to cause a high or moderate impact to the maximum onsite individual
S1	There is sufficient material and energy available to cause an industrial injury, radiological dose, or chemical exposure to one or more facility workers
S0	There is insufficient material and energy to adversely impact facility workers
E3	Offsite discharge or discharge to groundwater
E2	Significant discharge onsite
E1	Localized discharge of hazardous material
E0	No significant environmental consequence

PRELIMINARY HAZARDS ANALYSIS

Page _____ Date _____

Process Area _____ Participants _____ _____ _____

References used _____ Participants _____

ID	Location/ Activity	Hazardous Condition	Causes	Material-At-Risk	Consequence	Engineered Features	Administrative Features	Freq Cat	Cons Cat	Remarks

Figure A 4-1: PHA Form

Figure A 4-2: Hazard/Energy Identification Checklist

ID: _____ PHA: _____ Date:

A. Electrical ☐

Y N
☐ ☐1. Battery banks
☐ ☐2. Cable runs
☐ ☐3. Diesel generators
☐ ☐4. Electrical equipment
☐ ☐5. HVAC heaters
☐ ☐6. High voltage
☐ ☐7. Motors
☐ ☐8. Pumps
☐ ☐9. Power tools
☐ ☐10. Switch gear
☐ ☐11. Service outlets, fittings
☐ ☐12. Transformers
☐ ☐13. Transmission lines
☐ ☐14. Underground wires
☐ ☐15. Wiring
☐ ☐16. Other _____

B. Thermal ☐

Y N
☐ ☐1. Bunsen burner/hot plates
☐ ☐2. Electrical equipment
☐ ☐3. Furnaces/boilers/heater
☐ ☐4. Steam lines
☐ ☐5. Welding torch/arc
☐ ☐6. Diesel units/fire box/exhaust line
☐ ☐7. Radioactive decay heat
☐ ☐8. Exposed hot components
☐ ☐9. Power tools
☐ ☐10. Convective
☐ ☐11. Solar
☐ ☐12. Cryogenic
☐ ☐13. Other _____

C. Friction ☐

Y N
☐ ☐1. Belts
☐ ☐2. Bearings
☐ ☐3. Fans
☐ ☐4. Gears
☐ ☐5. Motors
☐ ☐6. Power tools
☐ ☐7. Other _____

D. Corrosives ☐

Y N
☐ ☐1. Acids
☐ ☐2. Caustics
☐ ☐3. Natural chemicals
☐ ☐4. Decontamination solution
☐ ☐5. High temperature waste
☐ ☐6. Galvanic interactions
☐ ☐7. Other _____

E. Kinetic - Rotational ☐

Y N
☐ ☐1. Centrifuges
☐ ☐2. Motors
☐ ☐3. Pumps
☐ ☐4. Cooling tower fans
☐ ☐5. Laundry equipment
☐ ☐6. Shop equipment
☐ ☐7. Other _____

F. Kinetic - Linear ☐

Y N
☐ ☐1. Cars, trucks, buses
☐ ☐2. Forklifts, dollies, carts
☐ ☐3. Railroad
☐ ☐4. Obstructions
☐ ☐5. Crane loads
☐ ☐6. Pressure vessel blowdown
☐ ☐7. High pressure jets
☐ ☐8. Abrasive blasters
☐ ☐9. Other _____

G. Mass, Gravity, Height ☐

Y N
☐ ☐1. Human effort
☐ ☐2. Stairs
☐ ☐3. Lifts and cranes
☐ ☐4. Bucket and ladder
☐ ☐5. Trucks
☐ ☐6. Slings
☐ ☐7. Hoists
☐ ☐8. Elevators
☐ ☐9. Jacks
☐ ☐10. Scaffold and ladders
☐ ☐11. Pits and excavations
☐ ☐12. Elevated doors
☐ ☐13. Vessels
☐ ☐14. Other _____

H. Pressure - Volume ☐

Y N
☐ ☐1. Boilers
☐ ☐2. Surge tanks
☐ ☐3. Autoclave
☐ ☐4. Test loops
☐ ☐5. Gas bottles
☐ ☐6. Pressure vessels
☐ ☐7. Stressed members
☐ ☐8. Gas receivers
☐ ☐9. Negative pressure collapse
☐ ☐10. Steam headers and lines
☐ ☐11. Hydraulic systems
☐ ☐12. High pressure cleaners
☐ ☐13. Other _____

J. Explosives/Pyrophorics ☐

Y N
☐ ☐1. Caps
☐ ☐2. Primer cord
☐ ☐3. Dynamite
☐ ☐4. Scrub chemicals
☐ ☐5. Dusts
☐ ☐6. Hydrogen
☐ ☐7. Gases, others _____
☐ ☐8. Nitrates/Nitrites
☐ ☐9. Peroxides
☐ ☐10. Pu and U metal
☐ ☐11. Sodium
☐ ☐12. Other _____

K. Nuclear Criticality ☐

Y N
☐ ☐1. Vaults
☐ ☐2. Temporary storage areas
☐ ☐3. Shipping and receiving area
☐ ☐4. Filters
☐ ☐5. Casks
☐ ☐6. Burial ground
☐ ☐7. Storage racks
☐ ☐8. Canals and basins
☐ ☐9. Decontamination solution
☐ ☐10. Trucks, forklifts, dollies
☐ ☐11. Hand carry
☐ ☐12. Cranes/lifts
☐ ☐13. Hot cells, assembly, inspection
☐ ☐14. Laboratories
☐ ☐15. Other _____

L. Flammable Materials ☐

Y N
☐ ☐1. Packing materials
☐ ☐2. Rags
☐ ☐3. Gasoline
☐ ☐4. Lube oil/Grease
☐ ☐5. Coolant oil
☐ ☐6. Paint solvent
☐ ☐7. Diesel fuel
☐ ☐8. Hydrogen
☐ ☐9. Nitric acid
☐ ☐10. Organics
☐ ☐11. Gases - others _____
☐ ☐12. Liquids - others _____
☐ ☐13. Buildings and contents
☐ ☐14. Trailers and contents
☐ ☐15. Other _____

M. Hazardous Materials ☐

Y N
☐ ☐1. Alkali metals
☐ ☐2. Asphyxiants
☐ ☐3. Biological agents
☐ ☐4. Carcinogens
☐ ☐5. Corrosives
☐ ☐6. Oxidizers
☐ ☐7. Toxins
☐ ☐8. Heavy metals
☐ ☐9. Other _____

N. Ionizing Radiation Sources ☐

Y N
☐ ☐1. Fissile material
☐ ☐2. Radiography equipment
☐ ☐3. Radioactive material
☐ ☐4. Radioactive sources
☐ ☐5. Other _____

P. External events ☐

Y N
☐ ☐1. Explosion
☐ ☐2. Fire
☐ ☐3. Other sites

Q. Vehicles In Motion (external to facility) ☐

Y N
☐ ☐1. Airplane
☐ ☐2. Helicopter
☐ ☐3. Train
☐ ☐4. Truck/bus/car
☐ ☐5. Other _____

R. Natural Phenomena ☐

Y N
☐ ☐1. Earthquake
☐ ☐2. Flood
☐ ☐3. Lightning
☐ ☐4. Rain
☐ ☐5. Snow, freezing weather
☐ ☐6. Straight wind
☐ ☐7. Dust devil
☐ ☐8. Tornado
☐ ☐9. Ashfall
☐ ☐10. Range fire
☐ ☐11. Other _____

A 5.0 HAZARD IDENTIFICATION

A 5.1 PHA Assumptions

The major assumptions used in this PHA are:

1. All electrical power (except for surveillance lighting, canyon exhaust system, Cell 10 liquid level detection) to B Plant facilities will be disconnected in support of the B Plant Surveillance and Maintenance Phase.

2. Issues involving standard industrial hazards are assumed to be adequately addressed by existing health and safety programs. However, standard industrial hazards are addressed in this Hazards Evaluation.

3. Facility worker covers the personnel involved in the quarterly surveillance of the B Plant facility (inspection personnel, Health Physicists Technician) and any maintenance personnel associated with minor repair of facility components (surveillance lighting system, minor leaks, HEPA filter changes, handrails, steps, etc.).

4. All buildings will be locked closed and there will be no routine access to them, except those listed on the surveillance route.

5. The period of time over which the B Plant S&M Phase is in force was taken to be 40 years for the purpose of this PHA. Aging of B Plant facilities and structures is a major concern and accounted for in this HI&E.

6. Tornadoes are not considered in this PHA based on DOE guidance as provided in (UCRL-53526).

A 5.2 PHA Organization

The PHA for the B Plant S&M Phase was developed for the various locations within the facility to identify and evaluate hazardous conditions. The B Plant facility is comprised of several large buildings which contain hazardous material. Other buildings which are a part of the facility contain either small amounts of hazardous materials or none at all. The B Plant facility was broken down into 11 groups. The placement of a particular building or facility into a particular group was based on the amount and/or type of hazardous material contained in the building or facility and the physical isolations between buildings and groups of buildings. The building groups used in the PHA are as follows:

1. 221B Can	The areas of the 221-B building contained in this grouping are the canyon proper, process cells, wind tunnel, and hot pipe trench.
2. 221B Gal	The areas of the 221-B building contained in this grouping are the Operating Gallery, Piping Gallery, and Electrical Gallery and the SWP change room.
3. 291B	All of the buildings and structures associated with the original B Plant ventilation system, including the underground filter vaults and filter instrumentation buildings.
4. 221B-Exhst	All of the equipment associated with the new exhaust system for B Plant. This includes the equipment and ductwork from the entry point in Cell 10 through the new exhaust stack and the 221BK instrument building.
5. 271B	The 271-B Plant Support Building
6. 212B	The 212-B Cask Receiving Station
7. 221BB/BF	The 221-BB, 221-BB Condensate Pit, and the 221-BF building
8. 222B	The 222-B Office Building
9. 211B	The 211-B Chemical Tank Farm and 211-BB building
10. UPR	Unplanned Release Sites
11. Misc	B Plant buildings 207-BA, 217-B, 221-BA, 221-BC, 221-BD, 221-BG, 271-BA, 2711-B, 2715-B, 2716-B, and 276-B.

A 5.3 Preliminary Hazards Analysis

The PHA was performed according to the methodology described in Section 4.0. The starting point for the PHA was the development of hazard/energy checklist for each building group defined in Section 5.2. These checklists were developed on the first two days of the PHA, June 15-16, 1998. The eleven hazard/energy checklists developed for this PHA are provided in Attachment B.

Additional background information was obtained from two PHAs, (McCullough 1996) and (Schmitt 1997), that had been conducted earlier for the Deactivation Phase of B Plant. The applicable hazardous conditions from these previously conducted PHAs were used as source of information for the B Plant S&M PHA. The accident analyses provided in the B Plant Basis for Interim Operation (BIO 1998) was used as a source of information for the B Plant S&M Phase PHA.

A 5.4 PHA Results

The PHA identified 58 hazardous conditions associated with the B Plant S&M phase. The number of events in each of the consequence categories is summarized below.

S0 - 7
S1 - 27
S2 - 23
S3 - 0

Of the 58 hazardous conditions, 2 were categorized as S0-E3, indicating an environmental release threat only.

The PHA worksheets are documented in Attachments B and C of this report. Attachment B contains the Hazard/Energy Checklists, and Attachment C contains the PHA data sheets.

A 6.0 HAZARDS EVALUATION AND RESULTS

A 6.1 Hazards Evaluation

The hazardous conditions identified in the PHA were evaluated according to the methodology provided in Section 4.2. All of the hazardous conditions provided in Attachment C were evaluated using this methodology.

Sixteen accidents having a qualitative consequences ranking greater than S1 and a frequency ranking greater than F0 were identified and selected for further analysis. Accident Release Categories were developed for each of these hazardous conditions based on the Energy Level, Release Location, and Initial Release Form. A major cause or initiating event was assigned to each hazardous condition. Using these two sets of information the hazardous conditions were assigned to bins. This binning information is provided in Table A 6-1, Hazardous Conditions Binning Information.

A 6.2 Hazards Evaluation Results

Table A 6-2, B Plant S&M Hazardous Condition Bins, shows the binning results of the 16 hazardous conditions selected for further analysis based on Release Categories and Cause. Table A 6-3 contains a list of the hazardous conditions having only environmental release to the ground water (E3) and are not contained in Table A 6-2. This type of accident is of concern in the long term rather than the short term. This table is included to highlight potential environmental release accidents that would not appear in Table A 6-2.

The results presented in Table A 6-2: B Plant S&M Hazardous Condition Bins consist of the following information:

- The assigned Hazardous Condition Bin Name - Presented as the shaded header below which the S2 or S3 hazardous conditions are assigned to the specified bin.
- ID - The unique identifier of the hazard assigned during the PHA meetings
- Location/Activity - Location or activity associated with identified hazard.
- Hazardous Conditions - This is a standardized statement that describes the uncontrolled release of hazardous and/or radioactive materials.
- Candidate Causes - A description of the causes of the initiating event of the accident sequence.
- Consequences - The potential outcome of the hazardous condition.
- Freq Cat - Hazardous Condition Frequency - The estimated likelihood (frequency) of the hazard based on the qualitative assessment of the PHA team. The estimated frequency does not take credit for the effects of any mitigative features.
- Cons Cat - The safety (S) and environmental (E) consequence severity to the public, onsite worker, facility worker, and environment receptors based on the qualitative assessment of the PHA team. The estimated consequence does not take credit for the effects of any mitigative features.

The results presented in Table A 6-3, B Plant S&M Environmental Release Hazards Conditions, contain the same information groups as that contained in Table A 6-2 with the addition of the following information:

- Engineered Features - Equipment having potential for mitigating or preventing the event
- Administrative Features - Administrative controls having the potential for preventing or reducing the likelihood of the event
- Remarks - Pertinent information relating to the hazardous condition

A 6.3 Results

During the hazard identification the analysts accounted for B Plant facilities being unmanned for long periods of time; there would be a long term surveillance and maintenance program for the facilities; and aging/degradation of the facilities would occur.

The 16 hazardous conditions selected for further analysis are identified in Table A 6-2. The highest consequence of any of the hazardous conditions is an S2 (onsite worker). These hazardous conditions are discussed below.

A 6.3.1 Natural Phenomena

The first three bins of hazardous conditions are comprised of natural phenomena: Seismic, Rain/Snow/Ash, and Wind. If the facility structures are not maintained, the probability of failure of these structures will increase over time due to water damage, freezing, aging, etc. Facility structural failure could result in the release of radioactive and hazardous materials to the environment and onsite facility workers.

A 6.3.1.1 Seismic (BIN 1)

Seismic events 291B-Sei-01 and 221B-Sei-02 were identified as having a potential for causing radiological releases to workers and the environment. 221B-Sei-01 and 291B-Sei-02 are BDBEs and will be analyzed for purposes described in Section 3.4.3.

A 6.3.1.2 Rain/Snow/Ash (BIN 2)

Two hazards in this bin were selected for further analysis. One results in the release of radioactive material to the atmosphere or ground from the 221-B building. The cause of the release is degradation of the building over an extended period of time with subsequent intrusion of water (221B-Rain) into the building. The second hazard is heavy snow or ash fall (221B-Load) which results in the collapse of the 221-B building roof. This results in the release of radioactive material to the atmosphere.

A 6.3.1.3 Wind (BIN 3)

Effects of wind driven missiles (291B-Wind-01, 221Ehst-03, B-Plant-02) were also identified as a concern with the new canyon exhaust system. The presence of B Plant buildings having metal siding and roofs presents a vulnerability to this hazard. As these building age, the probability of a portion of the siding or roof coming off during a wind storm will increase over time. With the B Plant S&M program, the buildings will be repaired when building deterioration is observed during the surveillance process.

A 6.3.2 Exhaust System Filter Failure (BIN 4)

Two hazards in this bin were selected for further analysis. The first hazard (221B-Ehst-02) is a seismic event which results in a failure of the canyon exhaust system filter with a subsequent release of radioactive material to the atmosphere. The second hazard (221B-Ehst-06) is a filter failure (filter degradation, filter seal) with continued operation of the exhaust system. A release of radioactive material to the atmosphere results.

A 6.3.3 Fire/Explosion (BIN 5)

The most severe hazard in this category is a hydrogen explosion in the 291-B Filter Building (291B-Rain-01) due to flooding of vault resulting in building up hydrogen in the building. This hazard is addressed in the B Plant S&M Phase Fire Hazards Analysis (FHA) (HNF 1999a). A potential for Fire/Explosion accidents was identified associated with the rupture of a fuel tank during a vehicle accident by the canyon exhaust system (221B-Ehst-07) or the 291-B filters (291B-Impact-03). The buildup of tumbleweeds next to the Canyon Exhaust system (221B-Ehst-09) could have a high probability of occurrence which could result in a fire next to the exhaust system and a release of hazardous material to onsite personnel. The B Plant FHA addresses this hazard.

Based on multiple layers of defense in depth features, it is stated in the FHA that the hydrogen concentration in the vaults is not expected to exceed to concentration limits of NFPA 69, *Explosion Prevention Systems*.

A 6.3.4 Hanford Site Accidents (BIN 6)

Potential accidents at other Hanford facilities (WESF, Waste Tanks, etc.) could result in hazards to facility workers at B Plant in the S&M phase. This is addressed as a general hazard (B-Plant-03) which accounts for all Hanford facilities and the hazards they represent to facility workers at B Plant in the S&M phase.

A 6.3.5 Environmental

The environmental release concerns identified in the PHA (Table A 6-3) center around one mechanism: the potential for the aging and degradation of facility structures over a long duration. As a result of aging and degradation, roofs begin to leak water into the facility which in turn mobilizes contamination from within the building. This results in the release of radioactive and/or toxicological material to the environment. The B Plant surveillance and maintenance program (inspection and evaluation of roofs), if kept in place over the remaining life of the buildings, could prevent such an occurrence. Any hazardous condition resulting in the breaching of a containment barrier would lead to a release to the environment.

A 6.3.6 Worker Safety

The PHA forms present the hazard evaluation results. The forms identify potential accidents in terms of hazardous condition; location and cause event; material at risk; consequence frequency, category, and qualitative aspects; and engineered and administrative preventative and mitigative features.

The most significant hazards at B Plant involve the remaining radiological inventory in the canyon building and the retired filters. There are no significant hazards associated with chemicals since the liquid chemical inventories have ben removed and the dry chemical that remains in the canyon is stable Tri-Sodium Phosphate.

The most significant risks associated with the remaining radiological inventories in the canyon and the retired filters are postulated to be initiated by natural phenomena (seismic event, ash/snow load causing roof collapse, stack collapse on the retired filters) and explosion (hydrogen explosion in the retired filters).

Less consequential hazards resulting in potential releases from the canyon and/or the retired filter vaults were identified. These hazards are due to impacts to the new canyon exhaust system from missiles or vehicles, the retired filter risers and passive vent system, by vehicles, or by fires in or adjacent to the structures.

Aging of the structures by natural phenomena (rain, freeze/thaw cycles) could cause degradation to the structures which are relied on to contain their radiological inventory. The degradation of structural integrity could eventually lead to release of radiological inventory due to structural collapse.

Table A 6-1: Hazardous Conditions Binning Information

ID Number	Energy Level[a]	Release Location[b]	Initial Release form[c]	Accident Release Category	Cause	Bin[d]
291B-Sei-01	A	1	a	A-1-a	Seismic	I
291B-Sei-02	A	1	a	A-1-a	Seismic	I
221B-Sei-01	A	1	a	A-1-a	Seismic	I
221B-Sei-02	A	1	a	A-1-a	Seismic	I
221B-Rain	A	1	a	A-1-a	Rain/gravity	II
221B-Load	A	1	a	A-1-a	Ash/snow	II
BPlant-02	A	1	a	A-1-a	Wind/missiles	III
291B-Wind-01	A	1	a	A-1-a	Wind/missile	III
221B-Ehst-03	A	1	a	A-1-a	Wind/missile	III
221B-Ehst-02	B	1	a	B-1-a	Seismic/Filter Failure	IV
221B-Ehst-06	B	1	a	B-1-a	Filter seal failure	IV
291B-Rain-01	A	1	a	A-1-a	H2 explosion	V
221B-Ehst-07	A	1	a	A-1-a	Impact- vehicle with fire	V
221B-Ehst-09	A	1	a	A-1-a	Range fire	V
291B-Impact-03	A	1	a	A-1-a	Gas fire	V
BPlant-03	C	1	a	C-1-a	Site accidents	VI

a: A - High, B - Moderate, C - Low
b: 1 - Atmospheric, 2 - Surface, 3 - Subsurface
c: a - Aerosol, b - Liquid, c - Solid
d: I - Seismic; II - Rain/Snow/Ash; III - Wind; IV - Exhaust filter failure; V - Fire/explosion; VI - Site accidents

Table A 6-2: B Plant S&M Hazardous Condition Bins

ID	Location/Activity	Hazardous Condition	Causes	Consequences	Freq	Cons
BIN I - Seismic						
291B-Sei-01	291-B Filter Buildings	Release of radioactive material due to failure of A, B, or C filter building structures	Seismic Event 291-B-1 Exhaust Stack collapse	Release of radioactive material to the atmosphere or to the ground	F2	S2 E3
291B-Sei-02	291-B Filter Buildings	Release of radioactive material due to failure of D or E filter building structures	Seismic Event greater than .12g	Release of radioactive material to the atmosphere or to the ground	F2	S2 E3
221B-Sei-01	221-B Canyon including galleries, process cells and tanks	Release of radioactive material due to failure of structures to a beyond design basis seismic event	Seismic event - beyond design basis	Release of radioactive material to the atmosphere or to the ground	F1	S2 E3
221B-Sei-02	221-B Canyon including galleries, process cells and tanks	Release of radioactive material due to failure of structures to a design basis seismic event	Design basis seismic event	Release of radioactive material to the atmosphere or to the ground	F2	S2 E1
BIN II - Rain/Snow/Ash						
221B-Rain	221-B Canyon including galleries, process cells and tanks	Release of radioactive material due to failure of structure due to structural degradation of facility	Rain, water leaking into canyon	Release of radioactive material, contamination migration to the atmosphere or to the ground	F3	S2 E3
221B-Load	221-B Canyon including galleries, process cells and tanks	Release of radioactive material due to failure of structure due to volcanic ash or snow	Volcanic ash, snow	Release of radioactive material to the atmosphere	F2	S2 E2
BIN III - Wind						
B-Plant 02	B Plant Buildings	Damage to structures, systems or components(SSCs) due to generation of missile from degraded buildings	Facility degradation, aging	Damage to structures, systems, or components. Specific concerns are passive vent system and canyon exhaust system	F2	S2 E2
291B-Wind-01	291-B Filter Risers	Release of radioactive material due to loss of filter confinement due to breach of passive vent or risers	high wind missile	Release of radioactive material to the atmosphere	F2	S2 E2
221B-Ehst-03	Canyon exhaust system	Release of radioactive material due to missile penetrating filter	High wind	Release of radioactive material to the atmosphere	F2	S2 E2

Table A 6-2: B Plant S&M Hazardous Condition Bins

ID	Location/Activity	Hazardous Condition	Causes	Consequences	Freq	Cons
BIN IV - Exhaust Filter Failure						
221B-Ehst-02	Canyon exhaust system	Release of radioactive material due to filter failure	Seismic event	Release of radioactive materia to the atmosphere	F2	S2 E1
221B-Ehst-06	Canyon exhaust system	Unfiltered release due to loss of filtration	Filter failure filter seal failure Continued operation with damaged or degraded ACT equipment	Release of radioactive material to atmosphere	F2	S2 E2
BIN V - Fire/Explosion						
291B-Rain-01	291-B Filter Buildings	Release of radioactive material due to hydrogen accumulation and explosion in filter building	Flooding of vault due to rain, snow melt, or utility water line break.	Release of radioactive material to the atmosphere or to the ground	F1	S2 E3
221B-Ehst-07	Canyon exhaust system	Release of radioactive material due to breaching of filter confinement.	Human error Vehicle impact with gas tank fire	Release of radioactive material to the atmosphere	F2	S2 E2
221B-Ehst-09	Canyon exhaust system	Release of radioactive material on filters due to failure of confinement from fire	Build up of brush and tumble weeds around ventilation system with ignition	Release of radioactive material to the atmosphere	F2	S2 E2
291B-Impact-03	291-B Filter Building	Release of radioactive material from 291-B Filter Vaults due to breaching of passive filter confinement or filter vault risers	Impact from moving vehicle coupled with fire from gas tank	Release of radioactive material to the atmosphere	F1	S2 E2
BIN VI - Hanford Site Accidents						
B-Plant-03	B-Plant area	Facility workers hazard from accidents at other on-site facilities	Site accidents	Exposure to S&M facility workers	F3	S2

Table A 6-3: B Plant S&M Environmental Release Hazardous Conditions

ID	Location Activity	Hazardous Condition	Causes	Material-At-Risk	Consequence	Engineered Features	Administrative Features	Freq Cat	Cons Cat	Remarks
291B-Rain-03	291-B Sand Filter	Release of radioactive material due structural degradation (aging)	Water leaking into sand filter vaults causing damage (freeze/thaw)	Radioactive Material collected on sand filters	Release of radioactive material to the environment	Water barrier on top of filter, water sources drained and isolated,	S&M plan	F2	S0 E3	Low frequency due to barriers, low rains, low probability of freeze thaw cycles.
212B-03	Cask Station	Release of radioactive material due to structural failure due to aging	Water intrusion, (freezing and thawing	Hot cell contamination	Release of radioactive material to the ground	Stainless steel liner on walls and floors	S&M plan	F1	S0 E3	

A 7.0 CONCLUSIONS

A total of 58 hazardous conditions were identified as a result of the PHA for the B Plant during the S&M phase. Sixteen of these hazards were selected for further analysis and are listed in Table A 6-2. These hazardous conditions were sorted, based on common characteristics, into the following bins:

- Natural Phenomena (Seismic, Rain/Snow/Ash, Wind)
- Exhaust System Filter Failure
- Fire/Explosion
- Hanford Site Accidents
- Environmental

The hazards in these bins will be applied in the accident analysis process.

The highest consequence of any of the identified hazardous conditions involves adverse impacts to B Plant facility and Hanford onsite workers. There are no significant impacts to the public. The highest ranked hazards are associated with natural phenomena initiating events.

The most significant hazards at B Plant involve the remaining radiological inventory in the canyon building and the retired filters. There are no significant hazards associated with chemicals since the liquid chemical inventories have been removed and the dry chemical that remains in the canyon is stable TSP.

The radiological inventory in the canyon is primarily fixed contamination in the process cells and residual contamination in process cells vessels. The most significant radiological inventory at B Plant is in the retired filters. These are HEPA filters in the underground vaults in the 291-B area, south of the canyon building. This inventory is the result of filtering the canyon exhaust throughout the process and deactivation years. The filter vaults are now retired and isolated from the canyon. The exhaust system is deactivated, but the filters are passively vented to prevent buildup of dangerous gases in the vaults. The passive vent exhaust is HEPA filtered.

The most significant risks associated with the remaining radiological inventories in the canyon and the retired filters are postulated to be caused by natural phenomena (seismic event, ash/snow load causing roof collapse, stack collapse on the retired filters) and explosion (hydrogen explosion in the retired filters). Less consequential hazards resulting in potential releases from the canyon and/or the retired filter vaults were identified. These hazards are due to impacts to the new canyon exhaust system from missiles, the retired filter risers by vehicles, or by fires in or adjacent to the structures. Aging of the structures by nature (rain, freeze/thaw cycles) could cause degradation to the structures which are relied on to contain their radiological inventory. The degradation of structural integrity could eventually lead to release of radiological inventory due to partial structural collapse.

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Attachment A-A: B Plant PHA Team Member Biographies

B Plant S&M PHA Team Member Biographies

The Preliminary Hazards Analysis (PHA) for the B Plant S&M phase was completed on June 26, 1998, by a team of engineers with diverse disciplines and perspectives. The participants for this PHA are listed below.

David J. Braun - Fluor Daniel Northwest Inc - Engineer - Safety Analysis and Risk Assessment PE

Mr. Braun has over 21 years experience at Hanford working primarily in Safety Analysis. His experience includes Probabilistic Risk Analysis of nuclear reactors, tank farm activities, and hazards identification and evaluation of various Hanford site operations and facilities. He was one of the lead engineers on the hazards identification and evaluation team for the current TWRS BIO and draft FSAR. He has facilitated numerous PHA and HAZOP studies for projects at the Hanford site Mr. Braun has a Master of Science Degree in Mechanical Engineering from the University of California at Davis. He is a registered Professional Engineer in Mechanical Engineering (Washington State).

Benjamin Schwehr - B&W Hanford, Inc.- Electrical Engineer - B Plant Safety Basis Engineer

Mr. Schwehr has been an engineer for the past six years at Hanford. The first year he was a nuclear safety oversight engineer for Westinghouse Hanford Company. Mr. Schwehr has worked at WESF and B Plant since August 1993. He has worked throughout the B Plant facility providing valuable Unreviewed Safety Question and engineering expertise. Mr. Schwehr has been involved with the development and approval of the safety basis documents for B Plant since 1995. Mr. Schwehr has a Bachelor of Science in Electrical Engineering from the University of Idaho at Moscow.

John Van Keuren - Fluor Daniel Northwest Inc - Senior Engineer - Safety Analysis and Risk Assessment

Mr. Van Keuren is a Senior Engineer with FDNW Safety Analysis and Risk Assessment with more than 25 years experience in nuclear and safety analyses. Experience includes performing accident analyses with detailed radiological and toxicological analyses for a number of Hanford facilities, including tank farms, the cross site transfer system, and the fast flux test facility. Mr. Van Keuren has a Bachelor of Science in Physics, M. S., and Ph. D. in Nuclear Engineering.

Attachment A-B: B Plant S&M Hazard/Energy Identification Checklists

Hazard/Energy Identification Checklist

ID: 221B-Can PHA: 221 B Canyon Area, Process cells, Crane way, Wind tunnel, Hot pipe trench

Date: 6/15/98

A. Electrical ☐

Y N
- ☐ ■ 1. Battery banks
- ☐ ■ 2. Cable runs
- ☐ ■ 3. Diesel generators
- ■ ☐ 4. Electrical equipment - Lighting
- ☐ ■ 5. HVAC heaters
- ☐ ■ 6. High voltage
- ☐ ■ 7. Motors
- ☐ ■ 8. Pumps
- ☐ ■ 9. Power tools
- ☐ ■ 10. Switch gear
- ■ ☐ 11. Service outlets, fitting - In crane way
- ☐ ■ 12. Transformers
- ☐ ■ 13. Transmission lines
- ☐ ■ 14. Underground wires
- ■ ☐ 15. Wiring
- ■ ☐ 16. Other -Cell 10 liquid level detectors

B. Thermal ☐

Y N
- ☐ ■ 1. Bunsen burner/hot plates
- ☐ ■ 2. Electrical equipment
- ☐ ■ 3. Furnaces/boilers/heater
- ☐ ■ 4. Steam lines
- ☐ ■ 5. Welding torch/arc
- ☐ ■ 6. Diesel units/fire box/exhaust line
- ■ ☐ 7. Radioactive decay heat, (Minor)
- ☐ ■ 8. Exposed hot components
- ☐ ■ 9. Power tools
- ☐ ■ 10. Convective
- ☐ ■ 11. Solar
- ☐ ■ 12. Cryogenic
- ☐ ■ 13. Other _____

C. Friction ☐

Y N
- ☐ ■ 1. Belts
- ☐ ■ 2. Bearings
- ☐ ■ 3. Fans
- ☐ ■ 4. Gears
- ☐ ■ 5. Motors
- ☐ ■ 6. Power tools
- ☐ ■ 7. Other _____

D. Corrosives ☐

Y N
- ■ ☐ 1. Acids - residuals in heels in tanks
- ■ ☐ 2. Caustics - residuals in heels in tanks
- ☐ ■ 3. Natural chemicals
- ■ ☐ 4. Decontamination solution - Tank 100
- ☐ ■ 5. High temperature waste
- ☐ ■ 6. Galvanic interactions
- ☐ ■ 7. Other _____

E. Kinetic - Rotational ☐

Y N
- ☐ ■ 1. Centrifuges
- ☐ ■ 2. Motors
- ☐ ■ 3. Pumps
- ☐ ■ 4. Cooling tower fans
- ☐ ■ 5. Laundry equipment
- ☐ ■ 6. Shop equipment
- ☐ ■ 7. Other _____

F. Kinetic - Linear ☐

Y N
- ☐ ■ 1. Cars, trucks, buses
- ☐ ■ 2. Forklifts, dollies, carts
- ☐ ■ 3. Railroad
- ☐ ■ 4. Obstructions
- ☐ ■ 5. Crane loads
- ☐ ■ 6. Pressure vessel blowdown
- ☐ ■ 7. High pressure jets
- ☐ ■ 8. Abrasive blasters
- ☐ ■ 9. Other _____

G. Mass, Gravity, Height ☐

Y N
- ☐ ■ 1. Human effort
- ☐ ■ 2. Stairs
- ☐ ■ 3. Lifts and cranes
- ☐ ■ 4. Bucket and ladder
- ☐ ■ 5. Trucks
- ☐ ■ 6. Slings
- ☐ ■ 7. Hoists
- ☐ ■ 8. Elevators
- ☐ ■ 9. Jacks
- ☐ ■ 10. Scaffold and ladders
- ☐ ■ 11. Pits and excavations
- ☐ ■ 12. Elevated doors
- ■ ☐ 13. Vessels - Process vessels
- ■ ☐ 14. Other Tank 100

H. Pressure - Volume ☐

Y N
- ☐ ■ 1. Boilers
- ☐ ■ 2. Surge tanks
- ☐ ■ 3. Autoclave
- ☐ ■ 4. Test loops
- ☐ ■ 5. Gas bottles
- ☐ ■ 6. Pressure vessels
- ■ ☐ 7. Stressed members
- ☐ ■ 8. Gas receivers
- ☐ ■ 9. Negative pressure collapse
- ☐ ■ 10. Steam headers and lines
- ☐ ■ 11. Hydraulic systems
- ☐ ■ 12. High pressure cleaners
- ☐ ■ 13. Other _____

J. Explosives/Pyrophorics ☐

Y N
- ☐ ■ 1. Caps
- ☐ ■ 2. Primer cord
- ☐ ■ 3. Dynamite
- ☐ ■ 4. Scrub chemicals
- ☐ ■ 5. Dusts
- ■ ☐ 6. Hydrogen - from radiolysis
- ☐ ■ 7. Gases, others _____
- ■ ☐ 8. Nitrates/Nitrites -Residual heels
- ☐ ■ 9. Peroxides
- ☐ ■ 10. Pu and U metal
- ☐ ■ 11. Sodium
- ☐ ■ 12. Other _____

K. Nuclear Criticality ■ Exempt facility

Y N
- ☐ ■ 1. Vaults
- ☐ ■ 2. Temporary storage areas
- ☐ ■ 3. Shipping and receiving area
- ☐ ■ 4. Filters
- ☐ ■ 5. Casks
- ☐ ■ 6. Burial ground
- ☐ ■ 7. Storage racks
- ☐ ■ 8. Canals and basins
- ☐ ■ 9. Decontamination solution
- ☐ ■ 10. Trucks, forklifts, dollies
- ☐ ■ 11. Hand carry
- ☐ ■ 12. Cranes/lifts
- ☐ ■ 13. Hot cells, assembly, inspection
- ☐ ■ 14. Laboratories
- ☐ ■ 15. Other _____

L. Flammable Materials ☐

Y N
- ☐ ■ 1. Packing materials
- ☐ ■ 2. Rags
- ☐ ■ 3. Gasoline
- ■ ☐ 4. Lube oil/Grease in crane truck
- ☐ ■ 5. Coolant oil
- ☐ ■ 6. Paint solvent
- ☐ ■ 7. Diesel fuel
- ■ ☐ 8. Hydrogen, Radiolysis
- ■ ☐ 9. Nitric acid - heels
- ■ ☐ 10. Organics - heels
- ☐ ■ 11. Gases - others _____
- ☐ ■ 12. Liquids - others _____
- ☐ ■ 13. Buildings and contents
- ☐ ■ 14. Trailers and contents
- ■ ☐ 15. Other tires, hoses, oil in crane truck
- 16. See FHA for flammable materials

M. Hazardous Materials ☐

Y N
- ☐ ■ 1. Alkali metals
- ☐ ■ 2. Asphyxiate
- ☐ ■ 3. Biological agents
- ☐ ■ 4. Carcinogens
- ■ ☐ 5. Corrosives
- ☐ ■ 6. Oxidizers
- ■ ☐ 7. Toxins
- ■ ☐ 8. Heavy metals - Pb shielding blankets
- ☐ ■ 9. Other _____

N. Ionizing Radiation Sources ☐

Y N
- ☐ ■ 1. Fissile material
- ☐ ■ 2. Radiography equipment
- ■ ☐ 3. Radioactive material - residual heels
- ☐ ■ 4. Radioactive sources
- ☐ ■ 5. Other _____

P. External events ☐

Y N
- ☐ ■ 1. Explosion
- ☐ ■ 2. Fire
- ☐ ■ 3. Other sites

Q. Vehicles In Motion (external to facility) ☐

Y N
- ■ ☐ 1. Airplane
- ■ ☐ 2. Helicopter
- ☐ ■ 3. Train
- ☐ ■ 4. Truck/bus/car
- ☐ ■ 5. Other _____

R. Natural Phenomena ☐

Y N
- ■ ☐ 1. Earthquake
- ☐ ■ 2. Flood
- ☐ ■ 3. Lightning - Heavy Concrete Structure
- ■ ☐ 4. Rain
- ■ ☐ 5. Snow, freezing weather
- ■ ☐ 6. Straight wind
- ☐ ■ 7. Dust devil
- ■ ☐ 8. Tornado
- ■ ☐ 9. Ash fall
- ☐ ■ 10. Range fire - Heavy Concrete Structure
- ■ ☐ 11. Other- Aging Effects

Hazard/Energy Identification Checklist

ID: 221B-Gal PHA: 221 B Galleries (SWP Change Room, Operating, Piping and Electrical)

Date: 6/15/98

A. Electrical ☐

Y N
- ☐ ■ 1. Battery banks
- ☐ ■ 2. Cable runs
- ☐ ■ 3. Diesel generators
- ■ ☐ 4. Electrical equipment - Surveillance lighting
- ☐ ■ 5. HVAC heaters
- ☐ ■ 6. High voltage
- ☐ ■ 7. Motors
- ☐ ■ 8. Pumps
- ☐ ■ 9. Power tools
- ☐ ■ 10. Switch gear
- ■ ☐ 11. Service outlets, fitting
- ■ ☐ 12. Transformers
- ☐ ■ 13. Transmission lines
- ☐ ■ 14. Underground wires
- ■ ☐ 15. Wiring
- ☐ ■ 16. Other _____

B. Thermal ☐

Y N
- ☐ ■ 1. Bunsen burner/hot plates
- ■ ☐ 2. Electrical equipment
- ☐ ■ 3. Furnaces/boilers/heater
- ☐ ■ 4. Steam lines
- ☐ ■ 5. Welding torch/arc
- ☐ ■ 6. Diesel units/fire box/exhaust line
- ☐ ■ 7. Radioactive decay heat
- ☐ ■ 8. Exposed hot components
- ☐ ■ 9. Power tools
- ☐ ■ 10. Convective
- ☐ ■ 11. Solar
- ☐ ■ 12. Cryogenic
- ☐ ■ 13. Other _____

C. Friction ☐

Y N
- ☐ ■ 1. Belts
- ☐ ■ 2. Bearings
- ☐ ■ 3. Fans
- ☐ ■ 4. Gears
- ☐ ■ 5. Motors
- ☐ ■ 6. Power tools
- ☐ ■ 7. Other _____

D. Corrosives ☐

Y N
- ■ ☐ 1. Acids - small residuals in pipes
- ■ ☐ 2. Caustics - small residuals in pipes
- ☐ ■ 3. Natural chemicals
- ■ ☐ 4. Decontamination solution
- ☐ ■ 5. High temperature waste
- ☐ ■ 6. Galvanic interactions
- ☐ ■ 7. Other _____

E. Kinetic - Rotational ☐

Y N
- ☐ ■ 1. Centrifuges
- ☐ ■ 2. Motors
- ☐ ■ 3. Pumps
- ☐ ■ 4. Cooling tower fans
- ☐ ■ 5. Laundry equipment
- ☐ ■ 6. Shop equipment
- ☐ ■ 7. Other _____

F. Kinetic - Linear ☐

Y N
- ☐ ■ 1. Cars, trucks, buses
- ☐ ■ 2. Forklifts, dollies, carts
- ☐ ■ 3. Railroad
- ☐ ■ 4. Obstructions
- ☐ ■ 5. Crane loads
- ☐ ■ 6. Pressure vessel blowdown
- ☐ ■ 7. High pressure jets
- ☐ ■ 8. Abrasive blasters
- ☐ ■ 9. Other _____

G. Mass, Gravity, Height ☐

Y N
- ■ ☐ 1. Human effort - S&M activities
- ■ ☐ 2. Stairs
- ☐ ■ 3. Lifts and cranes
- ☐ ■ 4. Bucket and ladder
- ☐ ■ 5. Trucks
- ☐ ■ 6. Slings
- ☐ ■ 7. Hoists
- ☐ ■ 8. Elevators
- ☐ ■ 9. Jacks
- ☐ ■ 10. Scaffold and ladders
- ☐ ■ 11. Pits and excavations
- ☐ ■ 12. Elevated doors
- ■ ☐ 13. Vessels - deactivated
- ☐ ■ 14. Other _____

H. Pressure - Volume ☐

Y N
- ☐ ■ 1. Boilers
- ☐ ■ 2. Surge tanks
- ☐ ■ 3. Autoclave
- ☐ ■ 4. Test loops
- ☐ ■ 5. Gas bottles
- ☐ ■ 6. Pressure vessels
- ■ ☐ 7. Stressed members - Piping supports
- ☐ ■ 8. Gas receivers
- ☐ ■ 9. Negative pressure collapse
- ☐ ■ 10. Steam headers and lines
- ☐ ■ 11. Hydraulic systems
- ☐ ■ 12. High pressure cleaners
- ☐ ■ 13. Other _____

J. Explosives/Pyrophorics ☐

Y N
- ☐ ■ 1. Caps
- ☐ ■ 2. Primer cord
- ☐ ■ 3. Dynamite
- ☐ ■ 4. Scrub chemicals
- ☐ ■ 5. Dusts
- ☐ ■ 6. Hydrogen
- ☐ ■ 7. Gases, others _____
- ☐ ■ 8. Nitrates/Nitrites
- ☐ ■ 9. Peroxides
- ☐ ■ 10. Pu and U metal
- ☐ ■ 11. Sodium
- ☐ ■ 12. Other _____

K. Nuclear Criticality ■ Exempt facility

Y N
- ☐ ■ 1. Vaults
- ☐ ■ 2. Temporary storage areas
- ☐ ■ 3. Shipping and receiving area
- ☐ ■ 4. Filters
- ☐ ■ 5. Casks
- ☐ ■ 6. Burial ground
- ☐ ■ 7. Storage racks
- ☐ ■ 8. Canals and basins
- ☐ ■ 9. Decontamination solution
- ☐ ■ 10. Trucks, forklifts, dollies
- ☐ ■ 11. Hand carry
- ☐ ■ 12. Cranes/lifts
- ☐ ■ 13. Hot cells, assembly, inspection
- ☐ ■ 14. Laboratories
- ☐ ■ 15. Other _____

L. Flammable Materials ☐

Y N
- ☐ ■ 1. Packing materials
- ☐ ■ 2. Rags
- ☐ ■ 3. Gasoline
- ■ ☐ 4. Lube oil/Grease in crane truck
- ☐ ■ 5. Coolant oil
- ☐ ■ 6. Paint solvent
- ☐ ■ 7. Diesel fuel
- ☐ ■ 8. Hydrogen
- ☐ ■ 9. Nitric acid - heels
- ☐ ■ 10. Organics - heels
- ☐ ■ 11. Gases - others _____
- ☐ ■ 12. Liquids - others _____
- ☐ ■ 13. Buildings and contents
- ☐ ■ 14. Trailers and contents
- ■ ☐ 15. Other See FHA for flammable materials

M. Hazardous Materials ☐

Y N
- ☐ ■ 1. Alkali metals
- ☐ ■ 2. Asphyxiants
- ☐ ■ 3. Biological agents
- ■ ☐ 4. Carcinogens -Asbestos
- ☐ ■ 5. Corrosives
- ☐ ■ 6. Oxidizers
- ☐ ■ 7. Toxins
- ■ ☐ 8. Heavy metals - Pb shielding
- ☐ ■ 9. Other _____

N. Ionizing Radiation Sources ☐

Y N
- ☐ ■ 1. Fissile material
- ☐ ■ 2. Radiography equipment
- ■ ☐ 3. Radioactive material -small amounts of contamination
- ☐ ■ 4. Radioactive sources
- ☐ ■ 5. Other _____

P. External events ☐

Y N
- ☐ ■ 1. Explosion
- ☐ ■ 2. Fire
- ☐ ■ 3. Other sites

Q. Vehicles In Motion (external to facility) ☐

Y N
- ■ ☐ 1. Airplane
- ■ ☐ 2. Helicopter
- ☐ ■ 3. Train
- ☐ ■ 4. Truck/bus/car
- ☐ ■ 5. Other _____

R. Natural Phenomena ☐

Y N
- ■ ☐ 1. Earthquake
- ☐ ■ 2. Flood
- ☐ ■ 3. Lightning - - Heavy Concrete Structure
- ☐ ■ 4. Rain
- ☐ ■ 5. Snow, freezing weather
- ☐ ■ 6. Straight wind
- ☐ ■ 7. Dust devil
- ☐ ■ 8. Tornado
- ☐ ■ 9. Ashfall
- ☐ ■ 10. Range fire - Heavy Concrete Structure
- ■ ☐ 11. Other- Aging Effects

Hazard/Energy Identification Checklist

ID: 291B PHA: 291B filter area (includes A-E Filters, Sand Filter, 291B, 291BA, 291BB, 291BC, 291BD, 291BF, 291BG, 291BH, 291BJ, 291BK, 291B Passive Vent System, 292B, Stack Date: 6/15/98

A. Electrical ☐

Y N
- ☐ ■ 1. Battery banks
- ■ ☐ 2. Cable runs
- ☐ ■ 3. Diesel generators
- ■ ☐ 4. Electrical equipment -Retired vault liquid level detector (LLDs) low voltage
- ☐ ■ 5. HVAC heaters
- ☐ ■ 6. High voltage
- ■ ☐ 7. Motors - Purge fans
- ☐ ■ 8. Pumps
- ☐ ■ 9. Power tools
- ☐ ■ 10. Switch gear
- ☐ ■ 11. Service outlets, fitting
- ■ ☐ 12. Transformers - Converts 120 V to low voltage for LLDs
- ■ ☐ 13. Transmission lines- distribution lines
- ☐ ■ 14. Underground wires
- ■ ☐ 15. Wiring
- ☐ ■ 16. Other _____

B. Thermal ☐

Y N
- ☐ ■ 1. Bunsen burner/hot plates
- ☐ ■ 2. Electrical equipment
- ☐ ■ 3. Furnaces/boilers/heater
- ☐ ■ 4. Steam lines
- ☐ ■ 5. Welding torch/arc
- ☐ ■ 6. Diesel units/fire box/exhaust line
- ■ ☐ 7. Radioactive decay heat - minor
- ☐ ■ 8. Exposed hot components
- ☐ ■ 9. Power tools
- ☐ ■ 10. Convective
- ☐ ■ 11. Solar
- ☐ ■ 12. Cryogenic
- ☐ ■ 13. Other _____

C. Friction ☐

Y N
- ■ ☐ 1. Belts
- ■ ☐ 2. Bearings- Purge fans on passive vent system
- ■ ☐ 3. Fans Purge fans on passive vent system
- ☐ ■ 4. Gears
- ■ ☐ 5. Motors Purge fans on passive vent system
- ☐ ■ 6. Power tools
- ☐ ■ 7. Other _____

D. Corrosives ☐

Y N
- ☐ ■ 1. Acids
- ☐ ■ 2. Caustics
- ☐ ■ 3. Natural chemicals
- ☐ ■ 4. Decontamination solution
- ☐ ■ 5. High temperature waste
- ☐ ■ 6. Galvanic interactions
- ☐ ■ 7. Other _____

E. Kinetic - Rotational ☐

Y N
- ☐ ■ 1. Centrifuges
- ■ ☐ 2. Motors - purge fans
- ☐ ■ 3. Pumps
- ☐ ■ 4. Cooling tower fans
- ☐ ■ 5. Laundry equipment
- ☐ ■ 6. Shop equipment
- ☐ ■ 7. Other _____

F. Kinetic - Linear ☐

Y N
- ■ ☐ 1. Cars, trucks, buses
- ☐ ■ 2. Forklifts, dollies, carts
- ☐ ■ 3. Railroad
- ☐ ■ 4. Obstructions
- ☐ ■ 5. Crane loads
- ☐ ■ 6. Pressure vessel blowdown
- ☐ ■ 7. High pressure jets
- ☐ ■ 8. Abrasive blasters
- ☐ ■ 9. Other _____

G. Mass, Gravity, Height ☐

Y N
- ☐ ■ 1. Human effort
- ☐ ■ 2. Stairs
- ☐ ■ 3. Lifts and cranes
- ☐ ■ 4. Bucket and ladder
- ☐ ■ 5. Trucks
- ☐ ■ 6. Slings
- ☐ ■ 7. Hoists
- ☐ ■ 8. Elevators
- ☐ ■ 9. Jacks
- ☐ ■ 10. Scaffold and ladders
- ■ ☐ 11. Pits and excavations
- ☐ ■ 12. Elevated doors
- ■ ☐ 13. Vessels - Deactivated water seal maintenance tanks
- ■ ☐ 14. Other - Overhead piping

H. Pressure - Volume ☐

Y N
- ☐ ■ 1. Boilers
- ☐ ■ 2. Surge tanks
- ☐ ■ 3. Autoclave
- ☐ ■ 4. Test loops
- ☐ ■ 5. Gas bottles
- ☐ ■ 6. Pressure vessels
- ■ ☐ 7. Stressed members - Piping supports
- ☐ ■ 8. Gas receivers
- ☐ ■ 9. Negative pressure collapse
- ☐ ■ 10. Steam headers and lines
- ☐ ■ 11. Hydraulic systems
- ☐ ■ 12. High pressure cleaners
- ☐ ■ 13. Other _____

J. Explosives/Pyrophorics ☐

Y N
- ☐ ■ 1. Caps
- ☐ ■ 2. Primer cord
- ☐ ■ 3. Dynamite
- ☐ ■ 4. Scrub chemicals
- ☐ ■ 5. Dusts
- ■ ☐ 6. Hydrogen - from radiolysis
- ☐ ■ 7. Gases, others _____
- ☐ ■ 8. Nitrates/Nitrites
- ☐ ■ 9. Peroxides
- ☐ ■ 10. Pu and U metal
- ☐ ■ 11. Sodium
- ☐ ■ 12. Other _____

K. Nuclear Criticality ■ Exempt facility

Y N
- ☐ ■ 1. Vaults
- ☐ ■ 2. Temporary storage areas
- ☐ ■ 3. Shipping and receiving area
- ☐ ■ 4. Filters
- ☐ ■ 5. Casks
- ☐ ■ 6. Burial ground
- ☐ ■ 7. Storage racks
- ☐ ■ 8. Canals and basins
- ☐ ■ 9. Decontamination solution
- ☐ ■ 10. Trucks, forklifts, dollies
- ☐ ■ 11. Hand carry
- ☐ ■ 12. Cranes/lifts
- ☐ ■ 13. Hot cells, assembly, inspection
- ☐ ■ 14. Laboratories
- ☐ ■ 15. Other _____

L. Flammable Materials ☐

Y N
- ☐ ■ 1. Packing materials
- ☐ ■ 2. Rags
- ☐ ■ 3. Gasoline
- ■ ☐ 4. Lube oil/Grease
- ☐ ■ 5. Coolant oil
- ☐ ■ 6. Paint solvent
- ☐ ■ 7. Diesel fuel
- ■ ☐ 8. Hydrogen - from radiolysis
- ☐ ■ 9. Nitric acid
- ☐ ■ 10. Organics
- ☐ ■ 11. Gases - others _____
- ☐ ■ 12. Liquids - others _____
- ☐ ■ 13. Buildings and contents
- ☐ ■ 14. Trailers and contents
- ■ ☐ 15. Other Filter material

M. Hazardous Materials ☐

Y N
- ☐ ■ 1. Alkali metals
- ☐ ■ 2. Asphyxiants
- ☐ ■ 3. Biological agents
- ☐ ■ 4. Carcinogens
- ☐ ■ 5. Corrosives
- ☐ ■ 6. Oxidizers
- ☐ ■ 7. Toxins
- ☐ ■ 8. Heavy metals
- ☐ ■ 9. Other _____

N. Ionizing Radiation Sources ☐

Y N
- ■ ☐ 1. Fissile material A, B, C, D filters -1 g each, sand filter 11 g
- ☐ ■ 2. Radiography equipment
- ■ ☐ 3. Radioactive material - on filters see Table 1-10 BIO-003
- ☐ ■ 4. Radioactive sources
- ☐ ■ 5. Other _____

P. External events ☐

Y N
- ☐ ■ 1. Explosion
- ☐ ■ 2. Fire
- ☐ ■ 3. Other sites

Q. Vehicles In Motion (external to facility) ☐

Y N
- ■ ☐ 1. Airplane
- ■ ☐ 2. Helicopter
- ☐ ■ 3. Train
- ■ ☐ 4. Truck/bus/car
- ☐ ■ 5. Other _____

R. Natural Phenomena ☐

Y N
- ■ ☐ 1. Earthquake
- ☐ ■ 2. Flood
- ■ ☐ 3. Lightning- Ignition source
- ☐ ■ 4. Rain
- ☐ ■ 5. Snow, freezing weather
- ■ ☐ 6. Straight wind -Damage to passive filters
- ☐ ■ 7. Dust devil
- ■ ☐ 8. Tornado Damage to passive filters
- ■ ☐ 9. Ashfall - Plug up vents
- ■ ☐ 10. Range fire - Ignition source
- ■ ☐ 11. Other- Aging Effects

Hazard/Energy Identification Checklist

ID: 221BExhst PHA: 221B Canyon Exhaust System (Fans, Ducts, Filters, Stack, 221BK)

Date: 6/16/98

A. Electrical ☐

Y N
- ☐ ■ 1. Battery banks
- ■ ☐ 2. Cable runs
- ☐ ■ 3. Diesel generators
- ■ ☐ 4. Electrical equipment -Panel board, controls, detectors
- ☐ ■ 5. HVAC heaters
- ■ ☐ 6. High voltage - 480 V, 120 V
- ■ ☐ 7. Motors
- ☐ ■ 8. Pumps
- ☐ ■ 9. Power tools
- ☐ ■ 10. Switch gear
- ■ ☐ 11. Service outlets, fitting
- ■ ☐ 12. Transformers
- ■ ☐ 13. Transmission lines- distribution lines
- ☐ ■ 14. Underground wires - all above ground
- ☐ ■ 15. Wiring
- ☐ ■ 16. Other _____

B. Thermal ☐

Y N
- ☐ ■ 1. Bunsen burner/hot plates
- ■ ☐ 2. Electrical equipment
- ☐ ■ 3. Furnaces/boilers/heater
- ☐ ■ 4. Steam lines
- ☐ ■ 5. Welding torch/arc
- ☐ ■ 6. Diesel units/fire box/exhaust line
- ■ ☐ 7. Radioactive decay heat - very small
- ☐ ■ 8. Exposed hot components
- ☐ ■ 9. Power tools
- ☐ ■ 10. Convective
- ☐ ■ 11. Solar
- ☐ ■ 12. Cryogenic
- ☐ ■ 13. Other _____

C. Friction ☐

Y N
- ■ ☐ 1. Belts
- ■ ☐ 2. Bearings
- ■ ☐ 3. Fans
- ☐ ■ 4. Gears
- ■ ☐ 5. Motors
- ☐ ■ 6. Power tools
- ☐ ■ 7. Other _____

D. Corrosives ☐

Y N
- ☐ ■ 1. Acids
- ☐ ■ 2. Caustics
- ☐ ■ 3. Natural chemicals
- ☐ ■ 4. Decontamination solution
- ☐ ■ 5. High temperature waste
- ☐ ■ 6. Galvanic interactions
- ☐ ■ 7. Other _____

E. Kinetic - Rotational ☐

Y N
- ☐ ■ 1. Centrifuges
- ■ ☐ 2. Motors
- ☐ ■ 3. Pumps
- ☐ ■ 4. Cooling tower fans
- ☐ ■ 5. Laundry equipment
- ☐ ■ 6. Shop equipment
- ☐ ■ 7. Other _____

F. Kinetic - Linear ☐

Y N
- ■ ☐ 1. Cars, trucks, buses
- ■ ☐ 2. Forklifts, dollies, carts
- ☐ ■ 3. Railroad
- ☐ ■ 4. Obstructions
- ■ ☐ 5. Crane loads - maintenance
- ☐ ■ 6. Pressure vessel blowdown
- ☐ ■ 7. High pressure jets
- ☐ ■ 8. Abrasive blasters
- ■ ☐ 9. Other Dampers _____

G. Mass, Gravity, Height ☐

Y N
- ■ ☐ 1. Human effort - change of filter or fan motor
- ■ ☐ 2. Stairs
- ■ ☐ 3. Lifts and cranes change of filter or fan motor
- ■ ☐ 4. Bucket and ladder - maintenance
- ■ ☐ 5. Trucks
- ■ ☐ 6. Slings
- ☐ ■ 7. Hoists
- ☐ ■ 8. Elevators
- ☐ ■ 9. Jacks
- ☐ ■ 10. Scaffold and ladders
- ☐ ■ 11. Pits and excavations
- ☐ ■ 12. Elevated doors
- ☐ ■ 13. Vessels
- ☐ ■ 14. Other____

H. Pressure - Volume ☐

Y N
- ☐ ■ 1. Boilers
- ☐ ■ 2. Surge tanks
- ☐ ■ 3. Autoclave
- ☐ ■ 4. Test loops
- ☐ ■ 5. Gas bottles
- ☐ ■ 6. Pressure vessels
- ☐ ■ 7. Stressed members
- ☐ ■ 8. Gas receivers
- ■ ☐ 9. Negative pressure collapse - filter collapse prevented by fan design
- ☐ ■ 10. Steam headers and lines
- ☐ ■ 11. Hydraulic systems
- ☐ ■ 12. High pressure cleaners
- ☐ ■ 13. Other _____

J. Explosives/Pyrophorics ☐

Y N
- ☐ ■ 1. Caps
- ☐ ■ 2. Primer cord
- ☐ ■ 3. Dynamite
- ☐ ■ 4. Scrub chemicals
- ☐ ■ 5. Dusts
- ■ ☐ 6. Hydrogen - very small
- ☐ ■ 7. Gases, others _____
- ☐ ■ 8. Nitrates/Nitrites
- ☐ ■ 9. Peroxides
- ☐ ■ 10. Pu and U metal
- ☐ ■ 11. Sodium
- ☐ ■ 12. Other _____

K. Nuclear Criticality ☐ Exempt facility

Y N
- ☐ ■ 1. Vaults
- ☐ ■ 2. Temporary storage areas
- ☐ ■ 3. Shipping and receiving area
- ☐ ■ 4. Filters
- ☐ ■ 5. Casks
- ☐ ■ 6. Burial ground
- ☐ ■ 7. Storage racks
- ☐ ■ 8. Canals and basins
- ☐ ■ 9. Decontamination solution
- ☐ ■ 10. Trucks, forklifts, dollies
- ☐ ■ 11. Hand carry
- ☐ ■ 12. Cranes/lifts
- ☐ ■ 13. Hot cells, assembly, inspection
- ☐ ■ 14. Laboratories
- ☐ ■ 15. Other _____

L. Flammable Materials ☐

Y N
- ☐ ■ 1. Packing materials
- ☐ ■ 2. Rags
- ☐ ■ 3. Gasoline
- ■ ☐ 4. Lube oil/Grease
- ☐ ■ 5. Coolant oil
- ☐ ■ 6. Paint solvent
- ☐ ■ 7. Diesel fuel
- ■ ☐ 8. Hydrogen - very small
- ☐ ■ 9. Nitric acid
- ☐ ■ 10. Organics
- ☐ ■ 11. Gases - others _____
- ☐ ■ 12. Liquids - others _____
- ☐ ■ 13. Buildings and contents
- ☐ ■ 14. Trailers and contents
- ■ ☐ 15. Other Filter material See FHA

M. Hazardous Materials ☐

Y N
- ☐ ■ 1. Alkali metals
- ☐ ■ 2. Asphyxiants
- ☐ ■ 3. Biological agents
- ☐ ■ 4. Carcinogens -Asbestos
- ☐ ■ 5. Corrosives
- ☐ ■ 6. Oxidizers
- ☐ ■ 7. Toxins
- ☐ ■ 8. Heavy metals
- ☐ ■ 9. Other _____

N. Ionizing Radiation Sources ☐

Y N
- ☐ ■ 1. Fissile material
- ☐ ■ 2. Radiography equipment
- ■ ☐ 3. Radioactive material - on filters
- ☐ ■ 4. Radioactive sources
- ☐ ■ 5. Other _____

P. External events ☐

Y N
- ☐ ■ 1. Explosion
- ☐ ■ 2. Fire
- ☐ ■ 3. Other sites

Q. Vehicles In Motion (external to facility) ☐

Y N
- ■ ☐ 1. Airplane
- ■ ☐ 2. Helicopter
- ☐ ■ 3. Train
- ■ ☐ 4. Truck/bus/car
- ☐ ■ 5. Other _____

R. Natural Phenomena ☐

Y N
- ■ ☐ 1. Earthquake- Old stack collapse
- ☐ ■ 2. Flood
- ■ ☐ 3. Lightning- New stack is carbon steel
- ■ ☐ 4. Rain - Impact to HEPA filter
- ■ ☐ 5. Snow, freezing weather
- ■ ☐ 6. Straight wind - missiles
- ☐ ■ 7. Dust devil
- ■ ☐ 8. Tornado
- ■ ☐ 9. Ash fall - can affect fans, motors, bearings
- ■ ☐ 10. Range fire-Tumbleweed
- ■ ☐ 11. Other- Aging Effects

Hazard/Energy Identification Checklist

ID:271B PHA: 271-B Plant Support Building

Date: 6/16/98

A. Electrical ☐

Y N
☐ ■ 1. Battery banks
■ ☐ 2. Cable runs
☐ ■ 3. Diesel generators
■ ☐ 4. Electrical equipment
☐ ■ 5. HVAC heaters
■ ☐ 6. High voltage - 480 V, 120 V energized for S&M only
☐ ■ 7. Motors
☐ ■ 8. Pumps
☐ ■ 9. Power tools
☐ ■ 10. Switch gear
■ ☐ 11. Service outlets, fitting
■ ☐ 12. Transformers
☐ ■ 13. Transmission lines
☐ ■ 14. Underground wires
■ ☐ 15. Wiring
■ ☐ 16. Other Lighting

B. Thermal ☐

Y N
☐ ■ 1. Bunsen burner/hot plates
■ ☐ 2. Electrical equipment
☐ ■ 3. Furnaces/boilers/heater
☐ ■ 4. Steam lines
☐ ■ 5. Welding torch/arc
☐ ■ 6. Diesel units/fire box/exhaust line
☐ ■ 7. Radioactive decay heat
☐ ■ 8. Exposed hot components
☐ ■ 9. Power tools
☐ ■ 10. Convective
☐ ■ 11. Solar
☐ ■ 12. Cryogenic
☐ ■ 13. Other _____

C. Friction ☐

Y N
☐ ■ 1. Belts
☐ ■ 2. Bearings
☐ ■ 3. Fans
☐ ■ 4. Gears
☐ ■ 5. Motors
☐ ■ 6. Power tools
☐ ■ 7. Other _____

D. Corrosives ☐

Y N
☐ ■ 1. Acids
☐ ■ 2. Caustics
☐ ■ 3. Natural chemicals
☐ ■ 4. Decontamination solution
☐ ■ 5. High temperature waste
☐ ■ 6. Galvanic interactions
☐ ■ 7. Other _____

E. Kinetic - Rotational ☐

Y N
☐ ■ 1. Centrifuges
☐ ■ 2. Motors
☐ ■ 3. Pumps
☐ ■ 4. Cooling tower fans
☐ ■ 5. Laundry equipment
☐ ■ 6. Shop equipment
☐ ■ 7. Other _____

F. Kinetic - Linear ☐

Y N
☐ ■ 1. Cars, trucks, buses
☐ ■ 2. Forklifts, dollies, carts
☐ ■ 3. Railroad
☐ ■ 4. Obstructions
☐ ■ 5. Crane loads
☐ ■ 6. Pressure vessel blowdown
☐ ■ 7. High pressure jets
☐ ■ 8. Abrasive blasters
☐ ■ 9. Other _____

G. Mass, Gravity, Height ☐

Y N
☐ ■ 1. Human effort
■ ☐ 2. Stairs
☐ ■ 3. Lifts and cranes
☐ ■ 4. Bucket and ladder
☐ ■ 5. Trucks
☐ ■ 6. Slings
☐ ■ 7. Hoists
■ ☐ 8. Elevators- deactivated
☐ ■ 9. Jacks
☐ ■ 10. Scaffold and ladders
■ ☐ 11. Pits and excavations sump in basement, equipment service, outdoors door to basement
■ ☐ 12. Elevated doors -elevator doors (deactivated), truck dock, roof access
■ ☐ 13. Vessels (empty)
☐ ■ 14. Other____

H. Pressure - Volume ☐

Y N
☐ ■ 1. Boilers
☐ ■ 2. Surge tanks
☐ ■ 3. Autoclave
☐ ■ 4. Test loops
☐ ■ 5. Gas bottles
☐ ■ 6. Pressure vessels
■ ☐ 7. Stressed members
☐ ■ 8. Gas receivers
☐ ■ 9. Negative pressure collapse
☐ ■ 10. Steam headers and lines
☐ ■ 11. Hydraulic systems
☐ ■ 12. High pressure cleaners
☐ ■ 13. Other _____

J. Explosives/Pyrophorics ☐

Y N
☐ ■ 1. Caps
☐ ■ 2. Primer cord
☐ ■ 3. Dynamite
☐ ■ 4. Scrub chemicals
☐ ■ 5. Dusts
☐ ■ 6. Hydrogen
☐ ■ 7. Gases, others _____
☐ ■ 8. Nitrates/Nitrites
☐ ■ 9. Peroxides
☐ ■ 10. Pu and U metal
☐ ■ 11. Sodium
☐ ■ 12. Other _____

K. Nuclear Criticality ☐ Exempt facility

Y N
☐ ■ 1. Vaults
☐ ■ 2. Temporary storage areas
☐ ■ 3. Shipping and receiving area
☐ ■ 4. Filters
☐ ■ 5. Casks
☐ ■ 6. Burial ground
☐ ■ 7. Storage racks
☐ ■ 8. Canals and basins
☐ ■ 9. Decontamination solution
☐ ■ 10. Trucks, forklifts, dollies
☐ ■ 11. Hand carry
☐ ■ 12. Cranes/lifts
☐ ■ 13. Hot cells, assembly, inspection
☐ ■ 14. Laboratories
☐ ■ 15. Other _____

L. Flammable Materials ☐

Y N
☐ ■ 1. Packing materials
☐ ■ 2. Rags
☐ ■ 3. Gasoline
■ ☐ 4. Lube oil/Grease
☐ ■ 5. Coolant oil
☐ ■ 6. Paint solvent
☐ ■ 7. Diesel fuel
■ ☐ 8. Hydrogen
☐ ■ 9. Nitric acid
☐ ■ 10. Organics
☐ ■ 11. Gases - others _____
☐ ■ 12. Liquids - others _____
☐ ■ 13. Buildings and contents limited building internals
☐ ■ 14. Trailers and contents
■ ☐ 15. Other See FHA

M. Hazardous Materials ☐

Y N
☐ ■ 1. Alkali metals
☐ ■ 2. Asphyxiants
☐ ■ 3. Biological agents
■ ☐ 4. Carcinogens -Asbestos insulation, floor tile
☐ ■ 5. Corrosives
☐ ■ 6. Oxidizers
☐ ■ 7. Toxins
☐ ■ 8. Heavy metals
☐ ■ 9. Other _____

N. Ionizing Radiation Sources ☐

Y N
☐ ■ 1. Fissile material
☐ ■ 2. Radiography equipment
☐ ■ 3. Radioactive material
☐ ■ 4. Radioactive sources
☐ ■ 5. Other _____

P. External events ☐

Y N
☐ ■ 1. Explosion
☐ ■ 2. Fire
☐ ■ 3. Other sites

Q. Vehicles In Motion (external to facility) ☐

Y N
■ ☐ 1. Airplane
■ ☐ 2. Helicopter
☐ ■ 3. Train
☐ ■ 4. Truck/bus/car will not damage hot cell
☐ ■ 5. Other _____

R. Natural Phenomena ☐

Y N
■ ☐ 1. Earthquake
☐ ■ 2. Flood
■ ☐ 3. Lightning-
■ ☐ 4. Rain
■ ☐ 5. Snow, freezing weather
■ ☐ 6. Straight wind
☐ ■ 7. Dust devil
■ ☐ 8. Tornado
■ ☐ 9. Ashfall
☐ ■ 10. Range fire
■ ☐ 11. Other- Aging Effects

Hazard/Energy Identification Checklist

ID:212B PHA: 212B Cask Station

Date: 6/16/98

A. Electrical ☐

Y N
- ☐ ■ 1. Battery banks
- ■ ☐ 2. Cable runs
- ☐ ■ 3. Diesel generators
- ■ ☐ 4. Electrical equipment -Panel board, controls disconnect switch, lights
- ☐ ■ 5. HVAC heaters
- ■ ☐ 6. High voltage - 480 V, 120 V
- ☐ ■ 7. Motors
- ☐ ■ 8. Pumps
- ☐ ■ 9. Power tools
- ☐ ■ 10. Switch gear
- ■ ☐ 11. Service outlets, fitting
- ■ ☐ 12. Transformers
- ☐ ■ 13. Transmission lines
- ☐ ■ 14. Underground wires
- ■ ☐ 15. Wiring
- ☐ ■ 16. Other _____

B. Thermal ☐

Y N
- ☐ ■ 1. Bunsen burner/hot plates
- ■ ☐ 2. Electrical equipment
- ☐ ■ 3. Furnaces/boilers/heater
- ☐ ■ 4. Steam lines
- ☐ ■ 5. Welding torch/arc
- ☐ ■ 6. Diesel units/fire box/exhaust line
- ■ ☐ 7. Radioactive decay heat
- ☐ ■ 8. Exposed hot components
- ☐ ■ 9. Power tools
- ☐ ■ 10. Convective
- ☐ ■ 11. Solar
- ☐ ■ 12. Cryogenic
- ☐ ■ 13. Other _____

C. Friction ☐

Y N
- ☐ ■ 1. Belts
- ☐ ■ 2. Bearings
- ☐ ■ 3. Fans
- ☐ ■ 4. Gears
- ☐ ■ 5. Motors
- ☐ ■ 6. Power tools
- ☐ ■ 7. Other _____

D. Corrosives ☐

Y N
- ☐ ■ 1. Acids
- ☐ ■ 2. Caustics
- ☐ ■ 3. Natural chemicals
- ☐ ■ 4. Decontamination solution
- ☐ ■ 5. High temperature waste
- ☐ ■ 6. Galvanic interactions
- ☐ ■ 7. Other _____

E. Kinetic - Rotational ☐

Y N
- ☐ ■ 1. Centrifuges
- ☐ ■ 2. Motors
- ☐ ■ 3. Pumps
- ☐ ■ 4. Cooling tower fans
- ☐ ■ 5. Laundry equipment
- ☐ ■ 6. Shop equipment
- ☐ ■ 7. Other _____

F. Kinetic - Linear ☐

Y N
- ☐ ■ 1. Cars, trucks, buses
- ☐ ■ 2. Forklifts, dollies, carts
- ☐ ■ 3. Railroad
- ☐ ■ 4. Obstructions
- ☐ ■ 5. Crane loads
- ☐ ■ 6. Pressure vessel blowdown
- ☐ ■ 7. High pressure jets
- ☐ ■ 8. Abrasive blasters
- ☐ ■ 9. Other _____

G. Mass, Gravity, Height ☐

Y N
- ■ ☐ 1. Human effort
- ■ ☐ 2. Stairs
- ■ ☐ 3. Lifts and cranes deactivated
- ☐ ■ 4. Bucket and ladder
- ☐ ■ 5. Trucks
- ☐ ■ 6. Slings
- ■ ☐ 7. Hoists
- ☐ ■ 8. Elevators
- ☐ ■ 9. Jacks
- ☐ ■ 10. Scaffold and ladders
- ■ ☐ 11. Pits and excavations
- ☐ ■ 12. Elevated doors
- ☐ ■ 13. Vessels
- ☐ ■ 14. Other____

H. Pressure - Volume ☐

Y N
- ☐ ■ 1. Boilers
- ☐ ■ 2. Surge tanks
- ☐ ■ 3. Autoclave
- ☐ ■ 4. Test loops
- ☐ ■ 5. Gas bottles
- ☐ ■ 6. Pressure vessels
- ☐ ■ 7. Stressed members
- ☐ ■ 8. Gas receivers
- ☐ ■ 9. Negative pressure collapse
- ☐ ■ 10. Steam headers and lines
- ☐ ■ 11. Hydraulic systems
- ☐ ■ 12. High pressure cleaners
- ☐ ■ 13. Other _____

J. Explosives/Pyrophorics ☐

Y N
- ☐ ■ 1. Caps
- ☐ ■ 2. Primer cord
- ☐ ■ 3. Dynamite
- ☐ ■ 4. Scrub chemicals
- ☐ ■ 5. Dusts
- ☐ ■ 6. Hydrogen
- ☐ ■ 7. Gases, others _____
- ☐ ■ 8. Nitrates/Nitrites
- ☐ ■ 9. Peroxides
- ☐ ■ 10. Pu and U metal
- ☐ ■ 11. Sodium
- ☐ ■ 12. Other _____

K. Nuclear Criticality ☐ Exempt facility

Y N
- ☐ ■ 1. Vaults
- ☐ ■ 2. Temporary storage areas
- ☐ ■ 3. Shipping and receiving area
- ☐ ■ 4. Filters
- ☐ ■ 5. Casks
- ☐ ■ 6. Burial ground
- ☐ ■ 7. Storage racks
- ☐ ■ 8. Canals and basins
- ☐ ■ 9. Decontamination solution
- ☐ ■ 10. Trucks, forklifts, dollies
- ☐ ■ 11. Hand carry
- ☐ ■ 12. Cranes/lifts
- ☐ ■ 13. Hot cells, assembly, inspection
- ☐ ■ 14. Laboratories
- ☐ ■ 15. Other _____

L. Flammable Materials ☐

Y N
- ☐ ■ 1. Packing materials
- ☐ ■ 2. Rags
- ☐ ■ 3. Gasoline
- ■ ☐ 4. Lube oil/Grease Crane mechanisms
- ☐ ■ 5. Coolant oil
- ☐ ■ 6. Paint solvent
- ☐ ■ 7. Diesel fuel
- ■ ☐ 8. Hydrogen
- ☐ ■ 9. Nitric acid
- ☐ ■ 10. Organics
- ☐ ■ 11. Gases - others _____
- ☐ ■ 12. Liquids - others _____
- ■ ☐ 13. Buildings and contents limited building internals
- ☐ ■ 14. Trailers and contents
- ■ ☐ 15. Other See FHA

M. Hazardous Materials ☐

Y N
- ☐ ■ 1. Alkali metals
- ☐ ■ 2. Asphyxiants
- ☐ ■ 3. Biological agents
- ■ ☐ 4. Carcinogens -Asbestos floor tile, insulation
- ☐ ■ 5. Corrosives
- ☐ ■ 6. Oxidizers
- ☐ ■ 7. Toxins
- ☐ ■ 8. Heavy metals
- ☐ ■ 9. Other _____

N. Ionizing Radiation Sources ☐

Y N
- ☐ ■ 1. Fissile material
- ☐ ■ 2. Radiography equipment
- ■ ☐ 3. Radioactive material - Inside hot cells
- ☐ ■ 4. Radioactive sources
- ☐ ■ 5. Other _____

P. External events ☐

Y N
- ☐ ■ 1. Explosion
- ☐ ■ 2. Fire
- ☐ ■ 3. Other sites See WESF AB for confirmation

Q. Vehicles In Motion (external to facility) ☐

Y N
- ■ ☐ 1. Airplane
- ■ ☐ 2. Helicopter
- ☐ ■ 3. Train
- ☐ ■ 4. Truck/bus/car will not damage hot cell
- ☐ ■ 5. Other _____

R. Natural Phenomena ☐

Y N
- ■ ☐ 1. Earthquake
- ☐ ■ 2. Flood
- ■ ☐ 3. Lightning - Conductive Structure Grounded
- ■ ☐ 4. Rain
- ■ ☐ 5. Snow, freezing weather
- ■ ☐ 6. Straight wind
- ☐ ■ 7. Dust devil
- ■ ☐ 8. Tornado
- ■ ☐ 9. Ashfall
- ☐ ■ 10. Range fire - Noncombustible Structure
- ■ ☐ 11. Other- Aging Effects

Hazard/Energy Identification Checklist

ID:221BB/BF PHA: 221BB, 221 BB Condensate Pit, 221BF, 296-B-13, and 296-B-5

Date: 6/16/98

A. Electrical ☐
Y N
☐ ■1. Battery banks
☐ ■2. Cable runs
☐ ■3. Diesel generators
☐ ■4. Electrical equipment
☐ ■5. HVAC heaters
☐ ■ 6. High voltage
☐ ■ 7. Motors
☐ ■8. Pumps
☐ ■9. Power tools
☐ ■10. Switch gear
☐ ■ 11. Service outlets, fitting
☐ ■12. Transformers
☐ ■ 13. Transmission lines
☐ ■ 14. Underground wires
☐ ■15. Wiring
☐ ■16. Other _____

B. Thermal ☐
Y N
☐ ■1. Bunsen burner/hot plates
☐ ■2. Electrical equipment
☐ ■3. Furnaces/boilers/heater
☐ ■4. Steam lines
☐ ■5. Welding torch/arc
☐ ■6. Diesel units/fire box/exhaust line
■ ☐7. Radioactive decay heat - low activity levels
☐ ■8. Exposed hot components
☐ ■9. Power tools
☐ ■10. Convective
☐ ■11. Solar
☐ ■12. Cryogenic
☐ ■13. Other _____

C. Friction ☐
Y N
☐ ■1. Belts
☐ ■2. Bearings
☐ ■3. Fans
☐ ■4. Gears
☐ ■5. Motors
☐ ■6. Power tools
☐ ■7. Other _____

D. Corrosives ☐
Y N
■ ☐1. Acids 221 BF Heels
■ ☐2. Caustics 221BF heels
☐ ■3. Natural chemicals
☐ ■4. Decontamination solution
☐ ■5. High temperature waste
☐ ■6. Galvanic interactions
☐ ■7. Other _____

E. Kinetic - Rotational ☐
Y N
☐ ■1. Centrifuges
☐ ■2. Motors
☐ ■3. Pumps
☐ ■4. Cooling tower fans
☐ ■5. Laundry equipment
☐ ■6. Shop equipment
☐ ■7. Other _____

F. Kinetic - Linear ☐
Y N
☐ ■ 1. Cars, trucks, buses
☐ ■ 2. Forklifts, dollies, carts
☐ ■ 3. Railroad
☐ ■ 4. Obstructions
☐ ■ 5. Crane loads
☐ ■ 6. Pressure vessel blowdown
☐ ■ 7. High pressure jets
☐ ■8. Abrasive blasters
☐ ■ 9. Other _____

G. Mass, Gravity, Height ☐
Y N
☐ ■1. Human effort
■ ☐ 2. Stairs 221BF
☐ ■3. Lifts and cranes
☐ ■4. Bucket and ladder
☐ ■5. Trucks
☐ ■ 6. Slings
☐ ■ 7. Hoists
☐ ■8. Elevators
☐ ■9. Jacks
☐ ■10. Scaffold and ladders
■ ☐11. Pits and excavations
☐ ■12. Elevated doors
■ ☐13. Vessels
☐ ■ 14. Other____

H. Pressure - Volume ☐
Y N
☐ ■1. Boilers
☐ ■2. Surge tanks
☐ ■3. Autoclave
☐ ■4. Test loops
☐ ■ 5. Gas bottles
☐ ■6. Pressure vessels
☐ ■7. Stressed members
☐ ■8. Gas receivers
☐ ■9. Negative pressure collapse
☐ ■10. Steam headers and lines
☐ ■11. Hydraulic systems
☐ ■12. High pressure cleaners
☐ ■13. Other _____

J. Explosives/Pyrophorics ☐
Y N
☐ ■1. Caps
☐ ■2. Primer cord
☐ ■3. Dynamite
☐ ■4. Scrub chemicals
☐ ■5. Dusts
■ ☐ 6. Hydrogen
☐ ■7. Gases, others _____
☐ ■8. Nitrates/Nitrites
☐ ■9. Peroxides
☐ ■10. Pu and U metal
☐ ■11. Sodium
☐ ■12. Other _____

K. Nuclear Criticality ☐ Exempt facility
Y N
☐ ■1. Vaults
☐ ■2. Temporary storage areas
☐ ■3. Shipping and receiving area
☐ ■4. Filters
☐ ■5. Casks
☐ ■6. Burial ground
☐ ■7. Storage racks
☐ ■8. Canals and basins
☐ ■9. Decontamination solution
☐ ■10. Trucks, forklifts, dollies
☐ ■11. Hand carry
☐ ■12. Cranes/lifts
☐ ■13. Hot cells, assembly, inspection
☐ ■14. Laboratories
☐ ■15. Other _____

L. Flammable Materials ☐
Y N
☐ ■1. Packing materials
☐ ■2. Rags
☐ ■3. Gasoline
■ ☐ 4. Lube oil/Grease Crane mechanisms
☐ ■5. Coolant oil
☐ ■6. Paint solvent
☐ ■7. Diesel fuel
☐ ■8. Hydrogen
☐ ■9. Nitric acid
☐ ■10. Organics
☐ ■11. Gases - others _____
☐ ■12. Liquids - others _____
☐ ■13. Buildings and contents
☐ ■14. Trailers and contents
■ ☐15. Other See FHA

M. Hazardous Materials ☐
Y N
☐ ■1. Alkali metals
☐ ■2. Asphyxiants
☐ ■3. Biological agents
■ ☐4. Carcinogens -Asbestos 221BB
■ ☐ 5. Corrosives 221BF
☐ ■6. Oxidizers
☐ ■7. Toxins
☐ ■8. Heavy metals
☐ ■9. Other _____

N. Ionizing Radiation Sources ☐
Y N
☐ ■1. Fissile material
☐ ■2. Radiography equipment
■ ☐ 3. Radioactive material
☐ ■4. Radioactive sources
☐ ■ 5. Other _____

P. External events ☐
Y N
☐ ■ 1. Explosion
☐ ■2. Fire
☐ ■3. Other sites

Q. Vehicles In Motion (external to facility) ☐
Y N
■ ☐ 1. Airplane
■ ☐2. Helicopter
☐ ■ 3. Train
■ ☐ 4. Truck/bus/car
☐ ■ 5. Other _____

R. Natural Phenomena ☐
Y N
■ ☐1. Earthquake
☐ ■ 2. Flood
☐ ■ 3. Lightning - concrete structures
■ ☐4. Rain
■ ☐ 5. Snow, freezing weather
■ ☐ 6. Straight wind
☐ ■ 7. Dust devil
■ ☐8. Tornado
■ ☐ 9. Ashfall
☐ ■10. Range fire - concrete structures
■ ☐11. Other- Aging Effects

Hazard/Energy Identification Checklist

ID:222B PHA: 222B Office Building

Date: 6/16/98

A. Electrical ☐
Y N
☐ ■1. Battery banks
☐ ■2. Cable runs
☐ ■3. Diesel generators
☐ ■4. Electrical equipment
☐ ■5. HVAC heaters
☐ ■ 6. High voltage
☐ ■ 7. Motors
☐ ■8. Pumps
☐ ■9. Power tools
☐ ■10. Switch gear
☐ ■ 11. Service outlets, fitting
☐ ■12. Transformers
☐ ■ 13. Transmission lines- distribution lines
☐ ■ 14. Underground wires
☐ ■15. Wiring
☐ ■16. Other _____

B. Thermal ☐
Y N
☐ ■1. Bunsen burner/hot plates
☐ ■2. Electrical equipment
☐ ■3. Furnaces/boilers/heater
☐ ■4. Steam lines
☐ ■5. Welding torch/arc
☐ ■6. Diesel units/fire box/exhaust line
☐ ■7. Radioactive decay heat
☐ ■8. Exposed hot components
☐ ■9. Power tools
☐ ■10. Convective
☐ ■11. Solar
☐ ■12. Cryogenic
☐ ■13. Other _____

C. Friction ☐
Y N
☐ ■1. Belts
☐ ■2. Bearings
☐ ■3. Fans
☐ ■4. Gears
☐ ■5. Motors
☐ ■6. Power tools
☐ ■7. Other _____

D. Corrosives ☐
Y N
☐ ■1. Acids
☐ ■2. Caustics
☐ ■3. Natural chemicals
☐ ■4. Decontamination solution
☐ ■5. High temperature waste
☐ ■6. Galvanic interactions
☐ ■7. Other _____

E. Kinetic - Rotational ☐
Y N
☐ ■1. Centrifuges
☐ ■2. Motors
☐ ■3. Pumps
☐ ■4. Cooling tower fans
☐ ■5. Laundry equipment
☐ ■6. Shop equipment
☐ ■7. Other _____

F. Kinetic - Linear ☐
Y N
☐ ■ 1. Cars, trucks, buses
☐ ■ 2. Forklifts, dollies, carts
☐ ■ 3. Railroad
☐ ■ 4. Obstructions
☐ ■ 5. Crane loads
☐ ■ 6. Pressure vessel blowdown
☐ ■ 7. High pressure jets
☐ ■8. Abrasive blasters
☐ ■ 9. Other _____

G. Mass, Gravity, Height ☐
Y N
☐ ■1. Human effort
☐ ■ 2. Stairs
☐ ■3. Lifts and cranes
☐ ■4. Bucket and ladder
☐ ■5. Trucks
☐ ■ 6. Slings
☐ ■ 7. Hoists
☐ ■8. Elevators
☐ ■9. Jacks
☐ ■10. Scaffold and ladders
☐ ■ 11. Pits and excavations
☐ ■12. Elevated doors
☐ ■13. Vessels
■ ☐14. Other Roof access

H. Pressure - Volume ☐
Y N
☐ ■1. Boilers
☐ ■2. Surge tanks
☐ ■3. Autoclave
☐ ■4. Test loops
☐ ■ 5. Gas bottles
☐ ■6. Pressure vessels
☐ ■7. Stressed members
☐ ■8. Gas receivers
☐ ■9. Negative pressure collapse
☐ ■10. Steam headers and lines
☐ ■11. Hydraulic systems
☐ ■12. High pressure cleaners
☐ ■13. Other _____

J. Explosives/Pyrophorics ☐
Y N
☐ ■1. Caps
☐ ■2. Primer cord
☐ ■3. Dynamite
☐ ■4. Scrub chemicals
☐ ■5. Dusts
☐ ■6. Hydrogen
☐ ■7. Gases, others _____
☐ ■8. Nitrates/Nitrites
☐ ■9. Peroxides
☐ ■10. Pu and U metal
☐ ■11. Sodium
☐ ■12. Other _____

K. Nuclear Criticality ☐ Exempt facility
Y N
☐ ■1. Vaults
☐ ■2. Temporary storage areas
☐ ■3. Shipping and receiving area
☐ ■4. Filters
☐ ■5. Casks
☐ ■6. Burial ground
☐ ■7. Storage racks
☐ ■8. Canals and basins
☐ ■9. Decontamination solution
☐ ■10. Trucks, forklifts, dollies
☐ ■11. Hand carry
☐ ■12. Cranes/lifts
☐ ■13. Hot cells, assembly, inspection
☐ ■14. Laboratories
☐ ■15. Other _____

L. Flammable Materials ☐
Y N
☐ ■1. Packing materials
☐ ■2. Rags
☐ ■3. Gasoline
☐ ■ 4. Lube oil/Grease
☐ ■5. Coolant oil
☐ ■6. Paint solvent
☐ ■7. Diesel fuel
☐ ■8. Hydrogen
☐ ■9. Nitric acid
☐ ■10. Organics
☐ ■11. Gases - others _____
☐ ■12. Liquids - others _____
■ ☐13. Buildings and content- Limited building internals
☐ ■14. Trailers and contents
■ ☐15. Other See FHA

M. Hazardous Materials ☐
Y N
☐ ■1. Alkali metals
☐ ■2. Asphyxiants
☐ ■3. Biological agents
■ ☐4. Carcinogens -Asbestos insulation, tile
■ ☐ 5. Corrosives
☐ ■6. Oxidizers
☐ ■7. Toxins
☐ ■8. Heavy metals
☐ ■9. Other _____

N. Ionizing Radiation Sources ☐
Y N
☐ ■1. Fissile material
☐ ■2. Radiography equipment
■ ☐ 3. Radioactive material - one contaminated spot
☐ ■4. Radioactive sources
☐ ■ 5. Other _____

P. External events ☐
Y N
☐ ■ 1. Explosion
☐ ■2. Fire
☐ ■3. Other sites

Q. Vehicles In Motion (external to facility) ☐
Y N
■ ☐ 1. Airplane
■ ☐ 2. Helicopter
☐ ■ 3. Train
☐ ■ 4. Truck/bus/car
☐ ■ 5. Other _____

R. Natural Phenomena ☐
Y N
■ ☐ 1. Earthquake
☐ ■ 2. Flood
■ ☐ 3. Lightning - Concrete Structures
■ ☐ 4. Rain
■ ☐ 5. Snow, freezing weather
■ ☐ 6. Straight wind
☐ ■ 7. Dust devil
■ ☐ 8. Tornado
■ ☐ 9. Ashfall
■ ☐ 10. Range fire - Concrete Structures
■ ☐ 11. Other- Aging Effects

Hazard/Energy Identification Checklist

ID:211B PHA: 211B Chemical Tank Farm, 211BB

Date: 6/15/98

A. Electrical ☐
Y N
☐ ■1. Battery banks
☐ ■2. Cable runs
☐ ■3. Diesel generators
☐ ■4. Electrical equipment
☐ ■5. HVAC heaters
☐ ■ 6. High voltage
☐ ■ 7. Motors
☐ ■8. Pumps
☐ ■9. Power tools
☐ ■10. Switch gear
☐ ■ 11. Service outlets, fitting
☐ ■12. Transformers
☐ ■ 13. Transmission lines- distribution lines
☐ ■ 14. Underground wires
☐ ■15. Wiring
☐ ■16. Other _____

B. Thermal ☐
Y N
☐ ■1. Bunsen burner/hot plates
☐ ■2. Electrical equipment
☐ ■3. Furnaces/boilers/heater
☐ ■4. Steam lines
☐ ■5. Welding torch/arc
☐ ■6. Diesel units/fire box/exhaust line
☐ ■7. Radioactive decay heat
☐ ■8. Exposed hot components
☐ ■9. Power tools
☐ ■10. Convective
☐ ■11. Solar
☐ ■12. Cryogenic
☐ ■13. Other _____

C. Friction ☐
Y N
☐ ■1. Belts
☐ ■2. Bearings
☐ ■3. Fans
☐ ■4. Gears
☐ ■5. Motors
☐ ■6. Power tools
☐ ■7. Other _____

D. Corrosives ☐
Y N
☐ ■ 1. Acids Heels remain in tanks
☐ ■ 2. Caustics Heels remain in tanks
☐ ■3. Natural chemicals
☐ ■4. Decontamination solution
☐ ■5. High temperature waste
☐ ■6. Galvanic interactions
☐ ■7. Other _____

E. Kinetic - Rotational ☐
Y N
☐ ■1. Centrifuges
☐ ■2. Motors
☐ ■3. Pumps
☐ ■4. Cooling tower fans
☐ ■5. Laundry equipment
☐ ■6. Shop equipment
☐ ■7. Other _____

F. Kinetic - Linear ☐
Y N
☐ ■ 1. Cars, trucks, buses
☐ ■ 2. Forklifts, dollies, carts
☐ ■ 3. Railroad
☐ ■ 4. Obstructions
☐ ■ 5. Crane loads
☐ ■ 6. Pressure vessel blowdown
☐ ■ 7. High pressure jets
☐ ■8. Abrasive blasters
☐ ■ 9. Other _____

G. Mass, Gravity, Height ☐
Y N
☐ ■ 1. Human effort
☐ ■ 2. Stairs
☐ ■3. Lifts and cranes
☐ ■4. Bucket and ladder
☐ ■5. Trucks
☐ ■ 6. Slings
☐ ■ 7. Hoists
☐ ■8. Elevators
☐ ■9. Jacks
☐ ■10. Scaffold and ladders
☐ ■11. Pits and excavations
☐ ■12. Elevated doors
☐ ■ 13. Vessels
■ ☐14. Other Catch basins

H. Pressure - Volume ☐
Y N
☐ ■1. Boilers
☐ ■2. Surge tanks
☐ ■3. Autoclave
☐ ■4. Test loops
☐ ■ 5. Gas bottles
☐ ■6. Pressure vessels
☐ ■7. Stressed members
☐ ■8. Gas receivers
☐ ■9. Negative pressure collapse
☐ ■10. Steam headers and lines
☐ ■11. Hydraulic systems
☐ ■12. High pressure cleaners
☐ ■13. Other _____

J. Explosives/Pyrophorics ☐
Y N
☐ ■1. Caps
☐ ■2. Primer cord
☐ ■3. Dynamite
☐ ■4. Scrub chemicals
☐ ■5. Dusts
☐ ■6. Hydrogen
☐ ■7. Gases, others _____
☐ ■8. Nitrates/Nitrites
☐ ■9. Peroxides
☐ ■10. Pu and U metal
☐ ■11. Sodium
☐ ■12. Other _____

K. Nuclear Criticality ☐ Exempt facility
Y N
☐ ■1. Vaults
☐ ■2. Temporary storage areas
☐ ■3. Shipping and receiving area
☐ ■4. Filters
☐ ■5. Casks
☐ ■6. Burial ground
☐ ■7. Storage racks
☐ ■8. Canals and basins
☐ ■9. Decontamination solution
☐ ■10. Trucks, forklifts, dollies
☐ ■11. Hand carry
☐ ■12. Cranes/lifts
☐ ■13. Hot cells, assembly, inspection
☐ ■14. Laboratories
☐ ■15. Other _____

L. Flammable Materials ☐
Y N
☐ ■1. Packing materials
☐ ■2. Rags
☐ ■3. Gasoline
☐ ■ 4. Lube oil/Grease
☐ ■5. Coolant oil
☐ ■6. Paint solvent
☐ ■7. Diesel fuel
☐ ■8. Hydrogen
☐ ■ 9. Nitric acid heels
☐ ■10. Organics
☐ ■11. Gases - others _____
☐ ■12. Liquids - others _____
☐ ■13. Buildings and content-
☐ ■14. Trailers and contents
☐ ■ 15. Other

M. Hazardous Materials ☐
Y N
☐ ■1. Alkali metals
☐ ■2. Asphyxiants
☐ ■3. Biological agents
☐ ■4. Carcinogens
☐ ■ 5. Corrosives
☐ ■6. Oxidizers
☐ ■7. Toxins
☐ ■ 8. Heavy metals Pb
☐ ■9. Other _____

N. Ionizing Radiation Sources ☐
Y N
☐ ■1. Fissile material
☐ ■2. Radiography equipment
☐ ■ 3. Radioactive material
☐ ■4. Radioactive sources
☐ ■ 5. Other _____

P. External events ☐
Y N
☐ ■ 1. Explosion
☐ ■2. Fire
☐ ■3. Other sites

Q. Vehicles In Motion (external to facility) ☐
Y N
■ ☐ 1. Airplane
■ ☐2. Helicopter
☐ ■ 3. Train
☐ ■ 4. Truck/bus/car
☐ ■ 5. Other _____

R. Natural Phenomena ☐
Y N
■ ☐1. Earthquake
☐ ■ 2. Flood
■ ☐ 3. Lightning-
☐ ■ 4. Rain
☐ ■ 5. Snow, freezing weather
■ ☐ 6. Straight wind
☐ ■ 7. Dust devil
■ ☐8. Tornado
☐ ■ 9. Ashfall
■ ☐10. Range fire
■ ☐11. Other- Aging Effects

Hazard/Energy Identification Checklist

ID: UPR ____ PHA: Unplanned Release Sites (Table 3-1), Railroad Tunnel, 216-B-4/13/59/64, 270-E-1, Waste Sites

Date: 6/16/98

A. Electrical ☐

Y N
- ☐ ■ 1. Battery banks
- ☐ ■ 2. Cable runs
- ☐ ■ 3. Diesel generators
- ☐ ■ 4. Electrical equipment
- ☐ ■ 5. HVAC heaters
- ☐ ■ 6. High voltage
- ☐ ■ 7. Motors
- ☐ ■ 8. Pumps
- ☐ ■ 9. Power tools
- ☐ ■ 10. Switch gear
- ☐ ■ 11. Service outlets, fitting
- ☐ ■ 12. Transformers
- ☐ ■ 13. Transmission lines- distribution lines
- ☐ ■ 14. Underground wires
- ☐ ■ 15. Wiring
- ☐ ■ 16. Other _____

B. Thermal ☐

Y N
- ☐ ■ 1. Bunsen burner/hot plates
- ☐ ■ 2. Electrical equipment
- ☐ ■ 3. Furnaces/boilers/heater
- ☐ ■ 4. Steam lines
- ☐ ■ 5. Welding torch/arc
- ☐ ■ 6. Diesel units/fire box/exhaust line
- ☐ ■ 7. Radioactive decay heat
- ☐ ■ 8. Exposed hot components
- ☐ ■ 9. Power tools
- ☐ ■ 10. Convective
- ☐ ■ 11. Solar
- ☐ ■ 12. Cryogenic
- ☐ ■ 13. Other _____

C. Friction ☐

Y N
- ☐ ■ 1. Belts
- ☐ ■ 2. Bearings
- ☐ ■ 3. Fans
- ☐ ■ 4. Gears
- ☐ ■ 5. Motors
- ☐ ■ 6. Power tools
- ☐ ■ 7. Other _____

D. Corrosives ☐

Y N
- ☐ ■ 1. Acids
- ■ ☐ 2. Caustics
- ☐ ■ 3. Natural chemicals
- ☐ ■ 4. Decontamination solution
- ☐ ■ 5. High temperature waste
- ☐ ■ 6. Galvanic interactions
- ☐ ■ 7. Other _____

E. Kinetic - Rotational ☐

Y N
- ☐ ■ 1. Centrifuges
- ☐ ■ 2. Motors
- ☐ ■ 3. Pumps
- ☐ ■ 4. Cooling tower fans
- ☐ ■ 5. Laundry equipment
- ☐ ■ 6. Shop equipment
- ☐ ■ 7. Other _____

F. Kinetic - Linear ☐

Y N
- ☐ ■ 1. Cars, trucks, buses
- ☐ ■ 2. Forklifts, dollies, carts
- ☐ ■ 3. Railroad
- ☐ ■ 4. Obstructions
- ☐ ■ 5. Crane loads
- ☐ ■ 6. Pressure vessel blowdown
- ☐ ■ 7. High pressure jets
- ☐ ■ 8. Abrasive blasters
- ☐ ■ 9. Other _____

G. Mass, Gravity, Height ☐

Y N
- ☐ ■ 1. Human effort
- ☐ ■ 2. Stairs
- ☐ ■ 3. Lifts and cranes
- ☐ ■ 4. Bucket and ladder
- ☐ ■ 5. Trucks
- ☐ ■ 6. Slings
- ☐ ■ 7. Hoists
- ☐ ■ 8. Elevators
- ☐ ■ 9. Jacks
- ☐ ■ 10. Scaffold and ladders
- ☐ ■ 11. Pits and excavations
- ☐ ■ 12. Elevated doors
- ☐ ■ 13. Vessels
- ☐ ■ 14. Other _____

H. Pressure - Volume ☐

Y N
- ☐ ■ 1. Boilers
- ☐ ■ 2. Surge tanks
- ☐ ■ 3. Autoclave
- ☐ ■ 4. Test loops
- ☐ ■ 5. Gas bottles
- ☐ ■ 6. Pressure vessels
- ☐ ■ 7. Stressed members
- ☐ ■ 8. Gas receivers
- ☐ ■ 9. Negative pressure collapse
- ☐ ■ 10. Steam headers and lines
- ☐ ■ 11. Hydraulic systems
- ☐ ■ 12. High pressure cleaners
- ☐ ■ 13. Other _____

J. Explosives/Pyrophorics ☐

Y N
- ☐ ■ 1. Caps
- ☐ ■ 2. Primer cord
- ☐ ■ 3. Dynamite
- ☐ ■ 4. Scrub chemicals
- ☐ ■ 5. Dusts
- ☐ ■ 6. Hydrogen
- ☐ ■ 7. Gases, others _____
- ☐ ■ 8. Nitrates/Nitrites
- ☐ ■ 9. Peroxides
- ☐ ■ 10. Pu and U metal
- ☐ ■ 11. Sodium
- ☐ ■ 12. Other _____

K. Nuclear Criticality ☐ Exempt facility

Y N
- ☐ ■ 1. Vaults
- ☐ ■ 2. Temporary storage areas
- ☐ ■ 3. Shipping and receiving area
- ☐ ■ 4. Filters
- ☐ ■ 5. Casks
- ☐ ■ 6. Burial ground
- ☐ ■ 7. Storage racks
- ☐ ■ 8. Canals and basins
- ☐ ■ 9. Decontamination solution
- ☐ ■ 10. Trucks, forklifts, dollies
- ☐ ■ 11. Hand carry
- ☐ ■ 12. Cranes/lifts
- ☐ ■ 13. Hot cells, assembly, inspection
- ☐ ■ 14. Laboratories
- ☐ ■ 15. Other _____

L. Flammable Materials ☐

Y N
- ☐ ■ 1. Packing materials
- ☐ ■ 2. Rags
- ☐ ■ 3. Gasoline
- ☐ ■ 4. Lube oil/Grease
- ☐ ■ 5. Coolant oil
- ☐ ■ 6. Paint solvent
- ☐ ■ 7. Diesel fuel
- ☐ ■ 8. Hydrogen
- ☐ ■ 9. Nitric acid
- ☐ ■ 10. Organics
- ☐ ■ 11. Gases - others _____
- ☐ ■ 12. Liquids - others _____
- ☐ ■ 13. Buildings and content
- ☐ ■ 14. Trailers and contents
- ☐ ■ 15. Other _____

M. Hazardous Materials ☐

Y N
- ☐ ■ 1. Alkali metals
- ☐ ■ 2. Asphyxiants
- ☐ ■ 3. Biological agents
- ☐ ■ 4. Carcinogens
- ☐ ■ 5. Corrosives
- ☐ ■ 6. Oxidizers
- ☐ ■ 7. Toxins
- ☐ ■ 8. Heavy metals
- ☐ ■ 9. Other _____

N. Ionizing Radiation Sources ☐

Y N
- ☐ ■ 1. Fissile material
- ☐ ■ 2. Radiography equipment
- ■ ☐ 3. Radioactive material
- ☐ ■ 4. Radioactive sources
- ☐ ■ 5. Other _____

P. External events ☐

Y N
- ☐ ■ 1. Explosion
- ☐ ■ 2. Fire
- ☐ ■ 3. Other sites

Q. Vehicles In Motion (external to facility) ☐

Y N
- ☐ ■ 1. Airplane
- ☐ ■ 2. Helicopter
- ☐ ■ 3. Train
- ☐ ■ 4. Truck/bus/car
- ☐ ■ 5. Other _____

R. Natural Phenomena ☐

Y N
- ■ ☐ 1. Earthquake
- ☐ ■ 2. Flood
- ☐ ■ 3. Lightning-
- ☐ ■ 4. Rain
- ☐ ■ 5. Snow, freezing weather
- ☐ ■ 6. Straight wind
- ☐ ■ 7. Dust devil
- ☐ ■ 8. Tornado
- ☐ ■ 9. Ash fall
- ☐ ■ 10. Range fire
- ☐ ■ 11. Other _____

Hazard/Energy Identification Checklist

ID: Misc PHA: 207BA, 217B, 221BA, 221BC, 221BD, 221BG, 271BA, 2711B, 2715B, 2716B, 276B, Septic Tank

Date: 6/16/98

A. Electrical ☐

Y N
- ☐ ■ 1. Battery banks
- ☐ ■ 2. Cable runs
- ☐ ■ 3. Diesel generators
- ☐ ■ 4. Electrical equipment
- ☐ ■ 5. HVAC heaters
- ☐ ■ 6. High voltage
- ☐ ■ 7. Motors
- ☐ ■ 8. Pumps
- ☐ ■ 9. Power tools
- ☐ ■ 10. Switch gear
- ☐ ■ 11. Service outlets, fitting
- ☐ ■ 12. Transformers
- ☐ ■ 13. Transmission lines- distribution lines
- ☐ ■ 14. Underground wires
- ☐ ■ 15. Wiring
- ☐ ■ 16. Other _____

B. Thermal ☐

Y N
- ☐ ■ 1. Bunsen burner/hot plates
- ☐ ■ 2. Electrical equipment
- ☐ ■ 3. Furnaces/boilers/heater
- ☐ ■ 4. Steam lines
- ☐ ■ 5. Welding torch/arc
- ☐ ■ 6. Diesel units/fire box/exhaust line
- ☐ ■ 7. Radioactive decay heat
- ☐ ■ 8. Exposed hot components
- ☐ ■ 9. Power tools
- ☐ ■ 10. Convective
- ☐ ■ 11. Solar
- ☐ ■ 12. Cryogenic
- ☐ ■ 13. Other _____

C. Friction ☐

Y N
- ☐ ■ 1. Belts
- ☐ ■ 2. Bearings
- ☐ ■ 3. Fans
- ☐ ■ 4. Gears
- ☐ ■ 5. Motors
- ☐ ■ 6. Power tools
- ☐ ■ 7. Other _____

D. Corrosives ☐

Y N
- ☐ ■ 1. Acids
- ■ ☐ 2. Caustics 217B has NaOH spill on floor, epoxied over
- ☐ ■ 3. Natural chemicals
- ☐ ■ 4. Decontamination solution
- ☐ ■ 5. High temperature waste
- ☐ ■ 6. Galvanic interactions
- ☐ ■ 7. Other _____

E. Kinetic - Rotational ☐

Y N
- ☐ ■ 1. Centrifuges
- ☐ ■ 2. Motors
- ☐ ■ 3. Pumps
- ☐ ■ 4. Cooling tower fans
- ☐ ■ 5. Laundry equipment
- ☐ ■ 6. Shop equipment
- ☐ ■ 7. Other _____

F. Kinetic - Linear ☐

Y N
- ☐ ■ 1. Cars, trucks, buses
- ☐ ■ 2. Forklifts, dollies, carts
- ☐ ■ 3. Railroad
- ☐ ■ 4. Obstructions
- ☐ ■ 5. Crane loads
- ☐ ■ 6. Pressure vessel blowdown
- ☐ ■ 7. High pressure jets
- ☐ ■ 8. Abrasive blasters
- ☐ ■ 9. Other _____

G. Mass, Gravity, Height ☐

Y N
- ☐ ■ 1. Human effort
- ■ ☐ 2. Stairs 276B loading dock
- ☐ ■ 3. Lifts and cranes
- ☐ ■ 4. Bucket and ladder
- ☐ ■ 5. Trucks
- ☐ ■ 6. Slings
- ☐ ■ 7. Hoists
- ☐ ■ 8. Elevators
- ☐ ■ 9. Jacks
- ☐ ■ 10. Scaffold and ladders
- ■ ☐ 11. Pits and excavations 207BA
- ☐ ■ 12. Elevated doors
- ☐ ■ 13. Vessels
- ☐ ■ 14. Other s

H. Pressure - Volume ☐

Y N
- ☐ ■ 1. Boilers
- ☐ ■ 2. Surge tanks
- ☐ ■ 3. Autoclave
- ☐ ■ 4. Test loops
- ☐ ■ 5. Gas bottles
- ☐ ■ 6. Pressure vessels
- ☐ ■ 7. Stressed members
- ☐ ■ 8. Gas receivers
- ☐ ■ 9. Negative pressure collapse
- ☐ ■ 10. Steam headers and lines
- ☐ ■ 11. Hydraulic systems
- ☐ ■ 12. High pressure cleaners
- ☐ ■ 13. Other _____

J. Explosives/Pyrophorics ☐

Y N
- ☐ ■ 1. Caps
- ☐ ■ 2. Primer cord
- ☐ ■ 3. Dynamite
- ☐ ■ 4. Scrub chemicals
- ☐ ■ 5. Dusts
- ☐ ■ 6. Hydrogen
- ☐ ■ 7. Gases, others _____
- ☐ ■ 8. Nitrates/Nitrites
- ☐ ■ 9. Peroxides
- ☐ ■ 10. Pu and U metal
- ☐ ■ 11. Sodium
- ☐ ■ 12. Other _____

K. Nuclear Criticality ☐ Exempt facility

Y N
- ☐ ■ 1. Vaults
- ☐ ■ 2. Temporary storage areas
- ☐ ■ 3. Shipping and receiving area
- ☐ ■ 4. Filters
- ☐ ■ 5. Casks
- ☐ ■ 6. Burial ground
- ☐ ■ 7. Storage racks
- ☐ ■ 8. Canals and basins
- ☐ ■ 9. Decontamination solution
- ☐ ■ 10. Trucks, forklifts, dollies
- ☐ ■ 11. Hand carry
- ☐ ■ 12. Cranes/lifts
- ☐ ■ 13. Hot cells, assembly, inspection
- ☐ ■ 14. Laboratories
- ☐ ■ 15. Other _____

L. Flammable Materials ☐

Y N
- ☐ ■ 1. Packing materials
- ☐ ■ 2. Rags
- ☐ ■ 3. Gasoline
- ☐ ■ 4. Lube oil/Grease
- ☐ ■ 5. Coolant oil
- ☐ ■ 6. Paint solvent
- ☐ ■ 7. Diesel fuel
- ☐ ■ 8. Hydrogen
- ☐ ■ 9. Nitric acid
- ☐ ■ 10. Organics
- ☐ ■ 11. Gases - others _____
- ☐ ■ 12. Liquids - others _____
- ■ ☐ 13. Buildings and content- Limited building internals
- ☐ ■ 14. Trailers and contents
- ■ ☐ 15. Other See FHA

M. Hazardous Materials ☐

Y N
- ☐ ■ 1. Alkali metals
- ☐ ■ 2. Asphyxiants
- ☐ ■ 3. Biological agents
- ■ ☐ 4. Carcinogens -Asbestos in 276B, 217B siding is As
- ■ ☐ 5. Corrosives
- ☐ ■ 6. Oxidizers
- ☐ ■ 7. Toxins
- ☐ ■ 8. Heavy metals Pb in 217B
- ☐ ■ 9. Other _____

N. Ionizing Radiation Sources ☐

Y N
- ☐ ■ 1. Fissile material
- ☐ ■ 2. Radiography equipment
- ☐ ■ 3. Radioactive material
- ☐ ■ 4. Radioactive sources
- ☐ ■ 5. Other _____

P. External events ☐

Y N
- ☐ ■ 1. Explosion
- ☐ ■ 2. Fire
- ☐ ■ 3. Other sites

Q. Vehicles In Motion (external to facility) ☐

Y N
- ■ ☐ 1. Airplane
- ■ ☐ 2. Helicopter
- ☐ ■ 3. Train
- ■ ☐ 4. Truck/bus/car
- ☐ ■ 5. Other _____

R. Natural Phenomena ☐

Y N
- ■ ☐ 1. Earthquake
- ☐ ■ 2. Flood
- ☐ ■ 3. Lightning-
- ■ ☐ 4. Rain 217B due to NaOH spill
- ■ ☐ 5. Snow, freezing weather 217B due to NaOH spill
- ■ ☐ 6. Straight wind -old buildings could generate missiles, hazard to personnel and equipment
- ☐ ■ 7. Dust devil
- ■ ☐ 8. Tornado
- ☐ ■ 9. Ashfall
- ☐ ■ 10. Range fire
- ■ ☐ 11. Other- Aging Effects

Attachment A-C: B Plant S&M Phase PHA Tables

PRELIMINARY HAZARDS ANALYSIS

Process Area B-Plant S&M Phase Participants Dave Braun Ben Schwehr John Van Keuren Date 6/23/98
References used

ID	Location/ Activity	Hazardous Condition	Causes	Material-At-Risk	Consequence	Engineered Features	Administrative Features	Freq Cat	Con Cat	Remarks
221B-Can-01	221-B Building Process Cells	Accumulation of vapors from tanks in process cells	Failure of exhaust system	Toxic vapors from tank heels	Exposure facility worker to toxic vapors	Canyon exhaust system, 221-B Deactivated, Tanks vented Cell 10 cover blocks are sealed	Limited access to galleries Air monitoring during surveillance Limited access to canyon	F1	S1 E1	Exhaust system operating No processing and no chemical additions or transfers. Cold tanks, only small volumes of chemicals remain (heels) Large airspaces Process cells isolated from galleries
221B-Can-02	221-B Building Organic Process Cells	Release of TSP to process cell floor due to loss of tank integrity	Seismic Event, aging of Tank Galvanic corrosion	TSP material in process cell organic tank	Release of TSP to process cell floor	No active heat systems, stainless steel tanks, Neutral pH	221-B Deactivated-no processing, no chemical additions or transfers	F1	S0 E0	Low ambient temperatures, phosphoric acid and NaOH form stable dry solid TSP, Extremely minimal amount of Organic present
221B-Can-03	221-B Building Organic Process Cells/Cell 10	Release of organic heel and nitric acid heel to process cell floor drains	Nitric acid/organic chemical reaction (red oil explosion)	Radioactive material in process cell floor drain	Release of radioactive material to the atmosphere or to the ground	Cell Cover Blocks, No active heat systems, stainless steel tanks	221-B Deactivated - no processing, no chemical additions or transfers	F0	S2 E2	Low ambient temperature, vessel not sealed. BIO determined red oil explosion to be F0. Organic heels have been reacted with phosphoric acid and NaOH to form stable dry solid TSP
221B-Can-04	221-B Building Process Cells	Release of hydrogen from process tanks due to radiolysis	Hydrogen generation from radioactive material combined with water and an ignition source	Contamination in process cell and vessels	Release of radioactive material due to hydrogen burn /explosion to the atmosphere or to the ground	Canyon exhaust, system, Large air space in Canyon Vessels vented, no ignition sources	221-B Deactivated no processing, no chemical additions or transfers	F1	S1 E1	Analysis of this accident is given in the BIO HNF-SD-WM-BIO-003 low H_2O present will evaporate in time reduced low rad inventory
221B-Can-05	221-B Building Cell 4	Release of waste from drums due to drum failure	Aging of drums, Gas generation in drums	Radioactive contaminated solid waste	Release of radioactive contamination to cell	Cell structure	Limited Access due to 221-B deactivation Drums contain dry solid waste with little or no gas generation	F2	S0 E0	43 drums of solid waste
221B-Can-06	221-B Canyon	Release of radioactive material into canyon from process cells due to failure of canyon crane	Seismic event cause crane collapse over contaminated cell	Radioactive contamination in cell	Release of radioactive contamination to the atmosphere	Power disconnected from crane	Crane stored over Cell 2 - East End of Canyon	F1	S1 E0	Cell 2 contains failed process equipment

PRELIMINARY HAZARDS ANALYSIS

Process Area B-Plant S&M Phase Participants Dave Braun Ben Schwehr John Van Keuren Date 6/23/98
References used

ID	Location/ Activity	Hazardous Condition	Causes	Material-At-Risk	Consequence	Engineered Features	Administrative Features	Freq Cat	Con Cat	Remarks
221B-Can-07	221-B Canyon	Release of radioactive material from 221-B building due to fire in canyon	Fire on the 221-B Canyon floor resulting in failure of exhaust system filter failure	Radioactive contamination in canyon and exhaust system filter loading	Release of radioactive contamination to the atmosphere	Exhaust filter - fire resistance	Removal of all combustible and flammable material from canyon floor	F0	S2 E0	Fire Hazards Analysis - 18.2.1 • Stack of Wooden Pallets • 10 gallon combustible liquid spill
221B-Sei-01	221-B Canyon including galleries, process cells and tanks	Release of radioactive material due to failure of structures to a beyond design basis seismic event	Seismic event - beyond design basis	Radioactive material in canyon	Release of radioactive material to the atmosphere or to the ground	None Identified	None Identified	F1	S2 E3	Analyzed in BIO Reanalyze with reduced inventory
221B-Sei-02	221-B Canyon including galleries, process cells and tanks	Release of radioactive material due to failure of structure due to a design basis earthquake	Seismic event - design basis event	Radioactive material in Canyon	Release of radioactive material to the atmosphere	Canyon structure qualified for DBE	S&M of roofing and structures	F2	S2 E1	Analyzed in BIO Reanalyze with reduced inventory
221B-Wind	221-B Canyon including galleries, process cells and tanks	Release of radioactive material due to failure of structure due to a high wind	High wind	Radioactive material in canyon	Release of radioactive material to the atmosphere	Existing roof structures	S&M, Emergency preparedness	F0	S2 E2	Based on assumption of continued roofing/ structural maintenance
221B-Load	221-B Canyon including galleries, process cells and tanks	Release of radioactive material due to failure of structure due to volcanic ash or snow	Volcanic ash, snow	Radioactive material in canyon	Release of radioactive material to the atmosphere	Existing roof structures	Worker protection, Emergency preparedness	F2	S2 E2	Analyzed in BIO Reanalyze with reduced inventory
221B-Rain	221-B Canyon including galleries, process cells and tanks	Release of radioactive material due to failure of structure due to structural degradation of facility	Rain, water leaking into canyon	Radioactive material in canyon	Release of radioactive material, contamination migration to the atmosphere or to the ground	Roofing, maintenance, TK-10-1 liquid level detection	S&M	F3	S2 E3	S&M of roof required, E3 due to potential discharge to ground water. Long term leaks could result in partial facility collapse.
221B-Ind	221-B Canyon including galleries, process cells and tanks	Personal injury due to tripping hazards, falling objects, hazardous material	Low lighting levels, deactivated/degraded facility, leaks or spills	Facility worker	Injury or death	Surveillance lighting	Occupational/institutional safety standards	F3	S1 E0	
221B-Gal-01	221-B Galleries	Release of radioactive material from process cell to galleries due barrier failure	Failure of process lines/ valve, wall cracks	Radioactive contamination in process cells	Migration of radioactive material to the galleries Worker contamination	Roofing Plugs in exterior wall penetrations Closed valves Blanks in pipes	S&M	F3	S1 E0	

PRELIMINARY HAZARDS ANALYSIS

Process Area B-Plant S&M Phase Participants Dave Braun Ben Schwehr John Van Keuren Date 6/23/98
References used

ID	Location/ Activity	Hazardous Condition	Causes	Material-At-Risk	Consequence	Engineered Features	Administrative Features	Freq Cat	Con Cat	Remarks
221B-Gal-02	221-B Electrical Gallery Piping Gallery	Release of radioactive contamination or toxic vapors due to an electrical fire	Failure of surveillance electrical lighting system	Radioactive contamination in gallery	Lighting system inoperative, Minor toxic intake of surveillance personnel	Lighting system installed to electrical code	S&M	F1	S1 E0	Minimal contamination and combustibles in galleries Lighting system operated only during surveillances
291B-Sei-01	291-B Filter Buildings	Release of radioactive material due to failure of A, B, or C filter building structures	Seismic Event 291-B-1 Exhaust Stack collapse	Radioactive Material collected on A, B, & C, Filters	Release of radioactive material to the atmosphere or to the ground	BIO indicates filters may fail under seismic loads.	None Identified	F2	S2 E3	All water has been removed for seal tanks and pipes. Water sources have been isolated from the 291B area (Sections of piping removed). Analyzed in BIO.
291B-Sei-02	291-B Filter Buildings	Release of radioactive material due to failure of D or E filter building structures	Seismic Event greater than .12g	Radioactive Material collected on D, & E Filters	Release of radioactive material to the atmosphere or to the ground	Structural Design of filter building for D & E filters shown adequate for 0.12 g earthquake in BIO	None Identified	F2	S2 E3	All water has been removed for seal tanks and pipes. Water sources have been isolated from the 291B area (Sections of piping removed)
291B-Sei-03	291-B Sand Filter Building	Release of radioactive material due to failure of filter building structures and loss of confinement	Seismic Event 291-B-1 Exhaust Stack collapse	Radioactive Material contained in sand filter	Release of radioactive material to the atmosphere or to the ground	Structural Design of filter building for D & E filters S&M on filter cover	None Identified	F2	S1 E1	All water has been removed for seal tanks and pipes. Water sources have been isolated from the 291B area (Sections of piping removed)
291B-Sei-04	291-B Exhaust Stack	Release of radioactive material due to collapse of exhaust stack	Seismic Event Impact from moving vehicle/airplane	Internal Radioactive Contamination	Release of radioactive material to the atmosphere or to the ground	None Identified	None Identified	F2	S1 E0	
291B-Sei-05	ACT Filter	Release of radioactive material due to collapse of ACT filter	Seismic Event	Release of radioactive material on ACT filter	Release of radioactive material to the atmosphere or the environment	None Identified	None Identified	F1	S1 E1	
291B-Rain-01	291-B Filter Buildings	Release of radioactive material due to hydrogen accumulation and explosion in filter building	Flooding of vault due to rain, snow melt, or utility water line break.	Radioactive Material collected on A, B, C, D, & E Filters	Release of radioactive material to the atmosphere or to the ground	Water barrier on top of filter building, berming around filters, filters under several feet of ground, liquid level detection, purging system, water sources drained and isolated, no man-made ignition sources	Air sampling required periodically by TSR to verify hydrogen concentrations less than limits.	F1	S2 E3	Low frequency of heavy rains in general vicinity Large H_2O volume required Fire Hazards Analysis - Section 18.1.7

PRELIMINARY HAZARDS ANALYSIS

Process Area B-Plant S&M Phase Participants Dave Braun Ben Schwehr John Van Keuren Date 6/23/98
References used

ID	Location/ Activity	Hazardous Condition	Causes	Material-At-Risk	Consequence	Engineered Features	Administrative Features	Freq Cat	Con Cat	Remarks
291B-Rain-02	291-B Filter s A, B, C, D, or E	Release of radioactive material due structural degradation (aging)	Water leaking into filter vaults causing damage (freeze/thaw)	Radioactive Material collected on A, B, C, D, & E Filters	Release of radioactive material to the environment	Water barrier on top of filter building, berming of filters, filters under several feet of ground, water sources drained and isolated,	S&M plan	F2	S1 E3	Low frequency due to barriers, rains, low probability of freeze thaw cycles in vaults due to underground temperature
291B-Rain-03	291-B Sand Filter	Release of radioactive material due structural degradation (aging)	Water leaking into sand filter vaults causing damage (freeze/thaw)	Radioactive Material collected on sand filters	Release of radioactive material to the environment	Water barrier on top of filter, water sources drained and isolated,	S&M plan	F2	S0 E3	Low frequency due to barriers and typical small rain storms for area.
291B-Light	291-B Filter Building	Release of radioactive material due to ignition of combustible filter material	Lightning, range fire, static electricity discharge	Radioactive material collected on A, B, C, D, & E Filters	Release of radioactive material to the atmosphere or to the ground	Filter is fire resistant, no man made ignition sources, concrete structures. Filter is isolated from canyon and fans.	None Identified	F2	S1 E1	Analyzed in BIO
291B-Impact-01	291-B Filter Building	Release of radioactive material due to breaching of filter containment	Impact from airplane	Radioactive material collected on A, B, C, D, & E Filters	Release of radioactive material to the atmosphere or to the ground	None Identified	None Identified	F0	S2 E3	Frequency of airplane strike has been shown to be beyond extremely unlikely.
291B-Impact-02	291-B Filter Building	Release of radioactive material due to breaching of filter containment	Impact from moving vehicle	Radioactive material collected on A, B, C, D, & E Filters	Release of radioactive material to the atmosphere or to the ground	Berm around filters, filters located away from roads, restricted access	None Identified	F2	S1 E1	Analyzed in BIO
291B-Impact-03	291-B Filter Vaults	Release of radioactive material from 291-B Filter Vaults due to breaching of passive filter confinement or filter vault risers	Impact from moving vehicle coupled with fire from gas tank	Radioactive material collected on A, B, C, D, & E Filters	Release of radioactive material to the atmosphere	Berm around filters, filters located away from roads	restricted access	F1	S2 E2	Analyzed in BIO
291B-Impact-04	291-B Sand Filter Building	Release of radioactive material due to breaching of sand filter confinement	Impact from moving vehicle	Radioactive material collected on sand filters	Release of radioactive material to the atmosphere	Berm around filters, filters located away from roads	restricted access	F2	S0 E0	vehicle fire will not increase consequences since wall will not breech

PRELIMINARY HAZARDS ANALYSIS

Process Area B-Plant S&M Phase Participants Dave Braun Ben Schwehr John Van Keuren Date 6/23/98
References used

ID	Location/ Activity	Hazardous Condition	Causes	Material-At-Risk	Consequence	Engineered Features	Administrative Features	Freq Cat	Con Cat	Remarks
291B-Wind-01	291-B Filter Risers	Release of radioactive material due to loss of filter confinement due to breach of passive vent or risers	high wind missile	Radioactive material collected on A, B, C, D, & E Filters+ passive filter	Release of radioactive material to the atmosphere	Concrete structure, vault containing filters located 1m below ground	S&M program	F2	S2 E2	Breach of riser included in this scenario
291B-Wind-02	291-B Filter Risers	Release of radioactive material due to loss of filter confinement due to breach A, B, C, D, E or sand filter structures	high wind missile	Radioactive material collected on A, B, C, D, & E Filters+ sand filter	Release of radioactive material to the atmosphere	Concrete structure, vault containing filters located 1m below ground	S&M Program	F0	S2 E2	
291B-Wind 03	291-B Sand Filter Building	Release of radioactive material due to breaching of building containment	high wind, missile	Radioactive material collected on sand filters	Release of radioactive material to the atmosphere	Berm around filters	S&M Program	F2	S0 E0	
221B-Ehst-01	Canyon exhaust system	Release of radioactive material due to new stack falling on new (ACT) filter	Seismic event	New filter loading	Release of radioactive material to the atmosphere	Stack anchored to 221B building	Material build-up limits Gamma detection	F2	S1 E1	
221B-Ehst-02	Canyon exhaust system	Release of radioactive material due to filter failure	Seismic event or other DBA (i.e. roof collapse)	New filter loading + suspended contamination in canyon	Release of radioactive material to the atmosphere	All components designed to same seismic criteria- not seismically qualified	Material build-up limits Gamma detection	F2	S2 E2	CES fans unlikely to continue to operate after seismic vent that causes filter failure
221B-Ehst-03	Canyon exhaust system	Release of radioactive material due to missile penetrating filter	High wind	Filter loading	Release of radioactive material to the atmosphere	none identified	none identified	F2	S2 E2	
221B-Ehst-04	Canyon exhaust system	Personnel radiation exposure due to radioactive material loading on filters higher than limits	Human error Instrumentation failure	Filter loading	Excessive acute exposure Unexpected uncontrolled high radiation areas	Gamma detector on filter	Radioactive material Build-up limits Periodic surveillance(filter change) S&M	F3	S1 E0	Bounded by BIO analysis
221B-Ehst-05	Canyon exhaust system	Personnel radiation exposure due to sudden loading of filters to a radioactive inventory higher than limits	Unforeseen activities in B Plant releasing large quantities of fission product material Failure of wind tunnel plug to seal	Filter loading	Excessive acute exposure Unexpected uncontrolled high radiation areas	Gamma detector on filter (ensure not G-M)	Occupational safety program	F2	S1 E0	G-M tubes can saturate in high gamma dose rate fields, and could mislead someone into thinking there is no dose rate Hard to recover from

PRELIMINARY HAZARDS ANALYSIS

Process Area B-Plant S&M Phase Participants Dave Braun Ben Schwehr John Van Keuren Date 6/23/98
References used

ID	Location/ Activity	Hazardous Condition	Causes	Material-At-Risk	Consequence	Engineered Features	Administrative Features	Freq Cat	Con Cat	Remarks
221B-Ehst-06	Canyon exhaust system	Unfiltered release due to loss of filtration	Filter failure filter seal failure Continued operation with damaged or degraded ACT equipment	Contamination in B Plant Canyon	Release of radioactive material to atmosphere	Filter design Continuous air monitor	Filter test S&M Plan	F2	S2 E2	
221B-Ehst-07	Canyon exhaust system	Release of radioactive material due to breaching of filter confinement.	Human error Vehicle impact with gas tank fire	Filter loading	Release of radioactive material to the atmosphere	None Identified	Restricted vehicle access	F2	S2 E2	90 day surveillance
221B-Ehst-08	Canyon exhaust system	Release of contamination from B Plant and CES filter due to loss of ventilation	Electrical power failure Failure of fans Plugging of filters	Residual contamination inside of the system/building	Loss of confinement	Natural draft from CES stack	None identified	F3	S1 E0	Power failure occurs from range fire affecting the ability to bring off-site power to facility. There is no back-up or emergency power available.
221B-Ehst-09	Canyon exhaust system	Release of radioactive material on filters due to failure of confinement from fire	Build up of brush and tumble weeds around ventilation system with ignition	New filter loading	Release of radioactive material to the atmosphere	B-Plant fence	S&M to control tumbleweed or other combustible buildup around the ACT equipment	F2	S2 E2	Build-up due to reduced surveillance and failure to control brush adequately Fire Hazards Analysis - Section 13.5
221B-Ehst-10	Canyon exhaust system	Release of radioactive material on filters due to failure of confinement	Aircraft impact	New filter loading	Release of radioactive material	None identified	None identified	F0	S2 E2	Research into the frequency of aircraft impact to various facilities has been done for PFP, the vitrification plant and the solid waste facilities
221B-Ehst-11	Canyon exhaust system	Release of radioactive material on filters due to failure of confinement	Tornado	Residual contamination inside of the CES + canyon	Release of radioactive material to atmosphere	None Identified	Radioactive inventory limits on the ACT filter	F0	S2 E2	High wind analysis is appropriate at Hanford rather than tornado.
221B Fire-01	221 B plant area	Release of radioactive material due range fire	Fire results in damage to building	Radioactive material in buildings in 221B complex plus CES filters	None	Large, thick walled concrete buildings	S&M Plan	F1	S0 E0	Range fire could initiate facility fire
212B-01	Cask Station	Release of radioactive material due to structural failure	Seismic events	Hot Cell Contamination	Release of radioactive material to the atmosphere	Structure	S&M Plan	F1	S1	Analyzed in the BIO, Hot cell survives high wind. Contamination si only located in below grade hot cell

PRELIMINARY HAZARDS ANALYSIS

Process Area B-Plant S&M Phase Participants Dave Braun Ben Schwehr John Van Keuren Date 6/23/98
References used

ID	Location/ Activity	Hazardous Condition	Causes	Material-At-Risk	Consequence	Engineered Features	Administrative Features	Freq Cat	Con Cat	Remarks
212B-02	Cask Station	Release of radioactive material due to structural failure	Wind	Hot cell contamination	Release of radioactive material to the ground	Hot cell is below grade	S&M plan	F0	S1 E1	Subsurface release
212B-03	Cask Station	Release of radioactive material due to structural failure due to aging	Water intrusion, (freezing and thawing	Hot cell contamination	Release of radioactive material to the ground	Stainless steel liner on walls and floors	S&M plan	F1	S0 E3	
212B-04	Cask Station	Release of radioactive material due to roof collapse	Snow, volcanic ash	Hot cell contamination	Release of radioactive material to the atmosphere	Slanted metal roof steel structure contamination in hot cell	S&M plan	F0	S1 E1	Hot cell is below grade, roof collapse will not cause collapse of hot cell (See BIO)
212B-05	Cask Station	Personnel injury due to leak, spills falls	Deactivated, degraded (aged) facility, low lighting, asbestos, lead	NA	Personnel Injury	Surveillance Lighting	S&M plan	F3	S1 E0	Minimum chemical and radiological exposure
271B/222B-01	271B, 222B	Personnel injury due to leaks, spills, falls	Deactivated, degraded (aged) facility, low lighting	NA	Personnel Injury	Surveillance lighting	S&M plan	F3	S1 E0	Minimum chemical and radiological exposure
271B/222B-02	271B, 222B	Release of radioactive material due to aging, building degradation	Water intrusion, facility structure degradation	Fixed surface contamination	Release of radioactive material to the environment	Contamination is fixed, roof/water barrier, drains, penetrations have been plugged	S&M plan	F3	S0 E1	Surface contamination levels are low
221BB/BF-01	221BB, 221BB condensate pit and 221BF	Loss of confinement due to natural phenomena	Seismic, wind, volcanic ash, heavy snow	Radioactive contamination in the facilities	Release of radioactive material to the atmosphere	Concrete structures Majority of radioactive material is in tanks	S&M Plan	F2	S1 E1	
221BB/BF-02	221BB, 221BB condensate pit and 221BF	Loss of confinement due to structural degradation	Water intrusion, aging, freeze thaw cycles	Radioactive contamination in the facility	Release of radioactive material to the atmosphere or the ground	Water barrier Piping and penetrations are plugged Tanks are stainless steel	S&M Plan	F3	S1 E1	
211B-01	211B Tank farm	Release of toxic chemicals due to natural phenomena	Seismic, wind, range fire, lighting	Sodium Hydroxide, Nitric acid	Toxic fume release to the atmosphere, spill to the ground, mixing of chemicals	Stainless steel tanks, vented tanks concrete catch basin Only heels remain in tanks	S&M Plan	F3	S1 E1	F3 due to range fire

PRELIMINARY HAZARDS ANALYSIS

Process Area B-Plant S&M Phase Participants Dave Braun Ben Schwehr John Van Keuren Date 6/23/98
References used

ID	Location/ Activity	Hazardous Condition	Causes	Material-At-Risk	Consequence	Engineered Features	Administrative Features	Freq Cat	Con Cat	Remarks
211B-02	211B Tank farm	Toxic release due to spill or mix	Aging Vehicle impact	Sodium Hydroxide, Nitric acid	Toxic fume release to the atmosphere, spill to the ground, mixing of chemicals	Stainless steel tanks, vented tanks concrete catch basin Only heels remain in tanks	S&M Plan	F1	S1 E0	
211B-03	211B Tank farm	Industrial Hazard	Deactivated, degraded (aged) facility, low lighting	NA	Personnel Injury	None Identified	S&M Plan	F3	S1 E0	
B-Plant-01	B Plant Area	Industrial Hazards	Facility degradation, aging debris	NA	Personnel Injury	None Identified	S&M Plan	F3	S1 E0	Surveillance personnel walk around deactivated facilities
B-Plant 02	B Plant Buildings	Release of radioactive material due to damage to structures, systems or components as a result of a missile generated from a degraded building	Facility degradation, aging	Contamination	Damage to structures, systems, or components. Specific concerns are passive vent system and canyon exhaust system	None Identified	S&M Plan	F2	S2 E2	
B-Plant-03	B-Plant area	Facility workers hazard from accidents at other on-site facilities	Site accidents	Release of radioactive or chemical inventory at other site facilities	Exposure to S&M facility workers	WESF alarms B-plant alarms	Emergency preparedness program	F3	S2 E0	

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Attachment A-D: Hazard Identification and Evaluation Report Peer Review Checklist

CHECKLIST FOR PEER REVIEW

Document Reviewed: B Plant S&M Hazard Identification and Evaluation Report

Scope of Review: Technical Peer Review of Report

Yes	No	NA	
[ ]	[ ]	[✓]	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
[✓]	[ ]	[ ]	Problem completely defined.
[✓]	[ ]	[ ]	Accident scenarios developed in a clear and logical manner.
[✓]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[ ]	[ ]	[✓]	Computer codes and data files documented.
[ ]	[ ]	[✓]	Data used in calculations explicitly stated in document.
[✓]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[ ]	[ ]	[✓]	Mathematical derivations checked including dimensional consistency of results.
[ ]	[ ]	[✓]	Models appropriate and used within range of validity or use outside range of established validity justified.
[ ]	[ ]	[✓]	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
[ ]	[ ]	[✓]	Software input correct and consistent with document reviewed.
[ ]	[ ]	[✓]	Software output consistent with input and with results reported in document reviewed.
[✓]	[ ]	[ ]	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
[ ]	[ ]	[✓]	Safety margins consistent with good engineering practices.
[✓]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
[✓]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.
[✓]	[ ]	[ ]	Format consistent with appropriate NRC Regulatory Guide or other standards
[ ]	[ ]*	None	Review calculations, comments, and/or notes are attached.

[✓] [ ] [ ] **Document approved.**

MILTON V. SHULTZ Milton V. Shultz September 30, 1998

Reviewer (Printed Name and Signature) Date

*Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist. Such material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.

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APPENDIX B:

BHI PROGRAMMATIC CHAPTERS

6.0 PREVENTION OF INADVERTENT CRITICALITY

There is no fissile material in the B Plant facility complex, therefore, the B Plant facility is exempt from Criticality prevention requirements. (Reed 1994a).

Prevention of inadvertent criticality is part of the nuclear safety program. Standards and Requirements applicable to the S&M activities performed in the B Plant facility are provided in Appendix C. Additional requirements may be imposed on facility modifications to meet DOE safety requirements.

Criticality controls are in the form of either engineered or administrative controls. Because the B Plant facility is in a shutdown status, activities covered by this SAR do not involve the processing, modification, or reconfiguration of significant quantities of fissionable material. Engineered controls established for operation and shutdown of the facilities are not impacted by S&M activities without formal evaluation by the USQ process.

The Environmental Restoration Contractor (ERC) responsibilities and policies for nuclear safety are described in BHI-SH-01, *Hanford ERC Environmental Safety and Health Program*. Changes to the Criticality Safety Program do not require USQ evaluation.

7.0 RADIATION PROTECTION

The ERC radiation protection program is designed to protect workers from the harmful effects of radiation. Standards and Requirements applicable to the S&M activities performed in the B Plant facility are provided in Appendix D and the DOE Radiological Control Manual (DOE 1994c). Additional requirements may be imposed on facility modifications to meet DOE safety requirements.

The radiological controls and protection program is defined in DOE-approved programs and BHI-approved procedures BHI-SH-04 and BHI-SH-01. This program implements ERC policy to reduce safety or health risks to levels that are ALARA and to ensure adequate protection of workers. Appropriate dosimetry, Radiological Work Permits, personnel protective equipment, ALARA planning, periodic surveys, and radiological control technician support are provided.

The Radiological Protection Program implements the requirements of 10 CFR 835 and has been approved by the DOE. Changes to the ERC radiological protection program will occur, and review and approval of these changes does not require USQ evaluation.

8.0 HAZARDOUS MATERIAL PROTECTION

The hazardous material protection and controls program is designed to protect workers from the harmful effects of exposure to or contact with hazardous materials. Standards and Requirements applicable to the S&M activities performed in the B Plant facility are provided in Appendix C. Additional requirements may be imposed on facility modifications to meet DOE safety requirements.

The hazardous material protection program is established to minimize health and safety risks to workers, the public, and the environment. The program and responsibilities are specified in BHI-SH-01. A few items handled under this program include the ALARA program, hazardous material monitoring, hazardous material protection record keeping, and the hazard communication program. Changes to the program do not require USQ evaluation.

9.0 RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

This section addresses the management program, and describes the radioactive and hazardous waste streams and controls associated with the B Plant facility S&M activities. Standards and Requirements applicable to the S&M activities performed in the B Plant facility are in Appendix C. Additional requirements may be imposed on facility modifications to meet DOE safety requirements.

The B Plant facility S&M activities are associated with confinement and cleanup rather than routine processes and operations. The radioactive and hazardous waste management program and organizational responsibilities are specified in BHI-SH-01. Changes to the program do not require USQ evaluation.

10.0 IN-SERVICE SURVEILLANCE AND MAINTENANCE

This section addresses the in-service S&M activities associated with the B Plant facility. Standards and Requirements applicable to the S&M activities performed in the B Plant facility are in Appendix D. Additional requirements may be imposed on facility modifications to meet DOE safety requirements.

Procedures control the methods to perform and document 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 that appropriate action can be taken. The maintenance program is to perform preventative maintenance and accomplish work tasks that are identified during the surveillance activities that are within the bounds of the safety basis. The program requirements for each are specified in BHI-SH-01 and BHI-FS-01, *Field Support Administration*. The work is performed using approved work plans and procedures. A DOE-approved Maintenance Implementation Plan is given in BHI (1997c). Changes to the Maintenance Implementation Plan will occur and do not require USQ evaluation.

11.0 OPERATIONAL SAFETY

This section addresses the general aspects of operational safety as established by the use of programmatic controls associated with the B Plant facility S&M activities. Programmatic controls are designed to ensure worker safety and to protect the worker from radiological and chemical hazards. Programmatic controls also govern S&M activities necessary to maintain confinement of contaminants and prevent releases to the environment. Standards and Requirements applicable to the S&M activities performed in the B Plant facility are provided in Appendix C. Additional requirements may be imposed on facility modifications to meet DOE safety requirements.

Conduct of operations (CONOPS) for S&M activities is addressed in a provided matrix (Goodenough 1997), which identifies both the applicable elements of DOE Order 5480.19 for S&M activities and the implementing documents for these activities. This graded approach to CONOPS has been approved by RL. Review and approval of changes to the ERC CONOPS program and matrix do not require a USQ evaluation.

Fire Protection Program requirements are specified in BHI-SH-01. Project-specific controls for fire protection are described in the FHA in Appendix B. The FHA provides an evaluation of fire hazards, combustible loading, ignition sources, and fire protection specific to each fire area.

12.0 PROCEDURES AND TRAINING

This section addresses the processes by which the technical content of procedures and training associated with the B Plant facility S&M activities are developed, verified, and validated. Standards and Requirements applicable to the S&M activities performed in the B Plant facility are in Appendix D. Additional requirements may be imposed on facility modifications to meet DOE safety requirements.

The S&M activities are scheduled and controlled by approved work packages and procedures. The work control procedures define responsibilities and requirements for preparing, scheduling, executing, and monitoring status of activities.

Procedure Program

ERC programmatic controls covered by procedures are typically defined at two levels:

1. Procedures that apply universally to certain activities (e.g., radiological protection, hoisting and rigging, lock and tag)

2. Additional facility-specific procedures (e.g., surveillance of a building) containing facility-specific information or requirements.

The programs that govern universal or ERC-wide controls are located in the appropriate sections of this SAR and include the following:

- CONOPS
- Work Controls
- Radiological Protection Program Controls
- Worker Health and Safety Controls
- Training Requirements
- Maintenance requirements
- Configuration Controls
- Quality Assurance
- Emergency Preparedness
- Criticality Safety
- Hazardous Material Protection
- Radioactive and Hazardous Waste Management.

Changes to these programs and the related procedures are evaluated, reviewed, and approved under the cognizance of the appropriate functional manager (DOE or contractor) without need to review this document.

However, changes to project-specific controls identified in this document (Section 5.0) require a USQ evaluation to determine if the change can be made under contractor authority or if DOE review and approval is required. Discovery of conditions that are inconsistent with the description or analysis within this document also require a USQ evaluation.

12.1 Development Of Procedures

One of three work processes is used to schedule and control work: (1) routine work, (2) scheduled maintenance work request, and (3) demand work request.

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, safety, and radiological requirements for the work to be performed. The packages are reviewed by appropriate functional groups (e.g., field engineering, safety and health, radiological control) to ensure that requirements and documentation are appropriate for the work to be performed. To meet the requirements of 29 CFR 1910.120, all BHI-managed surplus facilities will require a Site Specific Health and Safety Plan (SSHASP). The SSHASP provides the S&M project worker safety and health commitments. B Plant-specific hazards or applicable commitments will be found in an appendix to the S&M project SSHASP.

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

If the need for a nonroutine activity is identified, a demand work request is generated. The work activity may be required to implement a new design, design change, corrective maintenance action, deactivation action, system isolation, etc.

Procedures control the methods to perform and document S&M of the retired surplus facilities managed by the ERC. 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.

12.2 Training

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 initially and periodically thereafter. Facility-specific training on hazards associated with the facility is also provided for S&M workers. Special briefings are conducted when new or changing hazards are encountered.

Procedures define responsibilities and methods for establishing training requirements, course work, individual training plans, and training records.

13.0 HUMAN FACTORS

This section addresses the application of human factors to activities associated with the B Plant facility. Standards and Requirements applicable to the S&M activities performed in the B Plant facility are provided in Appendix C. Additional requirements may be imposed on facility modifications to meet DOE safety requirements.

The deactivated B Plant facility does not require operational functions that are dependent on human factors. However, operation of required equipment during S&M activities, effective task completion, or responses to off-normal situations are dependent on human preparation and readiness. All ERC personnel must complete general and job-specific training and are subject to work plans and procedures as discussed in Section 12.0. Training materials and procedures are developed based on both general and job-specific requirements using a team approach to ensure input of technical expertise, operational experience, safety and health, and recognized standards This input includes the application of human factors as appropriate.

14.0 QUALITY ASSURANCE

This section addresses the Quality Assurance (QA) Program associated with the B Plant facility S&M activities. Standards and Requirements applicable to the S&M activities performed in the B Plant facility are provided in Appendix C. Additional requirements may be imposed on facility modifications to meet DOE safety requirements.

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 and applicable regulation and DOE orders; Part II describes how the quality program requirements are implemented through a system of manuals and procedures; and Part III describes how the ERC quality program will be implemented for nuclear scopes 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 quality assurance 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 in BHI-QA-03. Changes to the program do not require USQ evaluation.

15.0 EMERGENCY PREPAREDNESS PROGRAM

This section addresses the Emergency Preparedness Program associated with the B Plant facility S&M activities. Standards and Requirements applicable to the S&M activities performed in the B Plant facility are provided in Appendix C. Additional requirements may be imposed on facility modifications to meet DOE safety requirements.

BHI-SH-03, *Emergency Management Program* (EMP) for the ERC complies with and implements the requirements of the *Hanford Emergency Response Plan* (DOE-RL 1996), and ultimately the applicable DOE orders. The EMP establishes a coordinated emergency response organization (ERO) capable of planning for, responding to, and recovering from industrial, security, or hazardous materials incidents.

The EMP ensures these activities are integrated with similar activities of other Hanford Site contractors; RL; and relevant local, tribal, state, and Federal agencies. The EMP provides for organizational control of emergencies; training; emergency preparedness drills, assessment, and classification; preparation of emergency procedures, plans, and guides; and post-accident re-entry and recovery.

The EMP defines the ERO, which has responsibility 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 program do not require USQ evaluation.

16.0 PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

This section addresses the provisions for D&D applicable to B Plant facility S&M activities. Standards and Requirements applicable to the S&M activities performed in the B Plant facility are provided in Appendix C. Additional requirements may be imposed on facility modifications to meet DOE safety requirements.

Because the B Plant facility was deactivated in 1995, 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. S&M activities will, by definition, ensure confinement of existing material or will dispose of some portion of the material inventory through cleanup or relocation.

17.0 MANAGEMENT, ORGANIZATIONAL, AND INSTITUTIONAL SAFETY PROVISIONS

This section addresses the management, organizational, and institutional safety provisions associated with the S&M activities for B Plant facility. Standards and Requirements applicable to the S&M activities performed in the B Plant facility are provided in Appendix C. Additional requirements may be imposed on facility modifications to meet DOE safety requirements.

The ERC health and safety program is composed of 10 elements:

- Radiation protection
- Nuclear safety
- Hazardous waste operations
- ALARA.
- Industrial safety
- Fire protection
- Safety and health
- Industrial hygiene
- Occupational health
- Emergency management

Implementing procedures have been developed for each of these programs that define the scope, applicability, management, employee involvement, work site analysis, hazard prevention and control, and training requirements associated with the work to be performed. Review and approval of changes to the ERC health and safety program that may occur do not require USQ evaluation.

APPENDIX C
B PLANT STANDARDS AND REQUIREMENTS

C 1.0 GENERAL DISCUSSION

This appendix presents the detailed set of requirements identified by evaluating the activities and requirements for surveillance and maintenance (S&M) activities at B Plant. This set of standards and requirements is considered necessary and sufficient to protect the workers, the public, and the environment from the hazards associated with B Plant S&M activities.

The Environmental Restoration Contractor (ERC) has the responsibility for complying with all applicable Federal and state regulations. The detailed subparts and elements of regulatory standards relevant to the planned B Plant facility S&M scope of work are shown in the following tables. This listing of subparts and elements is not meant to exclude any portion not listed that may be applicable at the time of operation. If, during implementation, other parts of the general standard are determined applicable, those parts shall be included in the set of standards and requirements. However, for activities that are not included in the S&M scope, a special analysis and authorization of those activities must be conducted and the applicable standards must be defined before the work is performed.

The detailed listing of requirements is provided in the following subsections.

C 2.0 STANDARDS AND REQUIREMENTS FOR B PLANT SURVEILLANCE AND MAINTENANCE ACTIVITIES

C 3.0 ENGINEERING PROGRAM

C 4.0 QUALITY ASSURANCE

C 5.0 TRAINING AND QUALIFICATION

C 6.0 EMERGENCY MANAGEMENT

C 7.0 OPERATIONS AND MAINTENANCE

C 8.0 RADIOLOGICAL PROTECTION

C 9.0 WASTE MANAGEMENT AND ENVIRONMENTAL PROTECTION

C 10.0 NUCLEAR SAFETY

C 11.0 OCCUPATIONAL SAFETY AND HEALTH AND FIRE PROTECTION

C 2.0 STANDARDS AND REQUIREMENTS FOR B PLANT S&M ACTIVITIES

C 2.1 Hazard Evaluation

This safety analysis documents an evaluation of hazards associated with surveillance and maintenance activities. Each identified hazard was assessed for its impact on the surveillance activity. If the hazard applied to the scope of work, it was evaluated as part of a recognition, evaluation, and control process. This recognition of an impact on the scope of work by the hazard was followed by an evaluation of the control(s) required to ensure worker safety. The solution, or control measure, was selected from the appropriate standard citation. A comparison was made of what was required by standard versus what was in the working-level documents (BHI-FS-02, *Field Support Administration*). No attempt was made to assess actual working conditions. If the working-level document gave assurance that the worker had adequate guidance that was consistent with the standard, then implementation met the established criteria (described in the following paragraphs).

The hazard assessment was performed by individuals with B PLANT experience. Identification of the hazards associated with the B PLANT facility was then reassessed and an evaluation of the S&M activities was performed to ensure that potential hazards for both S&M activities were identified. Although additional sources and potential events were identified, the specific hazards associated with the additions remained the same.

C 2.2 Necessary and Sufficient Set of Standards for Work Planning and Execution

The tables in this appendix provide the set of standards and requirements that are necessary and sufficient for the performance of surveillance activities in the B PLANT facility, including worker protection, programmatic quality assurance, waste management, and environmental protection requirements necessary for protection of public health and the environment.

The tables identify hazards and standards necessary to mitigate the hazards identified. For each standard, BHI procedures that implement the standard are shown along with an evaluation of the effectiveness of the incorporation of that standard into the implementing procedures. For new tasks, the incorporation of the standard set into work planning would occur prior to initiation of work activities.

Criteria for incorporation of standards included in the following:

Direct incorporation (i.e., a statement was included in the procedure requiring compliance to a specific standard by surveillance workers (e.g., warnings not to handle asbestos-containing materials).

Incorporated by reference (e.g., training requirements).

Incorporation was inferred (e.g., a mandate to comply with radiation work permits inferred compliance with certain portions of 10 CFR 835).

C 2.3 Configuration Management

C 2.3.1 Regulatory Basis Determination

Configuration Management (CM) is a discipline that applies technical and administrative direction and surveillance to a configuration item over its life cycle. This direction and surveillance consists of the following:

Identification and documentation of the functional and physical characteristics of the configuration item

Control of changes to the configuration item and the related documentation

Information (records and reports) needed to manage the configuration item effectively, which includes the status of proposed changes and the implementation status of approved changes

Auditing configuration items to verify conformance to specifications, drawings, and interface control documents.

With B PLANT designated as a deactivated nonreactor nuclear facility and direction (as noted below) to use a graded approach, the configuration controls required for the limited S&M activities are considerably less than would be appropriate for facilities with operational or process-related activities. The standards applicable to CM for S&M activities are contained in 10 CFR 830, "Nuclear Safety Management." The 10 CFR 830 establishes requirements for the safe management of work at all DOE nuclear facilities. Inherent in the application of 10 CFR 830 to B PLANT S&M activities is the use of a graded approach that establishes the level of analysis, documentation, and actions necessary to comply with a requirement commensurate with the following:

- Relative importance to safety, safeguards, and security
- Magnitude of any hazard involved
- The life cycle stage of the facility
- Programmatic mission of the facility
- Particular characteristics of the facility
- Any other relevant factor.

10 CFR 830.120(c)(1)(iv) provides the basis of CM in that it requires documents be prepared, reviewed, approved, issued, used, and revised when their purpose is to prescribe processes, specify requirements, or establish a design. Records related to these CM activities must be specified, prepared, reviewed, approved, and maintained.

C 2.3.2 Evaluation

The following documents were reviewed during the identification phase to determine the applicable set of standards and requirements. Inclusion in the following listing does not mean the document is relevant to work planned during the B PLANT S&M period. DOE is revising its directives system and the orders contained in current contracts will be revised, deleted, or combined to form new documents.

1. CM guidance is provided by DOE-STD-1073-93 (DOE 1993c). This standard also contains two adjunct programs, the Design Reconstitution program and the Material Condition and Aging Management program. The guidance was developed for operating DOE nuclear facilities based on nuclear utility plant, commercial industry, and DOE complex experience. This guidance document was an attempt to standardize the approach to CM for operating nuclear facilities rather than those facilities in the design/construction phases.

2. CM as a process is explicitly defined in DOE Order 4700.1 (DOE 1987). This order provided implementing instructions, formats, and procedures for the acquisition (design and construction) of new DOE facilities. In 1994, DOE began a process to streamline all its orders and eventually combined its facility acquisition-related orders into the Life Cycle Asset Management (LCAM) program. The LCAM policy (DOE 1996b) became effective July 9, 1996.

3. Quality assurance requirements contained in DOE Order 5700.6C (DOE 1991b) were initially applicable to all DOE facilities and included certain aspects of a CM program. Specifically, Criterion 4 (documents) and Criterion 5 (work processes) detail steps to be taken to establish a technical baseline. This order referenced ASME NQA-1 (ASME 1994), which is a commercial nuclear industry consensus standard based on the requirements of the Nuclear Regulatory Commissions 10 CFR 50, Appendix B. With the implementation of 10 CFR 830.120, the DOE Order 5700.6C (DOE 1991b) scope is being revised for applicability to non-nuclear facilities.

4. The DOE codified the rules for managing its nuclear facilities when 10 CFR 830 became effective on May 5, 1994. Consensus standards (e.g., NQA-1 [ASME 1994] and ISO 9004 [ASTM 1987]) are provided as sources of methods to meet the requirements of 10 CFR 830 in the Implementation Guide (DOE 1994c). 10 CFR 830 is legally enforceable on all DOE contractors.

5. The DOE has adopted the guidance of Office of Management and Budget (OMB) Circular A-119, *Federal Participation in the Development and Use of Voluntary Standards* (OMB 1993). The *National Technology Transfer and Advancement Act of 1995* continues the policy of OMB A-119 and requires all Federal agencies to use and assist in the development of voluntary, private sector, and industry consensus standards.

6. WAC 246-247 requires licensed facilities to have a documented quality assurance program that is compatible with standards such as ASME NQA-1 (ASME 1994) and ASME NQA-2 (ASME 1989).

C 2.3.3 Recommended Action Determination

The deactivation process at B PLANT has been ongoing for several years. Baseline drawings and related descriptive documents are placed under configuration control once their contents are verified. BHI procedures for document control and engineering processes ensure that the initial facility configuration is or will be documented and a solid basis exists for making future changes during the S&M period.

Table C-1. Standards and Requirements for Configuration Management

Hazard Category	Standard/Requirement	Applicable ERC Directive	Observations and Recommendations
Loss of Configuration Control	10 CFR 830.120(c)(1)(iv) Documents shall be prepared, reviewed, approved, issued, used, and revised to prescribe processes, specify requirements, or establish design. Records shall be specified, prepared, reviewed, approved, and maintained.	BHI-MA-02, *ERC Project Procedures*, Procedure 8.3, "Configuration Management Change Control" EDPI-4.01-01, "Design Criteria" EDPI-4.03-01, "Project Design Basis" EDPI-4.27-01, "Design Verification" EDPI-4.28-01, "Project Hazard Classification" EDPI-4.30-01, "Safety Analysis Documentation" EDPI-4.40-01, "Unreviewed Safety Question Process for Nuclear Facilities" EDPI-4.46-01, "Project Drawings" EDPI-4.47-01, "Design Change Notice" EDPI-4.48-01, "Design Drawing Management" EDPI-4.62-01, "Field Change Request (FCR) and Field Change Notice (FCN)" EDPI-4.63-01, "Supplier Deviation Disposition Request (SDDR)"	Active system (ventilation, electrical power/lighting/heating, instrumentation, and monitoring) drawings were or are being marked up as funded and scheduled to provide the as-built deactivated configuration and consigned to the ERC. Any changes to the facility during the S&M period will be controlled by stand-alone work packages and will require implementing existing engineering procedures.

C 3.0 ENGINEERING PROGRAM

C 3.1 Regulatory Basis Determination

During the B PLANT S&M period, significant modifications to the facility that will require engineering evaluations and calculations are not anticipated. Routine maintenance will be performed on the operating support systems using prescribed procedures/work packages. However, if unanticipated conditions occur within the facility or its deactivated process systems, the Inactive Facilities Surveillance and Maintenance group may require engineering support. The Engineering Program (ENG) translates the identified need into design media using a structured process. Once initiated, this structured process produces the media by:

- Evaluating the need to define the solution requirements
- Proposing solutions based on the identified requirements
- Selecting appropriate codes and consensus standards consistent with the importance/status of the system (graded approach)
- Preparing the design media with appropriate reviews/approvals.
- Verifying that final design media provides a cost-effective solution to the initial need.

During the engineering process, adequate documentation (e.g., reports, calculations, and sketches) must be maintained to show the evolution of the completed design. This documentation provides a technical baseline from which future changes (if required) can be made.

With B PLANT designated a deactivated nonreactor nuclear facility, the standards applicable to ENG for S&M activities are contained in 10 CFR 830. This part establishes requirements for the safe management of work at all DOE nuclear facilities. Inherent in the application of 10 CFR 830 to B PLANT S&M activities is the use of a graded approach, which establishes the level of analysis, documentation, and actions necessary to comply with a requirement commensurate with the following:

- Relative importance to safety, safeguards, and security
- Magnitude of any hazard involved
- Life cycle stage of the facility
- Programmatic mission of the facility
- Particular characteristics of the facility
- Any other relevant factor.

10 CFR 20(c)(2)(ii) provides the basis for ENG in that it requires items and processes to be designed using sound engineering/scientific principles and appropriate standards. In addition, design work, including changes, must incorporate applicable requirements and design bases. Design interfaces must be identified and controlled. The adequacy of design products must be verified or validated by individuals or groups other than those who performed the initial work. Finally, the verification and validation work must be completed before approval and implementation of the design.

C 3.2 Evaluation

The documents listed in Section F1.2 and the additional documents listed below were reviewed as appropriate to the engineering program during the identification phase to determine the set of applicable standards and requirements. Inclusion in the review does not mean the document is relevant to work planned during the B PLANT S&M period. The DOE is revising its directives system and the orders contained in current contracts will be revised, deleted, or combined to form new documents.

1. The Department of Defense has prepared its own systems engineering program, which is detailed in draft standard MIL-STD-499B, *Systems Engineering* (DOD 1992).

2. The international standard ISO 9004-1 (ASTM 1987) identifies elements of a systems engineering approach and presents recommendations on how to implement the approach during the design phase of a project. The design elements of engineering are further defined in ISO 9004-2 (ASTM 1993).

C 3.3 Recommended Action Determination

ERC procedures for document control and engineering activities ensure that the initial facility configuration is properly documented and that a process exists to make future changes.

Table C-2: Standards and Requirements for the Engineering Program			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations And Recommendations**
Lack of Engineering Control Process	10 CFR 830.120(c)(2)(ii) Items and processes shall be designed using sound engineering/scientific principles and appropriate standards. Design interfaces shall be identified and controlled. The adequacy of design products shall be verified or validated by individuals or groups other than those who performed the work. Verification and validation work shall be completed before approval and implementation of the design.	EDPI-4.01-01, "Design Criteria" EDPI-4.03-01, "Project Design Basis" EDPI-4.27-01, "Design Verification" EDPI-4.28-01, "Project Hazard Classification" EDPI-4.30-01, "Safety Analysis Documentation" EDPI-4.31-01, "ALARA Review" EDPI-4.34-01, "Off-Project Design Review: Design Control Checklist (DCCL) and Design Review Notice (DRN)" EDPI-4.35-01, "Criticality Evaluation" EDPI-4.37-01, "Project Calculations" EDPI-4.40-01, "Unreviewed Safety Question Process for Nuclear Facilities" EDPI-4.46-01, "Project Drawings" EDPI-4.47-01, "Design Change Notice" EDPI-4.48-01, "Design Drawing Management" EDPI-4.49-01, "Project Specifications" EDPI-4.55-01, "Project Material Requisitions and Purchase Memorandums (For Purchase Orders)" EDPI-4.56-01, "Project Material Requisitions and Purchase Memorandums (for Subcontracts)" EDPI-4.58-01, "Supplier Engineering and Quality Verification Documentation" EDPI-4.62-01, "Field Change Request (FCR) and Field Change Note (FCN)" EDPI-4.63-01, "Supplier Deviation Disposition Request (SDDR)" BHI-MA-02, "Configuration Management Change Control"	Routine maintenance will be provided by the Inactive Facilities Surveillance and Maintenance personnel. Approved procedures will be used. If nonroutine problems develop or if system modifications are required, engineering assistance will be requested. Engineering assistance will be provided using the established procedures.

C 4.0 QUALITY ASSURANCE

The ERC Quality Program (as documented in BHI-QA-01, *ERC Quality Program,* Parts I and II) has been formally approved RL as satisfying the requirements of both DOE Order 5700.6C (DOE 1991b) and 10 CFR 830.120. If a facility is identified as nuclear, a quality plan is prepared that describes how the ERC Quality Program will be implemented for the nuclear scope of work. The typical content and structure of nuclear quality plans is described in BHI-QA-01, Part III.

Quality assurance plans for nuclear facilities provide additional assurance that the work is planned and performed in a safe and compliant manner, based on the technical description of the work to be performed and the associated hazards analysis. The plans are approved by project management and the BHI Quality Program Manager and issued as controlled documents in BHI-QA-03, Section 3.2.

C 5.0 TRAINING AND QUALIFICATION

ERC Training (ERCT) has a program in place that provides consistent, effective, and efficient training for ERC personnel. A systematic, performance-based, graded approach is used in the ERCT ensuring on-time, as-needed training that is based on the requirements of the projects. ERCT is responsible for the management and administration of all training categories and subjects, records, any necessary accreditation, and key interfaces. The operating procedure BHI-HR-02, *ERC Training Procedure* Section 1.1, "ERC Training Program Procedure," describes the necessary processes involved in conducting required training, and an ERC Training Implementation Matrix will be developed that will cover the facility-specific training for B PLANT. The DOE reviewed and approved Training Implementation Matrix, which provides a matrix of the appropriate standards and regulations and corresponding procedures.

The ERCT requirements procedure, BHI-HR-02, Section 1.4, defines a suggested matrix for training courses to be taken in accordance with job descriptions (i.e., RAD Worker II training for any person working in a radiation/contamination zone). ERCT gives projects the flexibility to develop all necessary training that may arise due to site-specific needs.

NOTE: All procedures that apply and were developed for B PLANT will be part of required reading. ERCT will train personnel using procedures that are based on the standards/requirements.

C 6.0 EMERGENCY MANAGEMENT

The emergency management standard for the S&M activity of B PLANT is 29 CFR 1910.38 (a), "Emergency Action Plan." This standard states the requirements for an emergency action plan for employers who will evacuate their employees rather than respond to an emergency to mitigate the incident.

The emergency management actions for B PLANT are as follows:

- Planning includes development of the emergency action plan
- Preparedness includes training of personnel
- Response includes evacuating the building.

The above emergency management actions are outlined as requirements in 29 CFR 1910.38.

If an emergency occurs at the B PLANT facility, the response to mitigate would not be part of the S&M; instead, it would fall under the ERC Emergency Management Program, as outlined in BHI-SH-03, *Emergency Management Program.* This program implements the *Hanford Emergency Response Plan* (DOE/RL 1994) and the applicable emergency implementing procedures. Re-entry to the B PLANT facility following an emergency would be controlled based on BHI-FS-01, *Field Support Administration,* Section 10, "Access Control."

C 7.0 OPERATIONS AND MAINTENANCE

C 7.1 Conduct of Operations Applicability Matrix

The Conduct of Operations Graded Approach Applicability Matrix (Goodenough 1997) 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 (DOE 1990) guidelines applicable during S&M until final disposition of the B PLANT facility. The document was prepared by BHI for submittal to the DOE for review and approval.

When DOE Order 4330.4B (DOE 1994a) concerning maintenance of nuclear facilities (Draft 10 CFR 830.340, "Nuclear Facility Maintenance") becomes law, this section will have to be revised.

A DOE-approved Maintenance Implementation Plan will be developed.

C 8.0 RADIOLOGICAL PROTECTION

C 8.1 Regulatory Basis Determination

The standards applicable to radiation protection for S&M of B PLANT are contained in 10 CFR 835, "Occupational Radiation Protection." This regulation, which is enforceable by law, represents those elements deemed necessary by the DOE to provide an acceptable radiation protection program for the protection of occupationally exposed workers. A program based on 10 CFR 835 requirements will provide protection to the required worker and the public.

In evaluating the individual requirements in 10 CFR 835, the determination if a particular requirement was necessary was based on whether or not the type of hazard to be controlled by the regulation was present in the scope of the S&M activities. Many of the requirements in 10 CFR 835 were programmatic requirements of the overall Radiation Protection Program and were not being discussed specifically in the procedure or parent document. In these cases, the program

level requirements are contained in *Bechtel Hanford, Inc. Implementation Plan for 10 CFR 835* (BHI 1995).

C 8.2 Hazard Evaluation

The radiological hazards associated with the surveillance activities at B PLANT were taken from the facility hazards analysis included in this SAR and the *Risk Management Study for the Retired Hanford Site Facilities* (WHC 1993, 1994a, and 1994b), and the work description in the surveillance procedures.

C 8.3 Recommended Action Determination

In most cases, no actions were necessary to implement the cited requirement. In those cases where additional action was thought to be desirable, the recommended action in the original B PLANT closure process document was to discuss the identified hazard in a Site Specific Health and Safety Plan. Currently BHI policies, procedures, and work planning add general site-specific health and safety requirements to the specific work packages as applicable.

Table C-3: Standards and Requirements for Radiological Protection

Hazard Category	Standard/Requirement	Applicable ERC Directive	Observations and Recommendations
Radiation and Transferable Surface Contamination and Airborne Radioactive Materials	10 CFR 835.202 (a). The occupational exposure to general employees resulting from DOE activities, other than planned special exposures under 835.204 and emergency exposure situations under 835.1302, shall be controlled so the following annual limits are not exceeded: Total effective dose equivalent of 5 rems (0.05 sievert); The sum of the deep dose equivalent for external exposures and the committed dose equivalent to any organ or tissue other than the lens of the eye of 50 rems (0.5 sievert); A lens of the eye dose equivalent of 15 rems (0.15 sievert); and A shallow dose equivalent of 50 rems (0.5 sievert) to the skin or to any extremity.	BHI-SH-02, Vol. 1, 1.14 and 1.9; Vol. 2, 2.82 and 2.8.13 BHI-MA-01, 3.1 BHI-MA-02, 10.1 BHI-SH-04, 8.1 PNL-MA-552	This procedure requires that personnel control their exposure to Administrative Control Limits, which are less than the limits established in 10 CFR 835, and requires specific authorization to exceed these limits.
Radiation and Transferable Surface Contamination and Airborne Radioactive Materials	10 CFR 835.202 (b). All occupational exposure received during the current year shall be included when demonstrating compliance with 10 CFR 835.202(a).	BHI-SH-02, Vol. 1, 1.14, 1.18 and 1.9; Vol. 2, 2.8.2 and 2.8.13 BHI-MA-01,3.1,3.3 BHI-MA-02, 10.1 BHI-SH-04, 8.1 PNL-MA-552	These procedures require that all these exposures be evaluated and included in the final occupational dose.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Radiation	10 CFR 835.202 (c). Exposures from background, therapeutic and diagnostic medical radiation, and voluntary participation in medical research programs shall not be included in dose records or in the assessment of compliance with the occupational exposure limits.	BHI-SH-02, Vol. 1, 1.14; Vol. 2, 2.8.2 BHI-MA-01, 3.1 PNL-MA-552, and 842	Dosimetry is a contracted service and requirements are understood.
Radiation and Transferable Surface Contamination and Airborne Radioactive Materials	10 CFR 835.203 (a). The total effective dose equivalent during a year shall be determined by summing the effective dose equivalent from external exposures and the committed effective dose equivalent from intakes during the year. For purposes of compliance with this part, deep dose equivalent to the whole body may be used	BHI-SH-02, Vol. 1, 1.14; Vol. 2, 2.8.2 BHI-MA-01, 3.1 PNL-MA-552, and 842	The procedures require that all of the various elements of dosimetry to be available. Dosimetry is a contracted service, and applicable reference to these requirements is
Radiation and Airborne Radioactive Material and Transferable Surface Contamination	10 CFR 835.205 (a). Nonuniform exposures of the skin from X-rays, beta radiation, and/or radioactive material on the skin are to be assessed as specified in this section.	BHI-SH-02, Vol. 1, 1.14; Vol. 2, 2.8.13 BHI-MA-01, 3.1 PNL-MA-842	The procedures require that all of the various elements of dosimetry to be available. Dosimetry is a contracted service, and applicable reference to these requirements is included.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Radiation and Transferable Surface Contamination	10 CFR 835.205(b). For purposes of demonstrating compliance with 835.202(a)(4), assessments shall be conducted as follows: Area of skin irradiated is 100 cm^2 or more. The nonuniform dose equivalent received during the year shall be averaged over the 100 cm^2 of the skin receiving the maximum dose, added to any uniform dose equivalent also received by the skin, and recorded as the shallow dose equivalent to any extremity or skin for the year. Area of skin irradiated is 10 cm^2 or more, but is less than 100 cm^2. The nonuniform dose equivalent (H) to the irradiated area received during the year shall be added to any uniform dose equivalent also received by the skin and recorded as the shallow dose equivalent to any extremity or skin for the year. H is the dose equivalent averaged over the 1 cm^2 skin receiving the maximum absorbed dose, D, reduced by the fraction f, which is the irradiated area in cm^2 divided by 100 cm^2 (i.e., H=fD). In no case shall a value of f less than 0.1 be used. Area of skin irradiated is less than 10 cm^2. The nonuniform dose equivalent shall be averaged over the 1 cm^2 of skin receiving the maximum dose. This dose equivalent shall: (I) Be recorded in the individual's occupational exposure history as a special entry; and (ii) Not be added to any other shallow dose equivalent to any extremity or skin recorded as the dose equivalent for the year.	BHI-SH-02, Vol. 1, 1.14; Vol. 2, 2.8.13 BHI-MA-01, 3.1 PNL-MA-842	The procedures require that all of the various elements of assessment be performed and records maintained as appropriate.
Radiation (Embryo/Fetus)	10 CFR 835.206 (a). The dose equivalent limit for the embryo/fetus from the period of conception to birth, as a result of occupational exposure of a declared pregnant worker, is 0.5 rem (0.005 sievert).	BHI-SH-02, Vol. 1, 1.14; Vol. 2, 2.8.2 and 2.8.4 BHI-MA-01, 3.1	The procedures implement the language of this requirement for workers who have declared their pregnancy.
Radiation (Embryo/Fetus)	10 CFR 835.206 (b). Substantial variation above a uniform exposure rate that would satisfy the limits provided in 835.206(a) shall be avoided.	BHI-SH-02, Vol. 1, 1.14; Vol. 2, 2.82 and 2.8.4 BHI-MA-01. 3.1	These procedures require that all of the various elements of dosimetry to be available. Dosimetry is a contracted service, and applicable reference to these requirements is

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Radiation (Embryo/Fetus)	10 CFR 835.206 (c). If the dose equivalent to the embryo/fetus is determined to have already exceeded 0.5 rem (0.005 sievert) by the time a worker declares her pregnancy, the declared pregnant worker shall not be assigned to tasks where additional occupational exposure is likely during the remaining gestation period.	BHI-SH-02, Vol. 1, 1.14; Vol. 2, 2.82 and 2.8.4 BHI-MA-01, 3.1	The procedures implement the language of this requirement for workers who have declared their pregnancy.
Airborne Radioactive Materials	10 CFR 835.209 (a). The derived air concentration (DAC) values given in Appendices A and C to this part shall be used in the control of occupational exposures to airborne radioactive material.	BHI-SH-02, Vol. 1, 1.19, Vol. 2, 2.2.1 BHI-MA-01, 3.1 BHI-MA-02, 10.2	These procedures detail the air sampling program, and mandate the use of these derived air contamination values.
Airborne Radioactive Materials	10 CFR 835.209 (b). With regard to inhalation exposures and external exposures from airborne radionuclides, compliance with this part shall be demonstrated through conformity with 835.101 and 835.202, which establishes the applicable regulatory limits.	BHI-SH-02, Vol. 1, 1.9 and 1.22; Vol. 2, 2.8.2	The procedures require that such internal exposures be evaluated.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.209 (c). The estimation of internal dose shall be based on bioassay data rather than air concentration values unless bioassay data are: unavailable; inadequate; or internal dose estimates based on representative air concentration values are demonstrated to be as or more accurate.	BHI-SH-02, Vol. 2, 2.8.2 BHI-MA-01, 3.1 PNL-MA-552	This procedure requires that such internal exposures be evaluated. Bioassay is a contracted service, and applicable reference to these requirements is included.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.401(a). Monitoring of individuals and areas shall be performed to: Demonstrate compliance with the regulations in this part; Document radiological conditions in the workplace; Detect changes in radiological conditions; Detect the gradual buildup of radioactive material in the workplace; and Verify the effectiveness of engineering and process controls in containing radioactive material and reducing radiation exposure.	BHI-SH-02, Vol. 1, 1.14 and 1.22, Vol. 2, 2.14, 2.2.1 and 2.3.2 BHI-MA-01, 3.1 BHI-MA-2.3 and 10.1 BHI-SH-04, 3.11	These procedures and work instruction detail the means for monitoring the workplace to demonstrated compliance with these requirements.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.401(b). Area monitoring in the workplace shall be routinely performed, as necessary, to identify and control potential sources of personnel exposure to radiation and/or radioactive material.	BHI-SH-02, Vol. 1, 1.22, Vol. 2, 2.2.1 BHI-SH-04, 2.1, 3.10, and 3.11 BHI-MA-01, 3.1	These procedures detail the means for monitoring the workplace to demonstrate compliance with these requirements.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.401 (c). Instruments used for monitoring and contamination control shall be: Periodically maintained and calibrated on an established frequency of at least once per year; Appropriate for the type(s), levels, and energies of the radiation(s) encountered; Appropriate for existing environmental conditions; and Routinely tested for operability.	BHI-SH-02, Vol. 2, 2.2.1 BHI-MA-01, 3.1 BHI-SH-04, 3.1, 7.8, 7.22, 7.25, and 7.32 PNL-MA-562	These procedures detail the means for ensuring quality control on those instruments used for monitoring the workplace to demonstrate compliance with these requirements.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.402 (a). For the purpose of monitoring individual exposures to external radiation, personnel dosimetry shall be provided to and used by: Radiological workers who, under typical conditions, are likely to receive one or more of the following: An effective dose equivalent to the whole body of 0.1 rem (0.001 sievert) or more in a year; A shallow dose equivalent to the skin or to any extremity of 5 rems (0.05 sievert) or more in a year; A lens of the eye dose equivalent of 1.5 rems (0.015 sievert) or more in a year; A deep dose equivalent from external exposures to any organ or tissue other than the lens of the eye of 5 rems (0.05 sievert); Declared pregnant workers who are likely to receive from external sources a dose equivalent to the embryo/fetus in excess of 10 percent of the applicable limit in 835.206; Minors and members of the public likely to receive, in 1 year, from external sources, a dose in excess of 50 percent of the applicable limits in 853.207 or 835.208 respectively, or Individuals entering a high or very high radiation area.	BHI-SH-02, Vol. 1, 1.14 and 1.21, Vol. 2, Procedures 2.8.4 and 2.8.13 BHI-MA-01, 3.1	These procedures require that such external exposures be evaluated. Dosimetry is a contracted service, and applicable reference to these requirements is included.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.402 (b). Personnel external dosimetry programs shall be adequate to demonstrate compliance with 835.202, including routine dosimeter calibration and conformance with the requirements of the DOE Laboratory Accreditation Program for Personnel Dosimetry.	BHI-SH-02, Vol. 1, 1.14, BHI-MA-01, 3.1 PNL-MA-842	Dosimetry is a contracted service, and applicable reference to these requirements is included.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.402 (c). For the purpose of monitoring individual exposures to internal radiation, internal dose evaluation programs (including routine bioassay programs) shall be conducted for: Radiological workers who, under typical conditions, are likely to receive 0.1 rem (0.001sievert) or more committed effective dose equivalent, and/or 5 rems (0.05 sievert) or more committed dose equivalent to any organ or tissue, from all occupational radionuclide intakes in a year; Declared pregnant workers likely to receive an intake resulting in a dose equivalent to the embryo/fetus in excess of 10 percent of the limit stated in 835.206; or Minors and members of the public who are likely to receive, in 1 year, an intake resulting in a committed effective dose equivalent in excess of 50 percent of the limits stated in 835.207 or 835.208, respectively.	BHI-SH-02, Vol. 2, 2.8.2 and 2.8.4 BHI-MA-01, 3.1	These procedures require that such internal exposures be evaluated. Dosimetry is a contracted service, and applicable reference to these requirements is included.
Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.402 (d). Internal dose evaluation programs shall be adequate to demonstrate compliance with 835.202.	BHI-SH-02, Vol. 2, 2.1.4 and 2.8.2 BHI-MA-01, 3.1 BHI-MA-02, 1.7 PNL-MA-552	These procedures require internal dose evaluations. Dosimetry is a contracted service, and applicable reference to these requirements is included.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Airborne Radioactive Materials	10 CFR 835.403 (a). Measurements of radioactivity concentrations in the ambient air of the workplace shall be performed as follows: Air sampling shall be performed in occupied areas where, under typical conditions, an individual is likely to receive an annual intake of 2 percent or more of the specified ALI values. For a given radionuclide and lung retention class, the ALI is the product of the DAC listed in Appendix A of this part and the constant 2.4×10^9 ml. Samples shall be taken as necessary to detect and evaluate the level or concentration of airborne radioactive material at work locations. Real-time air monitoring, using continuous air monitors, as defined in 835.2, shall be performed in normally occupied areas where an individual is likely to be exposed to a concentration of airborne radioactivity exceeding 1 DAC, as specified in Appendix A of this part, or where there is a need to alert potentially exposed individuals to unexpected increases in airborne radioactivity levels. For the airborne radioactive material that could be encountered, real-time air monitors shall have alarm capability and sufficient sensitivity to alert potentially exposed individuals that immediate action is necessary in order to minimize or terminate inhalation exposures.	BHI-SH-02, Vol.1, 1.22; Vol. 2, 2.2.1 and 2.2.1 BHI-MA-01, 3.1 BHI-SH-04, 2.1, 3.10 and 3.11 PNL-MA-562	These procedures and work instructions require that air sampling be performed when there is the potential for exceeding the prescribed limits.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.403 (b). Monitoring of radiation in the workplace shall be performed using stationary (area) or portable radiation instruments, or a combination thereof. The instruments shall be readily available and shall be capable of measuring ambient radiation dose rates for the purpose of controlling radiation exposures.	BHI-SH-02, Vol. 1, 1.22; Vol. 2, 2.2.1 and 2.3.2 BHI-MA-01, 3.1 BHI-SH-04, 3.10, 3.11, and 7.32	These procedures and work instructions detail the means for monitoring the workplace to demonstrate compliance with these requirements.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.404 (a). Instruments and techniques used for radioactive contamination monitoring and control shall be adequate to ensure compliance with the requirements specified in this section.	BHI-SH-02, Vol. 2, 2.3.2 BHI-MA-01, 3.1 BHI-SH-04, 3.1 and 3.11	These procedures and work instructions detail the means for monitoring the workplace to demonstrate compliance with these requirements.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Transferable Surface Contamination	10 CFR 835.404 (b). Appropriate controls shall be maintained and verified that prevent the inadvertent transfer of removable contamination to locations outside of radiological areas under normal operating conditions.	BHI-SH-02, Vol. 1, 1.12, 1.2.1 and 1.22; Vol. 2, 2.2.1, 2.3.2 and 2.3.3 BHI-SH-04, 3.8, 3.11, 12.1 and 12.2 BHI-MA-01, 3.1 and 3.7 BHI-MA-02, 2.17 BHI-DE-01, EDPI-431-01	These procedures and work instructions detail the means for monitoring the workplace to demonstrate compliance with these requirements.
Transferable Surface Contamination	10 CFR 835.404 (c). Any area in which contamination levels exceed the values specified in Appendix D of this part shall be: Posted in accordance with 835.603; and Controlled in a manner commensurate with the physical and chemical characteristics of the contaminant, the radionuclides present, and the fixed and removable contamination levels.	BHI-SH-02, Vol. 1, 1.22 BHI-SH-04, 3.1, and 12.1 BHI-MA-01, 3.1	These procedures detail the process for controlling the workplace via Radiation Work Permits (RWPs) to demonstrate compliance with this requirement. Postings are provided as required by the applicable section of 10 CFR 835 below.
Transferable Surface Contamination	10 CFR 835.404 (f). Appropriate monitoring to detect and prevent the spread of contamination shall be performed by individuals exiting radiological areas established to control removable contamination and/or airborne radioactivity.	BHI-SH-02, Vol. 1. 1.13 and 1.22; Vol. 2, 2.4.2 BHI-MA-01, 3.1	These procedures detail the means for monitoring personnel to demonstrate compliance with this requirement.
Transferable Surface Contamination	10 CFR 835.404 (g). Protective clothing shall be required for entry to areas in which removable contamination exists at levels exceeding those specified in Appendix D to this part.	BHI-SH-02, Vol. 1, 1.12, 1.21 and 1.22; Vol. 2, 2.2.1 BHI-MA-01, 3.1 BHI-SH-04, 3.10	These procedures detail the means for determining the proper personal protective equipment to protect workers to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.501 (a). Personnel entry control shall be maintained for each radiological area.	BHI-SH-02, Vol. 1, 1.9, 1.12, 1.21, and 1.22	These procedures detail the process for controlling the workplace via RWPs to demonstrate compliance with this requirement.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.501 (b). The degree of control shall be commensurate with existing and potential radiological hazards within the area.	BHI-SH-02, Vol. 1, 1.9, 1.12, 1.21, and 1.22	These procedures detail the process for controlling the workplace via RWPs to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.501 (c). One or more of the following methods shall be used to ensure control: Signs and barricades; Control devices on entrances; Conspicuous visual and/or audible alarms; Locked entrance ways; or Administrative controls.	BHI-SH-02, Vol. 1, 1.12 and 1.21; Vol. 2, 2.3.2 and 2.4.1 BHI-MA-01, 3.1 BHI-SH-04, 12.1	These procedures detail the means for controlling entry to the workplace to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.501 (d). Administrative procedures shall be written as necessary to demonstrate compliance with the provisions of this section. These administrative procedures shall include actions essential to ensure the effectiveness and operability of barricades, devices, alarms, and locks. Authorizations shall be required to perform specific work within the area and shall include specific radiation protection measures.	BHI-SH-02, Vol. 1, 1.9, 1.12, 1.21, and 1.22; Vol. 2, 2.2.1 and 2.4.1 BHI-MA-01, 3.1	These procedures detail the means for controlling entry to the workplace to demonstrate compliance with this requirement. Additional requirements are placed on High Radiation and Very High Radiation Areas as detailed below.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.501 (e). No control(s) shall be installed at any radiological area exit that would prevent rapid evacuation of personnel under emergency conditions.	BHI-SH-02, Vol. 1, 1.12 and 1.21 BHI-MA-01, 3.1	This is a programmatic requirement of the Safety and Health Program. This procedure details the means for ensuring egress from the workplace to demonstrate compliance with this requirement.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Radiation	10 CFR 835.502 (a). High radiation areas. One or more of the following features shall be used for each entrance or access point to a high radiation area where radiation levels exist such that an individual could exceed a deep dose equivalent to the whole body of 1 rem (0.01 sievert) in any one hour at 30 centimeters from the source or from any surface that the radiation penetrates: A control device that prevents entry to the area when high radiation levels exist or upon entry causes the radiation level to be reduced below that level defining a high radiation area; A device that functions automatically to prevent use or operation of the radiation source or field while personnel are in the area; A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; Entryways that are locked. During periods when access to the area is required, positive control over each entry is maintained; Continuous direct or electronic surveillance that is capable of preventing unauthorized entry.	BHI-SH-02, Vol. 1, 1.1.21; Vol. 2, 2.4.1 BHI-MA-01, 3.1	These procedures detail the means for controlling access to High Radiation Areas to demonstrate compliance with this requirement.
Radiation	10 CFR 835.502 (b). Very high radiation areas. In addition to the above requirements, additional measures shall be implemented to ensure individuals are not able to gain access to very high radiation areas when dose rates are in excess of the posting requirements of 835.603(c).	BHI-SH-02, Vol. 1, 1.12, 1.21 and 1.22; Vol. 2, 2.21 and 2.4.1 BHI-MA-01, 3.1 BHI-SH-04, 12.1	These procedures detail the means for controlling access to Very High Radiation Areas to demonstrate compliance with this requirement.
Radiation	10 CFR 835.502 (c). No control(s) shall be established in a high or very high radiation area that would prevent rapid evacuation of personnel.	BHI-SH-02, Vol. 1, 1.21; Vol. 2, 2.4.1 BHI-MA-01, 3.1	These procedures detail the means for controlling access to High or Very High Radiation Areas to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 35.601 (a). Working areas that require posting because of the presence, or potential presence, of radiation and/or radioactive material are delineated in the subsequent paragraphs of this section. Radioactive items or containers of radioactive materials, shall be individually labeled if adequate warning is not provided by control measures and required posting.	BHI-SH-02, Vol. 1, 1.12, 1.15; Vol. 2, 2.3.3 BHI-SH-04, 3.7, 3.8, 6.4 and 12.1 BHI-MA-01, 3.1	This procedure detail the means for post radiologically controlled areas to demonstrate compliance with this requirement.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.601 (b). DOE approved signs, labels, and radiation symbols shall be used to identify areas specified in this subpart.	BHI-SH-02, Vol. 1, Procedure 1.19	This procedure details the means for posting radiologically controlled areas to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.601 (c). Required signs and labels shall have a yellow background. The radiation symbol shall be black or magenta.	BHI-SH-02, Vol. 1, 1.12 and 1.22 BHI-MA-01, 3.1 BHI-SH-04, 6.4	These procedures details the means for posting radiologically controlled areas to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.601 (d). Signs required by this subpart shall be clear and conspicuously posted and may include radiological protection instructions.	BHI-SH-02, Vol. 1, 1.19	This procedure details the means for posting radiologically controlled areas to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.603. Each access point to a radiological area (as defined in 835.2) shall be posted with conspicuous signs bearing the wording provided in this section. Radiation Area. The words "Caution, Radiation Area" shall be posted at any area accessible to individuals in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.005 rem (0.05 millisievert) in 1 hour at 30 cm from the source or from any surface that the radiation penetrates. High Radiation Area. The words "Danger, High Radiation Area" shall be posted at any area accessible to individuals in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.1 rem (0.001 sievert) in 1 hour at 30 cm from the radiation source or from any surface that the radiation penetrates. Very High Radiation Area. The words "Grave Danger, Very High Radiation Area" shall be posted at any area accessible to individuals in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in one hour at 1 meter from the radiation source or from any surface that the radiation penetrates.	BHI-SH-02, Vol. 1, 1.12 and 1.21; Vol. 2, 2.2.1 BHI-MA-01, 3.1 BHI-SH-04, 4.7 and 12.1	These procedures detail the means for posting radiologically controlled areas to demonstrate compliance with this requirement.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.603 (d). Airborne Radioactivity Area. The words "Caution, Airborne Radioactivity Area" shall be posted for any occupied area in which airborne radioactivity levels exceed, or are likely to exceed, 10 % of the DAC value listed in Appendix A or Appendix C of this part. Contamination Area. The words "Caution, Contamination Area" shall be posted where contamination levels exceed values listed in Appendix D of this part, but are less than or equal to 100 times those values. High Contamination Area. The words "Danger, High Contamination Area" shall be posted where contamination levels are greater than 100 times the values listed in Appendix D of this part.	BHI-SH-02, Vol. 1, 1.12 and 1.21; Vol. 2, 2.2.1 BHI-MA-01, 3.1 BHI-SH-04, 4.7 and 12.1 BHI-SH-02, Vol. 1, 1.22 BHI-SH-04, Appendix B	These procedures detail the means for posting radiologically controlled areas to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.701 (a). Records shall be maintained to document compliance with this part and with radiation protection programs required by 835.101.	BHI-SH-02, Vol. 1, 1.9; Vol. 2, 2.1.4; Vol. 4, 9.2 BHI-MA-01, 3.3 BHI-MA-02, 1.7 and 10.1 BHI-SH-04, 3.11	These procedures detail the means for controlling radiological records to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.701 (b). Unless otherwise specified in this subpart, records shall be retained until final disposition is authorized by DOE.	BHI-MA-02, 1.7 and 1.9; Vol. 2, 2.1.4 BHI-MA-01, 3.3 BHI-MA-02, 10.1 BHI-SH-04, 3.11	These procedures detail the means for controlling radiological records to demonstrate compliance with this requirement.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.703. The following information shall be documented and maintained: Results of surveys for radiation and radioactive material in the workplace as required by 835.401, 835.403, and 835.404; Results of surveys, measurements, and calculations used to determine individual occupational exposure from external and internal sources; Results of surveys for the release of material and equipment as required by 835.1101(d); and Results of maintenance and calibration performed on: (a) Instruments used for area monitoring and contamination control as required by 835.401; and (b) Devices used for individual monitoring as required by 835.401 and 835.402.	BHI-SH-02, Vol. 1, 1.14; Vol. 2, 2.1.4, 2.1.5, 2.2.1, 2.3.2, 2.3.3, 2.6 and 2.8.2 BHI-SH-04, 3.11 BHI-MA-01, 3.3 BHI-MA-02, 1.7 and 2.6 PNL-MA-562	These procedures detail the means for controlling radiological records to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.704 (a). Training records shall be maintained, as necessary, to demonstrate compliance with 835.901, 835.902, and 835.903.	BHI-HR-02, 1.1 BHI-MA-01, 3.5 BHI-MA-02, 5.2	This is an ERC programmatic requirement. This procedure describes how training records will be maintained to demonstrate compliance with these requirements.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.704 (b). Actions taken to maintain occupational exposures ALARA, including the actions required for this purpose by 835.101, as well as facility design and control actions required by 835.1001, 835.1002, and 835.1003, shall be documented.	BHI-SH-02, Vol. 1, 1.6, 1.7, 1.9 and 1.22; Vol. 2, 2.1.3, 2.1.4, 2.2.1 and 2.3.2 BHI-MA-01, 3.1, 3.5, 3.7, and 6.4.5 BHI-MA-02, 2.7, 2.9, 2.17, 2.18, 10.1 and 10.2	These procedures detail the means for controlling radiological ALARA records to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.704 (c). Records shall be maintained to document the results of internal audits and other reviews of program content and implementation.	BHI-SH-02, Vol. 2, 2.1.4 BHI-MA-01, 3.5 BHI-MA-02, 2.7, 2.9, 2.17, and 2.18	This is an ERC programmatic requirement. These procedures detail the means for controlling radiological assessments, audits, and surveillance to demonstrate compliance with this requirement.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Radiation	10 CFR 835.704 (d). Written declarations of pregnancy shall be maintained.	BHI-SH-02, Vol. 2, 2.1.4 and 2.8.4 BHI-MA-01, 3.5	These procedures detail the means for controlling written declarations of pregnancy records to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.704 (e). Changes in equipment, techniques, and procedures used for monitoring in the workplace shall be documented.	BHI-SH-02, Vol. 2, 2.1.4, 2.2.1 and 2.3.2 BHI-MA-01, 3.3 BHI-MA-02, 1.7 BHI-SH-04, 3.11	These procedures detail the means for controlling documents related to changes in equipment, techniques and procedures to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.801 (a). Radiation exposure data for individuals monitored in accordance with 835.402 shall be reported as specified in this section. The information shall include the data required under 835.702 (c). Each notification and report shall be in writing and include: the DOE site or facility name, the name of the individual, and the individual's social security number or employee number.	BHI-SH-02, Vol. 2, 2.1.4 BHI-MA-01, 3.5 BHI-MA-02, 1.7	This is a contracted function. These procedures detail the means for ensuring dosimetry is used so the contractor can provide this information to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.801 (b). Upon the request from an individual terminating employment, records of exposure shall be provided to that individual as soon as the data are available, but not later than 90 days after termination. A written estimate of the radiation dose received by that employee based on available. Information shall be provided at the time of termination, if requested.	BHI-SH-02,Vol. 2, 2.1.4 BHI-MA-01, 3.5 BHI-MA-02, 1.7	This is a contracted function. These procedures detail the means for ensuring dosimetry reports are provided to the individuals to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.801 (d). Detailed information concerning any individual's exposure shall be made available to the individual upon request of that individual, consistent with the provisions of the Privacy Act (5 U.S.C.552a).	BHI-SH-02,Vol. 2, 2.1.4 and 2.8.13 BHI-MA-01, 3.5 BHI-MA-02, 1.7	This is a contracted function. These procedures detail the means for ensuring dosimetry reports are provided to the individuals to demonstrate compliance with this requirement.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.902. Radiological worker training programs and retraining shall be 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 shall include both classroom and applied training. Training shall either precede assignment as a radiological worker or be concurrent with assignment as a radiological worker if the worker is accompanied by and under the direct supervision of a trained radiological worker. Radiological worker training not specific to a given site or facility may be waived provided that: This training has been received at another DOE site or facility within the past 2 years; there is provision of proof-of-training in the form of a certification document containing the individual's name, date of training, and specific topics covered; and an appropriate official has certified the training of the individual. The knowledge of radiation safety possessed by radiological workers shall be verified by examination prior to an unsupervised assignment. The training shall include procedures specific to an individual's job assignment. The level of training is to be commensurate with each worker's assignment.	BHI-SH-02, Vol. 1, 1.12 and 1.21; Vol. 2, 2.1.6, 2.10.1, 2.10.5 and 2.10.6 BHI-HR-02, 1.1 BHI-MA-01, 3.5 BHI-MA-02, 2.7 and 5.2	These procedures address qualifications the individuals need to complete to demonstrate compliance with this requirement.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.903. Training and retraining programs for radiological control technicians shall be established and conducted at intervals not to exceed 2 years to familiarize technicians with the fundamentals of radiation protection and the proper procedures for maintaining exposures ALARA. This program shall include both classroom and applied training. The training shall either precede performance of tasks assigned to radiological control technicians or be concurrent with such task assignments if the individual is accompanied by and under the direct supervision of a trained individual. The required level of knowledge of radiation safety possessed by radiological control technicians shall be verified by examination to include demonstration prior to any unsupervised work assignment. The training program shall include procedures specific to the site or facility where the technician is assigned. The level of training shall be commensurate with the technician's assignment. Allowance may be made for previous DOE training on generic radiation safety topics (i.e., those not specific to a site or facility), provided the training was received within the past 2 years. Documentation of the previous training shall clearly identify the individual's name, date of training, topics covered, and name of the certifying individual.	BHI-SH-02, Vol. 2, 2.10.1, 2.10.3, 2.10.4 and 2.10.6 BHI-HR-02, 1.1 BHI-MA-01, 3.5 BHI-MA-02, 5.2	These procedures detail the processes for ensuring Radiological Control Technicians are adequately trained to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.1001 (a). Measures shall be taken to maintain radiation exposure in controlled areas ALARA through facility and equipment design and administrative control. The primary methods used shall be physical design features (e.g., confinement, ventilation, remote handling, and shielding). Administrative controls and procedural requirements shall be employed only as supplemental methods to control radiation exposure.	BHI-SH-02, Vol. 1, 1.2.2, 1.23, and 1.24; Vol. 2, 2.2.1 BHI-MA-01, 3.4 and 3.7 BHI-MA-02, 2.17, 6.2 and10.1 BHI-DE-01, EDPI-4.29-01 and 4.31-01	These procedures detail the means for controlling radiological exposures ALARA to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.1001 (b). For specific activities where use of physical design features are demonstrated to be impractical, administrative controls and procedural requirements shall be used to maintain radiation exposures ALARA.	BHI-SH-02, Vol. 1, 1.12, 1.22 and 1.9; Vol. 2, 2.2.1 BHI-MA-01, 3.4 BHI-MA-02, 2.17 and 10.1	These procedures detail the means for controlling radiological exposures ALARA to demonstrate compliance with this requirement.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.1002 (b). The design objective for controlling personnel exposure from external sources of radiation in areas of continuous occupational occupancy (2000 hours per year) shall be to maintain exposure levels below an average of 0.5 mrem (5 microsieverts) per hour and as far below this average as is reasonably achievable. The design objectives for exposure rates for potential exposure to a radiological worker where occupancy differs from the above shall be ALARA and shall not exceed 20 percent of the applicable standards in 835.202.	BHI-SH-02, Vol. 1, 1.22, 1.23, and 1.24; Vol. 2, 2.2.1 BHI-MA-01, 3.1and 3.7 BHI-MA-02, 2.17, 6.2 and 10.1 BHI-DE-01, EDPI-4.29-01 and 4.31-01	These procedures detail the means for controlling radiological exposures ALARA to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.1002 (c). Regarding the control of airborne radioactive material, the design objective shall be, under normal conditions, to avoid releases to the workplace atmosphere and in any situation, to control the inhalation of such material by workers to levels that are ALARA; confinement and ventilation shall normally be used.	BHI-SH-02, Vol. 1, 1.9 and 1.22; Vol. 2, 2.2.1 BHI-MA-01, 3.1 and 3.4 BHI-MA-02, 2.17, 6.2, and 10.1 BHI-DE-01, 4.29-01	These procedures detail the means for controlling radiological exposures ALARA to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.1003 (a). During routine operations, the combination of design features and administrative control procedures shall provide that: The anticipated magnitude of the total effective dose equivalent shall not exceed 5 rems (0.05 sievert) in a year; The anticipated magnitude of the committed dose equivalent to any organ or tissue, plus any deep dose equivalent from external exposure, shall not exceed 50 rems (0.5 sievert) in a year; and Exposure levels are ALARA.	BHI-SH-02, Vol. 1, 1.14, 1.19, 1.22, 1.23 and 1.24; Vol. 2, 2.82 BHI-MA-01, 3.1, 3.4 and 3.7 BHI-MA-02, 2.17, 6.2 and 10.1 BHI-DE-01, 4.29-01 and 4.31-01	These procedures detail the means for controlling radiological exposures ALARA to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.1003 (b). Compliance with the requirements in paragraph (a) of this section shall be demonstrated by appropriate monitoring pursuant to the provisions of subpart E of this part.	BHI-SH-02, Vol. 1, 1.22; Vol. 2, 2.2.1 BHI-MA-01, 3.1 BHI-SH-04, 3.11	These procedures detail the means for controlling radiological exposures ALARA to demonstrate compliance with this requirement.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination	10 CFR 835.1101 The following requirements apply for the release of materials and equipment from radiological areas for use in controlled areas: (a) In radiological areas established to control surface or airborne radioactive material, material and equipment shall be treated as radioactive material and shall not be released from radiological areas to controlled areas if either of the following conditions exist: Measurements of accessible surfaces show that either the total or removable contamination levels exceed the values specified in Appendix D to this part; or Prior use suggests that the contamination levels on inaccessible surfaces are likely to exceed the values specified in Appendix D to this part. (b) Material and equipment exceeding the total or removable contamination levels specified in Appendix D to this part may be conditionally released for movement onsite from one radiological area for immediate placement in another radiological area only if appropriate monitoring and control procedures are established and exercised.	BHI-SH-02, Vol.1, 1.12 and 1.15, Vol. 2, 2.1.4, 2.3.2, and 2.3.3 BHI-SH-04, 3.1, 3.7, 3.8, 3.11, 6.3, 6.4, 12.1 and 12.2 BHI-MA-01, 3.1 and 3.3 BHI-MA-02, 1.7 BHI-SH-02, Vol. 2, 2.3.3	These procedures detail the means for controlling release of materials from radiological areas to demonstrate compliance with this requirement.
Radiation and Airborne Radioactive Materials and Transferable Surface Contamination (Cont.)	© Material and equipment with fixed contamination levels that exceed the limits specified in Appendix D to this part may be released for use in controlled areas outside of the radiological areas with the following provisions: Removable contamination levels are below the level specified in Appendix D of this part; and Materials shall be routinely monitored, clearly labeled, or tagged to alert personnel of the contaminated status; appropriate administrative procedures shall be established and exercised to maintain control of these items. (d) The records for release of material and equipment shall describe the property, date on which the release survey was performed, identity of the individual who performed the survey, type and identification number of the survey instrument used, and results of the survey.		
Airborne Radioactive Materials	10 CFR 835, Appendices A and C. Appendices A and C provide values of the DAC which are derived from the relative risk of internal exposure from inhalation of various radionuclides.	BHI-SH-02, Vol. 2, 2.2.1	This procedure details the means for determining the amounts of airborne radiological areas for comparison with these values.

Table C-3: Standards and Requirements for Radiological Protection			
Hazard Category	**Standard/Requirement**	**Applicable ERC Directive**	**Observations and Recommendations**
Transferable Surface Contamination	10 CFR 835, Appendix D. Appendix D provides the numerical values for removable and total surface contamination based on the type of radioactivity encountered.	BHI-SH-02, Vol.2, 2.3.3	This procedure details the means for determining the amounts of radiological contamination for comparison with these values.
ALARA = as low as reasonably achievable.			

C 9.0 WASTE MANAGEMENT AND ENVIRONMENTAL PROTECTION

C 9.1 Regulatory Basis Determination

Waste management requirements during S&M activities at B PLANT 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 disposition of waste generated from small-scaled cleanup, spill cleanup, and housekeeping activities; there are no routine waste streams.

Environmental protection requirements directly related to the S&M scope of work are limited to inspections of differential air pressures and nitrogen flow meters. The requirements for this scope of work are related to company-specific implementing requirements. High efficiency particulate air (HEPA) inspection and change criteria are implemented under a self-imposed DOE guidance standard. Requirements appropriate for monitoring and control of radiological conditions in the B PLANT facility have been identified in Section F7.0 and will not be addressed here.

An inspection activity for an inactive *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage, and/or disposal (TSD) unit (underground chemical tanks) is included in the workscope. Other environmental-protection requirements relate to the facility, but not to the subject workscope.

C 9.1.1 Waste Management

B PLANT 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 disposition of waste generated from small-scaled cleanup, spill cleanup, and housekeeping activities. Various nondestructive assay and sampling techniques are used for identification and characterization of potentially hazardous materials encountered or anticipated during S&M activities materials and determination methods are handled on a job-specific basis. The S&M activities involve handling and disposition of small quantities of waste generated from small-scaled cleanup, spill clean-up, and housekeeping activities. The potential regulated wastes involve the following:

- Heavy metals (e.g., lead, mercury)
- Light bulbs
- Radioactively-contaminated rain water
- Contaminated oils

- Fuels
- Batteries
- Miscellaneous chemicals
- Miscellaneous liquids
- Asbestos
- Polychlorinated biphenyls (PCBs).

Waste management requirements for hazardous (Washington State dangerous) and radioactive mixed waste are primarily derived from the Washington Administrative Code (WAC), which is generally more stringent than the comparable Federal standards. DOE Order 5820.2A, *Radioactive Waste Management* (DOE 1988) 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.

C 9.1.2 Environmental Protection

In addition to waste management requirements, environmental protection concerns involve the potential for releases to air and to soil and emergency/contingency planning and other environmental reporting requirements.

Standards for release of surface water discharge and underground injection of rainwater are no longer applicable because drains have been plugged as part of deactivation. However, the potential exists for external discharge of contaminated rainwater through cracks and joints in the floor. Because the piping systems were drained as part of transition, significant quantities of liquids are not likely to remain; therefore, any such spills should be fully contained within the building.

Standards for air protection from release of radioactive particulates were evaluated. The requirements were compared against the subject scope of work. The air-protection standards focus on permitting and monitoring programs. It was concluded that the requirements apply to the facility, but not to the limited scope of S&M activities. Instead, a DOE inspection standard for differential air pressures for HEPA filters was noted as applicable. Invoking this standard was also based on its existing presence in an ERC document describing environmental requirements for the protection of air quality.

Release of liquids is considered to be a low risk because process liquids have been removed. The safety of the heels in the tanks is addressed in the SAR, and the close-out of the environmental compliance issues identified for the tanks has been approved by the appropriate agencies.

The potential wastes that might result from small-scaled cleanup activities during surveillance activities were evaluated. Any larger-scaled cleanup would be performed by some other organization under a separate scope of work. This larger cleanup also involves the potential for the presence of hazardous materials/waste in areas involving exposures to radiation. These areas are avoided during surveillance inspections as part of the ALARA program to minimize exposures to radiation. Consequently, generation of waste from areas of significant radiation is outside the routine S&M scope of work.

C 9.2 Hazard Evaluation

For the S&M scope of work, the Environmental Protection functional area is associated with avenues for release of contaminants to the environment and the public. Potentially, some amount of airborne radioactive particulates could be released from the building. The negative air pressure system and HEPA filters are used to ensure releases do not occur through this avenue. The surveillance scope of work ensures the function of the HEPA filters by measurement of the differential pressure taken across the filters. The maintenance scope of work covers the replacement and disposal of the HEPA filters.

The waste management and environmental hazards associated with the S&M activities at B PLANT were also taken from the facility hazards identification studies used for the radiological evaluation. The B PLANT canyon and other areas with significant quantities of fissionable materials are not routinely entered during S&M. Therefore, no waste is expected to be generated from these areas as part of the routine S&M scope of work. Management controls and job-specific planning ensure that the small quantities of hazardous wastes generated during S&M activities are properly managed and disposed.

C 9.3 Recommended Action Determination

In most cases, no actions were necessary to implement the cited requirement. In those cases where additional action was thought to be desirable, the recommended action in the original B PLANT closure process document and Table F-4 is to discuss the identified hazard in a facility specific procedure or job-specific work package.

Table C-4: Waste Management and Environmental Protection			
Hazard	**Standard/Requirement**	**Applicable ERC Field Support Procedures**	**Observations and Recommendations**
Air Emissions	Applicability: B PLANT exhaust stack.	--	--
Air Emissions	WAC 246-247-075(2); 40 CFR 61.93(b)(4), "Confirmatory Measurements and Record Samples."	BHI-EE-02, Section 8 BHI-FS-01, Proc. 3.15	Procedures provide requirements for measurements and sampling.
Air Emissions	HEPA filters. WAC 246-247-040, "ALARACT Compliance Demonstration." Nuclear Air Cleaning Handbook; ERDA 76-21, Section 2.3.5, p. 23. Differential pressure drops of HEPA filters under surveillance determine change frequency.	BHI-EE-02, Section 8	Facility needs to be able to demonstrate that ALARA control technology is met. DP measurement across filters will monitor for build-up of ice or particulates.
Air Emissions	WAC 246-247-080 (8 and 10) 40 CFR 61.95, "Records Management for Effluent Monitoring."	BHI-EE-02, Section 8 BHI-MA-02, Proc. 1.4	Procedures provide requirements for record preparation and management.
Air Emissions	WAC 246-247-080(5), "Reporting." Identification of problems will be to Washington State Department of Health.	BHI-MA-02, Proc. 2.6 BHI-EE-02, Section 8	Procedures provide requirements for reporting.
Programmatic Requirement Release Reporting	Applicability: All buildings, structures, and tanks.		
Release Reporting	Spill reporting. Report spills to air, ground, groundwater, and surface water, and mitigate. WAC 173-303-145, 40 CFR 302.	BHI-EE-02, Section 3 BHI-MA-02, Proc. 2.6	Designated ERC and sitewide oversight organizations track and report detailed data reported by the project. Sitewide oversight bodies constitute formal points of contact with the national DOE occurrence reporting center, Coast Guard, national EPA, regional EPA, Washington Departments of Health and Ecology, counties, and fire departments.
Programmatic Requirement Environmental Reporting	Applicability: Storage or other use of hazardous chemicals.		
Environmental Reporting	Hazardous Chemical Inventory (312) and Toxic Chemical Usage (313) Reporting. 40 CFR 370 and 40 CFR 372.	BHI-EE-02, Section 3	ERC task-specific work packages and procedures determine whether contaminant inventories require reporting.

Table C-4: Waste Management and Environmental Protection			
Hazard	**Standard/Requirement**	**Applicable ERC Field Support Procedures**	**Observations and Recommendations**
Programmatic Requirement Radioactive Waste Generation	Applicability: Radioactive waste generated during S&M.		
Radioactive Waste Generation	DOE 5820.2A, Chapter III, Section 3.c(1). The volumes of radioactive wastes should be managed by minimizing the mixing of radiological wastes with nonradioactive materials, particularly hazardous/dangerous wastes.	BHI-EE-02 and BHI-EE-10, Sections 1, 2, and 3	Task-specific procedures and work packages minimize the gross volume of radioactive and mixed waste by minimizing the mixing of radiological waste with nonradioactive hazardous and other waste types.
Radioactive Waste Generation	DOE 5820.2A, Chapter III, Section 3.c(2). Written procedures and other measures are required to provide objective evidence for generators of radioactive and mixed waste at DOE facilities.	BHI-EE-02 and BHI-EE-10	ERC procedures ensure waste minimization goals and processes.
Radioactive Waste Generation	Waste generators must consider waste acceptance criteria in controlling the generation of waste DOE Order 5820.2A, Chapter lll, 3.e(1).	BHI-EE-02 and BHI-EE-10	ERC procedures provide for meeting waste acceptance criteria. Waste acceptance criteria from multiple facilities are identified, considered, and incorporated in procedures.
Radioactive Waste Generation	Generators must have control systems in place to be accepted to send radioactive waste to a DOE disposal unit. DOE Order 5820.2A, Chapter III, 3.e(3).	BHI-EE-02	Waste generator procedures contain task-specific requirements to comply with the waste certification program.

Table C-4: Waste Management and Environmental Protection			
Hazard	**Standard/Requirement**	**Applicable ERC Field Support Procedures**	**Observations and Recommendations**
Radioactive Waste Generation	Waste characterization. The waste needs to be documented relative to constituents and activity levels. DOE Order 5820.2A, Chapter III, Section 3,d.	LLW requirements are identified in BHI-FS-01, Proc. 4.12	Waste characterization requirements are specified by procedures and by the waste acceptance criteria at the appropriate disposal facility.
Radioactive Waste Generation	Labeling waste according to acceptance criteria. Label each waste container for each type of waste. This labeling may be permanent or temporary within the facility, DOE Order 5820.2A, Chapter III, 3, g(4).	BHI-EE-02, Section 11, identifies sources for detailed requirements.	Permanent labeling for full containers leaving the facility is ensured by BHI Field Services Waste Management.
Radioactive Waste Generation and Tank Operation	Liquid radioactive waste management and treatment. Liquid radioactive waste that is accumulated in condensate tanks or recovered by routine cleanup needs to be properly managed, treated, and dispositioned. DOE Order 5820.2A, Chapter III, 3,f(1).		Liquid condensate waste from the exhaust stack is monitored and transported for treatment. BHI Field Services Waste Management arranges transportation, treatment, and disposal, according to applicable waste acceptance criteria. S&M staff ensures waste acceptance criteria for disposal of waste is met.
Programmatic Requirement Hazardous Waste Generation	Applicability: Hazardous waste generated during S&M.		
Hazardous Waste Generation	WAC-173-303.070(3). Individual waste streams need to be correctly designated according to specific types of waste. This requires use of specific methods to identify the wastes.	BHI-EE-02, Section 11 BHI-EE-10, Sections 1 and 2	Task specific procedures and work packages include provisions for recognition, segregation, and correct classification of each waste stream.
Hazardous Waste Generation	WAC-173-303.110. Sampling and testing of samples for the purpose of waste designation require use of specific methods that are identified by Washington State.	BHI-EE-02 BHI-EE-10, Sections 1 and 2	Task specific procedures and work packages provide for analyses of wastes to permit adequate designation, segregation, accumulation, and disposal.
Hazardous Waste Generation	WAC-173-303.160. Containers that held wastes or contain residues of waste need to be managed according to Washington State requirements.	BHI-EE-02, BHI-EE-10, Sections 1, 2, and 3	Task specific procedures and work packages include provisions for managing containers of hazardous materials.

Table C-4: Waste Management and Environmental Protection			
Hazard	**Standard/Requirement**	**Applicable ERC Field Support Procedures**	**Observations and Recommendations**
Hazardous Waste Generation	WAC-173-303.200. Generators of hazardous waste must manage waste according to Washington State requirements. Satellite accumulation and waste accumulation must adhere to specific requirements relating to time, volumes, and environmental protection.	BHI-EE-02 BHI-EE-10, Sections 1, 2,and 3	Task-specific procedures and work packages ensure segregation and accumulation of waste according to Washington state requirements. Facility-specific procedures provide for separate containers and improved formal interfaces with waste management organizations and facilities.
Fire	WAC-173-303.320 – Inspection plans.	BHI-EE-02, Section 11	Existing procedures provide for inspection of these tanks.
PCB Waste Generation	Applicability: PCBs are present in the B PLANT facility.		40 CFR 761, Part 60(g)
PCB Waste Generation	40 CFR 761, Part 60(d). Spill cleanup residue must be controlled as PCB wastes.	BHI-EE-02, Section 10 BHI-EE-10	Task-specific procedures and work packages address waste management, segregation, spill cleanup, and disposition of PCB-contaminated materials. Procedures for managing suspected or unknown PCB material, especially fluids, are addressed in the work plan.
PCB Waste Generation	Oils and cleanup materials suspected of containing PCBs are subject to specific testing requirements. 40 CFR 761, Part 60(g).	BHI-EE-02, Section 10 BHI-EE-10	Task-specific procedures and work packages for D&D S&M ensure segregation and testing of waste. Specific testing requirements are invoked for suspected PCB materials.
PCB Waste Generation	Storage of PCBs. PCB containers shall be dated, inspected, labeled, and moved to a PCB storage-for-disposal facility within 30 days. 40 CFR 761.40; 40 CFR 761.65(c).	BHI-EE-02, Section 10	Procedure provides requirements for identification and disposal of PCB-contaminated waste.
PCB Waste Generation	PCB spills. Requirements include cleanup, sampling, record keeping, and response within 48 hours. 40 CFR 761.125 and .130.	BHI-EE-02, Section 10	Procedure provides requirements for cleanup, sampling, record keeping, and response.
Asbestos Waste Generation	Applicability: Minor amounts of asbestos will be cleaned up as part of routine S&M.		

Table C-4: Waste Management and Environmental Protection			
Hazard	**Standard/Requirement**	**Applicable ERC Field Support Procedures**	**Observations and Recommendations**
Asbestos Waste Generation	Asbestos cleanup. Asbestos cleanup involves wetting, bagging, and marking for disposal. Best management practice.	BHI-EE-02, Section 10	This standard of 40 CFR 61.150 is followed as a best management practice for cleanup of small amounts of asbestos. Asbestos demolition or renovation is not conducted as part of routine S&M.
Waste Sites	Applicability: B PLANT waste sites.		
Waste Sites	Radioactive contamination control and monitoring. Migration of radionuclides should be prevented. Monitoring of waste sites should include inspection for subsidence. DOE Order 5820.2A, Chapter III, 3,k,2.	BHI-EE-02	S&M scope involves inspection of signs, markers, fences, and monitoring of the spread of contaminants (Implements DOE Order 5400.5).
Waste Sites	Protective measures. As necessary, measures should be taken to control site access and prevent human exposure to contaminants, including fences, signs, and site stabilization. 40 CFR 300.415(e).	BHI-EE-02	Appropriate mapping, posting, and access control measures are verified by S&M activities.
EPA = Environmental Protection Agency.			

C 10.0 NUCLEAR SAFETY

The following set of DOE orders defines the elements of a nuclear safety program for a nonreactor nuclear facility such as B PLANT.

4330.4B, *Maintenance Management Program* (DOE 1994a)
Specific maintenance requirements are being incorporated in a S&M Plan consistent with requirement of Section 8.0 of the TPA. Maintenance activities are implemented through BHI Field Support Procedures.

5480.7A, *Fire Protection* (DOE 1993a)
Fire hazards are evaluated in Appendices C and D. Program requirements are implemented through BHI S&H procedures. Transient fire loading hazards for selected areas are implemented in the Administrative technical safety requirements.

5480.19, *Conduct of Operations for DOE Facilities* (DOE 1990)
Conduct of Operations requirements are implemented consistent with the project Conduct of Operations matrix that was approved by DOE.

5480.20A, *Personnel Selections, Qualification, and Training Requirements for DOE Nuclear Facilities* (DOE 1994b)

5480.21, *Unreviewed Safety Questions* (DOE 1991a)

5480.22, *Technical Safety Requirements* (DOE 1992a)

5480.23, *Nuclear Safety Analysis Reports* (DOE 1992b)

5480.24, *Nuclear Criticality Safety* (DOE 1992c)
Criticality safety requirements are defined by BHI Engineering and Technology procedures, implemented through the BHI work flow process and Field Support procedures.

5480.28, *Natural Phenomenon Hazards Mitigation* (DOE 1992d)
Applicable natural phenomenon hazards requirements have been incorporated in the hazard evaluation in Section 3.0.

5480.31, *Startup and Restart of Nuclear Facilities* (DOE 1993b)
Requirements related to startup and restart are implemented through the BHI management program and procedures.

6430.1A, *General Design Criteria* (DOE 1989)
Applicable criteria are used in the evaluations in Section 3.0. This document identifies the standards for quality assurance, fire protection, training and qualification, and conduct of operations and maintenance at B PLANT during the S&M phase.

B PLANT is classified as a deactivated nuclear facility under DOE Order 5480.23 (DOE 1992b). Consequently, SAR documentation, as defined in DOE-STD-3009-94 (DOE 1994d), was prepared using the graded approach. One of the functions of the SAR is to define the controls,

technical and administrative, that are necessary for protection of the public, workers, and the environment.

The SAR will receive approval from the Manager, RL, based on the recommendation of the Office of Environment, Safety and Health and Restoration Projects Division, RL. A safety evaluation report (SER) will document the basis for this approval and, in conjunction with the SAR, will define the updated authorization basis for the B PLANT facility in the S&M phase.

The commitments defined in the authorization basis will be managed consistent with DOE Order 5480.21 (DOE 1991a). The Unreviewed Safety Question (USQ) process will be implemented in accordance with BHI-DE-01, *Design Engineering Procedure Manual*, 4.30, "Safety Analysis Documentation." Changes to the procedures governing S&M at B PLANT will be assessed against the authorization basis using the USQ process. Tasks and work packages composed of procedures or work instructions that have not been assessed against the authorization basis will also be reviewed using the USQ process.

Because specific nuclear safety requirements will be defined in the SAR and SER, these are not cited in this document. The only nuclear safety requirements identified here are implementation of the safety analysis and USQ processes. These requirements are equivalent to requirements in the commercial nuclear industry. Consequently, there is no benefit for the implementation of private sector requirements.

Table C-5: Nuclear Safety

Hazard Category	Standard/ Requirement	Applicable ERC Directives	Observations and Recommendation
Hazards of S&M Activities	DOE Order 5480.23, and DOE-STD-3009-94	BHI-DE-01: EDPI 4.28-01, EDPI 4.30-01,	Use of the graded approach SAR complies with DOE Nuclear Safety Orders and rules.
Hazards of S&M Activities	DOE Order 5480.21	BHI-DE-01: EDPI 4.41-01	Procedure provides requirements to ensure that planned changes are evaluated prior to implementation and that discovery is evaluated as applicable.
Hazards and S&M Activities	DOE Order 5480.22	BHI-DE-01: EDPI 4.30-01 "Technical Safety Requirements Using DOE Order 5480.22 and DOE-STD-3009-94" (CCN 054660)	Use of the graded approach complies with DOE Nuclear Safety Orders and rules.
Hazards and S&M Activities	DOE Order 5480.23	BHI-DE-01: EDPI 4.35-01	Implements applicable DOE requirements and ANSI/ANS standards for ERC project.

ANSI = American National Standards Institute.
ANS = American Nuclear Society

C 11.0 OCCUPATIONAL SAFETY AND HEALTH AND FIRE PROTECTION

C 11.1 Regulatory Basis Determination

The Occupational Safety and Health Administration (OSHA) regulations in 29 CFR 1910 and 29 CFR 1926 apply contractually to all Hanford Government Owned Contractor Operated facilities and DOE contractor and subcontractor employees. These OSHA requirements are mandated by DOE Order 440.1 (DOE 1995) and DOE Order 5480.4 (DOE 1990) and are considered the minimum acceptable standards for implementation.

The OSHA standards pertinent to facility S&M are 29 CFR 1910 and 29 CFR 1926. The requirements of 29 CFR 1910 are applicable to the routine S&M activities conducted by ERC personnel, while 29 CFR 1926 requirements are applied to work that is subject to the Davis-Bacon Act. This evaluation has been limited to S&M activities conducted by ERC personnel; therefore, the application of 29 CFR 1910 is required.

A single standard was not found to address all the applicable fire protection requirements. DOE orders mandate the National Fire Protection Association (NFPA) 101, *Life Safety Code*, and NFPA I, *National Fire Code*. For this process, the requirements of these codes were cross referenced to OSHA 29 CFR 1910 requirements, and where the requirements were the same or similar, the appropriate citation from 29 CFR 1910 was used.

C 11.2 Hazard Evaluation

After a process of identifying energy sources, potential chemical hazards, and potential physical hazards, the worker exposure to these potential hazards was evaluated. Many of the potential hazards were in areas that were not to be accessed by the workers. Some of the areas to be accessed contained piping and equipment that had been drained of process chemicals but still had the potential of containing residual that was toxic and hazardous. Hazards that the workers would not reasonably be exposed to during routine S&M activities were not addressed.

Nonroutine activities could include responses to undesirable observations. Responses may include facility repairs, or facility modifications and upgrades. Nonroutine activities are reviewed against the authorization safety basis. Activities that are found to be outside of the bounding conditions of the safety basis are subject to RL approval prior to performance of the specific activity. BHI procedures provide requirements for the safety basis screening and evaluations. Nonroutine activities (i.e., any work/task package not of a pre-approved work procedure) that require safety basis review include the following:

- Revisions to existing work procedures
- Entry into any area not specifically included in the facility work procedures (e.g., canyon cells, sand filter)
- Entry into process vessels, piping, and equipment
- Any S&M activity that could change the form and distribution of known or suspected radioactive materials that are confined by systems, structures, and components (SSC).
- Modification of any SSC that is specified in S&M requirements.

After identifying those risks the workers could reasonably be exposed to, the applicable regulation or code was selected to control the risk. If an improvement in implementation of a requirement was possible, a recommendation was made.

Table C-6: Standards and Requirements for Occupational Safety and Fire Protection

Hazard Category	Standard/Requirement *	Applicable ERC Directive	Observations and Recommendations
Unspecified/ Newly Defined Hazards	Use the following as needed based on newly defined hazards. 29 CFR 1910 29 CFR 1926	As implemented by BHI-SH-02	This item recognized that the length and breadth of the S&M scope can change over time and acknowledges that contractual and legal requirements demand implementation through the existing ERC Safety Programs. This listing of subparts and elements may not be all-inclusive of applicable legal standards and is not meant to exclude any portion of legal standards that may be applicable at the time of operation.
Electrical	29 CFR 1910.305(g)(1)(I) (iii). Flexible cords and cables may not be used: As a substitute for the fixed wiring of a structure; Where run through holes in walls, ceilings, or floors; Where run through doorways, windows, or similar openings; Where attached to building surfaces; or Where concealed behind building walls, ceilings, or floors.	BHI-SH-02, Vol. 3	Task-specific procedures and work packages reflect appropriate requirements.
Hoisting/ Lifting Material	ANSI B30.2, B30.9b, B30.15, B30.16. Installation, inspection, maintenance, and operation of power-operated cranes; power-operated overhead hoists; attachments and slings will be to this Code.	BHI-SH-01, Section 10 DOE-RL-92-36 (DOE 1993d)	Task-specific procedures and work packages reflect appropriate requirements.
Electrical	29 CFR 1910.334(a)(2). (I) Portable cord and plug-connected equipment and flexible cord sets (extension cords) shall be visually inspected before use on any shift for external defects (such as loose parts, deformed and missing pins, or damage to outer jacket or insulation) and for evidence of possible internal damage (such as pinched or crushed outer jacket). Cord and plug-connected equipment and flexible cord sets (extension cords) that remain connected once they are put in place and are not exposed to damage need not be visually inspected until they are relocated.	BHI-SH-02, Vol. 3	Appropriate grounding, use of GFCIs, etc., are utilized as appropriate. Procedures and work packages reflect requirements as applicable.

Table C-6: Standards and Requirements for Occupational Safety and Fire Protection			
Hazard Category	**Standard/Requirement ***	**Applicable ERC Directive**	**Observations and Recommendations**
Electrical	29 CFR 1910.333 (1). Live parts to which an employee may be exposed if the employee works on or near them, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations. Live parts that operate at less than 50 volts to ground need not be de-energized if there will be no increased exposure to electrical burns or to explosion due to electric arcs.	BHI-SH-02, Vol. 3	Task-specific procedures and work packages reflect appropriate requirements.
Electrical	29 CFR 1910.333(b)(2). While any employee is exposed to contact with parts of fixed electric equipment or circuits that have been de-energized, the circuits energizing the parts shall be locked out or tagged or both.	BHI-FS-01, Procedure 1.13	Task-specific procedures and work packages reflect appropriate requirements.
Electrical	29 CFR 1910.303(f). Identification of disconnecting means and circuits. Each disconnecting means required by this subpart for motors and appliances shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident. Each service, feeder, and branch circuit, at its disconnecting means or over current device, shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident. These markings shall be of sufficient durability to withstand the environment involved.	BHI-SH-02, Vol.3	Task-specific procedures and work packages reflect appropriate requirements.
Fall of Person or structure subsidence	29 CFR 1910.22(d) (2). It shall be unlawful to place, or cause, or permit to be placed, on any floor or roof of a building or other structure a load greater than that for which such floor or roof is approved by the building official.	BHI-FS-01, Section 10 BHI-SH-02	Task-specific procedures and work packages reflect appropriate requirements.
Hazardous Atmosphere	29 CFR 1910.146(c)(1). The employer shall evaluate the workplace to determine if any spaces are permit-required confined spaces.	BHI-SH-02, Vol. 3	Task-specific planning, procedures and work packages reflect appropriate requirements. Requirements for areas with any potential (non-permit) for confined spaces hazards are reflected as appropriate.
Hazardous Atmosphere	29 CFR 1910.146(c)(3). If the employer decides that its employees will not enter permit required confined spaces, the employer shall take effective measures to prevent its employees from entering the permit spaces.	BHI-SH-02, Vol. 3	Task-specific planning, procedures and work packages reflect appropriate requirements.

Table C-6: Standards and Requirements for Occupational Safety and Fire Protection			
Hazard Category	**Standard/Requirement ***	**Applicable ERC Directive**	**Observations and Recommendations**
Hazardous Atmosphere	29 CFR 1910.146(c)(4). If the employer decides that its employees will enter permit spaces, the employer shall develop and implement a written permit space program.	BHI-SH-02, Vol. 3	Task-specific procedures and work packages reflect appropriate requirements.
Hazardous Materials	29 CFR 1910.1200. The hazards of all chemicals produced or imported are evaluated, and that information concerning their hazards is transmitted to employees. This transmittal of information is to be accomplished by means of comprehensive hazard communication programs, which are to include container labeling and other forms of warning, material safety data sheets, and employee training.	BHI-SH-02, Vol. 3	Task-specific procedures and work packages reflect appropriate requirements.
Hazardous Materials	29 CFR 1910.1000. Employee shall not be exposed to toxic and hazardous substances at levels in excess of the permissible exposure level (PEL).	BHI-SH-02, Vol. 3	Task-specific procedures and work packages reflect appropriate requirements.
Hazardous Materials	29 CFR 1910.1001. The employer shall ensure that no employee is exposed to an airborne concentration of asbestos in excess of the PEL.	BHI-SH-02, Vol. .3	Task-specific procedures and work packages reflect appropriate requirements.
Hazardous Materials	29 CFR 1910.1025. The employer shall ensure that no employee is exposed to an airborne concentration of lead in excess of the PEL.	BHI-SH-02, Vol. 3	Task-specific procedures and work packages reflect appropriate requirements.
Unguarded Machinery	29 CFR 1910.212(a) (1). One or more method of machine guarding shall be provided to protect the operator and other employees in the machine area from hazards such as those created by point of operation, in going nip points, rotating parts, flying chips and sparks.	BHI-SH-02, Vol. 3	ERC procedures reflect requirements.
Walking/ Working Surfaces	29 CFR 1910.22(a). (1) All places of employment, passageways, storerooms, and service rooms shall be kept clean and orderly and in a sanitary condition. (2) The floor of every workroom shall be maintained in a clean and, so far as possible, a dry condition.	BHI-SH-02, Vol. 4	Task-specific procedures and work packages shall reflect requirements as applicable.

Table C-6: Standards and Requirements for Occupational Safety and Fire Protection			
Hazard Category	**Standard/Requirement ***	**Applicable ERC Directive**	**Observations and Recommendations**
Walking/ Working Surfaces	29 CFR 1910.26. Ladders must be maintained in good usable condition at all times. If a ladder is involved in any of the following, immediate inspection is necessary: (c)(2)(vi){a). If ladders tip over, inspect ladder for side rails dents or bends, or excessively dented rungs; check all rung-to-side-rail connections; check hardware connections; check rivets for shear. {d} If ladders are exposed to oil and grease, equipment should be cleaned of oil, grease, or slippery materials. (vii) Ladders having defects are to be marked and taken out of service.	BHI-SH-02, Vol. 3	ERC procedures reflect requirements. Nonconductive wood or fiberglass ladders are routinely used particularly around electrical equipment. procedures and work packages reflect specific appropriate requirements.
Fire Protection	29 CFR 1910.36 (b)(3). Afford all occupants convenient facilities for escape.	BHI-SH-02, Vol. 4	Task-specific procedures and work packages reflect applicable requirements.
Egress	NFPA 101, 29-2.9.1. All industrial occupancies shall have emergency lighting, Exception #1, Special purpose industrial occupancies where routine habitation is not the case.	BHI-SH-02, Vol. 4	Task specific procedures and work packages reflect appropriate requirements.
Egress	29CFR 1910.36 (b) (4). Every building or structure exit shall be so arranged as to provide free and unobstructed egress from all parts of the building when it is occupied.	BHI-SH-02, Vol. 4	Task specific procedures and work packages reflect appropriate requirements.
Egress	29 CFR 1910.36 (b) (5). The route to reach every exit shall be conspicuously indicated in a matter that occupants will readily know the direction to escape from any point.	BHI-SH-02, Vol. 4	Task specific procedures and work packages reflect appropriate requirements.
Egress	NFPA 101, 5-8.1.2. Illumination of the means of egress shall be continuous when the facility is occupied.	BHI-SH-02, Vol. 4	Task specific procedures and work packages reflect appropriate requirements.
Egress	NFPA 101, 5-2.2, NFPA 241, 5-4.8. At least one enclosed, fire rated stairway shall be provided in usable condition at all times.	BHI-SH-02, Vol. 4	Task specific procedures and work packages reflect appropriate requirements.
Fire Protection	29 CFR 1910.160(b)(6). The employer shall ensure that fixed fire suppression systems are inspected at least annually to ascertain that the system is in good operating condition.	BHI-SH-02, Vol. 4	Procured service. Tested in accordance with the requirements of NFPA 72; semi-annually
Fire Protection	NFPA1, Sections 2 and 3. Combustible loading in and around facilities shall be controlled.	BHI-FS-03 BHI-SH-02, Vol. 4	Required by ERC procedures. Task specific procedures and work packages reflect appropriate requirements.

Table C-6: Standards and Requirements for Occupational Safety and Fire Protection			
Hazard Category	**Standard/Requirement ***	**Applicable ERC Directive**	**Observations and Recommendations**
Life Safety	DOE 5480.7A 9.b.(2). Life safety provisions shall be provided in accordance with the Life Safety Code. Compliance with the LSC shall be considered to satisfy the exit requirements of the applicable building code and OSHA 29 CFR 1910.	BHI-SH-02, Vol. 4	Task-specific procedures and work packages reflect appropriate requirements.
Fire Protection	29 CFR 1910.106(7)(e), "Incidental Storage and Use of Flammable and Combustible Liquids in an Industrial Facility."	BHI-SH-02, Vol. 4	Task-specific procedures and work packages reflect appropriate requirements.

GFCI = ground fault circuit interrupter.

* This section recognizes that the length and breadth of the S&M scope can change over time and that contractual and legal requirements demand implementation through the existing ERC Safety Programs. This listing of subparts and elements may not be all-inclusive of applicable legal standards and is not meant to exclude any portion of legal standards that may be applicable at the time of operation.

C 12.0 REFERENCES

10 CFR 20, "Standards for Protection Against Radiation," *Code of Federal Regulations*, as amended.

10 CFR 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," *Code of Federal Regulations*, as amended.

10 CFR 830, "Nuclear Safety Management," *Code of Federal Regulations*, as amended.

10 CFR 830.120, "Quality Assurance Requirements," *Code of Federal Regulations*, as amended.

10 CFR 830.340, "Nuclear Facility Maintenance," *Code of Federal Regulations*, as amended.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations*, as amended.

29 CFR 1910.38 (a), "Emergency Action Plan," *Code of Federal Regulations*, as amended.

29 CFR 1926, "Safety and Health Regulations for Construction," *Code of Federal Regulations*, as amended.

ASME, 1989, *Quality Assurance Requirements for Nuclear Application*, ASME NQA-2, American Society of Mechanical Engineers, New York, New York.

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