S

ENGINEERING CHANGE NOTICE

H

Page 1 of 2

1. ECN 661041

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental ☐ Direct Revision ☒ Change ECN ☐ Temporary ☐ Standby ☐ Supersedure ☐ Cancel/Void ☐	L. I. Covey, 3N500, S6-51, 372-0296	☒ Yes ☐ No	October 23, 2000
	6. Project Title/No./Work Order No.: WESF Hazards Assessment	7. Bldg./Sys./Fac. No.: 225B/NA/2C	8. Approval Designator: S
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.): HNF-4013, Rev. 1	10. Related ECN No(s).: NA	11. Related PO No.: NA

12a. Modification Work	12b. Work Package No.	12c. Modification Work Completed	12d. Restored to Original Condition (Temp. or Standby ECNs only)
☐ Yes (fill out Blk. 12b) ☒ No (NA Blks. 12b, 12c, 12d)	NA	NA Design Authority/Cog. Engineer Signature & Date	NA Design Authority/Cog. Engineer Signature & Date

13a. Description of Change — 13b. Design Baseline Document? ☐ Yes ☒ No

The WESF Hazards Assessment is being revised to support implementation of the WESF Basis for Interim Operation, HNF-SD-WM-BIO-002, Rev. 1. The changes do not impact the emergency action levels (EALs) identified for any of the accidents.

14a. Justification (mark one)	14b. Justification Details
Criteria Change ☒ Design Improvement ☐ Environmental ☐ Facility Deactivation ☐ As-Found ☐ Facilitate Const. ☐ Const. Error/Omission ☐ Design Error/Omission ☐	This document is being revised to reflect the current facility inventory and accident analyses identified in the WESF BIO. USQ screening WESF-00-089 was performed for this change.

15. Distribution (include name, MSIN, and no. of copies)

L. I. Covey S6-61 (1)
J. L. Pennock S6-51 (1)
W. W. Wingfield S6-81 (1)
L. R. Campbell A3-05 (1)

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ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): 661041

16. Design Verification Required	17. Cost Impact: ENGINEERING	17. Cost Impact: CONSTRUCTION	18. Schedule Impact (days)
☐ Yes	Additional ☐ $ NA	Additional ☐ $ NA	Improvement ☐ NA
☒ No	Savings ☐ $ NA	Savings ☐ $ NA	Delay ☐ NA

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	☐	Seismic/Stress Analysis	☐	Tank Calibration Manual	☐
Functional Design Criteria	☐	Stress/Design Report	☐	Health Physics Procedure	☐
Operating Specification	☐	Interface Control Drawing	☐	Spares Multiple Unit Listing	☐
Criticality Specification	☐	Calibration Procedure	☐	Test Procedures/Specification	☐
Conceptual Design Report	☐	Installation Procedure	☐	Component Index	☐
Equipment Spec.	☐	Maintenance Procedure	☐	ASME Coded Item	☐
Const. Spec.	☐	Engineering Procedure	☐	Human Factor Consideration	☐
Procurement Spec.	☐	Operating Instruction	☐	Computer Software	☐
Vendor Information	☐	Operating Procedure	☐	Electric Circuit Schedule	☐
OM Manual	☐	Operational Safety Requirement	☐	ICRS Procedure	☐
FSAR/SAR	☐	IEFD Drawing	☐	Process Control Manual/Plan	☐
Safety Equipment List	☐	Cell Arrangement Drawing	☐	Process Flow Chart	☐
Radiation Work Permit	☐	Essential Material Specification	☐	Purchase Requisition	☐
Environmental Impact Statement	☐	Fac. Proc. Samp. Schedule	☐	Tickler File	☐
Environmental Report	☐	Inspection Plan	☐	None	☒
Environmental Permit	☐	Inventory Adjustment Request	☐		☐

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number/Revision
NA		

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng.	LI Covey [signature]	10/23/00	PE		
Cog. Mgr.	JL Pennock [signature]	11-9-00	QA		
QA	NA		Safety		
Safety	LI Covey [signature]	10/23/00	Design		
Environ.			Environ.		
Other			Other		
Facility EP	WW Wingfield [signature]	10/31/00			
FH EP	LR Campbell [signature]	11/1/00			

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

HNF-4013
Revision 2

Waste Encapsulation and Storage Facility (WESF) Hazards Assessment

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200
Fluor Hanford
P.O. Box 1000
Richland, Washington

HNF-4013
Revision 2
ECN 661041

Waste Encapsulation and Storage Facility (WESF) Hazards Assessment

Division: WM

L. I. Covey
Fluor Hanford

Date Published
November 2000

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

Fluor Hanford
P.O. Box 1000
Richland, Washington

11/27/00

Release Approval | Date

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HNF-4013, rev 2

RECORD OF REVISION

RECORD OF REVISION	(1) Document Number HNF-4013	Page 1

(2) Title
Waste Encapsulation and Storage Facility (WESF) Hazards Assessment

Change Control Record

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
	(7) Originally issued under EDT 623851 May 24, 1999		
1	Several administrative errors were corrected and outdated references were updated (ECN 650025).	LI Covey	JL Pennock 5/18/00
RS 2	Update analyses to reflect changes in Revision 1 of WESF BIO. No EALs affected. (ECN 661041)	LI Covey	JL Pennock 11-27-00

A-7320-005 (10/97)

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1.0 INTRODUCTION

This report documents the hazards assessment for the Waste Encapsulation and Storage Facility (WESF) located on the U.S. Department of Energy (DOE) Hanford Site. This hazards assessment was conducted to provide the emergency planning technical basis for WESF. DOE Orders require an emergency planning hazards assessment for each facility that has the potential to reach or exceed the lowest level emergency classification.

2.0 SITE AND FACILITY DESCRIPTION

2.1 Hanford Site Description

2.1.1 Location

The DOE Hanford Site lies within the semiarid Pasco Basin of the Columbia Plateau in southeastern Washington State (Figure 2.1). The Hanford Site occupies an area of about 1450 km^2 (~560 mi^2) north of the confluence of the Snake and Yakima Rivers with the Columbia River. The Hanford Site is about 50 km (30 mi) north to south and 40 km (24 mi) east to west. This land, with restricted public access, provides a buffer for the smaller areas currently used for research, waste storage, and waste disposal; only about 6% of the land area has been disturbed and is actively used. The Columbia River flows through the northern part of the Hanford Site, and turning south, it forms part of the Site's eastern boundary. The Yakima River runs along part of the southern boundary and joins the Columbia River south of the city of Richland, which bounds the Hanford Site on the southeast. Rattlesnake Mountain, the Yakima Ridge, and the Umtanum Ridge form the southwestern and western boundary. The Saddle Mountains form the northern boundary of the Hanford Site.

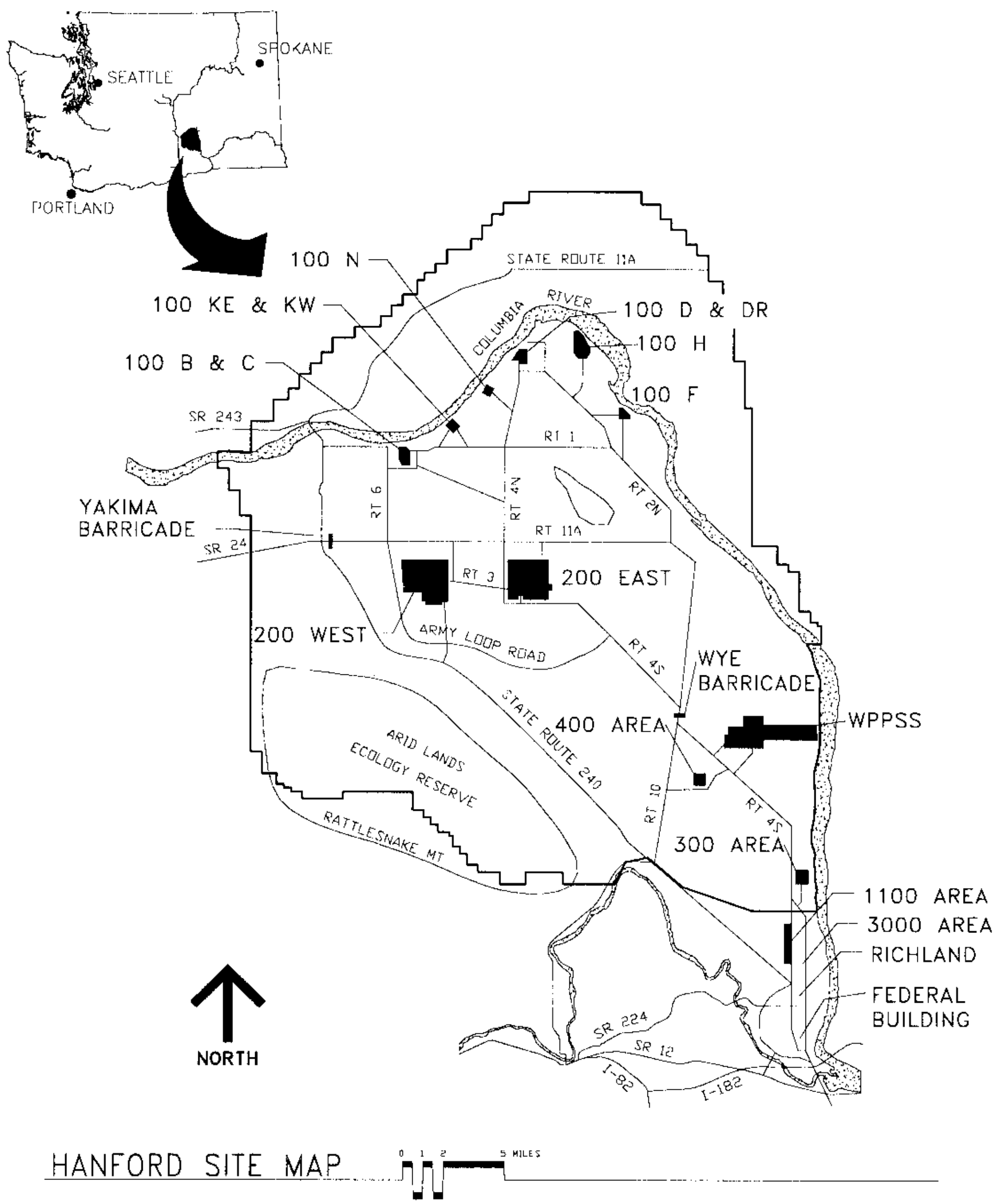
Major metropolitan areas within the broad vicinity of Hanford include Spokane, Washington, about 193 km (120 air miles) to the northeast; Seattle, Washington, about 209 km (130 air miles) to the northwest; and Portland, Oregon, about 241 km (150 air miles) to the southwest. Two other areas of significant population density in Washington State include Moses Lake, about 48 km (30 miles) north of the 100 K Area and the Yakima Valley, extending from Yakima, about 72 km (45 miles) west of Hanford, to the Tri-Cities which includes the cities of Richland, Pasco, and Kennewick. The nearest of the Tri-Cities, Richland, is immediately south of the Site.

2.1.2 Meteorology

Continuous observation and recording of meteorological data has been carried out at the Hanford Meteorological Station (HMS), located near the 200 West Area, since 1945. Climatological conditions on the 200 Area plateau are significantly different from those on the south end of the Site, especially during the winter months when the incidence of low clouds and fog is much greater at the HMS.

The predominant wind direction at the HMS and over much of the Hanford Site including the 200 Areas is northwesterly. Monthly average wind speeds are lowest during the winter months, averaging 10 to 11 km/h (6.2 to 6.8 mph), and highest during the summer, averaging 14 to 16 km/h (8.7 to 9.9 mph).

Figure 2.1 Location of the Hanford Site and the 200 East Area



2.1.3 Flooding

Large Columbia River floods have occurred in the past (DOE 1987), 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.

There are no Federal Emergency Management Agency (FEMA) flood plain maps for the Hanford Reach of the Columbia River. FEMA only maps developing areas, and the Hanford Reach is specifically excluded.

Evaluation of flood potential is conducted in part through the concept of the probable maximum flood (PMF), which is determined from the upper limit of precipitation falling on a drainage area and other hydrologic factors, such as antecedent moisture conditions, snow melt, and tributary conditions, that could result in maximum runoff. The probable maximum flood for the Columbia River below Priest Rapids Dam has been calculated to be 40,000 cms (1.4 million cfs) and is greater than the 500-year flood. The PMF is not expected to inundate the buildings in 200 and 300 Areas but will flood the 100 F, 100 H, and part of the 100 B/C Areas. The PMF may also flood access roads and temporarily cut off electrical power to the 100 and 300 Areas (see Figure 4.2-10 in Cushing, 1992).

Potential dam failures on the Columbia River have been evaluated. Upstream failures could arise from a number of causes, with the magnitude of the resulting flood depending on the degree of breaching at the dam. The U.S. Army Corps of Engineers evaluated a number of scenarios on the effects of failures of Grand Coulee Dam, assuming flow conditions of the order of 11,000 cms (400,000 cfs). For purposes of emergency planning, they hypothesized that 25% and 50% breaches, the "instantaneous" disappearance of 25% or 50% of the center section of the dam, would result from the detonation of nuclear explosives in sabotage or war. The discharge or flood wave resulting from such an instantaneous 50% breach at the outfall of the Grand Coulee Dam was determined to be 600,000 cms (21 million cfs). In addition to the areas inundated by the probable maximum flood (see figure 4.2-10 in Cushing, 1992), the remainder of the 100 Areas, the 300 Area, and nearly all of Richland, would be flooded (DOE 1986; see also ERDA 1976). Flooding of this magnitude would be a regional emergency along the entire downstream length of the Columbia River. Planning and assessment for flooding of this magnitude is beyond the scope of this document.

There have been fewer than 20 major floods on the Yakima River since 1862 (DOE 1986). The most severe occurred in November 1906, December 1933, May 1948 and February 1996. The recurrence intervals for the 1933 and 1948 floods are estimated at 170 and 33 years, respectively. The development of irrigation reservoirs within the Yakima River Basin has considerably reduced the flood potential of the river. The 200 Areas are not within lands susceptible to a 100-year flood on the Yakima River.

2.1.4 Wind and Tornado

The Site is subject to frequent strong westerly winds. The all-time peak wind recorded at the HMS tower in the 200 West Area at the 15 m (49 ft) level was a gust of 36.2 m/sec (81 mph) recorded January 11, 1972. The 35.8 m/sec (80 mph) gust is expected to occur once every 30 years. A peak of 38 m/sec (85 mph) would be expected to occur once every 100 years (Cushing, 1992).

The Site is well outside of established tornado alleys. The probability of a tornado in any year at any point within the 161 km (100 mi) radius of the HMS is 6.8 E-6/yr (Stone 1972).

2.1.5 Seismology

The Hanford Reservation 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 (MMI) scale, and is probably incomplete because the region was sparsely populated. Seismograph networks did not start providing earthquake locations and magnitudes of earthquakes in the Pacific Northwest until about 1960.

Large earthquakes (magnitude greater than Richter 7) in the Pacific Northwest have occurred in the vicinity of Puget Sound, Washington, and near the Rocky Mountains in eastern Idaho and western Montana. A large earthquake of uncertain location occurred in north-central Washington in 1872. This event had an estimated maximum MMI ranging from VII to IX and an estimated Richter magnitude of approximately 7. The distribution of intensities suggests a location within a broad region between lake Chelan, Washington, and the British Columbia border. 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 are two earthquakes that occurred in 1918 and 1973. These two events had magnitudes of 4.4 and intensity V and were located north of the Hanford Site. For more information concerning the seismology and geology of this area, see Section 4.2.3 of the Hanford Site National Environmental Policy Act (NEPA) Characterization (Cushing, 1992).

2.1.6 Ashfall

The Hanford Site is in a region subject to ashfall from volcanic eruptions. The three major volcanic peaks closest to the Site are: Mt. Adams about 160 km (100 mi) away, Mt. Rainier at about 180 km (110 mi) away, and Mt. St. Helens approximately 210 km (130 mi) away.

Important historical ashfalls affecting this location were from eruptions of Glacier Peak about 12,000 years before present time (BP), Mt. Mazama about 6,000 BP, and Mt. St. Helens about 3,600 BP. The most recent ashfall resulted from the May 18, 1980 eruption of Mt. St. Helens. The table below indicates the estimated ash depth deposited at the Hanford Site from past volcanic eruptions in the region.

Table 2.1 Estimated Ash Depth at Hanford from Major Eruptions

Volcano	Time	Depth of Ash	Equivalent Roof Loading Dry (psf)	Equivalent Roof Loading Wet(psf)
Glacier Peak	12,000 BP	1 in.	6	8.4
Mt Mazama	6,000 BP	6 in.	36	50
Mt. St. Helens	3,600 BP	1 in.	6	8.4
Mt. St. Helens	1980	0.5 in.	3	4.2

2.2 Facility Description

2.2.1 Facility Location

WESF is located in the northwest quadrant of the 200 East Area adjacent to B Plant on the DOE Hanford Site (Figure 2.1). The nearest site boundary is 16.7 kilometers (km) (10.3 miles) east. The 200 East Area (Figure 2.1) is a controlled area of approximately 8.4 km^2 located on a plateau at an elevation ranging from approximately 190 to 245 meters (623 to 804 ft) above mean sea level near the middle of the Hanford Site. The 200 East Area is about 10 km (6.2 mi) from the Columbia River and 14.8 km (9.2 mi) from the nearest site boundary to the west, south, or east. Land uses within the 200 East Area consist of waste processing and disposal activities.

2.2.2 Facility Mission

WESF was designed and constructed in 1971 – 1973 on the west end of B Plant to process, encapsulate and store extracted long-lived radionuclides Sr-90 and Cs-137, from wastes generated during chemical processing of defense fuel. B Plant separated strontium and cesium from liquid waste and delivered a liquid solution containing these isotopes to WESF. WESF converted the liquid to stable solid forms (strontium fluoride and cesium chloride) and then encapsulated the solid material. WESF contains several pool cells that are used to store the capsules. Cesium recovery was completed in 1983. Strontium encapsulation was completed in 1985. No additional liquid waste separation and processing is planned. The facility has been operational since 1974.

The current WESF mission is to receive and store the cesium and strontium capsules that were manufactured at the facility in a safe manner and in compliance with all applicable rules and regulations. In support of this mission the following activities are conducted; facility maintenance; receipt, inspection, and decontamination (as necessary) of capsules; and storage and surveillance of capsules. WESF will continue to store the capsules until a final disposition is determined.

2.3 Building Descriptions

The WESF consists of the 225-B Building and the following support buildings and systems:

- TK-100, Low-Level Waste Tank and Pit
- 211-BA, Auxiliary Building
- 225-BA, K-1 Filter Building
- 225-BB, K-3 Filter Pit
- 225-BC, WESF Compressor Building
- 225-BD, WESF Waste Monitor and Sample Building
- 225-BE, Maintenance Shop
- 225-BG, WESF Closed Loop Cooling System
- 272-B, Operations Support Building
- 272-BA, Auxiliary Building
- 272-BB, Auxiliary Building
- 282-B, Pump House
- 282-BA, Pump House
- 296-B-10, K1 and K-3 Exhaust Stack
- 294-B, Raw Water Backflow Preventer Building
- Diesel Generator

- MO-312, Laundry Storage Trailer
- MO-029, MO-232, MO-400, MO-408, MO-410, Office Trailers

WESF is described in detail in, HNF-SD-WM-BIO-002, Rev. 0. *Waste Encapsulation and Facility Basis for Interim Operation*. Figure 2.2 shows the WESF location in the 200 East Area. Figure 2.3 shows the WESF support buildings and systems. WESF is briefly described in the following sections.

2.3.1 225-B WESF Facility

The 225-B Building is adjacent to and structurally independent of the existing B Plant (221-B Canyon Building) to the east. The 225-B Building is a two story structure 47.8 m (157 ft) long by 29.6 m (97 ft) wide by 12.2 m (40 ft) high which is adjacent to the west end of B Plant. The ground elevation is about 213m (700 ft) above sea level and is approximately 61 m (200 ft) above the underground water table.

The floor plan is partitioned into several areas according to the functional requirements of each area. The process hot cell area contains seven hot cells that were used for chemical processing and encapsulation. The hot cells are equipped with lead-glass windows and mechanical manipulators. The 225-B Building canyon is approximately 6.7 m (22 ft) wide by 31 m (101 ft) long by 6 m (20 ft) deep. The Canyon provides access to the Hot Cells, Truckport and Pool Cell areas by means of removable high-density, stepped cover blocks. The Service Gallery is approximately 3 m (10 ft) wide by 25 m (83 ft) long. It is used to service the hot cells from the rear side and contains some of the auxiliary cold (non-radioactive) process piping. The Operating Gallery is approximately 6.7 m (22 ft) wide by 25 m (83 ft) long by 4.8 m (16 ft) high. Remote work in the cells is accomplished with master-slave manipulators operated from the Operating Gallery. The Aqueous Makeup Area (AMU) is on the second floor of the 225-B Building and contains several tanks that are no longer used, a manipulator storage area and a 3,785-L (1000-gal) storage tank for deionized water. The HVAC Room is approximately 9 m (30 ft) wide by 11 m (35 ft) long by 3.6 m (12 ft) high. The Manipulator Decontamination Area is located on the east end of the first floor and is accessible from the Operating Gallery and the access hallway. The Manipulator Repair Shop is located on the second floor west of the AMU and north of the Canyon. The pool cell area contains 12 pool cells which provide storage space for the capsules. Pool Cell 1 is 2.7 m (8 ft 9 in.) wide, 6.6 m (21 ft 9 in.) long, and 5.5 m (18 ft) deep. Pool Cells 2 through 11 are 1.3 m (4 ft 5 in.) wide, 6.6 m (21 ft 9 in.) long, and 5.5 m (18 ft) deep. Pool Cell 12 is 1 m (3 ft) wide by 19.8 m (64 ft 11 in.) long by 4.7 m (15 ft 6 in.) deep. The south end of Pool Cell 12 contains a cask pit 1.3 m (4 ft 5 in.) wide by 2.3 m (7 ft 5 in.) long by 5.5 m (18 ft) deep. Pool Cell 12 connects all of the pool cells and the G Cell capsule transfer chute. The basins are lined with Type 304L stainless steel. The Support Area consists of the Office Areas and two change rooms. The Truckport, located at the southwest corner on the first floor, is approximately 3.6 m (12 ft) by 11 m (37 ft) by 4.5 m (15 ft). A personnel door and a rollup door provide access from the outside. An opening (normally closed by cover blocks) in the Canyon Deck above provides for the movement of transport casks and solid waste burial boxes.

Four primary systems provide confinement of radioactive contamination within WESF, they are the capsules, WESF ventilation system, liquid radioactive waste system and the Facility structure. Capsules are designed to contain the highly radioactive Sr-90 and Cs-137 extracted from B-Plant waste and are constructed of Hastelloy and stainless steel. Four separate HVAC supply systems and three separate exhaust systems are provided for the 225-B Building. The K-3 system, which provides ventilation for the contaminated process cells, is the most contaminated. Large amounts of both cesium and strontium have been found in the K-3 exhaust duct. The exhaust stack from the K-1 and K-3 exhaust systems is located south of the 225-B building. The stack is 107 cm (42 in) in diameter by 21 m (70 ft)

Figure 2.2 WESF Location in the 200 East Area

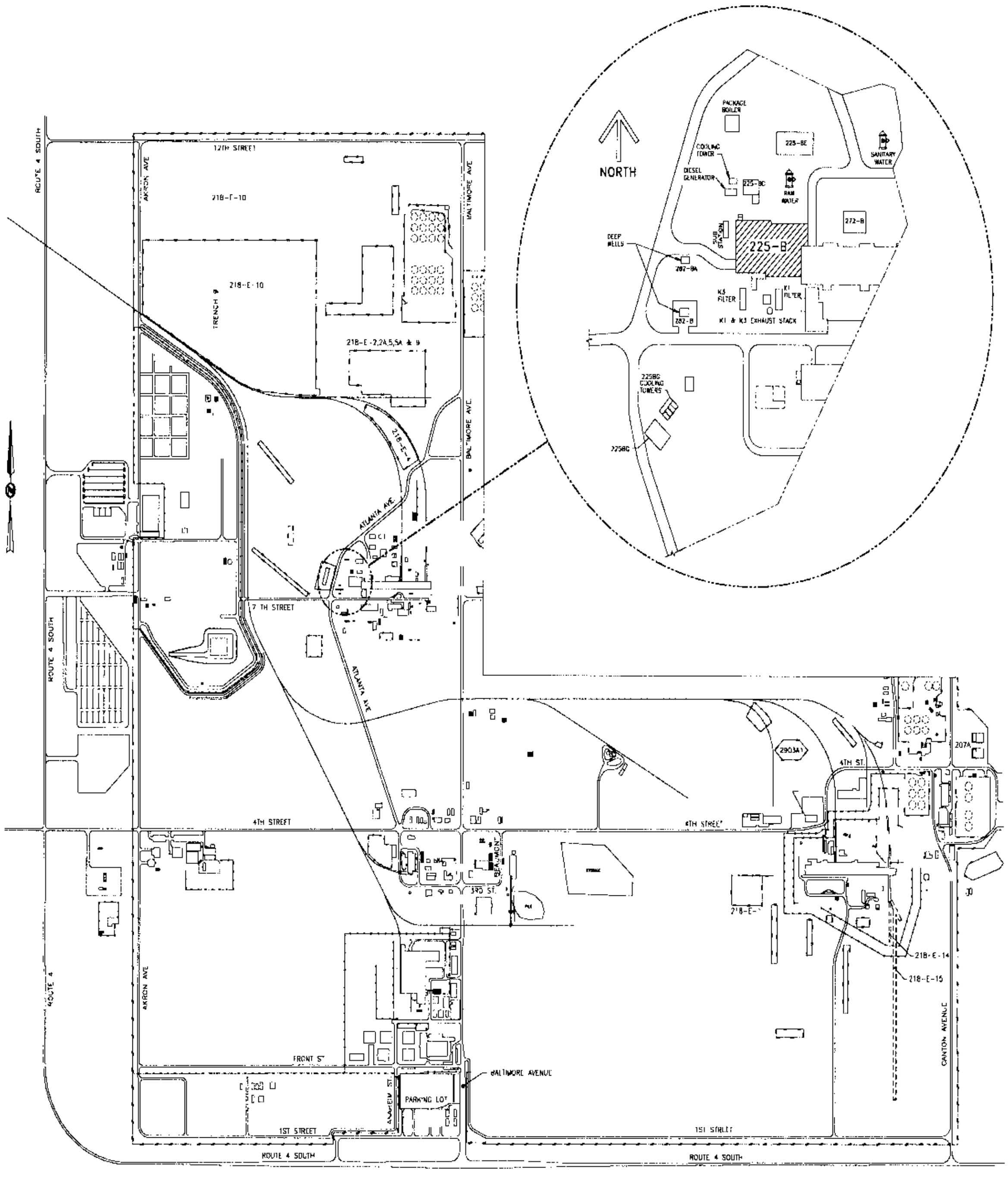
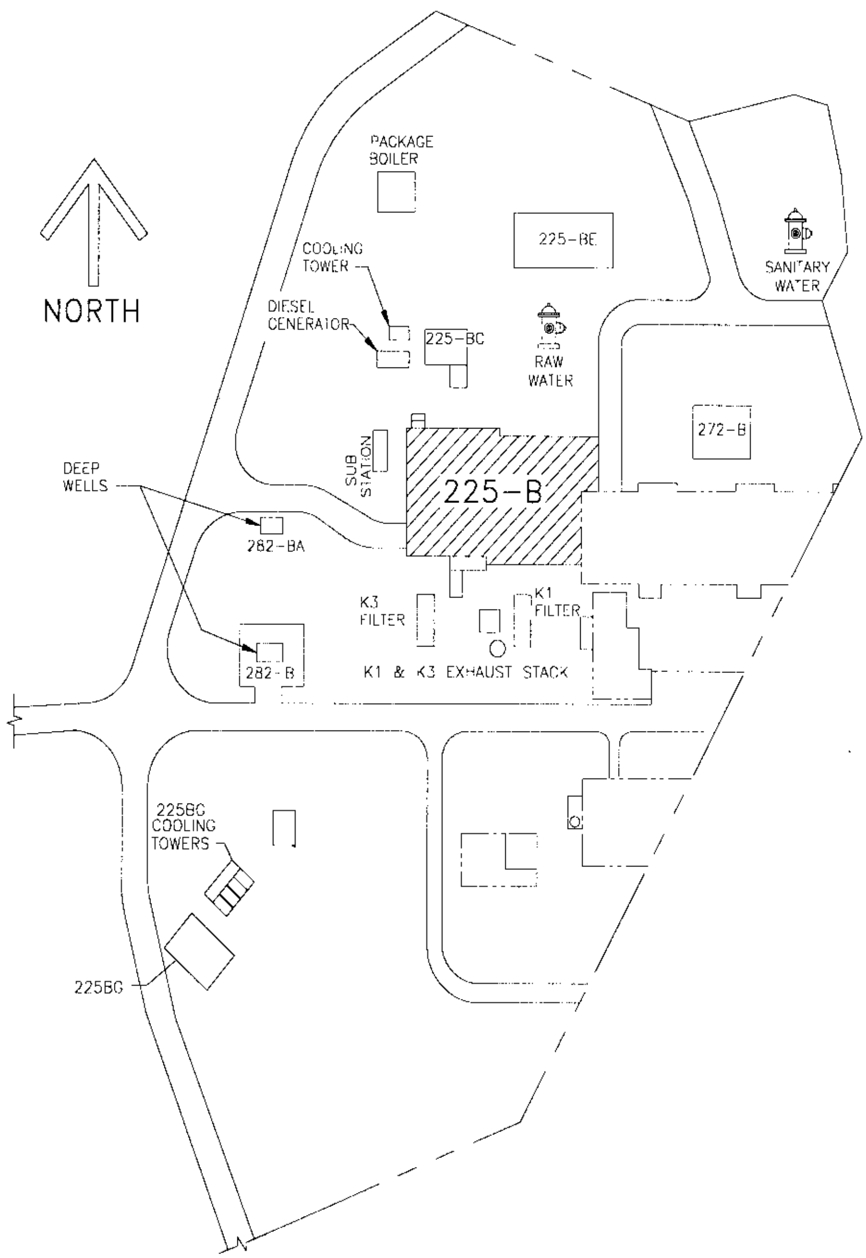


Figure 2.3 WESF Facility and Systems



high. Liquid radioactive waste confinement is provided by the Low-Level Waste System (TK-100). Facility structures that provide radiation confinement include the Hot Cells, Canyon, Hot Piping Trench, Pool Cell Area, Transmitter Rooms, and lead-glass shielding windows.

WESF safety support systems consist of the Fire Protection System and the Radiation Protection System. The Fire Protection system includes facility fire detectors with local and remote alarms and the fire sprinkler system. The radiation detection system consists of continuous air monitors (CAMs) and direct reading area radiation monitors (ARMs) with local and remote alarms.

3.0 IDENTIFICATION AND SCREENING OF HAZARDS

The Emergency Management Guide on Hazards Assessment suggests the following screening thresholds to determine the need for a quantitative hazards assessment.

Radiological:
10 CFR 30.72, Schedule C

Chemical:
The minimum value from the following lists:
29 CFR 1910.119 (TQ)
40 CFR 68.130 (TQ)
40 CFR 355 (TPQ)

These lists are not entirely inclusive. Other hazardous materials may exist in sufficient quantity which when released to the environment may pose public health hazards to Hanford workers and the general public.

The WESF radioactive material consists mainly of the cesium and strontium capsules, residual contamination in the hot cells and contamination in the ventilation system. The inventory in Table 3.1 below is from HNF-SD-WM-BIO-002, Table 3-3, "Hazards Identification Results for WESF." The values were developed by facility personnel and represent a combination of maximum allowable inventories and estimated actual or maximum conditions. The inventories specified for the Truckport and the K-3 filters are the expected maximum inventories for these areas. The inventories specified for the K-3 exhaust duct, the hot cells, and the pool cells are conservative estimates of the radioactive materials present in those areas. These inventories are bounding because operations that might introduce additional contamination are no longer performed.

WESF inventory exceeds the screening values specified in 10 CFR 30.72 Schedule C (1.11 E+14 bequerels (Bq) (3,000 Ci) of ^{137}Cs and 3.33 E+12 Bq (90 Ci) of ^{90}Sr). Therefore, an emergency planning hazards assessment and emergency planning is required for this facility.

There are no known chemicals of concern in the facility.

4.0 HAZARD CHARACTERIZATION

The screening process described above identified no chemical hazards exceeding the screening thresholds and an extensive radionuclide inventory that exceeds screening thresholds. The radionuclide inventory consists primarily of the capsules and large amounts of contamination in both facility systems and waste.

By far the most significant hazards arise from the radioactive isotopes ^{137}Cs and ^{90}Sr that are contained both in capsules in the pool cells (and possibly F and G Cells), and as contamination in the hot cells, K-3 exhaust duct, K-3 filters, and Truckport (as low-level waste). The radioactive materials represent both dispersal and direct radiation hazards.

Table 3.1 Radionuclide Inventory

Location	Quantity	Form	Remarks
Pool Cells	52.05 MCi ^{137}Cs	Doubly encapsulated cesium chloride capsules and singly encapsulated Type W overpack capsules	This is the total WESF cesium and strontium capsule inventory decayed to 1/1/96
	22.58 MCi ^{90}Sr	Doubly encapsulated strontium fluoride capsules	
A Cell	15 kCi ^{90}Sr or ^{137}Cs	208-L (55-gal) steel drums of contaminated solid waste	
B Cell	2 kCi ^{137}Cs and 20 kCi ^{90}Sr	Contamination on equipment, waste, and surfaces	
C Cell	2 kCi ^{137}Cs 20 kCi ^{90}Sr	Contamination on equipment, waste, and surfaces	
B/C Cell Furnace	40 kCi ^{90}Sr	Strontium fluoride floor sweepings contained in 4 boats and 2 waste pipes	
D/E Cells	20 kCi ^{137}Cs	Contamination on equipment, waste and surfaces	
F Cell	940 kCi ^{137}Cs	Encapsulated cesium chloride in suspect or single capsules	Since the capsules in F Cell would be suspect, the first confinement boundary is considered to be F Cell.
K-3 Exhaust duct	5 kCi ^{137}Cs or 200 kCi ^{90}Sr	Surface contamination	The makeup of the contamination is unknown so two possible isotopic distributions are given.
K-3 filter	240 Ci ^{137}Cs and 18 kCi ^{90}Sr on each train	Contamination	Based on BIO assumption
WIXM	31.5 kCi ^{137}Cs or 25.2 kCi ^{90}Sr per module	Resin bed	The WIXM is a shielded ion exchange column used for removal of radioactive contaminants from pool cell water in the event of a capsule failure. The WIXM is stored outside the facility and only installed if needed.
Truckport	5 kCi of ^{137}Cs or ^{90}Sr contained in drum(s)	One or more 208-L (55-gal) drums of contaminated hot cell waste	

4.1 Cesium

4.1.1 Inventory and Physical Properties

The inventory of the cesium^{137} is summarized in Table 3.1. The majority of the material is contained in the capsules stored in the water storage pools. Capsules suspected of leaking are stored in F Cell. The remaining material is present as contamination in waste and facility systems.

The inventories specified for the K-3 exhaust duct, the hot cells, and the pool cells are conservative estimates of the radioactive materials that are estimated to be actually present in those areas. These inventories are bounding because operations which might introduce additional contamination are no longer performed. For the K-3 exhaust duct, the inventory data are based on records of dose rates taken in the exhaust duct. This contamination is present from former processing activities in the hot cells. For the hot cells the inventory data represent estimates of residual contamination on equipment and surfaces within the hot cell, based on historical operations within each cell. For the pool cells, the inventory data are based on the capsule storage configuration at the time of the generation of the inventory; however, the accident analysis uses maximum storage conditions.

<u>Physical Properties</u>

^{137}Cs (radiological)

Atomic Number:	55			
Element Weight:	132.905			
Half Life:	30.17 years			
Daughter:	Ba-137m			
Decay:	Gamma			
	Probability per Decay		Maximum (Mev)	Average (Mev)
	1	0.946000	0.5111550	0.156800
	2	0.054000	1.173200	0.415200
Biological Half-Life:	Total Body	70 days		
	Muscle	140 days		
	Bone	140 days		
	Lungs	140 days		
	Kidneys	42 days		
	Liver	90 days		
	Spleen	98 days		

Cesium Chloride

Molecular Weight	168.358
Melting point	646 °C (1195 °F)
Specific Gravity	3.99
Solubility	Soluble in water (hygroscopic)

4.1.2 Conditions of Storage and Use

WESF cesium capsules and Type W overpack cesium capsules are currently stored in pool cells located in 225B. The WESF cesium inner and outer capsules and end caps are made of 316L stainless steel. Molten cesium chloride was cast into the inner capsule. Following the welding of the end cap and a helium leak test on the inner capsule, each capsule was welded into an outer capsule. The capsule diameters and wall thickness were changed during the course of the production runs. The outer diameter of the inner capsule increased from 5.72 cm to 6.48 cm (2.25 inches to 2.55 inches) and the wall thickness of the inner capsule increased from 0.241 cm to 0.262 cm to 0.345 cm (0.095 inches to 0.103 inches to 0.136 inches). The length of the inner capsule is 50.17 cm (19.75 inches). The inner diameter of the outer capsule decreased from 6.114 cm to 6.058 cm (2.407 inches to 2.385 inches); the outer diameter is 6.668 cm (2.625 inches). The wall thickness of the outer capsule increased from 0.277 cm to 0.302 cm to 0.345 cm (0.109 inches to 0.119 inches to 0.136 inches). The length of the outer capsule is 52.769 cm (20.775 inches).

The Type W overpack cesium capsules and end caps are also made of 316L stainless steel. Following the welding of failed cesium capsules or cesium powder and pellets into a Type W overpack capsule, a helium leak test was performed. The Type W overpack capsule outer diameter is 8.26 cm (3.25 inches), the inner diameter is 7.480 cm (2.945 inches), and the length is 53.912 cm (21.225 inches).

4.2 Strontium

4.2.1 Inventory and Physical Properties

Inventory of the strontium-90 involved in the postulated accidents is shown in Table 3.1. The majority of the material is contained in the capsules stored in the water storage pools. The remaining material is present as contamination in waste and facility systems.

Physical Properties

^{90}Sr (radiological)				
Atomic Number:	38			
Element Weight:	87.62			
Half Life:	28.6 years			
Daughter:	Y-90			
Decay:	Beta			
	Probability per Decay		Maximum (Mev)	Average (Mev)
	1	1.000000	0.546000	0.1956800
Biological				
Half-Life:	Total Body	13,000 days		
	Bone	18,000 days		

Strontium Fluoride	
Molecular Weight	125.6g
Melting point	1473 °C (2683 °F)
Specific Gravity	4.24
Solubility	Soluble in water

4.2.2 Conditions of Storage and Use

The strontium inner capsule and end caps are made of Hastelloy C-276. The strontium outer capsule and end caps are made of 316L stainless steel. Strontium fluoride was added to the inner capsule in increments and compacted after each addition. The dimensions of the inner capsule are 5.72 cm (2.25 inches) outside diameter by 48.39 cm (19.05 inches) long, including end caps, with a wall thickness of 0.30 cm (0.12 inches). Following the welding of the end cap and a helium leak test on the inner capsule, each capsule was welded into an outer capsule. The dimensions of the outer capsule are 6.668 cm (2.625 inches) outside diameter by 51.1 cm (20.1 inches) long, including end caps, with a wall thickness of 0.30 cm (0.12 inches).

4.3 WESF Exhaust Filters

Other than the capsules, the largest inventory of radioactive material at WESF is in the K-3 exhaust duct and filters. Exhaust air from the WESF Canyon and cells is filtered through two stages of HEPA filters connected in series and located in the K-3 Exhaust Filter Pit. In addition to this, air entering the hot cells from the canyon passes through a HEPA filter, and air exiting the hot cells into the K3 duct passes through an in-cell HEPA filter. The filtered exhaust is discharged via a centrifugal fan to the atmosphere via the stack. Filter inventory is shown in Table 3.1.

The K-3 Filter Pit is approximately 4.9 m (16.1 ft) wide by 11.3 m (37.1 ft) long by 3.4 m (11.2 ft) deep and is constructed from 0.3 m (1 ft) reinforced concrete. The top of the pit is at grade elevation. The pit is partitioned into five sections by reinforced concrete dividers. Each section is equipped with cover blocks for remotely replacing the filters. The building houses two filter assemblies that are operated one at a time. The exhaust fans are located on a concrete pad at the south end of the pit and connected to the last filter section via a 0.6 m (2 ft) diameter duct. There are two exhaust fans that are normally operated one at a time.

5.0 COMPUTER MODELS, RECEPTOR LOCATION, AND CLASSIFICATION CRITERIA

5.1 Calculation Models

Radiological consequences are estimated using the Hanford Unified Dose Utility (HUDU) computer code. This code is the primary emergency response tool for evaluating radiological releases on the Hanford Site and in the Unified Dose Assessment Center (UDAC).

HUDU employs a straight line Gaussian plume model and Pasquill-Gifford stability classes. Release source terms consider only the respirable fraction. Release of radionuclides into the environment are either elevated (effective release height is >2.5 times the building height) or ground level. By convention, release heights less than 10 meters default to ground level releases. In these analyses plume rise is not considered, producing conservative dose estimates.

Consequences from hazardous material events are estimated using the Emergency Prediction Information (EPI). The EPI program was developed by Homann Associates, Inc. for use in hazardous material emergency planning and response. The program has five source models; Continuous Release, Term Release, Area Continuous, Area Term, and Liquid Spill.

The liquid spill option calculates the source term from a pool of spilled liquid. The area continuous and area term options are also spills but the user must supply the source term. The EPI program uses both the plume and puff Gaussian dispersion models depending on the duration of the release. The program users manual documents the features of the program.

The consequences calculated in this document may not be identical to those identical accidents postulated in the facility's safety documentation. The primary reason for this is use of different computer codes.

5.2 Meteorological Conditions

In order to determine the proper event classification for each scenario analyzed, consequences are calculated for a severe meteorological condition. For the purposes of this assessment severe meteorology is assumed to be F stability and 1 m/s wind speed. To be conservative, and unless otherwise noted, all releases were modeled as ground level open air (i.e., no building wake effects). To create information that will be useful for response personnel, calculations are also performed for a wind speed of 1 m/s and D and A stability classes. The following assumptions were made for the mixing layer depth for each of the stability classes used, A = 300m, D = 200m and F = 60m. The results provide information that can be rapidly scaled by responders in the initial stages of response to estimate consequences for the current meteorological conditions.

5.3 Receptor Locations

Two receptor locations are evaluated for purposes of comparing with the emergency classification criteria: a maximum onsite individual at a distance of 100 m (328 ft) (facility boundary) and a maximum offsite individual at the distance of 11 km (7.1 mi), the nearest Columbia River shore. Calculations were performed for Highway 240 as it is 8.3 km (5.2 mi) distant.

5.4 Emergency Classification Consequence Criteria

A goal of the DOE emergency preparedness system is to quickly classify the severity of an accident. Preplanned actions are then implemented for each emergency class. The emergency classification is based, in part, on projected dose and concentration values at the facility and Hanford site boundaries for analyzed accident scenarios. The emergency classification criteria are shown in the following tables.

Table 5.1 Radiological Consequence Classification Criteria

Emerg. Category	Criteria
Alert	> 0.001 Sv (100 mrem) TEDE at the facility boundary
Site Area	≥ 0.01 Sv (1 rem) TEDE at the facility boundary
General	≥0.01 Sv (1 rem) TEDE at the site boundary

Table 5.2 Toxic Chemical Consequence Classification Criteria

Emerg. Category	Criteria
Alert	> ERPG 1 at facility boundary
Site Area	≥ ERPG 2 at facility boundary
General	≥ ERPG 2 at site boundary

*The criteria apply to a 15 minute average concentration of the substance in air. If ERPG values have not been established for a substance, alternative criteria specified in the Emergency Management Guide for Hazards Assessments (Temporary Emergency Exposure Limits – TEELs) shall be used.

There are also general criteria for emergency classification in addition to the numerical values in the tables above. The threshold between reportable occurrences and the Alert classification is difficult to establish based solely on a numerical value. The following general criteria apply in addition to the airborne release concentration values specified in the tables above.

ALERT

An ALERT Emergency shall be declared when events are in progress or have occurred which involve an actual or potential substantial degradation of the level of safety of the facility with an increased potential for a release.

In general, the ALERT classification is appropriate when the severity and/or complexity of an event may exceed the capabilities of the normal operating organization to adequately manage the event and its consequences.

SITE AREA

A SITE AREA Emergency shall be declared when events are in progress or have occurred which involve actual or likely major failures of facility functions needed for protection of workers and the public.

GENERAL

A GENERAL Emergency shall be declared when events are in progress or have occurred that involve actual or imminent catastrophic failure of facility safety systems with a potential for loss of confinement or containment integrity.

There is additional emergency classification guidance in the Emergency Management Guide on Event Classification and Emergency Action Levels. The Hazards Assessment in the following sections is based primarily on a comparison of calculated consequences with the numerical criteria in the tables above. However, some recommendations are provided based on the more general emergency classification criteria.

6.0 SCENARIOS AND CONSEQUENCES

6.1 Toxic Chemical Releases

No toxic chemicals exceeding the screening thresholds were identified at the WESF facility.

6.2 Radiological Release Events

The projected consequences from the events proposed in the following sections are used to establish the size of the emergency planning zone and to provide guidance for establishing Emergency Action Levels (EALs).

6.2.1 Natural Phenomena

Seismic events, high winds/tornadoes, and ash/snow roof loading are natural phenomena with potential emergency consequences. Seismic events are analyzed below.

6.2.1.1 Earthquake Scenario

Two earthquake scenarios were analyzed for WESF. The first is a design basis earthquake with a peak ground acceleration of 0.25 g, see subsection 3.4.2.1.2 of HNF-SD-WM-BIO-002. The second is a beyond design basis earthquake with a ground acceleration greater than 0.25 g, see subsection 3.4.3.2 of HNF-SD-WM-BIO-002.

During the design basis earthquake certain structures and facility systems survive the earthquake and continue to function normally. The immediate effects of the design basis earthquake on the hazardous materials in WESF result in the release from only two areas within the facility. The release is from the suspension of solid radioactive materials in the hot cells and the K-3 exhaust ducting.

During the beyond design basis earthquake it is assumed that all systems and structures that survived the design basis earthquake now fail in whatever configuration causes the greatest consequence.

6.2.1.2 Design Basis Earthquake Consequence

The following assumptions were made in determining the source term for this scenario:

The hot cell HEPA filters are assumed to provide no filtration and the total inventory of B through E Cells is at risk for a release through the 296-B stack. This results in an inventory at risk for this release path of 3.0E+15 Bq (80 kCi) of ^{90}Sr and 8.9E+14 Bq (24 kCi) of ^{137}Cs. The release from A Cell would be a ground level release and the total inventory at risk is 5.6 E+14 (15 kCi) of ^{90}Sr. (Note: because of its greater inhalation unit dose, the entire inventory at risk is assumed to be ^{90}Sr.). The inventory at risk in the K-3 ducting is 7.4 E+15 Bq (200 kCi) of ^{90}Sr. The ARF and RF values for all inventories are 1.0E-3 and 1.0 (DOE 1994). The Leak Path Factor (LPF) value for all releases is assumed to be 1.0

The resulting release source term will be 1.10E+13 Bq (295 Ci) ^{90}Sr and 8.9E+11 Bq (24 Ci) ^{137}Cs. HUDU results are shown below:

Table 6.1 Design Basis Earthquake Consequences

Effective Dose Equivalent (Rem)			
Stability Class	Facility Boundary (.1 km)	Highway 240 (8.3 km)	Site Boundary (11 km)
A	19	.021	.017
D	150	.110	.072
F	620	.620	.450

For the three conditions analyzed above, the approximate distances at which the EPA's PAG of 0.01 Sv (1 rem) is exceeded are as follows:

Table 6.2 Design Basis Earthquake PAG Distances

Approximate Distance At Which PAG (1 rem) Exceeded			
Distance	A Stability	D Stability	F Stability
Kilometers	0.4	2.1	6.1
Miles	0.2	1.3	3.8

The results of this analysis indicate that this event should be declared a SITE AREA Emergency since the facility boundary TEDE is greater than 0.01 Sv (1 rem) but is less then this value at the nearest site boundary.

6.2.1.3 Beyond Design Basis Earthquake Consequence

The following assumptions were made in determining the source term for this scenario:

All facility SSCs and support services fail in whatever configuration provides the worse-case consequences. The source term can be estimated as the combined source terms from the design basis earthquake above, impacts to capsules in F Cell and cover block impacts to the K-3 filters. Source term from design basis earthquake is 1.1E+13 Bq (295 Ci) ^{90}Sr and 8.9E+11 Bq (24 Ci) ^{137}Cs. Impacts to the capsules stored in F Cell will result in a release. The ARF and RF values for this material are 1E-3 and 0.1 (1E-4) (Section 4.4.3.3.1 of DOE 1994). Twenty-four capsules are assumed to be present with a total inventory of 3.48E+16 Bq (941 kCi) of ^{137}Cs. This results in a release source term of 3.48E+12 Bq (94.1 Ci) of ^{137}Cs.

Cover blocks over the K-3 filter pit are assumed to drop onto the filters causing a release. The ARF and RF values for this condition are 1E-2 and 1.0 (Section 5.4.4.2 of DOE 1994).

Assuming that only one of the filters is loaded with radioactive material the inventory is 8.9E+12 Bq (240 Ci) of ^{137}Cs and 6.7E+14 Bq (18 kCi) of ^{90}Sr. The resulting source term is 8.9E+10 Bq (2.4 Ci) of ^{137}Cs and 6.7E+12 Bq (180 Ci) of ^{90}Sr.

The total release source term is 1.77E+13 Bq (475 Ci) of ^{90}Sr and 4.46E+12 Bq (120.5 Ci) of ^{137}Cs.

Table 6.3 Beyond Design Basis Earthquake Consequences

Effective Dose Equivalent (Rem)			
Stability Class	Facility Boundary (.1 km)	Highway 240 (8.3 km)	Site Boundary (11 km)
A	32	.035	.027
D	250	.180	.120
F	1000	1.0	.750

For the three conditions analyzed above, the approximate distances at which the EPA's PAG of 0.01 Sv (1 rem) is exceeded are as follows:

Table 6.4 Beyond Design Basis Earthquake PAG Distances

Approximate Distance At Which PAG (1 rem) Exceeded			
Distance	A Stability	D Stability	F Stability
Kilometers	0.6	2.9	8.6
Miles	0.4	1.8	5.5

The results of this analysis indicate that this event should be declared a SITE AREA Emergency since the TEDE is greater than 0.01 Sv (1 rem) at the facility boundary but is less then this value at the nearest site boundary.

6.3 Facility Fires

Fire scenarios are considered for the hot cells and the Truckport. Due to the wide range of hazardous material inventory and physical configurations, hot cell fires are considered for all hot cells. The Truckport fire considers the presence of WESF hot cell waste drums and a contaminated WESF Ion Exchange Module (WIXM).

6.3.1 Hot Cell Fires

The analysis addresses potential fires in the following hot cell groups: A Cell, B through E Cells, and F and G Cells. Fire scenarios are analyzed in subsection 3.4.2.3, of HNF-SD-WM-BIO-002 (HNF 2000).

In addition to the calculated onsite and offsite consequences shown below, a hot cell fire could result in the spread of contamination within the facility. The analyses performed in HNF-SD-WM-BIO-002 (HNF 2000) show that the worst case release would occur through the canyon, but other pathways exist. A fire in A Cell could release contamination into the Service Gallery, while a fire in any of the hot cells could release contamination into the Operating Gallery through the manipulator penetrations. Also, if the hot cell fire suppression system were activated in F Cell during the course of the fire, the potential arises for flooding of the hot cell and water entering the K-3 exhaust duct, TK-100, or a K-3 filter housing.

6.3.2 A Cell Fire

The WESF A Cell contains radioactive solid wastes generated in other hot cells. The wastes are packaged in 208-L (55-gal) steel drums, which are staged in A Cell until they can be removed for disposal. For the worst-case scenario the assumptions were as follows:

- The plug port or one/both of the cover blocks has been removed and the fire burns to completion.
- HEPAs fail leaving an open flow path through the K-3 system.
- The fire propagated to consume combustibles in all waste drums.
- The A Cell inventory is 15 kCi of ^{90}Sr.
- The ARF and RF values are 5E-4 and 1.0 for packaged waste, from section 5.2.1.1 of DOE, 1994.
- The LPF is 1.0 corresponding to no HEPA filters.
- 200 kg (441 lb) of combustibles are burned in the fire.

No credit will be taken for plume rise as a result of the elevated temperature of the exhaust flow through the stack. Using the assumptions above the resulting release source term is 2.81E+11 Bq (7.5 Ci) ^{90}Sr. HUDU results are shown in the following table.

Table 6.5 A Cell Fire Consequences

Effective Dose Equivalent (Rem)			
Stability Class	Facility Boundary (.1 km)	Highway 240 (8.3 km)	Site Boundary (11 km)
A	.480	< 0.001	< 0.001
D	3.8	0.002	0.001
F	16	0.016	0.011

For the three conditions analyzed above, the approximate distances at which the EPA's PAG of 0.01 Sv (1 rem) is exceeded are as follows:

Table 6.6 A Cell Fire PAG Distances

Approximate Distance At Which PAG (1 rem) Exceeded			
Distance	A Stability	D Stability	F Stability
Kilometers	<0.1	0.2	0.6
Miles	<0.06	0.1	0.4

The results of this analysis indicate that under severe meteorological conditions this event should be declared a SITE AREA Emergency since the facility boundary TEDE is greater than 0.01 Sv (1 rem) but the value at the nearest site boundary is less then this value.

6.3.3 B through E Cell Fire

The WESF B through E Cells were used for strontium (B and C Cells) and cesium (D and E Cells) processing. These hot cells contain radioactive materials and unpackaged wastes. The radioactive material is in the form of contamination on walls, equipment, and combustibles. The combustibles are predominantly plastics and cellulose. Assumptions for this scenario include:

- A fire in B Cell propagates to C Cell (and vice-versa). Similarly a fire in D Cell propagates to E Cell (and vice-versa).
- The plug ports and cover blocks are in place.
- HEPAs fail leaving an open flow path through the K-3 system.
- Mitigation from fire detection and suppression systems is not considered.
- LPF is 1.0 corresponding to no HEPA filtration.
- The initial temperature of the canyon is 40 °C (104 °F).
- The maximum temperature of the hot cell reaches 400 °C (752 °F).
- The inventory of B/C is 3E15 Bq (80 kCi) of ^{90}Sr and 1.5E14 Bq (4 kCi) of ^{137}Cs.
- A fire in B/C Cells bounds the consequences of a fire in D/E Cells.
- The ARF and RF values are 1E-2 and 1.0, from Section 5.2.1.2 of DOE, 1994.
- All of the contamination is present on combustibles thus maximizing the calculated release.

No credit will be taken for plume rise as a result of the elevated temperature of the exhaust flow through the stack. Using the assumptions above the resulting release source term is 3.0E+13 Bq (800 Ci) ^{90}Sr and 1.5E+12 (40 Ci) ^{137}Cs. HUDU results are shown in the following table.

Table 6.7 B through E Cell Fire Source Term

Effective Dose Equivalent (Rem)			
Stability Class	Facility Boundary (.1 km)	Highway 240 (8.3 km)	Site Boundary (11 km)
A	52	0.057	0.045
D	400	0.290	0.200
F	1700	1.7	1.2

For the three conditions analyzed above, the approximate distances at which the EPA's PAG of 0.01 Sv (1 rem) is exceeded are as follows:

Table 6.8 B through E Cell Fire PAG Distances

Approximate Distance At Which PAG (1 rem) Exceeded			
Distance	A Stability	D Stability	F Stability
Kilometers	0.7	3.8	13.8
Miles	0.4	2.4	8.6

The results of this analysis indicate that this event should be declared a GENERAL Emergency because the site boundary TEDE is greater than 0.01 Sv (1 rem) for the most severe meteorology.

Note: If credit is taken for the K-3 filters and the normally installed plug ports and cover blocks the consequences listed above are reduced by a factor of ~20.

6.3.4 F and G Cell Fire

The WESF F and G Cells are used to store and handle cesium and strontium capsules. They do not contain appreciable radioactive contamination outside of capsules. The capsules are resistant to fires (HNF 2000), however it is anticipated that suspect or known compromised capsules may be stored in F and G Cells, and the capacity of these capsules to resist the effects of fire is unknown. Administrative controls are in place to prevent the concurrent conditions of capsules in the hot cell, loose combustibles in the hot cell, and hot cell cover block or plug removed. Assumptions for this scenario include:

- The cells do not contain significant quantities of combustibles.
- Pass-through doors between cells are normally closed.

Based on the administrative controls in place, lack of combustible material and the resistance of capsules to the effects of fire, any fire in either of these cells would have minimal consequences outside of the facility. These consequences are bounded by those analyzed for cells A through E above.

6.3.5 Truckport Fires

The Truckport, located at the west end of the WESF building, provides confinement for cask and low-level solid waste loading and unloading. The use of gasoline or propane in the Truckport has been identified as a possible cause for an explosion or fire. The consequence of an explosion is likely to be bounded by the fire analysis. Of the potential causes of a fire in the Truckport, the fuel fire is the most likely and has the greatest potential to spread to the solid waste. The following assumptions are used in this analysis:

- The worse case conditions exist in the Truckport, roll-up door is open and the cover blocks from the Truckport to the canyon are removed.
- The fire suppression system in unavailable or fails.

- The LPF is assumed to be 1.0 because of the possibility that the ventilation flows might be interrupted and the Truckport door open.
- The inventory at risk in the 208-L (55-gal) drum(s) is 1.9E+14 Bq (5 kCi) of ^{90}Sr.
- The ARF and RF values used for the release from the 208-L drum are 5.0E-4 and 1.0 from Section 5.2.1.1 of DOE 1994, for the burning of contaminated solid combustibles in packages.

Using the assumptions above the resulting release source term is 9.3E+10 Bq (2.5 Ci) ^{90}Sr. HUDU results are shown below:

Table 6.9 Truckport Fires Consequences

Effective Dose Equivalent (Rem)			
Stability Class	Facility Boundary (.1 km)	Highway 240 (8.3 km)	Site Boundary (11 km)
A	.160	< 0 .001	< 0.001
D	1.3	< 0 .001	< 0 .001
F	5.2	0.005	0.003

For the three conditions analyzed above, the approximate distances at which the PAG of 0.01 Sv (1 rem) is exceeded are as follows:

Table 6.10 Truckport Fires PAG Distances

Approximate Distance At Which PAG (1 rem) Exceeded			
Distance	A Stability	D Stability	F Stability
Kilometers	<0.1	0.16	0.6
Miles	<0.06	0.1	0.2

The results of this analysis indicate that under severe meteorological conditions this event should be declared a SITE AREA Emergency because the facility boundary TEDE is greater than 0.01 Sv (1 rem) but is less than this value at the nearest site boundary.

The WIXM is part of the Emergency Ion Exchange System (EMIX) that is used to decontaminate pool cell water in the event of a cesium or strontium capsule leak. If needed, a WIXM would be moved inside the truckport and connected to the EMIX. Section 3.4.2.3.2 of the WESF BIO analyzed the consequences of a Truckport fire with a contaminated WIXM installed. The concrete associated with the WIXM could suffer some external surface damage as a result of the elevated temperatures associated with the fire and the water inside the module could boil. The calculated worst case release is 1.7 Ci of ^{90}Sr. This release is smaller than the 2.5 Ci release from the waste fire analyzed above but would still warrant a Site Area emergency under severe meteorological conditions.

6.4 Loss of Confinement

This section considers the range of upset conditions associated with the TK-100 and the K-3 ventilation systems. These conditions include high flow in the K-3 system, K-3 system water accumulation, K-3 filter drop, high activity in TK-100 and hot cell hydrogen accumulation.

6.4.1 High Flow in K-3 Ventilation System

Under normal operations, one of the two K-3 ventilation system fans is operating at all times. If the pressure differential in any of the ventilated zones is unsatisfactory due to failure of the online fan or overload of the system, the standby fan starts automatically.

High flow through the K-3 ventilation system could be caused by instrumentation failure, allowing multiple fans to run simultaneously, or could be a result of opening a flow path, such as the removal of the Truckport cover block (leading to the canyon) while the Truckport is open to the environment. For the worst-case scenario the following assumptions were as follows:

- Both K-3 exhaust fans are operating.
- Contamination in the exhaust ducts breaks loose under sustained high flow rates.
- The K-3 HEPA filters fail.
- The K-3 duct inventory is no greater than 200 kCi of ^{90}Sr or 5 kCi of ^{137}Cs (^{90}Sr is used because it is the bounding case).
- The K-3 HEPA filter housing inventory is no greater than 18 kCi of ^{90}Sr and 240 Ci of ^{137}Cs.
- The ARR and RF values are 4E-05/h and 1.0, subsection 5.3.4, DOE 1994. It is further assumed that the high-flow condition lasts for 48 hours before being corrected resulting in a final ARF and RF of 1.9E-03 and 1.0.
- The LPF is 1.0 corresponding to the K-3 HEPA failure.

The resulting source term, based on the assumptions listed above, is 1.5E+13 Bq (414 Ci) of ^{90}Sr and 1.7E+10 Bq (0.46 Ci) of ^{137}Cs. HUDU results are shown below:

Table 6.11 High Flow in K-3 Ventilation System Consequences

Effective Dose Equivalent (Rem)			
Stability Class	Facility Boundary (.1 km)	Highway 240 (8.3 km)	Site Boundary (11 km)
A	27	0.030	0.023
D	210	0.150	0.100
F	860	0.870	0.630

For the three conditions analyzed above, the approximate distances at which the EPA's PAG of 0.01 Sv (1 rem) is exceeded are as follows:

Table 6.12 High Flow in K-3 Ventilation System PAG Distances

Approximate Distance At Which PAG (1 rem) Exceeded			
Distance	A Stability	D Stability	F Stability
Kilometers	0.5	2.7	7.6
Miles	0.3	1.7	4.7

The results of this analysis indicate that under severe meteorological conditions this event should be declared a SITE AREA Emergency because the threshold of 0.01 Sv (1 rem) is exceeded at the facility boundary but not at the site boundary.

<u>Note</u>: The results listed above would be reduced if the K-3 HEPA filters did not fail or the time to correct the condition were to be reduced. The consequences listed above would be reduced by 1.0E-03 if the filters did not fail and the source term could be adjusted by 4.0E-5/h of the release.

6.4.2 K-3 System Water Accumulation/Hydrogen Explosion

This scenario addresses the potential for inadvertent accumulation of water in the K-3 ventilation system. Potential consequences are the build-up of hydrogen gas, increased radiation exposure rates in the vicinity of the K-3 Filter Pit (i.e., radioactive material could be washed into the filter housing) and blockage of the K-3 airflow resulting in a loss of ventilation in the facility. The worst case scenario would be the buildup of hydrogen in the hot cells with a resulting explosion.

Three potential mechanisms exist for accumulation of water in the K-3 ventilation system, a hot cell flood, TK-100 overflow and K-3 Filter Washdown System activation.

Water has been isolated to A Cell through E Cell and G Cell cannot flood due to the capsule transfer shoot. Since there is no appreciable inventory in F Cell, the only inventory added to the K-3 filter sump in the event of a hot cell flood would be from the K-3 duct. Water could flood F Cell, exceed the level of the ventilation bypass or outlet duct, and travel until it reached the vent/drain line leading to TK-100. If the drain line were plugged, TK-100 was overflowing, or the water flow rate was sufficiently high, the 2.5 cm (1 in) dam could be overwhelmed and the water could proceed to the active K-3 HEPA filter housing sump.

TK-100 is used to collect and stage batches of potentially contaminated low-level liquid waste. In addition to acting as the receiver tank for the K-3 exhaust duct drain line, it also receives water from numerous floor drains throughout the facility. If water diverted to TK-100 exceeded its storage capacity, the tank could overflow through the 5-cm (2 in) vent line (K-3 duct drain line) and into the K-3 exhaust duct. If the TK-100 level monitors and/or alarms failed or if facility personnel could not identify and halt the flow, water could back up into the K-3 duct and begin to flood the active K-3 filter housing.

The K-3 filter washdown system is designed to allow washing (for decontamination purposes) of the in-line heaters, moisture separators, and other exposed surfaces upstream of the HEPA filters. The water from the washdown system is collected in the K-3 filter housing sump and is separated from the filter media by a steel wall across the interior of the filter housing.

The analysis performed in HNF-SD-WM-BIO-002 (HNF 2000a) indicates that there is insufficient hydrogen generation potential to be of concern from the TK-100 overflow or filter washdown system activation scenarios to be of concern. Therefore the analysis is based on the hot cell flood scenario.

The following assumptions were made:

- The hot cell ventilation bypass seals would not prevent water in the hot cells from entering the K-3 duct.
- One filter housing, containing the maximum possible radioactive material inventory dissolved in the water and present on the filters, is involved in a hydrogen explosion as a result of a K-3 flooding event. One housing is assumed instead of both because this maximizes the calculated consequences while minimizing the time required to reach 4% hydrogen.
- Cell inventory and waste packaging restrictions are in place.
- Contamination in the exhaust duct consists entirely of ^{137}Cs; 1.9E+14 Bq (5 kCi) and is washed into a K-3 filter housing.
- The contamination present on the K-3 filters is assumed to be 8.9E+12 Bq (240 Ci) of ^{137}Cs and 6.7E+14 Bq (18 kCi) of ^{90}Sr.
- All the energy from the material in the water flooding the filter housing is absorbed by the water.
- All hydrogen generated remains in the filter housing.
- The ARF and RF values of 1E-02 and 1.0 were chosen for a blast impact to a HEPA filter, from subsection 5.4.2.2, DOE 1994.

Applying the release fraction to the material at risk results in a source term of 1.9E+12 Bq (52.4 Ci) of ^{137}Cs and 6.7E+12 Bq (180 Ci) of ^{90}Sr. HUDU results are shown in the following table.

Table 6.13 K-3 Filter Water Accumulation/Hydrogen Explosion Consequences

Effective Dose Equivalent (Rem)			
Stability Class	Facility Boundary (.1 km)	Highway 240 (8.3 km)	Site Boundary (11 km)
A	12	0.013	0.010
D	94	0.066	0.043
F	390	0.390	0.270

For the three conditions analyzed above, the approximate distances at which the EPA's PAG of 0.01 Sv (1 rem) is exceeded are as follows:

Table 6.14 K-3 Filter Water Accumulation/Hydrogen Explosion PAG Distances

Approximate Distance At Which PAG (1 rem) Exceeded			
Distance	A Stability	D Stability	F Stability
Kilometers	0.4	1.4	4.3
Miles	0.2	0.9	2.7

The results of this analysis indicate that under severe meteorological conditions this event should be declared a SITE AREA Emergency since the threshold of 0.01 Sv (1 rem) is exceeded at the facility boundary but not at the nearest site boundary.

6.4.3 K-3 Filter Drop

This scenario postulates that a release of radioactive material occurred during the K-3 filter replacement effort. The filter is raised with a crane during the replacement operation. The scenario postulates that 0.1 percent of the radionuclide inventory is released in a respirable form.

The following assumptions were made during the development of this scenario:

- The inventory at risk is taken from Table 3-1 and the filter drop is assumed to affect the filters in one filter housing only.
- The six HEPA filters are contained in a single filter frame.
- The inventory at risk is 8.9E+12 Bq (240 Ci) ^{137}Cs and 6.66E+14 Bq (18 kCi) of ^{90}Sr.
- The ARF and RF values for this scenario are 5E-04 and 1.0, from subsection 5.4.4.1, DOE, 1994.
- The release pathway is directly to the atmosphere, therefore the LPF is 1.0.

The resulting source term is 4.45E+09 Bq (0.12 Ci) of ^{137}Cs and 3.33E+11 Bq (9 Ci) of ^{90}Sr. HUDU results are shown below:

Table 6.15 K-3 Filter Drop Consequences

Effective Dose Equivalent (Rem)			
Stability Class	Facility Boundary (.1 km)	Highway 240 (8.3 km)	Site Boundary (11 km)
A	0.58	< 0.001	< 0.001
D	4.5	0.003	0.002
F	19	0.019	0.014

For the three conditions analyzed above, the approximate distances at which the EPA's PAG of 0.01 Sv (1 rem) is exceeded are as follows:

Table 6.16 K-3 Filter Drop PAG Distances

Approximate Distance At Which PAG (1 rem) Exceeded			
Distance	A Stability	D Stability	F Stability
Kilometers	<0.1	0.3	0.7
Miles	<0.06	0.2	0.4

The results of this analysis indicate that under severe meteorological conditions this event should be declared a SITE AREA Emergency since the threshold of 0.01 Sv (1 rem) is exceeded at the facility boundary but not at the nearest site boundary.

6.4.4 TK-100 Hydrogen Explosion

The scenario addresses the possibility of ^{137}Cs and ^{90}Sr contamination accumulating in TK-100 and remaining for an extended period of time. The source of contamination could be water from the K-3 ductwork. Consequences are a buildup of hydrogen gas and a potential for increased radiation exposure rates in the vicinity of the TK-100 pit.

Accumulation of contaminated liquid is possible in two ways: (1) liquid enters the K-3 exhaust duct and carries contamination into the 5-cm (2 in) diameter vent/drain line to TK-100, and (2) liquid enters the exhaust duct and carries the contaminated material into the K-3 HEPA filter housing where it is jetted from the sump into TK-100. In addition, liquid from any of 225-B Building area drained by the LLW system will drain to TK-100.

The following assumptions were made during the development of this scenario:

- Hydrogen is generated in TK-100.
- A gas explosion occurs.
- The tank is assumed to be 75% full of liquid. This volume minimizes the time required to reach 4% hydrogen in the tank while allowing sufficient energy to cause failure of the tank.
- Hydrogen diffuses through the 5 cm (2 in) vent line according to the linear diffusion model.
- As a result of the explosion, the bottom of the tank ruptures resulting in a spray leak of the entire tank contents.

- The ARF and RF values associated with the spray leak is 1E-4 and 1.0, subsection 3.2.2.1, of DOE, 1994.
- The pit cover blocks do not provide any confinement of the released material resulting in an LPF of 1.0.

Applying the release fraction to the material at risk results in a source term of 9.3E+10 Bq (2.5 Ci) of ^{137}Cs. HUDU results are shown below:

Table 6.17 TK-100 Hydrogen Explosion Consequences

Effective Dose Equivalent (Rem)			
Stability Class	Facility Boundary (.1 km)	Highway 240 (8.3 km)	Site Boundary (11 km)
A	0.023	<0 .001	<0.001
D	0.180	<0.001	<0.001
F	0.750	<0.001	<0.001

For the three conditions analyzed above, the approximate distances at which the EPA's PAG of 0.01 Sv (1 rem) is exceeded are as follows:

Table 6.18 TK-100 Hydrogen Explosion PAG Distances

Approximate Distance At Which PAG (1 rem) Exceeded			
Distance	A Stability	D Stability	F Stability
Kilometers	<0.1	<0.1	<0.1
Miles	<0.06	<0.06	<0.06

The results of this analysis indicate that under severe meteorological conditions this event should be classified as an ALERT, since the dose at the facility boundary exceeds 0.001 Sv (100 mrem).

6.4.5 Hydrogen Accumulation/Explosion in Hot Cells

In order for hydrogen to accumulate to a concentration of 4% (the LFL for hydrogen in air) within a hot cell, three conditions must be met: (1) the cell must contain ionizing radiation for radiolysis to occur, (2) water must be added to the cell and remain for the duration of the event, and (3) ventilation airflow through the hot cell must cease for the duration of the event.

The following assumptions were made during the development of this scenario:

- Water to A through E Cells has been isolated.
- G Cell is normally uncontaminated and is not possible to flood due to the presence of a floor penetration leading into Pool Cell 12.
- Linear diffusion of hydrogen occurs out the length of the hot cell inlet duct to the canyon.
- The volume available for hydrogen generation in F Cell is 16 kL.

- F Cell is assumed to be flooded to the depth of the ventilation outlet ducts.
- The fraction of gamma-ray energy deposited in the water flooding F Cell is 0.148 MeV for each 0.662 MeV photon.
- The activity encapsulated in F Cell does not exceed 3.48E+16 Bq (9.4E+05 Ci) of ^{137}Cs.

The analysis documented in HNF-SD-WM-BIO-002, Rev. 0 (HNF 2000), subsection 3.4.2.4.5

indicates that the time required for sufficient hydrogen to build up in the cells ranges from 9 to 180 days and that consequences are not expected outside the facility for this type of scenario. Therefore, these events would not be classified as an ALERT or higher.

6.5 Facility Explosions

This section discusses the potential for explosions within the facility. This includes consideration of welding gases, gasoline fumes, propane and hydrogen generation in the pool cell area.

6.5.1 Hydrogen Explosion in the Pool Cell Area

Radiolysis of water in the pool cells generates hydrogen during normal operation. With ventilation supplying and exhausting air in the Pool Cell Area, as sited in HNF-SD-WM-BIO-002, Rev. 0 (HNF 2000) subsection 3.4.2.5, it has been shown that the maximum hydrogen concentration which occurs at the pool surface is substantially less than 1%. Therefore, it is assumed accumulation of hydrogen and subsequent combustion is not possible unless the K-1 and K-4 ventilation systems fail or are not operating. If the ventilation system fails, at least 226 hours (9 days) is required to build up a flammable concentration of hydrogen (Section 3.4.5.1.1, HNF 2000).

The following assumptions were made during the development of this scenario:

- Normal ventilation flow in the Pool Cell Area is approximately 140 m^3/min (5,000 cfm).
- In the event of a ventilation failure, there is no natural draft or air leakage.
- No cover blocks are placed over active pool cells.
- An ignition source is present.
- Gas combustion will cause the walls and ceiling to collapse.
- The maximum inventory in the Pool Cell Area is 52.05 MCi of ^{137}Cs. The gamma energy deposited in the water by the ^{137m}Ba (daughter product of ^{137}Cs) is the only ionizing radiation not shielded by the capsules.

For a hydrogen explosion in the Pool Cell Area, two release mechanisms have been identified. The failed structural components could result in capsule failure or loss of pool cell water. The analysis of a sudden capsule failure, including consideration for failed building structural components, is addressed in subsection 6.4 "Loss of Containment". The analysis of a loss of all pool cell water without ventilation is contained in subsection 6.6.2, "Loss of Pool Cell Water".

6.5.2 Flammable Gas Explosions

This section addresses the possibility of a flammable gas explosion (other than hydrogen) in all areas of the facility. The flammable gases considered include acetylene, propane, and gasoline fumes; however the analysis was performed so as to be bounding for all flammable gas cylinders (subsection 3.4.5.2, HNF 2000a).

The possibility of a flammable gas explosion in the facility can be divided into two cases: highly volatile liquid fuels and flammable gas cylinders. The case of highly volatile liquids relates only to the Truckport area. During normal operations most trucks associated with the operations are diesel-powered. However, there is the possibility that gasoline powered vehicles could be used. In addition, a diesel-powered forklift is used in normal operations, but a propane-powered forklift is an optional backup. Flammable gas cylinders could be in use at almost any area of the facility. Such cylinders may be used for facility maintenance and modification activities.

For highly volatile fuels used in the Truckport, the most severe condition would consist of a fuel leak or spill, generation of flammable gases, explosion and subsequent fire. The Truckport fire scenario has been analyzed in subsection 6.3.5, "Truckport Fire".

For the case involving flammable gas cylinders, the worst case condition would be gas leaking from the cylinder or the cylinder failing catastrophically. The gas would then be ignited resulting in an explosion. The bounding consequences would result from the pressure increase associated with the explosion. An explosion in any area of the facility has the potential to impact the Hot Cell and Pool Cell Area structures which contain the only radioactive materials vulnerable to this event.

The responses of the structural areas of the facility to an explosion are unknown. Impacts to the hot cells could result in cover block failure, loss of structural integrity, and subsequent suspension of radioactive material, as well as loss of shielding. Structural failure in the Pool Cell Area could result in a heavy object drop into an active pool cell and possible loss of cell water. The consequences from these two conditions are discussed in the following section.

6.5.3 Hydrogen Explosion in WIXM

This scenario postulates that a WIXM is installed in the truckport to remove contamination from pool cell water following a capsule failure. As the resin becomes loaded with radioactive material, the ionizing radiation results in radiolysis of the resin/water and produces hydrogen and oxygen gases. If hydrogen were to accumulate inside the WIXM in quantities of 4 percent volume or more, the hydrogen can become flammable and eventually detonable if it continues to increase.

The following assumptions were made during the development of this scenario (Subsection 3.4.2.5.3, HNF 2000a):

- A strontium capsule failure has occurred in a storage pool and the EMIX system put into service to cleanup the water.
- The WIXM is loaded to the maximum extent and then drained (allowing a void volume for the hydrogen to accumulate).
- The procedure requirement to fill the space above the resin bed with inert material during draining is not performed.
- An ignition source is present.

The resulting source term (subsection 3.4.2.5.3.2. HNF 2000), based on the assumptions listed above, is 2.8E+12 Bq (76.2 Ci) of ^{90}Sr. HUDU results are shown below:

Table 6.19 WIXM Hydrogen Explosion Consequences

Effective Dose Equivalent (Rem)			
Stability Class	Facility Boundary (.1 km)	Highway 240 (8.3 km)	Site Boundary (11 km)
A	.71	< 0.001	< 0.001
D	5.6	0.003	0.002
F	23	0.023	0.017

For the three conditions analyzed above, the approximate distances at which the EPA's PAG of 0.01 Sv (1 rem) is exceeded are as follows:

Table 6.20 WIXM Hydrogen Explosion PAG Distances

Approximate Distance At Which PAG (1 rem) Exceeded			
Distance	A Stability	D Stability	F Stability
Kilometers	< 0.5	.3	.6
Miles	< 0.06	.2	.4

The results of this analysis indicate that under severe meteorological conditions this event should be declared a SITE AREA Emergency since the threshold of 0.01 Sv (1 rem) is exceeded at the facility boundary but not at the nearest site boundary.

6.6 Loss of Containment

This section considers a loss of containment accident as the result of an underwater capsule failure due to drop impacts and the loss of pool cell water.

6.6.1 Underwater Capsule Failure Due to Drop Impacts

A drop and resulting impact of a heavy object is a mechanism that could result in simultaneous damage to several capsules. This event has the potential to lead to a very rapid increase in the concentration of radioactive material in a pool cell. It also has the potential to simultaneously damage the pool cell liner and structure and cause a leak of contaminated water to the ground which could lead in turn to capsules being uncovered.

An object drop into a pool cell could lead to the following conditions:

- A breach of the pool cell liner and structure.
- Mechanical damage to one or more capsules.
- Damage to the pool cell heat exchanger and recirculation piping.
- Flooding of the Pool Cell Area due to raw water leaking from a damaged heat exchanger.

The objects that pose a potential drop hazard include the pool cell crane, motorized catwalk, the pool cell cover blocks, and the Pool Cell Area structural components. The possible means by which a drop impact could occur are as follows: falling structural members following an explosion , aircraft impact or beyond design basis earthquake and heavy object drop (e.g., cover block, bridge crane or catwalk failure).

A capsule failure resulting from an object drop would release radioactive salt into the pool cell water. In addition to the high energy-gamma-ray from the ^{137m}Ba daughter product, cesium chloride salt is far more soluble than strontium fluoride and is the overriding concern. The dose rates associated with such a release could be sufficient to prevent personnel entry into the Operating Gallery or Pool Cell Area. The failure of recovery actions could lead to the consequences discussed in subsection 6.6.2, 'Loss of Pool Cell Water'.

The following assumptions were made:

- Pool cell concrete floor and sump will not act as a containment barrier for water leaking from a ruptured liner.
- The consequences and the number of capsule contents released are related in a linear fashion.
- For the purposes of this analysis it is assumed that one capsule is damaged.
- The leaking capsule is a cesium chloride capsule in Pool Cell 5 containing 1.97E+12 Bq (53.2 kCi).
- The cesium chloride is released so rapidly that no intervening actions are possible to halt the release.
- The cesium chloride immediately forms a uniform mixture within the pool water.
- The entrainment rate fraction (ERF) for cesium dissolved in a pool cell is 1.45E-10/h, assuming a bulk water temperature of 50 °C (122 °F) [subsection 3.4.2.6.2.2, HNF 2000].
- The ventilation flow rate is approximately 140 m^3/min (5,000 cfm).

Using the ERF above and the associated activity of the capsule dissolved in the pool the airborne release rate is approximately 2.5E+05 Bq/h (7.7E-06 Ci/h). Based on the flow rate assumed this results in an average concentration on the Pool Cell Area of 34 Bq/m^3 (9.2E-10 Ci/m^3). Based on this concentration the WESF BIO (HNF 2000), subsection 3.4.2.6.2.3 shows that the exposure time for the onsite receptor to reach 50 mSv (5 rem) is approximately 630 years. Therefore the airborne component is below concern for this analysis.

The direct radiation dose rate associated with a pool cell contaminated with the contents of the maximum capsule is approximately 8.8 mR/h/Ci leaked into the pool. For the single capsule assumed above, this results in an exposure rate of approximately 470 R/h at 1 m above the center of the pool [subsection 3.4.6.2.3, HNF 2000]. The dose field at various locations around WESF resulting from the dissolution of the maximum cesium capsule is provided in Figure 3-3 of HNF-SD-WM-BIO-002 (HNF 2000). Since there is no significant airborne release of hazardous material, this event would not require classification.

6.6.2 Loss of Pool Cell Water

This accident type is directed to those sequences that could lead to the total loss of water from one or more active pool cells. Initiators for this type of event are, heavy object drop, inadvertent pool drain, catastrophic failure of pool cell retention structure and failure to add makeup water with or without a loss of raw water. Two loss of water accidents are considered: (1) loss of water from a single pool, and (2) loss of water from all active pools.

6.6.3 Loss of Water from a Single Pool Cell

Potential initiators for the loss of water from a single pool cell include heavy object drop, drain line failure, and inadvertent water removal through operator error. A loss of water in one pool would lead to high radiation fields in the vicinity of the Pool Cell Area and, potentially, could result in an inability to maintain water level in the remaining active pool cells. Therefore, this event could be considered a potential precursor to the more severe loss of water from all pool cells.

The following assumptions were used in developing this scenario:

- The capsule storage configuration consisted of 494 cesium capsules (i.e., one 17 x 13 array and one 21 x 13 array) and 169 strontium capsules (i.e., one 13 x 13 array).

- Heat generated in the pool was 110% of what the configuration would generate if all capsules had an average thermal power as of 01/01/96. This corresponds to 149 kW, which includes the energy of emitted gamma radiation.
- For the source term analysis, the pool cell inventory was assumed to be all cesium capsules to bound the potential release.
- No strontium was released since the maximum centerline temperature of the strontium capsules does not exceed the melting point of strontium fluoride.
- Cesium chloride capsules failing due to corrosion release an average of 0.1 kg of salt, those failing due to stress (from salt expansion) release 2.9 kg of salt (Hey 2000). Where 2.9 kg is the average net weight of existing uncut cesium capsules. All capsule failures were treated as corrosion failures.
- No structural failures are expected as a result of this event.
- The release rate was assumed to be constant.
- HNF-SD-WM-BIO-002, Section, 3.4.3.3.1.2 (HNF 2000) indicates that a total of 51 capsules may fail due to corrosion or stress.

It should be noted that the analysis of capsule transient temperature response indicates that 2 days would be required for the maximum centerline cesium salt temperature to exceed 700 °C (1,292 °F), subsection, 3.4.3.3.1.2, HNF-SD-WM-BIO-002 (HNF 2000). From data presented in Hey (2000) and WHC (1996), no significant releases would be expected in this time frame. After 2 days, capsule failures could begin to occur due to stress and later by corrosion. For the consequences resulting from this scenario to occur, this situation would have to persist unmitigated for a prolonged period of time.

Two potential source terms associated with the draining of a single pool cell were examined. The first source term takes no credit for HVAC or HEPA operation and small leakage areas are assumed such that the building does not pressurize. Therefore, a small release of cesium salt occurs through leakage paths such as those present around doors seismic wall and ceiling joints (Wagenblast et al. 1999). This results in a release rate of approximately 6.7E-10 kg/h. The second condition places an upper bound on the first source term by assuming all vaporized salt escapes into the environment. This results in a release rate of 5.4E-06 kg/h. For the purposes of this analysis the worst case release rate will be assumed and an exposure duration of 8 hours at each of the receptor locations. This results in a source term of 4.32E-05 kg of cesium salt released to the environment. The specific activity for the cesium salt is provided in HNF-SD-WM-BIO-002, Table 3-16 and is 1.47E+04 Ci/kg. This results in a source term of 6.35E-01 Ci of ^{137}Cs. HUDU results are shown below:

Table 6.21 Loss of Water from a Single Pool Cell Consequences

Effective Dose Equivalent (Rem)			
Stability Class	Facility Boundary (.1 km)	Highway 240 (8.3 km)	Site Boundary (11 km)
A	0.006	<0.001	<0.001
D	0.046	<0.001	<0.001
F	0.190	<0.001	<0.001

For the three conditions analyzed above, the approximate distances at which the EPA's PAG of 0.01 Sv (1 rem) is exceeded are as follows:

Table 6.22 Loss of Pool Cell Water Single Pool Cell PAG Distances

Approximate Distance At Which PAG (1 rem) Exceeded			
Distance	A Stability	D Stability	F Stability
Kilometers	<0.1	<0.1	<0.1
Miles	<0.06	<0.06	<0.06

The results of the analysis from the airborne release indicate that under severe meteorological conditions this event would be classified as an ALERT classification because the threshold of 0.001 Sv (100 mrem) is exceeded at the facility boundary.

However, the immediate hazard from this event is direct radiation exposure due to loss of shielding water. Analyses documented in Hey (2000) indicated that the dose rate due to the direct gamma-ray shine at a receptor 100 m (328 ft) from the nearest WESF outside wall would be 20 mSv/h (2 rem/h). This dose rate would exceed the 0.01 Sv (1 rem) threshold for declaration of a SITE AREA Emergency within a half-hour. Dose field estimates (documented in Hey, 2000) at various locations in and around WESF, that could hamper recovery activities are provided in HNF-SD-WM-BIO-002, Table 3-32.

The loss of water in a single pool cell creates fatal dose fields within the Pool Cell Area and a field of approximately 120 R/h immediately outside the 225-B structure. Currently there is no control that could be relied upon to terminate this event once capsules have been uncovered. Thus, facility control is effectively lost. Continued progression of the event leads to a gradual evaporative loss of water in the remaining pool cells and thermally induced failure of uncovered capsules. Even though relatively little in the way of airborne release would be expected from capsules initially failed in the single pools, the loss of facility control indicates that this event is a potential initiator to the more severe consequences of loss of water from all pool cells.

6.6.4 Loss of Water from All Pool Cells

Three potential causes of loss of water from all pool cells are loss of water in a single pool cell, failure to add makeup water, and catastrophic pool cell structural failure. Three potential initiators of catastrophic pool cell structural failure are a beyond design basis earthquake, aircraft impact, and explosion in the facility.

The following assumptions were made in developing this scenario:

- The total thermal output of all remaining uncut cesium and strontium capsules as of 01/01/96 is 403 kW (Hey 2000).
- The worst case scenario was a moderate building leakage area equivalent to a 0.1 m^2 (1 ft^2) opening in both the roof and a side wall.
- The capsule storage configuration assumed 1,328 cesium and 600 strontium capsules.
- In comparison to cesium chloride, negligible strontium fluoride would be released.
- Cesium capsules failing due to corrosion or stress were assumed to release 2.9 kg of salt. This is the average net weight of existing uncut cesium capsules.
- The worst case scenario takes no credit for HVAC flow, cooling or HEPA filtration.
- Small leakage areas are modeled such that the building does not become pressurized.

- The transfer ports between the pool cells and the transfer aisle is closed at all times except as part of a predefined operation or an emergency response action.
- The inhalation dose pathway could begin to exist 2 days after the loss of water event and has the potential to overshadow the direct shine dose to all potential receptors (for the offsite receptor it is the only significant dose pathway).

Four building conditions were examined to determine the worst case source term, subsection 3.4.3.3.2.2, HNF-SD-WM-BIO-002 (HNF 2000). 1) HVAC flow with no HEPA filtration: Total Release 1.9E-02 kg; Release Rate 6.1E-05 kg/h, 2) No HVAC but large building leakage: Total Release 2.4E00 kg; Release Rate 3.6E-03 kg/h, 3) No HVAC but small building leakage: Total Release 6.6E+01 kg; Release Rate 1.0E-01 kg/h, and 4) No HVAC but moderate building leakage: Total Release 1.1E+02 kg; Release Rate 1.6E-01 kg/h.

For the purposes of this analysis the worst case release rate will be assumed and an exposure duration of 8 hours at each of the receptor locations. This results in a source term of 1.28 kg of cesium salt released to the environment. Since the specific activity for cesium salt is 1.47E+04 Ci/kg, the resulting source term is 1.88E+04 Ci of ^{137}Cs. HUDU results are shown below:

Table 6.23 Loss of Water from All Pool Cells Consequences

Effective Dose Equivalent (Rem)			
Stability Class	Facility Boundary (.1 km)	Highway 240 (8.3 km)	Site Boundary (11 km)
A	180	0.19	0.15
D	1400	0.98	0.66
F	5700	5.7	4.2

For the three conditions analyzed above, the approximate distances at which the EPA's PAG of 0.01 Sv (1 rem) is exceeded are as follows:

Table 6.24 Loss of Water from all Pool Cells PAG Distances

Approximate Distance At Which PAG (1 rem) Exceeded			
Distance	A Stability	D Stability	F Stability
Kilometers	1.5	8.3	50.1
Miles	0.9	5.2	31.1

The results of this analysis indicate that under severe meteorological conditions this event would be classified as a GENERAL Emergency because the threshold of 0.01 Sv (1 rem) is exceeded at the nearest site boundary.

The immediate hazard from this event is direct radiation exposure due to loss of shielding water. Analyses documented in Hey (2000) indicated that the dose rate due to the direct gamma-ray shine at a receptor 100 m (328 ft) from the nearest WESF outside wall would be 40 mSv/h (4 rem/h). Dose field estimates (documented in Hey, 2000) at various locations in and around WESF, that could hamper recovery activities are provided in HNF-SD-WM-BIO-002, Table 3-35.

7.0 SUGGESTED EVENTS TO DEVELOP EMERGENCY ACTION LEVELS AND EVENT CLASSIFICATIONS

7.1 Toxic Chemical Emergencies

No toxic chemicals exceeding the screening thresholds were identified at WESF.

7.2 Radiological Emergencies

7.2.1 Natural Phenomena

Two seismic events were analyzed in subsection 6.2.1. Events also considered in this section include high winds/tornadoes and ash roof loading.

Seismic Events. Two earthquake scenarios were analyzed for WESF. The first is a design basis earthquake with a peak ground acceleration of 0.25 g and the second is a beyond design basis earthquake with a ground acceleration greater then 0.25 g. It is unlikely that the exact magnitude of an earthquake will be immediately known, therefore based on the worst case analysis, any earthquake which results in damage to facility confinement structures should be classified as a SITE AREA Emergency.

High Winds/Tornadoes. Some damage is expected if high winds or a tornado strike the WESF Facility, such as damage to the external structure, upset of the ventilation system or damage to the exhaust stack. Release of hazardous materials from these type of events is expected to be minor and the consequences are bounded by the analyses of other scenarios.

The buildings have experienced two wind storms in recent years with gust to 3.6E+1 m/second (80 mph) (1972) and 3.4E+1 m/second (75 mph) (1990) with no damage. To maintain consistency with EALs in use at other facilities it is suggested that an ALERT should be declared if sustained winds exceed 4.0E+1 m/s (90 mph) and resulting damage to the facility is observed. And a SITE AREA Emergency should be declared if a tornado strikes the facility and causes damage to facility confinement structures.

Ash Roof Loading. Table 2.1 indicates the estimated ash depth deposited at the Hanford Site from past volcanic eruptions in the region. Although a heavy deposition could present health hazards to site workers due to respiration of ash, water supply contamination, and collapse of some of the older roofs, it is not expected that such an event would cause a significant release from the WESF Facility. There would probably be ample warning of an approaching large ash fall and the facility could be placed in a stable condition and steps taken to protect workers. Therefore, ash fall is not expected to result in a significant loss of control of hazardous material that would require classification as an Operational Emergency.

Potential Event Indicators. Indicators for these types of events which could be used to produce facility specific Emergency Action Levels (EALs) include:

- Personnel observations
- Indications from local seismic stations
- Local or site meteorological system
- Radiation monitor readings from the facility stack, ARMs or CAMs
- And confirmed structural damage to facility confinement. Which may be indicated by personnel

observations, ventilation system differential pressure monitors, activation of exhaust and supply interlocks, and failure of ventilation system components.

7.2.2 External Events

The following events were not specifically analyzed in section 6.0, but could result in consequences that require classification as an Operational Emergency. This accident type considers events which are man made but originate external to WESF, that could have an adverse effect on facility safety. Events discussed include loss of electrical power, aircraft accidents and accidents at nearby facilities such as B Plant.

Loss of Electrical Power. Considered for this event is a severe loss of normal electrical power to all essential motor control centers and failure of the backup diesel generator. Under these conditions the following facility support systems would not be available:

- All ventilation supply and exhaust fans
- All pool cell water recirculation cooling due to loss of power to recirculation pumps
- All CAM alarms, beta monitors, weight factor instruments, etc.

The following concerns are identified as the result of a loss of electrical power:

- Airborne contaminants in the hot cells, K-3 exhaust duct, and the K-3 filter housings may migrate to other areas within the facility and potentially to the environment.
- Inability to remove heat from pool cell water through the heat exchangers
- Potential for hydrogen buildup in the pool cell area and subsequent explosion leading to loss of cooling and makeup water.

Analyses in the WESF BIO (HNF 2000) concludes that the consequences of a loss of ventilation and subsequent loss of confinement would result in localized consequences within the facility, but would result in no significant consequences outside of the facility (see subsection 3.4.2.4). Therefore, this event should not be classified as an ALERT classification or higher.

The loss of power event has been identified as a potential initiator for a hydrogen explosion and rapid water loss or the loss of storage pool cooling capability. These events have been analyzed in subsections 6.2.5 and 6.2.7. Loss of all normal power would likely disable many of the installed facility monitoring systems.

Adjacent Facilities. The closest, and by far the most significant, facility is B Plant. Accidents at B Plant could initiate a subsequent accident at WESF. Or, an accident at B Plant could hamper recovery actions should WESF operating personnel be in the process of responding to a common cause event (e.g., earthquake, loss of power, etc.).

The design basis and beyond design basis earthquakes for B Plant are less severe, 0.12g and 0.20g respectively, than they are for WESF. Unmitigated doses to the onsite receptor from the beyond design basis earthquake are several mSv (rem) (HNF 1999).

The B Plant Safety Analysis Report (HNF 1999) assumes a 221-B Building roof collapse in the snow/ashfall event and a significant release and dose commitment to the onsite receptor. Several hours of warning would be expected for this type of event.

Due to the proximity of B Plant to WESF, any event involving the actual or potential release of hazardous material at B Plant could have serious health and safety implications for WESF personnel. Therefore, it is suggested that the declaration of an Operational Emergency and initiation of protective actions at B Plant should be closely coordinated with the WESF Building Emergency Director.

Aircraft Crash. The range of possible releases from an aircraft crash is quite wide. A light aircraft crash near the facility may not release any material whereas a direct hit from a commercial jet liner could cause extensive damage to the facility and a large release.

The airspace over WESF is declared a no-flight zone for local, low-level flights. Analyses carried out for other site facilities indicate that an aircraft crash into WESF is an extremely unlikely event (Mulestein, 1994). However, such a crash could result in impacts to the radioactive materials present in the facility. The consequences of such an impact could be similar to the beyond design basis earthquake analyzed in subsection 6.2.1, except the facility damage should be more localized and Hanford Site resources more readily available. An aircraft crash could impact the K-3 and K-1 filters, but more severe consequences would be expected if the aircraft impacted the hot cells and/or pool cells in the 225-B Building. The consequences of accidents in these areas have been analyzed above. However, by far the worst case consequences would arise from failed building structural components causing the failure of one or more pool cells (see subsection 6.2.7, Loss of Pool Cell Water).

The consequences of a light private, commercial or military aircraft crash have been bounded by scenarios addressed above. Based on the consequences from the worst-case, it is recommended that any aircraft accident at WESF that results in structural damage breaching the building outer walls or an impact on or near the HEPA filter pits be classified as a SITE AREA Emergency.

Potential Event Indicators. Indicators for these types of events that could be used to produce facility specific Emergency Action Levels (EALs) include:

- Personnel observations
- Notification from adjacent facility
- Radiation monitor readings from the facility stack, ARMs or CAMs
- And confirmed structural damage to facility confinement. Which may be indicated by personnel observations, ventilation system differential pressure monitors, activation of exhaust and supply interlocks, and failure of ventilation system components.

7.2.3 Facility Fires

Fire scenarios were analyzed for the hot cells and the Truckport. Fires which are not rapidly mitigated (e.g., within about 20 minutes) could result in significant release of radioactive material to the environment. The analysis results indicate that fires unmitigated for 20 minutes or longer in A Cell should be classified as an SITE AREA Emergency, in B and C Cells as a GENERAL Emergency, in D and E Cells as a SITE AREA and in the Truckport as a SITE AREA if hot cell waste drums or a loaded WIXM is present. The consequences of a fire in F and G Cells would not exceed the threshold for an ALERT.

Potential Event Indicators. Indicators for these types of events that could be used to produce facility specific Emergency Action Levels (EALs) include:

- Personnel observations
- Building fire detection alarms (activated by smoke, heat or suppression flow) in hot cells or

Truckport areas

- Failure of suppression system to activate, failure to extinguish fire, inability to activate manual hot cell water spray from Operating Gallery

AND

- Alarms from K-3 filter radiation monitors OR K-1 filter air sampler OR facility stack monitor OR ARMs/CAMs

7.2.4 Loss of Confinement

Events analyzed in section 6.0 include high flow in the K-3 system, K-3 system water accumulation, K-3 filter drop, high activity in TK-100 and hot cell hydrogen accumulation.

High Flow in K-3 Ventilation System. The results of the analysis indicate that for a high flow in the K-3 system with failed K-3 HEPA filters, under severe meteorology, the resulting consequences warrant the declaration of a SITE AREA Emergency. Indicators for this event include:

- Personnel observations
- K-3 filter differential pressure monitors

AND

- Alarms from K-3 filter radiation monitors, facility stack monitor OR ARMs/CAMs

K-3 System Water Accumulation/Hydrogen Explosion. Inadvertent accumulation of water and subsequent hydrogen explosion in the K-3 ventilation system results in consequences requiring the declaration of a SITE AREA Emergency. Indicators for this event include:

- Personnel observations (e.g., hot cell flooding is a possible precursor to this event)
- K-3 filter housing sump liquid detection alarm
- Failure of K-3 filter housing sump liquid removal
- Blockage of K-3 airflow (K-3 differential pressure monitors)

AND

- Alarms from K-3 filter radiation monitors, facility stack monitor OR ARMs/CAMs

K-3 Filter Drop. Results indicate that a drop of a K-3 filter housing during maintenance operations should be declared a SITE AREA Emergency. Indicators for this event include:

- Personnel observations

AND

- Alarms from K-3 filter pit radiation monitors

Explosion in TK-100. This event could be caused by accumulating contamination over an extended period of time. The buildup of hydrogen and a subsequent explosion create the potential for a release to he environment. Analysis indicated that under severe meteorological conditions this event would be classified as an ALERT.

Hydrogen Accumulation/Explosion in Hot Cells. This event could be caused by cell flooding with resulting hydrogen explosion. Results indicate that that this event would not create consequences that exceeded the threshold for an ALERT Emergency.

7.2.5 Facility Explosions

Subsection 6.5 discusses potential explosions within the facility. This includes hydrogen gas explosion in the pool cell area, flammable gas explosions and WIXM hydrogen explosion.

Hydrogen Explosion in the Pool Cell Area. Two release mechanisms were analyzed for this scenario. Failed structural components could result in capsule failure or loss of pool cell water. Underwater capsule failure would not require classification due to the airborne release of hazardous materials. Classification of events involving the loss of pool cell water are discussed below.

Hydrogen Explosion in WIXM. A hydrogen explosion in a contaminated WIXM could expel sufficient material to create a SITE AREA emergency.

7.2.6 Loss of Containment

Subsection 6.6.1 analyzes loss of containment events as a result of underwater capsule failure due to drop impacts and the loss of pool cell water.

Underwater Capsule Failure Due to Drop Impacts. A drop impact of a heavy object could result in simultaneous damage to several capsules leading to contamination of the pool cell water. The analysis of this event indicates it would not require classification due to the airborne release of hazardous materials. The immediate hazard from this event results from the elevated dose rates in the pool cell area. For a single capsule damaged by an impact the resulting exposure rate could be as high as 470 R/h at 1 m above the center of the pool. However, neither dose rates or airborne releases would exceed the threshold for an ALERT.

Indicators for this event include:

- Personnel observations
- Pool cell area ARMs/CAMs
- Pool cell in-line beta monitor system

Loss of Pool Cell Water. Two scenarios were examined. The first was a loss of water from one cell and the other involved the loss of water from all cells.

The immediate hazard is direct radiation exposure due to loss of shielding water. Analyses indicated that the dose rate due to the direct gamma-ray shine at a receptor 100 m (328 ft) from the nearest WESF outside wall would be 20 mSv/h (2 rem/h). The loss of water in a single pool cell creates fatal dose fields within the Pool Cell Area and a field of approximately 120 R/h immediately outside the 225-B structure.

Currently there is no control that could be relied upon to terminate this event once capsules have been uncovered. Thus, facility control is effectively lost. Based on the loss of facility control and the immediate dose rate of 20 mSv/h (2 rem/h) at 100 m, this event should be classified as a SITE AREA Emergency.

Continued progression of the event leads to a gradual evaporative loss of water in the remaining pool cells and thermally induced failure of uncovered capsules. Even though relatively little in the way of airborne release would be expected from capsules initially failed in the single pools, the loss of facility control indicates that this event is a potential initiator to the more severe consequences of loss of water from all pool cells.

Indicators for this event include:

- Personnel observations
- Pool cell level instrumentation

- Pool cell area ARMs/CAMs (and other facility ARMs due to high dose rates)
- Pool cell leak detection sump
- Pool cell temperature alarms

Based on the potential airborne release consequences, potential loss of facility control, immediate dose rates and difficulty of mitigation, the loss of all pool cell water should be classified as a GENERAL Emergency. As with the loss of water from one pool cell, the immediate hazards would be the dose rate due to the loss of shielding water. The analyses indicated that the dose rate due to gamma-ray shine at a receptor 100 m (328 ft) from the nearest WESF outside wall would be 40 mSv/h (4 rem/h). Indicators for this event would be similar for those listed above for loss of water from one pool cell.

7.2.7 Safeguards and Security

Malevolent acts involving explosive devices, sabotage, and hostage/armed intruder could result in degradation of facility safety or loss of control over hazardous materials that would warrant the declaration of an event classification. The WESF Vulnerability Assessment (B&W Protec, 1998) was examined to identify any additional conditions that should be addressed by the facility event classification system.

Explosive Device - An actual detonation of an explosive device in an area of the facility containing radioactive materials could result in their release to the environment. The consequences of this type of an event would be similar to or be bounded by the beyond design basis earthquake, aircraft crash or loss of pool cell water scenarios.

Based on the analysis in the WESF Vulnerability Assessment, it is suggested that the discovery, detonation or credible threatened detonation of an explosive device in the area of the K-3 filter pit be classified as a GENERAL Emergency.

Based on the scenarios analyzed in this assessment, it is suggested that the discovery, detonation or credible threatened detonation of an explosive device in any area (other than the K-3 filter pit) of the facility containing hazardous materials be classified as a SITE AREA Emergency.

Sabotage Scenario - Acts of sabotage could result in the release of hazardous material to the environment. For example, the deliberate misrouting of the capsule pool cell cooling water or misoperation of the facility ventilation system.

Confirmed physical damage from sabotage, which causes an actual or potential release of hazardous materials to the environment, should be classified as a SITE AREA Emergency.

Hostage Situation/Armed Intruder. - A confirmed hostage situation, armed intruder, credible security threat, or ongoing security compromise involving physical attack on the WESF site that causes the actual or potential release of hazardous materials should be classified as a SITE AREA Emergency. Some examples of these types of events are as follows:

An armed assault directed at an individual employee, at gaining access to valuable property or classified material, or at causing damage to facility property. The motivation for and objectives of such an assault may not be known until long after the fact. Taking of hostages at the facility undertaken to extort money, materials, or concessions from the DOE, contractor or individual employee. The DOE contractor, or employee, may come under great pressure to meet the perpetrator's demands, some of which may have safety, health or environmental implications.

8.0 THE EMERGENCY PLANNING ZONE

The Emergency Planning Zone (EPZ) is an area within which special planning and preparedness efforts are warranted to mitigate the consequences of a severe accident. DOE Orders endorses the EPZ concept and requires that the choice of an EPZ for each facility be based on an objective analyses of the hazards associated with the facility. The DOE Emergency Management Guide recommends developing a composite EPZ for a group of facilities located in close proximity to one another.

Using the results of facility hazards assessments and the method outlined in the EMG, a composite EPZ for the 200 East Area facilities has previously been established and documented in the Hanford Site Emergency Response Plan. The EPZ includes the area within a 10 mile radius of the geographic center of the 200 East Area. Ten miles, the maximum EPZ radius recommended by the EMG, was based on the combined weight of analysis results for postulated events associated with underground high level waste storage tank (Tank Farms) operations. The EPZ and its bases were reviewed against the results of this hazards assessment. It is concluded that the existing EPZ is still adequate and that no changes to the EPZ are warranted on the basis of this hazards assessment.

The following table contains the dose (TEDE) at the EPZ boundary, under severe meteorological conditions, for the scenarios analyzed in section 6.0 of this report. WESF is less then a mile from the geographic center of the 200 East Area, so a conservative distance of 9 miles to the nearest EPZ boundary was used.

Dose at EPZ Boundary		
Accident Scenario	Section	Dose (rem)
Design Basis Earthquake	6.2.1.2	0.340
Beyond Design Basis Earthquake	6.2.1.3	0.560
A Cell Fire	6.3.2	0.008
B-E Cell Fires	6.3.3	0.920
Truckport Fire	6.3.5	0.002
High Flow in K-3	6.4.1	0.470
K-3 Water Accumulation	6.4.2	0.210
K-3 Filter Drop	6.4.3	0.010
High Activity in TK-100	6.4.4	0.001
WIXM Hydrogen Explosion	6.5.3	0.013
Loss of Water in 1 Pool Cell	6.6.3	0.001
Loss of Water in All Pool Cells	6.6.4	3.1

The only event that exceeds the one rem PAG at the EPZ boundary is the loss of water in all pool cells. This low probability catastrophic event would take days to develop allowing sufficient time to take protective actions.

9.0 MAINTENANCE AND REVIEW OF THIS HAZARDS ASSESSMENT

WESF is responsible for ensuring that this Hazards Assessment is reviewed annually and maintained current. The review requirement is specified in DOE-RL-94-02, section 4.0.

10.0 REFERENCES

Ayer, J.E., et al., 1988, *Nuclear Fuel Cycle Facility Accident Analysis Handbook*, NUREG-1320, Division of Industrial and Medical Nuclear Safety, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC

B&W Protec, 1998. HNF-98-00023, *B Plant/Waste Encapsulation and Storage Facility Vulnerability/Risk Analysis Update*, Safeguards and Security, B&W Protec, Inc., March 23, 1998.

Code of Federal Regulations, Title 10, Part 30.72, Schedule C, as amended.

Code of Federal Regulations, Title 40, Part 355, Appendix A, as amended.

Cushing, 1992, *Hanford Site National Environmental Policy Act (NEPA) Characterization,*

DOE, 1996, *Emergency Management Guide, Guidance for Hazards Assessment*, U.S. Department of Energy, Washington, D.C. 20585.

DOE 1994, Recommended Values and Technical Bases for ARFs, ARRs, and RFs at DOE Non Reactor Nuclear Facilities, DOE-HDBK-3010-94, U.S. Department of Energy, Washington, D.C. 20585.

Hey, B. E., 2000, *Supporting Calculations and Documentation for the WESF Basis for Interim Operation*, HNF-SD-WM-TI-733, Rev. 1B, Fluor Hanford, June 2000.

HNF 1999, HNF-3358 Rev. 0, *B Plant Surveillance and Maintenance Phase Safety Analysis Report*, B&W Hanford Company, October 1999.

HNF 2000, HNF-SD-WM-BIO-002, Rev. 0, *Waste Encapsulation and Storage Facility Basis for Interim Operation,* Fluor Hanford, November 2000.

Homann, 1993, *Emergency Predictive Information Code*, Homann Associates, INC., Fremont, CA.

Mulestein, L. D., 1994. *Additional analysis related to the Multi-Function Waste Tank Facility*, WHC-SD-W236A-ANAL-002, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Scherpelz, R. I., 1991, *HUDU - The Hanford Unified Dose Utility Computer Code*, PNL-7636, Pacific Northwest Laboratory, Richland, Washington.

Stone, W.A., D.E. Jenne, and J.M. Thorp, 1972, "Climatography of the Hanford Area," BNWL-1605, Pacific Northwest Laboratories, Richland, Washington.

Wagenblast, G., K. C. Tu, and F. R. Vollert, 1999, *WESF Natural Phenomena Hazards Survey*, HNF-SD-WM-DB-034, Rev. 1A, Fluor Hanford, October 1999.

WHC, 1996. *FAI/96-1 Thermal Analysis of Hypothetical WESF Pool Drain Accidents*, WHC-SD-WM-TI-770, Rev. 0, Westinghouse Hanford Company, Richland, Washington.