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Basis for Interim Operation for Fuel Supply Shutdown Facility

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

Fluor Hanford
P.O. Box 1000
Richland, Washington

Contractor for the U.S. Department of Energy
Richland Operations Office under Contract DE-AC06-96RL13200

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MW Benecke, Fluor Hanford

February 2003

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EXECUTIVE SUMMARY

Introduction

This document establishes the Basis for Interim Operation (BIO) for the Fuel Supply Shutdown (FSS) Facility in accordance with the requirements of the Project Hanford Management Contract procedure (PHMC) HNF-PRO-700, *Safety Basis Development*. U.S. Department of Energy (DOE) Orders, DOE Order 5480.21, *Unreviewed Safety Questions* (USQ), DOE Order 5480.22, *Technical Safety Requirements* (TSR), and DOE Order 5480.23, *Nuclear Safety Analysis Reports* (SAR), impose requirements to upgrade nuclear facility safety documentation. This BIO has been developed by revising the document HNF-SD-NR-ISB-001, Rev. 1, *Interim Safety Basis for Fuel Supply Shutdown Facility* so that it meets the requirements of DOE-STD-3011-94, *Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans*. Furthermore, this BIO is compliant with the requirements of 10 CFR 830, Subpart B, Section 204, *Documented Safety Basis* (CFR 2001).

This BIO, supporting analyses, and Technical Safety Requirements (TSR) provide the required basis for the transitional activities identified for the FSS Facility to be transferred to the River Corridor Closure contractor. Also, the BIO, supporting analyses, and TSRs provide the safety basis for consideration of USQ issues as defined in DOE Order 5480.21 and HNF-PRO-062, *Unreviewed Safety Question Process*.

At this time, this BIO and TSRs apply only to the 303-B, 3712, and 3716 uranium storage buildings.

Summary of Operational History and Current and Future Missions

The 300 Area occupies about 1.6 km^2 (0.6 mi^2) of land. The 300 Area is located within the southeast corner of the Hanford Site. It is bounded by the Columbia River on the east and by the Hanford Site Route 4 to the west. The Hanford Site's southern boundary is about 1.7 km (1.1 mi) north of the Richland city limits and about 11 km (6.8 mi) north of the city center. The nearest residence to the 300 Area is about 1.5 km (0.9 mi) to the east, across the Columbia River. A number of irrigated farms are located immediately across the river from the 300 Area. The nearest city water intake is the Richland city pumping station 6 km (3.7 mi) downstream from the 300 Area.

The FSS Facility is located in the northeast corner of the 300 Area. The facility includes the following buildings with noncontiguous boundaries: 313, 333, 303-A, 303-B, 303-E, 303-G, 303-K/3707-G, 303-M, 304, 334 (and Tank Farm), 334-A, 3712, 3716, MO-052 (office trailer), and the Outside Storage and Transfer System including the 311 Tank Farm and the 303-F Pump House. The FSS Facility is managed by the 300 Area Deactivation Project (ADP) organization reporting to the Central Plateau Remediation Project.

Underlying the area to the east of the 333 Building is an inactive low-level radioactive solid waste burial ground (current Hanford Site waste management identification number 618-1, formerly referred to as 300 Area No. 1 Burial Ground). The burial ground and activities involving it are not addressed by this BIO; the burial ground is a part of the "Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)" (WHC 1989).

The history of the facility began in 1943 when the 313 Building was constructed to house manufacturing equipment for production of fuel for the Hanford single pass reactors. Fuel production began in mid-1944 and continued through the early 1950s. The facility was then 0expanded to allow for increased fuel production. In the late 1960s, a process, which included nickel-plating of the bare uranium cores prior to cladding, was developed and installed. This process continued until 1971, when the six production lines were shut down concurrent with the shutdown of the single pass reactors. Other programs conducted near the 313 Building include support of a tritium production program from 1948 to 1952 and a thorium program in the mid 1960s. For N Reactor fuel fabrication, the 313 Building housed a waste treatment system, administrative offices, and training and warehouse space. This building also housed a complete N Reactor pressure tube fabrication facility consisting of a 4000-ton Sutton extrusion press, draw bench, grinders, an autoclave, inspection equipment, and chemical cleaning equipment. The Commercial Hanford Metal Working process equipment has been sold to a commercial company, and the north section of the 313 Building has been leased for the commercial operation of the extrusion equipment. Operations ceased in late 2001 and the extrusion press has been relocated.

The 333 Building, constructed in 1958, houses the primary fabrication equipment formerly used for manufacturing N Reactor fuel, which began in 1962. From 1965 to 1967, the building was also used to assemble lithium aluminate targets for demonstration of co-production in the N Reactor. The building contained equipment for all operations from initial component cleaning to finished fuel assembly, inspection, and packaging for shipment. Fabrication activities continued until N Reactor entered the standby phase in 1987, and at that time, the facility also began transition to standby status. Other buildings comprising the facility provide storage space for fuel materials and finished fuel, and contain residual process equipment that supported fuel production.

The facility is currently undergoing transition activities required for permanent closure and subsequent decontamination and decommissioning (D&D). In this context, improvements are measured in terms of progress made in implementing activities associated with disposition of residual uranium inventories, removal of chemical inventories, removal/stabilization of radiological and chemical contamination, and deactivation of facility utilities and services. The removal of bulk chemical inventories was completed in April 1991, and disposal of the unirradiated uranium inventory is in progress. Transfer of 706 metric tons of uranium (MTU) (in the form of extrusion billets) to the United Kingdom was completed in September 1996. Another 235 MTU in billet form were transferred to the Oak Ridge Operations (ORO) Portsmouth Site in 2001. Also in 2001, 135 MTU in fuel form was sent to the Hanford Site Low-Level Burial Ground. Uranium disposition activities during FY 2001 consolidated storage of fuel assemblies, partially completed fuel assemblies, and scrap into three storage buildings. Activities associated with disposal and/or interim storage of the remaining inventory are continuing. Decontamination and waste disposal activities are also in progress.

Summary of Results of Safety Analysis

Safety analyses have been performed for the FSS Facility to establish a technical justification for the BIO conclusion that the FSS Facility does not represent an undue risk to the public, workers, or the environment. The analyses provide a basis for the FSS Technical Safety Requirements. This document summarizes and references the several safety analyses that were performed and describes the rationale upon which it was concluded that the current and future FSS Facility cleanup, fuel storage, and fuel handling and packaging activities associated with anticipated uranium disposition are within the risk guidelines. Additionally, none of the postulated accident consequences exceed the Safety Class criteria of recent guidance from DOE-Richland Operations (DOE-RL 2002).

Facility Hazard Classification

A hazard classification was prepared for the FSS Facility in accordance with DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (DOE 1992d). This has been updated to reflect a reduction of hazards resulting from facility shutdown activities (Benecke 2003a).

The hazard categorization was prepared based on a conservative Material At Risk (MAR) for the FSS Facility based on the bounding accident (see Section 3.2.2). FSS uranium fuel storage buildings have been assigned a hazard classification of Nuclear Facility, Category 3; other FSS Facility buildings are classified as Industrial.

Summary of Safety Assurance Programs

The following facility specific and site generic configuration management control systems regulate the operation and configuration of the FSS Facility:

Technical Safety Requirements (Benecke, et al., 2003b)

The principal 300 Area Deactivation Project (300 ADP) administrative controls that are the basis for the safety envelope and associated accident safety analyses and, as such, must be maintained for the validity of the safety envelope are identified in the TSRs.

Classification of Safety Systems

Accidents deserving consideration have been analyzed with focus on the fire loading of the 3712 Building and the associated worst-case fire. Analysis shows that no Safety Significant or Safety Class structures, systems, or components (SSC) are warranted.

Generic Institutional Controls and Safety Programs

The generic institutional controls and safety programs to assure maintenance of FSS in a configuration that supports the defined safety envelope include the following:

- Radiation Protection,
- As Low As Reasonably Achievable (ALARA),
- Occupational and Industrial Safety,
- Fire Protection,
- Industrial Hygiene,
- Criticality Safety,
- Training,
- Radioactive Waste Management,
- Occurrence Reporting,
- Quality Assurance,
- Configuration Management,
- Conduct of Operations,
- Emergency Planning,
- Maintenance, and
- Environmental Protection.

Summary of Facility Vulnerabilities

This BIO concludes that the FSS Facility has no specific vulnerabilities that require special controls.

Summary of Compensatory Measures and Restrictions on Interim Operations

This BIO concludes that no specific compensatory measures are warranted and that there is no need for restrictions on interim operations for the FSS Facility. Appropriate controls are defined by the TSRs (Benecke, et al., 2003b).

Basis for Safe Operation

This BIO concludes that the risks associated with the current and planned operational mode of the FSS Facility (uranium storage, uranium repackaging and shipment, cleanup, and transition activities, etc.) are acceptable. The potential radiological dose and toxicological consequences for a range of credible fires, including a uranium storage building fire, have been analyzed using Hanford accepted methods. Table 1.6-1 summarizes representative event frequencies, consequences, and risk classes per DOE evaluation guidelines (DOE-RL 2002). In all cases, the predicted consequences are substantially below the evaluation guidelines. Administrative controls are established on housekeeping and inventory control to protect assumptions regarding source term, and on the criticality safety program. Additional administrative programs are established as defense-in-depth to maintain the storage buildings fire protection systems and maintain the site radiological control program.

It is also concluded that because an accidental nuclear criticality is not credible based on the low uranium enrichment, the form of the uranium, and the required controls, a Criticality Alarm System (CAS) is not required.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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BASIS FOR INTERIM OPERATION FOR FUEL SUPPLY SHUTDOWN FACILITY

1.0 INTRODUCTION AND SUMMARY

1.1 Purpose

This document establishes the Basis for Interim Operation (BIO) for the Fuel Supply Shutdown Facility (FSS) as managed by the 300 Area Deactivation Project (300 ADP) organization in accordance with the requirements of the Project Hanford Management Contract procedure (PHMC) HNF-PRO-700, *Safety Analysis and Technical Safety Requirements*. U.S. Department of Energy (DOE) Orders, DOE Order 5480.21, *Unreviewed Safety Questions* (USQ), DOE Order 5480.22, *Technical Safety Requirements* (TSR), and DOE Order 5480.23, *Nuclear Safety Analysis Reports* (SAR), impose requirements to upgrade nuclear facility safety documentation. This BIO has been developed by revising the document HNF-SD-NR-ISB-001, Rev. 1, *Interim Safety Basis for Fuel Supply Shutdown Facility* so that it meets the requirements of DOE-STD-3011-94, *Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans*. Furthermore, this BIO is compliant with the requirements of 10 CFR 830, Subpart B, Section 204, *Documented Safety Basis* (CFR 2001).

This BIO, supporting analyses, and TSRs provide the required basis for the transitional activities identified for the FSS to be transferred to the River Corridor Closure contractor. Also, the BIO, supporting analyses, and TSRs provide the safety basis for consideration of USQ issues as defined in DOE Order 5480.21 and HNF-PRO-062, *Identifying and Resolving Unreviewed Safety Questions*.

1.2 Status of Facility Improvements

The facility is currently undergoing transition activities required for permanent closure and transfer to the Environmental Restoration Contractor (ERC) for decontamination and decommissioning (D&D). In this context, progress is measured in terms of implementing activities associated with disposition of residual uranium inventories, removal of chemical inventories, removal/stabilization of radiological and chemical contamination, and deactivation of facility utilities and services. The removal of bulk chemical inventories was completed in April 1991, and disposal of the unirradiated uranium inventory is in progress. Transfer of 706 MTU (in the form of extrusion billets) to the United Kingdom was completed in September 1996. Another 235 MTU of billets were transferred to the Oak Ridge Operations (ORO) Portsmouth Site in 2001. Also, 135 MTU in the form of contaminated fuel assemblies were transferred to the Hanford Site Low-Level Burial Ground in 2001. Uranium disposition activities during FY 2001 consolidated storage of fuel assemblies, partially completed fuel assemblies, and scrap being stored in three storage buildings. Activities associated with disposal and/or interim storage of the remaining inventory are continuing. Decontamination and waste disposal activities are also in progress.

1.3 Safety Basis Documentation Upgrades

This BIO has been prepared to be responsive to the requirements of 10 CFR 830, Subpart B, Section 204, and is based on the DOE-approved Interim Safety Basis (ISB) for the FSS Facility (Benecke 2000). The ISB was originally prepared following shutdown of the N Reactor Fuel Fabrication Facility (which now is represented by the FSS Facility) to provide appropriate controls for safe management of the operations associated with continuing storage of the remaining uranium and chemical inventories and to initiate overall deactivation activities. The ISB was prepared to be responsive to the "Implementation Plan for DOE Orders 5480.21, 5480.22, and 5480.23," reference letter, J. M. Knoll, Westinghouse Hanford to R. D. Larson, DOE Richland Field Office (RL), same subject, 9257875, dated October 28, 1992. The following safety analyses were prepared to support that ISB – some of these have been updated and revised to support changes in facility status; most are invoked as-is, with appropriate updates to the analyses being incorporated into revisions of the ISB and this BIO.

Facility Hazard Analysis (Johnson and Brehm 1994)

A facility hazard analysis was prepared by a multi-disciplined team including representatives from the facility to identify hazards, energy sources, potential accidents and sequences, targets for potential accident consequences, available mitigating barriers, and qualitative accident severity levels. The most significant accidents were evaluated further in the accident safety analysis. Hazards and potential accidents were evaluated for each FSS Facility building, including the non-uranium storage buildings.

Accident Safety Analysis and Associated Dose Consequences (Johnson 1994)

Accident safety analysis scenarios were analyzed based on the significant events identified in the facility hazard analysis (Johnson and Brehm 1994) and the initial fire hazard analysis, which was updated in response to changing facility conditions using site-specific meteorological conditions and analysis methodology.

Fire Hazards Analysis (Myott 2002)

Fire hazards analyses have been prepared that address the FSS Facility and associated fire and safety systems, the fire loading and potential fire exposure, fire systems, and Hanford Fire Department response to fires. These have established a basis for the accident safety analysis (Johnson 1994) and the fire criticality probability analysis (Kelly 1995).

Fire Criticality Probability Analysis (Kelly 1995)

This probability analysis shows that no credible accident scenario has been postulated that could result in a criticality. Therefore, per DOE Order 420.1, Facility Safety (DOE 2000), a criticality detection and alarm system is not required.

Criticality Safety Evaluation (Schwinkendorf 1995)

Criticality safety support calculations for the FSS Facility were performed to update values currently found in the criticality prevention specifications. In addition, certain accident or upset conditions were analyzed. These scenarios include fire, the bringing together of multiple masses into one neutronically coupled system, mis-stacking, and accidental interspersed moderation.

Hazard Classification (Benecke 2003a)

A hazard classification was prepared for the FSS Facility in accordance with DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (DOE 1992d). This has been updated to reflect a reduction of hazards resulting from facility shutdown activities. The hazard categorization was prepared based on a conservative Material At Risk for the FSS Facility based on the bounding accident (see Section 3.2.1). FSS uranium fuel storage buildings have been assigned a hazard classification of Nuclear Facility, Category 3; other FSS Facility buildings are classified as Industrial.

Technical Safety Requirements (Benecke, et al., 2003b)

TSRs have been prepared based on this BIO. Controls are provided to ensure risk remains within the evaluation guidelines of DOE-RL 2002.

Uranium Storage Building Fire Scenario (Benecke 2002)

Fire probability and consequences were updated to reflect new data regarding probability and the changed configuration of the remaining uranium inventory.

1.4 Summary of Safety Assurance Program

During shutdown and fuel disposal activities, essential services and buildings will be maintained in a safe and stable environmental condition to protect personnel, the public, and property in accordance with appropriate requirements.

The TSRs (Benecke, et al., 2003b) are controls that define the safety envelope and are based on the accident safety analyses. These controls are:

a) Limits on uranium and beryllium (which is associated with the uranium fuel elements), and combustible material inventories in individual storage buildings to limit consequences of the potential fire,

b) Requirements to maintain the fire protection systems.

c) Maintaining the criticality safety program, including maintaining the criticality drains in the uranium storage buildings.

d) Mode control of the uranium storage buildings.

e) Requirements to maintain a radiation protection program, and

f) Requirements to maintain a configuration management program.

Classification of Safety Systems

Accidents with significant consequences have been analyzed. No dependence on systems, structures, or components (SSC) is required to ensure that the consequences of worst-case accidents or events do not exceed the risk guidelines.

Generic Institutional Controls and Safety Programs

The generic institutional controls and safety programs to assure maintenance of the FSS Facility in a configuration that supports the defined safety envelope include the following:

- Radiation Protection,
- As Low As Reasonably Achievable (ALARA),
- Occupational and Industrial Safety,
- Fire Protection,
- Industrial Hygiene,
- Criticality Safety,
- Training,
- Radioactive Waste Management,
- Occurrence Reporting,
- Quality Assurance,
- Configuration Management,
- Conduct of Operations,
- Emergency Planning,
- Maintenance, and
- Environmental Protection.

1.5 Summary of Safety Analyses

Safety analyses have been performed for the FSS Facility to establish a technical justification for the BIO conclusion that the FSS Facility does not represent an undue risk to the public, workers, or the environment. The analyses provide a basis for the FSS TSRs. This document summarizes and references the several safety analyses that were performed and describes the rationale upon which it was concluded that the current and future FSS Facility cleanup, fuel storage, and fuel handling and packaging activities associated with anticipated uranium disposition are within the risk guidelines. Additionally, none of the postulated accident consequences exceed the Safety Class criteria of recent guidance from DOE-RL (DOE-RL 2002).

1.6 Conclusions

A hazard classification (Benecke 2003a) has been prepared for the facility in accordance with DOE-STD-1027-92 resulting in the assignment of Hazard Category 3 for FSS Facility buildings that store N Reactor fuel materials (303-B, 3712, and 3716). All others are designated Industrial buildings.

It is concluded that the risks associated with the current and planned operational mode of the FSS Facility (uranium storage, uranium repackaging and shipment, cleanup, and transition activities, etc.) are acceptable. The potential radiological dose and toxicological consequences for a range of credible uranium storage building have been analyzed using Hanford accepted methods. Risk Class designations are summarized for representative events in Table 1.6-1. Mitigation was not considered for any event except the random fire event that exceeds predicted consequences based on existing source and combustible loading because of an inadvertent increase in combustible loading. For that event, a housekeeping program to manage transient combustibles is credited to reduce the probability. An additional administrative control is established to protect assumptions regarding source term by limiting inventories of fuel and combustible materials. Another is established to maintain the criticality safety program. Additional defense-in-depth controls are established to perform fire protection system testing, inspection, and maintenance to ensure predicted availability of those systems, and to maintain the radiological control program.

It is also concluded that because an accidental nuclear criticality is not credible based on the low uranium enrichment, the form of the uranium, and the required controls, a Criticality Alarm System (CAS) is not required as allowed by DOE Order 420.1 (DOE 2000).

Table 1.6-1. Summary of Representative Events and Risk Classes

EVENT	RADIOLOGICAL CONSEQUENCES		TOXICOLOGICAL CONCENTRATION		RISK CLASS	
	Onsite[a]	Offsite[b]	Onsite[a]	Offsite[b]	Onsite[a]	Offsite[b]
Random Fire, Consequences (Anticipated)	3.4 mSv (0.34 rem) (Low)	0.22 mSv (0.022 rem) (Low)	Be: 14.8 μg/m^3 (Low) U: 0.30 mg/m^3 (Low)	Be: 1.00 μg/m^3 (Low) U: 0.020 mg/m^3 (Low)	**Radiological**: III **Toxicological**: III	**Radiological**: III **Toxicological**: III
Fire associated with Inadvertent Combustible Material Increase (Anticipated)	5.1 mSv (0.51 rem) (Low)	0.33 mSv (0.033 rem) (Low)	Be: 22.2 μg/m^3 (Low) U: 0.45 mg/m^3 (Low)	Be: 1.5 μg/m^3 (Low) U: 0.052 mg/m^3 (Low)	**Radiological**: III **Toxicological**: III	**Radiological**: III **Toxicological**: III
Package Boiler Related Fire, Aircraft Crash, Vehicle Impact Event Consequences (Extremely Unlikely)	58 mSv (5.8 rem) (Low)	3.7 mSv (370 mrem) (Low)	Be: 59 μg/m^3 (Mod) U: 5.1 mg/m^3 (Mod)	Be: 4.0 μg/m^3 (Low) U: 0.35 mg/m^3 (Low)	**Radiological**: IV **Toxicological**: IV	**Radiological**: IV **Toxicological**: IV
BLEVE Induced Seismic Induced Fire, Consequences (Extremely Unlikely)	3.4 mSv (0.34 rem) (Low)	0.22 mSv (0.022 rem) (Low)	Be: 14.8 μg/m^3 (Low) U: 0.30 mg/m^3 (Low)	Be: 1.00 μg/m^3 (Low) U: 0.020 mg/m^3 (Low)	**Radiological**: IV **Toxicological**: IV	**Radiological**: IV **Toxicological**: IV

a Onsite – 100 m east.
b Offsite – 490 m east at adjacent river bank.

All unmitigated representative accidents identified in Table 1.6-1 are Risk Class III or IV.

2.0 SITE, FACILITY AND ORGANIZATION DESCRIPTION

2.1 Hanford Site and 300 Area Description

The DOE Hanford Site lies within the semi-arid Pasco Basin, part of the Columbia Plateau in southeastern Washington State (Figure 2.1-1). The Hanford Site occupies an area of about 1,500 km^2 (560 mi^2) and is about 48 km (30 mi) north to south and 38 km (24 mi) east to west. This land area, with restricted public access, presently provides a buffer for the smaller areas currently used for nuclear materials storage, waste storage, and waste disposal. The Columbia River flows through the northern part of the Hanford Site, and forms part of the eastern boundary as it turns south. The Yakima River runs along part of the southern boundary and joins the Columbia River near the City of Richland. Adjoining lands to the west, north, and east are principally range and agricultural land. The cities of Richland, Kennewick, and Pasco (known as the Tri-Cities) comprise the nearest population center and are located southeast of the Hanford Site.

Figure 2.1-1 shows the major areas of the Hanford Site. The Hanford Site was initially established in 1943 for production of plutonium by the U.S. Government through the exercise of eminent domain for the Manhattan Project. Current activities on the Hanford Site include lay up of Fast Flux Test Facility (FFTF) reactor, lay up of fuel reprocessing plants, waste management, laboratory operations, ecological studies, and operation of the Energy Northwest Nuclear Plant No. 2.

Figure 2.1-1. Location of Hanford Site.

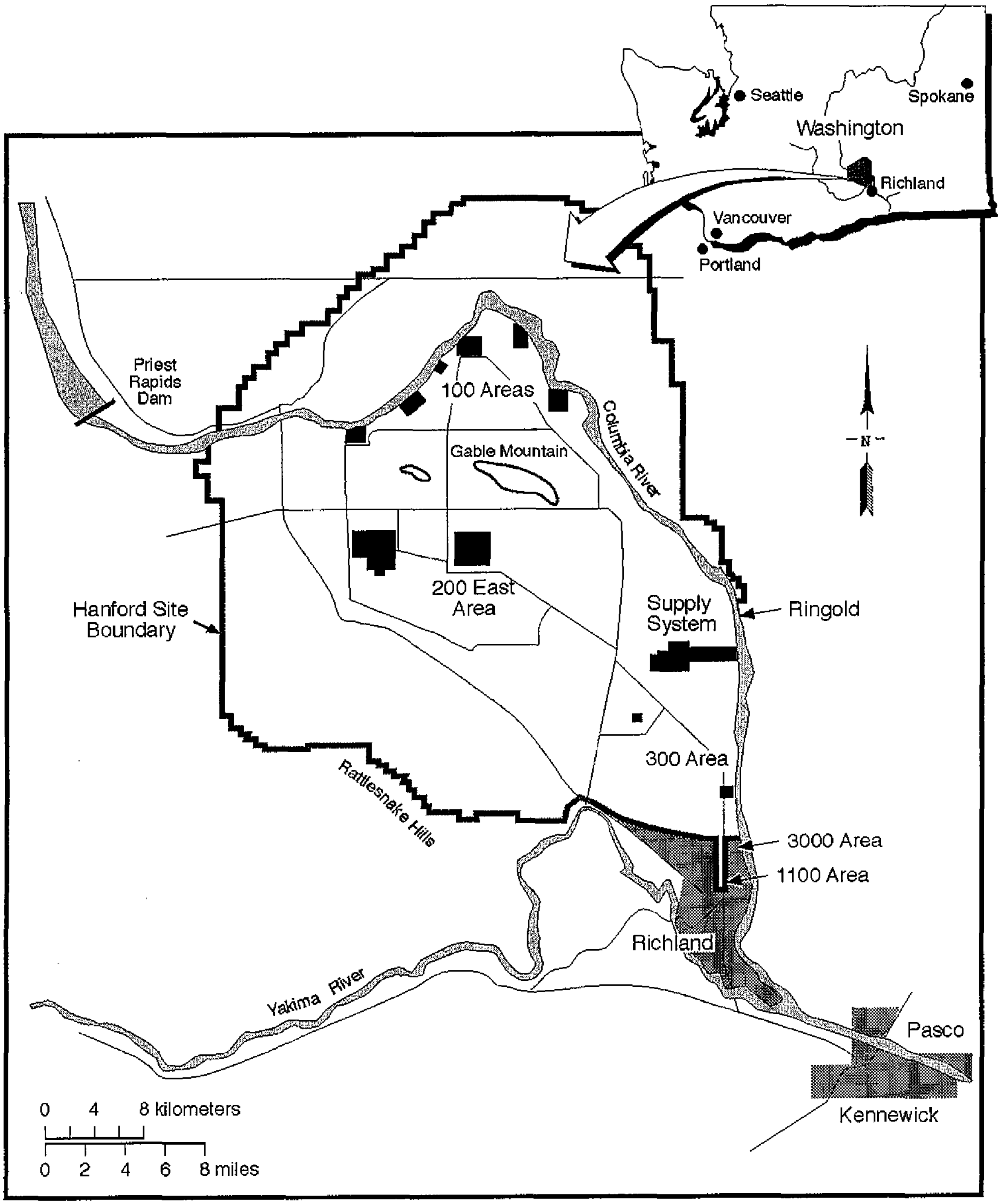

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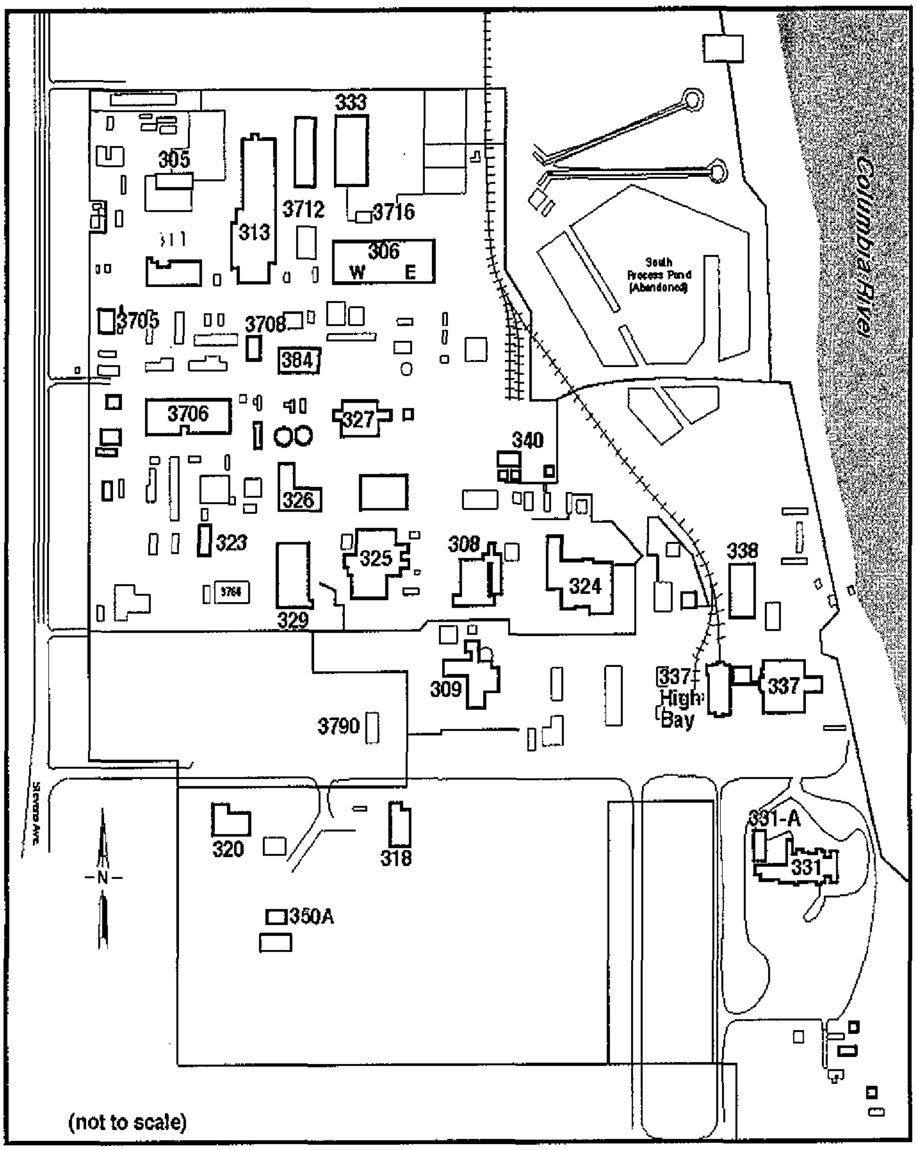
Figure 2.1-2. Hanford 300 Area Detail.

"300 Area"



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The 300 Area occupies about 1.6 km^2 (0.6 mi^2) of land. See Figure 2.1-2 for the principal 300 Area buildings. The 300 Area is located within the southeast corner of the Hanford Site. It is bounded by the Columbia River on the east and by the Hanford Site Route 4 to the west. The Hanford Site's southern boundary is about 1.7 km (1.1 mi) north of the Richland city limits and about 11 km (6.8 mi) north of the city center. The nearest residence to the 300 Area is about 1.5 km (0.9 mi) to the east, across the Columbia River. A number of irrigated farms are located immediately across the river from the 300 Area. The nearest city water intake is the Richland city pumping station 6 km (3.7 mi) downstream from the 300 Area.

2.2 Fuel Supply Shutdown Facility

2.2.1 Background and Facility Description

The Fuel Supply Shutdown facility is managed by the 300 ADP organization reporting to the Central Plateau Remediation Project. The facility is located in the northeast corner of the 300 Area (see Figure 2.1-1). The facility includes the following buildings with noncontiguous boundaries: 313, 333, 303-A, 303-B, 303-E, 303-G, 303-M, 304, 334 (and Tank Farm), 334-A, 3712, 3716, MO-052 (office trailer), and the Outside Storage and Transfer System including the 311 Tank Farm and the 303-F Pump House (see Figure 2.2.2-1).

Underlying the area to the east of the 333 Building is an inactive low-level radioactive solid waste burial ground (current Hanford Site waste management identification number 618-1, formerly referred to as 300 Area No. 1 Burial Ground). The burial ground and activities involving it are not addressed by this BIO; the burial ground is a part of the "Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)" (WHC 1989).

The history of the facility began in 1943 when the 313 Building was constructed to house manufacturing equipment for production of fuel for the Hanford single pass reactors. Fuel production began in mid-1944 and continued through the early 1950s. The facility was then expanded to allow for increased fuel production. In the late 1960s, a process, which included nickel-plating of the bare uranium cores prior to cladding, was developed and installed. This process continued until 1971, when the six production lines were shut down concurrent with the shutdown of the single pass reactors. Other programs conducted near the 313 Building included support of a tritium production program from 1948 to 1952 and a thorium program in the mid-1960s. For N Reactor fuel fabrication, the 313 Building housed a waste treatment system, administrative offices, and training and warehouse space. This building also housed a complete N Reactor pressure tube fabrication facility consisting of a 4000-ton Sutton extrusion press, draw bench, grinders, an autoclave, inspection equipment, and chemical cleaning equipment. The Hanford Metal Working process equipment has been sold to a commercial company, and the north section of the 313 Building has been leased for the commercial operation of the extrusion equipment. In January 2002, commercial operations (and the extrusion press) were relocated.

The 333 Building, constructed in 1958, houses the primary fabrication equipment for manufacturing N Reactor fuel, which began in 1962. From 1965 to 1967, the building was also used to assemble lithium aluminate targets for demonstration of co-production in the N Reactor. The building contained equipment for all operations from initial component cleaning to finished fuel assembly, inspection, and packaging for shipment. Fabrication activities continued until N Reactor entered the standby phase in 1987, and at that time, the facility also began transition to standby status. Other buildings comprising the facility provide storage space for fuel materials and finished fuel, and contain residual process equipment that supported fuel production. At this time, the FSS complex is in transition from standby status and undergoing cleanup and shutdown activities required for permanent closure and transfer to the River Corridor Closure contractor. The individual buildings are listed in Table 2.2.1-1 with their function/activity and facility classifications.

Table 2.2.1-1. Fuel Supply Shutdown Facility Building Identification, Current Function/Activity, and Hazard Category.

BUILDING	CURRENT FUNCTION/ACTIVITY	HAZARD CATEGORY*
303-A	Empty **	Industrial
303-B	Fuel Storage (39 MTU)	Nuclear Cat 3
303-E	Empty**	Industrial
303-F/311-Tank Farm	RCRA Clean Closed	Industrial
303-G	Empty**	Industrial
303-K/3707-G	RCRA Closure Demolished	N/A
303-M	Uranium Oxide Facility (Shutdown)	Industrial
304	RCRA Clean Closed (Empty **)	Industrial
313-South	RCRA Clean Closed	Industrial
313-North	Private enterprise metal fabrication operations have ceased; Empty**	Industrial
333	Cleanup/RCRA Clean Closed	Industrial
334 and Tank Farm	Empty**	Industrial
334-A	RCRA Clean Closed (Empty**)	Industrial
3712	Finished Fuel, and Scrap Storage (647 MTU)	Nuclear Cat 3
3716	Unfinished Uranium Fuel Storage (137 MTU)	Nuclear Cat 3
MO-052	Offices (Vacated)	Industrial

NOTE: MTU = Metric Ton Uranium.
* Facility Hazard Category (See Section 3.1.2).
** Empty signifies no fuel materials, hazardous materials, or equipment.

2.2.2 Building Description, Construction, and Status

Descriptions of the individual nuclear facility buildings including their size, construction, fire protection systems, and status are included below. See Figures 2.1-2 and 2.2.2-1 for layout of the buildings with respect to other buildings in the 300 Area. Individual building layouts are shown in Figures 2.2.2-2, 2.2.2-3 and 2.2.2-4.

Building 303-B Fuel Storage

Description: The structure is single story, 120.4 m^2 (1,296 ft^2), 8.2 m by 14.6 m (27 ft by 48 ft), concrete block and cement construction, three doors, no windows. The roof is 15.3 cm (6 in.) pre-cast concrete slab covered with felt, tar, and gravel. There are four 25 cm (10 in.) diameter holes in the sidewalls at floor level for water drainage. The building is unheated. The building is equipped with an automatic fire alarm and sprinkler (dry) systems with freeze protection in the valve room.

Status: The 303-B Building, which contains unirradiated fuel elements (wrapped in plastic) taken from N Reactor that were contaminated with fission and activation products (max removable contamination approximately 50,000 dpm), is used to store uranium materials. The building is kept locked and Tamper Indicating Device (TID) sealed when unoccupied and fissionable material is being stored.

Building 3712 Finished Fuel, Billet and Scrap Storage

Description: The 3712 Building is a single story steel frame structure, 27.4 m x 32.9 m (90 ft by 108 ft), with metal panel siding and roof, and a concrete floor and foundation. It is equipped with an automatic fire alarm and sprinkler (dry) system with freeze protection in the valve room. The steam heated forced-air system has been disconnected. There are no floor drains. The building floor is at or above grade, and the structure is supported approximately 8 in. above the floor on a concrete curb. Water accumulation would naturally be retained by this curb; however, there are two 5-m (16-ft) wide roll-up doors, with 11 cm (4.5 in.) high flaps at the bottom for drainage and two 2.4 m (8 ft) and two 1 m (3 ft) doors. An insulated wall divides the north and south ends. The south end is also served by an electric recirculating positive pressure HVAC system (with no stack), which is generally used only when the area is occupied.

Status: The building is used for storage of finished fuel in wooden boxes, and uranium scrap and standards. The south end of the building was modified to support the campaign to repackage billets for shipment to the United Kingdom. This area may be used in the future to support fuel disposition efforts. The building is kept locked and TID-sealed when unoccupied and fissionable material is being stored.

Building 3716 Unfinished Uranium Fuel Storage

Description: The 3716 Building is a single story, 12.2 m by 24.4 m (40 ft x 80 ft) aluminum frame building with corrugated aluminum siding and roof. The building is equipped with an automatic alarm and a sprinkler (dry) system with freeze protection in the valve room. It has a grate at the bottom of the west roll-up door for potential water drainage.

Status: The building is used for storage of unfinished fuel pieces capped with plastic caps in wooden boxes. The building is kept locked and TID-sealed when unoccupied and fissionable material is being stored.

Figure 2.2.2-1. Fuel Supply Shutdown Facility Layout

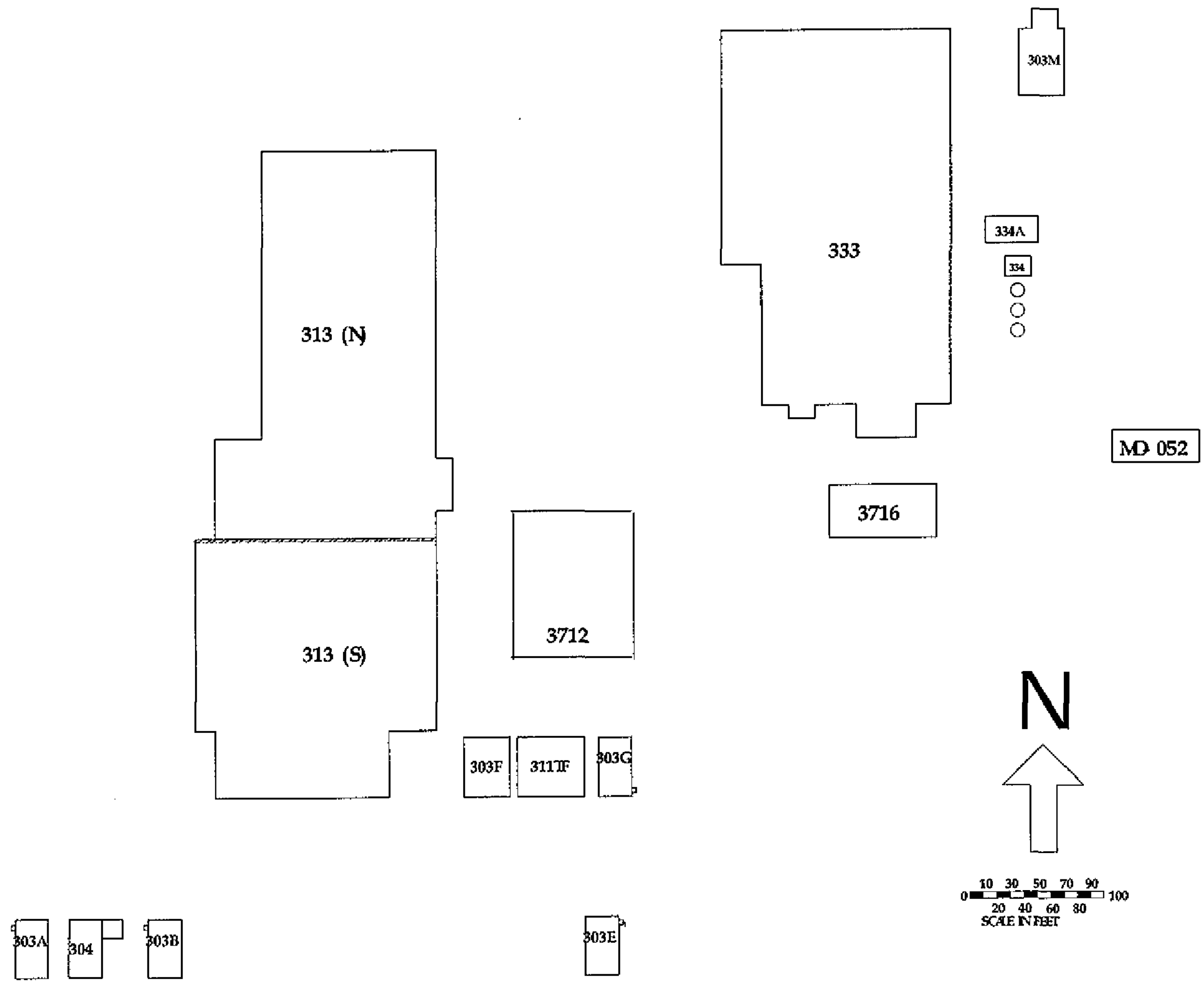
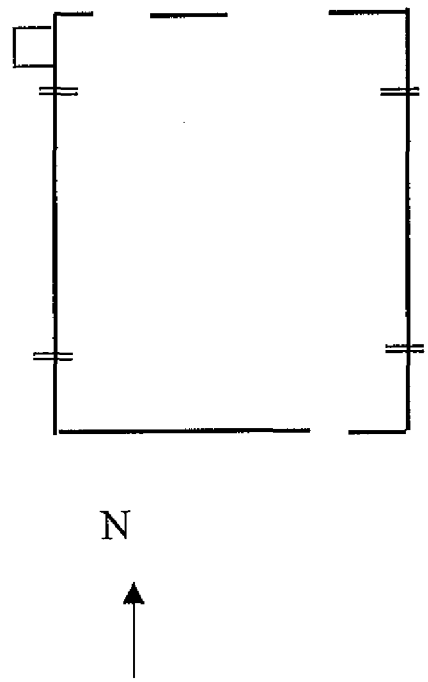


Figure 2.2.2-2. Building 303-B



___ : 10" dia drain hole at floor level

303-B has a 4' and a 5' wide door on North end and a 3'wide door on the South end.

Figure 2.2.2-3. Building 3712

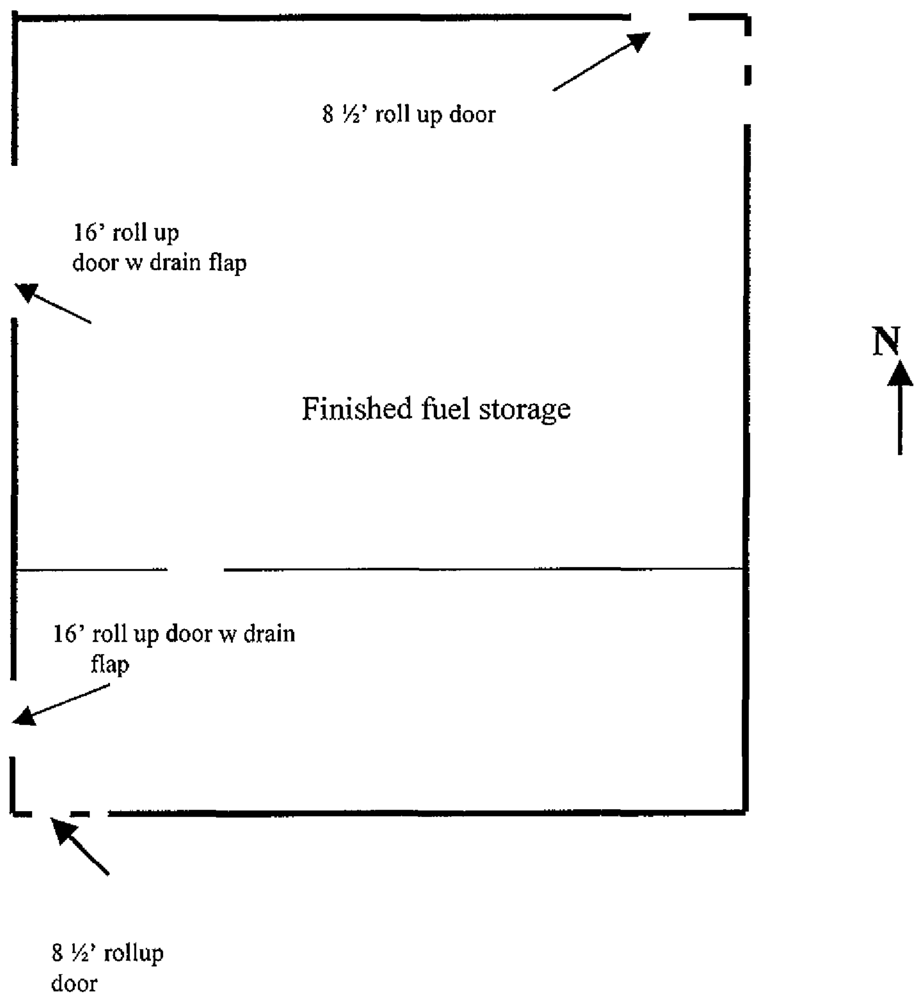
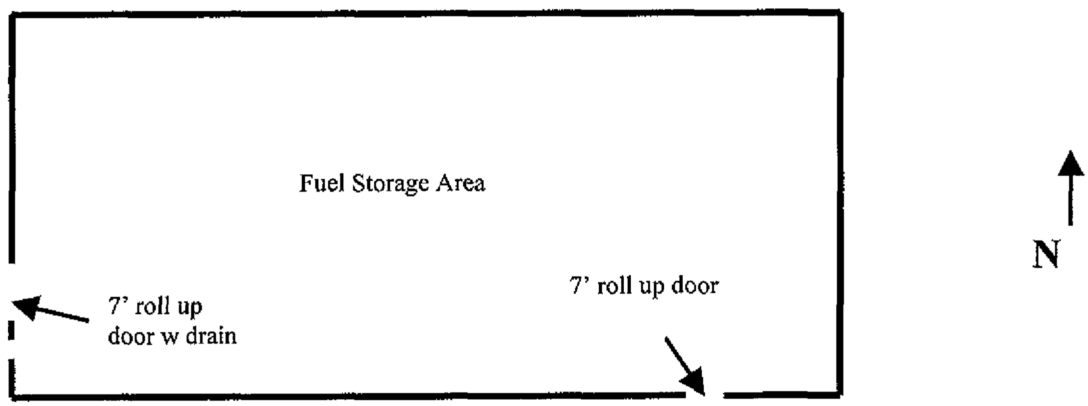


Figure 2.2.2-4. Building 3716



2.2.3 Current and Planned Operational Mode

The transition from standby to the shutdown phase began in March 1992. Ongoing major areas of work are planned for consolidation and disposition of the uranium fuel, completion of work defined in the RCRA Closure Plans, and shutdown and cleanup of the remaining facility for turnover to the River Corridor Closure contractor. The 300 ADP operating staff currently manages these activities and provides surveillance and basic maintenance for the facility. The operations staff is also involved with the disposal of essential materials and waste.

A significant unirradiated uranium inventory, present at the time N Reactor standby was announced, remains in the facility. Of the approximate 823 metric tons uranium (MTU) remaining in the facility 303-B: 39 MTU, 3712: 647 MTU, and 3716: 137 MTU, a major portion consists of 0.95 wt% to a maximum of 1.25 wt% U-235 enrichments now packaged in wooden boxes. Less than 80 MTU is natural or depleted uranium. All but 1.3 MT of the uranium inventory is in the form of fuel elements, some of which were partially fabricated at the time operations ceased. A portion of the fuel had been loaded into N Reactor, but was never irradiated and later returned for storage at the facility. This fuel has low-level fission and activation radionuclide surface contamination (see Table 2.2.6-1). The remaining uranium will require storage at the facility until an alternate storage facility or a specific use/user has been identified or burial is authorized. The storage buildings will require continuing surveillance, including building and system maintenance, active fire systems, safeguards and security, and regulatory compliance until the uranium has been relocated for alternate storage or use.

Several RCRA Closure Plans have been approved for several of the non-uranium storage buildings (DOE-RL 1989, DOE-RL 1990a, DOE-RL 1990b, and DOE-RL 1991). The RCRA closures for these buildings are expected to be completed in FY 2002 (provided that required funding is available), prior to turnover to the River Corridor Closure contractor. Two RCRA-permitted areas will remain for CERCLA remediation. Besides the RCRA closure, the non-uranium storage buildings will require removal of radioactive and hazardous wastes, cleanup and/or stabilization of radioactive/contaminated areas and process equipment, stabilization/cleanup of residual beryllium contamination, removal of excess materials, and disposition of assets prior to acceptance into the D&D program.

Removal of bulk chemical inventories was completed in April 1991. The cleanup of uranium metal residues (chips and fines) from fabrication equipment was completed in FY 1994. Cleanup has minimized radiological concerns and eliminated the risk of spontaneous or accidental fires involving residual pyrophoric uranium chips and fines.

This BIO provides the safety basis for facility activities throughout the cleanup and shutdown, such as fuel storage operations, and limited fuel handling and packaging for shipment elsewhere until turnover to the River Corridor Closure contractor. Limited fuel handling and packaging is defined as limiting each fuel handling activity to quantities less than the minimum hemispherical safe mass quantities (Schwinkendorf 2001).

2.2.4 Major Nuclear Facility Processes and Facility Segments

With cleanup and shutdown activities underway, the term "major processes" no longer applies. Using a graded approach, only systems that provide or support the uranium storage function and anticipated uranium disposition activities, including limited fuel handling, are identified and addressed in this BIO. Buildings in which uranium fuel is stored require periodic surveillance for fire systems, maintenance, safeguards, and regulatory and DOE compliance. As buildings/systems are shutdown and deactivated and residual hazardous contamination removed or stabilized, use of the institutional safety programs designed to prevent the spread of contamination will facilitate future decontamination and deactivation (D&D) activities.

It is anticipated that handling and packaging of uranium fuel for disposal and temporary storage of the packaged material, as in the case of recent billet shipments to the United Kingdom and the Oak Ridge Operations Portsmouth Site, will occur.

2.2.5 Facility Support Systems

2.2.5.1 Heating, Ventilation, and Air Conditioning (HVAC)

The 3712 Building is the only uranium storage building with an active heating or cooling system. Installation of a recirculating positive pressure electric HVAC with no stack in the 3712 Building billet repackaging area was completed in 1996. Portions of the 333 Building and MO-052 also have active HVAC systems; however, these systems are planned to be shutdown in the near future now that personnel have been relocated.

2.2.5.2 Electrical Power

Offsite power is supplied from the Bonneville Power Administration (BPA) network to the 115-kV/13.8 B3-S4 substation in the 300 Area. The 300 Area 13.8-kV distribution lines supply a variety of office, laboratory, and fabrication facilities in the 300 Area.

Two separate lines run through the 300 Area distribution system to the C-3-3 switching station and then to the FSS Facility 13.8-kV/480-V substation. The power is used for HVAC, lighting, offices, heating of the fire protection valve enclosures, fire protection alarm systems, etc.

There is no requirement for emergency power to the FSS Facility.

2.2.5.3 Water Systems

Water for the facility is supplied from the 300 Area water supply system. This distribution network supplies both the sanitary and fire protection water for the entire 300 Area. It consists of multiple supply pumps, a filter plant, a chlorine addition system, and distribution network that are supplied by the City of Richland. In addition, two head tanks (382 C and 382 D) provided on the network ensure a 4-hour supply at 4,100 gpm in case the normal supply pumps fail or the backup engine driven pumps fail to start. These backup pumps start automatically upon loss of pressure in the distribution line. As appropriate, the water supply system is separated into fire protection, sanitary water, and process water systems at the facilities. The distribution system is a closed-loop system that allows for multi-direction feeds to 300 Area facilities.

With the fuel fabrication operations shut down, the primary water usage is sanitary and fire protection.

2.2.5.4 Drains, Trenches, and Process Sewer System

No sanitary drains exist in the 303-B, 3712, or 3716 Buildings. Floor and trench drains in the 3716 Building connect to the 300 Area Treated Effluent Disposal Facility (TEDF).

When the Facility Effluent Monitoring Plan (FEMP) (Nickels and Brendel 1991) for the facility was published, the facility fuel fabrication activities were no longer being performed. Routine liquid effluent discharge to the 300 Area process sewer has been decreasing ever since and is now limited to storm water. However, there is potential for liquids to enter the process sewer from fire protection water release and storm water. The facility was reevaluated in the Hanford Site Plan and it was determined that no changes were required.

2.2.6 Radioactive and Hazardous Wastes

2.2.6.1 Liquid Wastes

The principal facility liquid waste discharges to the 300 Area Process Sewer are precipitation and controlled and non-controlled fire protection system releases. A complete description of the discharges to the process sewer system is contained in the FEMP (Nickels and Brendel 1991). There are no anticipated radioactive liquid waste discharges.

There are no releases or interconnections to the shutdown 300 Area 340 Radioactive Liquid Waste System.

Since the facility mission has changed from operations to shutdown and no longer releases liquid effluents to the environment, the facility was reevaluated using the FEMP determination process, and it was determined that no FEMP is required.

2.2.6.2 Radioactive Gaseous Wastes

The exhaust and HEPA filter systems associated with specific fuel manufacturing processes and equipment that had the potential for generating airborne contamination were shut down and blanked off. With this shut down, there are no anticipated radioactive gaseous waste discharges from these sources.

Radioactive air emissions from facility shutdown and deactivation activities are expected to be minimal. However, emissions from these activities will be controlled through the use of pollution controls described in appropriate permits.

2.2.6.3 Radiological Hazardous Waste

Wastes generated from activities associated with the transition from standby to shutdown consist primarily of cleaning materials and those associated with cleanup of the radiological surface-contaminated and RCRA areas. The wastes include residual beryllium (Be) and asbestos. The waste generation criteria include:

- Controls to reduce waste generation
- Establishment of waste minimization programs
- Segregation of low level, mixed, hazardous, and nonregulated waste
- Low level, mixed, hazardous, and nonregulated waste management
- Incorporation of design principles to minimize waste generation
- Waste treatment
- Audits
- Annual update of 30-yr forecast.

Normal radiological dose rates and contamination levels associated with the facility are included in Table 2.2.6-1. These dose rates are from residual fixed and removable residual uranium and uranium compounds resulting from the fuel manufacturing process. Some trenches and drains also contain small residual uranium and various uranium compound contamination. There is no history of mixed fission product or activation product contamination despite the presence of the contaminated fuel in the 303-B Building (see Table 2.2.6-1).

Table 2.2.6-1. Facility Radiological Dose Rates and Contamination Levels

LOCATION	MAXIMUM DOSE RATE	GENERAL AREA DOSE RATE	FIXED CONTAMINATION LEVELS (MAXIMUM)	REMOVABLE CONTAMINATION LEVELS(1) (MAXIMUM)
303- B, Fuel* Storage	7 mrem/hr	4.5 mrem/hr	60,000 dpm beta-gamma <1,000 dpm alpha	Not applicable
3712 Fuel & Scrap Storage	7 mrem/hr	1.5 mrem/hr	<1,000 dpm beta-gamma <20 dpm alpha	25,000 dpm beta-gamma 1,400 dpm alpha
3716 Unfinished Fuel Storage	7 mrem/hr	3 mrem/hr	<1,000 dpm beta-gamma <20 dpm alpha	Not applicable

* Unirradiated fuel assemblies have surface contamination consisting of activation and fission products. Maximum removable contamination approximately 50,000 dpm.
(1) Removable contamination associated with the building.

The facility total dose impact associated with the eight facility radiation workers and their three supervisors was less than 1.1 person-rem for calendar year 1996, when 700 MT of uranium billets were individually repackaged for shipment to the UK. This was the highest dose received for the FSS Facility during the current mission. Future annual exposures to workers are expected to be less since the total quantity of remaining uranium is not expected to be repackaged entirely in the same year. Exposures are documented in Facility Radiological Exposure Status Reports.

2.2.7 Fuel Supply Shutdown Facility Organization

The FSS Facility is operated by the 300 ADP organization which is described in FSP-FSS-5-35, *300 Area Deactivation Project Control Manual*. The 300 ADP is part of the Fluor Hanford Central Plateau Remediation Project.

The organization is comprised of management and clerical personnel, cognizant engineers, hazardous waste specialists, and nuclear chemical operators who are responsible and perform duties required for management, operation, surveillance, maintenance, RCRA, and facility cleanup and shutdown.

2.2.8 Principal Interfaces and Support

Organizations interfacing with and providing support to the 300 ADP organization include:

- Fluor Federal Services (safety analysis and evaluation services)
- Fluor Hanford (maintenance, transportation, fire protection services, quality assurance, safety, environmental assurance, analytical services, and waste services).
- Duratek Federal Services (transportation analyses, shipper support).

2.2.9 Facility Access Control

The FSS Facility is within the fenced 300 Area where pedestrian gates and vehicle gates are unlocked.

All buildings remain locked unless opened for specific surveillances, maintenance, or cleanup activities.

Tamper-indicating devices (seals) are also used on doors into active Special Nuclear Material (SNM) storage areas: 303-B, 3712, and 3716 Buildings.

2.3 Facility Fire Protection

Elements of the fire hazards analysis (Myott 2002) for the FSS Facility have been included in this document. Each of the uranium fuel storage buildings is equipped with an automatic fire alarm and dry sprinkler system with freeze protection in the valve rooms. The sprinkler and alarm systems were installed in the mid-1980s to contemporary standards at the time and are maintained to applicable NFPA codes and standards, subject to exemptions granted by DOE-RL per HNF-RD-7899. Sprinkler/alarm systems installed in the 333 Building are planned to be disconnected in 2002 since that building is unoccupied.

The facility fire protection alarm system is part of the Hanford Fire Department (HFD) Station No. 92 radio fire alarm reporting system. Trouble alarms (valve tamper, low air pressure, low temperature) are in series for each building. Actuation of a trouble alarm or fire alarm (system water flow) will sound in the HFD Station No. 92 Central Dispatch office, alerting people in this continuously manned area of this condition. The Station No. 93 on-shift crew will then be dispatched to investigate. Unless there is an actual fire, the crew will notify Fire System Maintenance to take action to mitigate the concern.

The normal water supply to the facility fire protection systems, both the sprinklers and outside hydrants, is the 300 Area sanitary water system. This closed loop system allows multi-direction water feed to each fuel storage building. A 1.4-million gallon supply reserved for fire protection is maintained in two head tanks with delivery assured by two dedicated diesel powered fire pumps, each with 3000 gpm capacity, that start automatically upon loss of line pressure. Although the water delivery system is aging and subject to deterioration, periodic testing is performed to ensure its availability and monitor its condition.

Additional information on the sprinkler and alarm system, capacities and response to fires, and associated maintenance and surveillance are contained in the Fire Hazard Analyses (Myott 2002).

2.3.1 Hanford Fire Department

The HFD consists of four stations; each is open 24 h/day, seven days/wk:

- HFD Station No. 91 is located in the 100 Area and is about 53 km (33 mi) away.
- HFD Station No. 92, the 609-A Building, is located in the 200 Area, and is about 35 km (22 mi) away,
- HFD Station No. 93, the 3709-A Building, is located at the southeast corner of the 300 Area and is about 0.4 km (0.25 mi) away, and
- HFD Station No. 94, 4709-A Building, is located at the 400 Area, about 9.6 km (6 miles) away.

The HFD stations and engines are equipped with separate radio systems for communication during emergencies.

Fire Systems Maintenance personnel periodically inspect and test the fire protection systems and equipment in accordance HNF-RD-7899, "System Testing/Inspection/Maintenance/ Deficiencies," which addresses inspection, testing, and maintenance. HNF-RD-7899 also defines the minimum frequencies for these activities.

Further information on the HFD, protection systems, and associated operation, maintenance and surveillance, training requirements, and response times is contained in the fire hazard analyses (Myott 2002).

2.4 Nearby Facilities and Activities

Following is information on nearby facilities operated by other PHMC organizations and Pacific Northwest National Laboratory (PNNL) that were considered to have the potential for impacting the facility.

3720 Central Services Laboratory

The 3720 Central Services Laboratory was built in 1959 on the site of the old 3722-A Building, and was used by General Electric, Douglas United Nuclear, and United Nuclear Industries for analytical chemistry work in support of Hanford Works reactors in the 1960s and early 1970s. It is a two-story metal frame structure, 73.2 m by 30.5 m (240 ft by 100 ft), erected on a concrete foundation, footings, and floor slab, with a basement 7.3 m by 33.2 m (24 ft by 109 ft) under the southwest corner. In 1980, a one-story concrete block addition, 14.6 m by 12.2 m (48 ft by 40 ft), was constructed on the north end, giving the structure a total area of nearly 2,323 m^2 (25,000 ft^2). The addition contained general laboratory and office facilities.

The building, now called the Central Services Laboratory, has been used by PNNL for vitrification and grout developmental experiments, including radioactive laboratory work. The radioactive and other hazardous material content is relatively small, and the facility is classified a fissile exempt facility. The building is scheduled to be vacated by the end of CY 2003.

To the south of the 3720 Building is an underground propane tank, [about 28 m (90 ft) north of 3712] which has not been used for several years and is not scheduled to be placed back in service. Inspection has shown it to be empty and disconnected from the building.

3720 BA Package Boiler Building

On the south side of the 3720 Building and approximately 24 m (80 ft) north of the 3712 Building is a natural gas-fired package steam boiler that provides steam to the 3720 Building. Potential impact to the 3712 Building from accidents (boiler explosion, boiler annex fire, jet flame from ruptured gas pipeline) would be minimal since the distance between the two facilities exceeds the minimum separation distances calculated for these accidents (Daling and Graham 1997). Other fuel storage buildings are farther away. Events related to the potential use of a mobile diesel-fueled package boiler when the primary natural gas fueled unit is out of service are considered in Section 3.2.2.1.

306 Metal Fabrication Development Building

The initial mission for the 306 Building, also known then as the "Met Semi-Works," was to support 313 Building operations and to pilot process improvements in single-pass reactor fuel fabrication methods. Later it was expanded to develop the co-extrusion fabrication process for N Reactor fuel elements.

The overall building dimensions are approximately 55 m by 115.8 m x 7.6 m high (180 ft by 380 ft by 25 ft high), with a total area of 7,447 m^2 (80,160 ft^2). The building is two stories high, with no basement, and has a framework of bolted steel.

Throughout the history of the 306 Building, its missions have centered on various alloy and fabrication test and development work. The 306 Building continues to operate today, performing a variety of fabrication and testing tasks under joint PHMC/PNNL occupancy.

The 306W (PNNL) Building is essentially shut down except for a few offices and laboratories.

The 306E (FH) Building is classified as a low-hazard radiological facility.

313 North Building

Until early CY 2002, the north end of the 313 Building was under the control of a private company that fabricated specialty metal parts using the large metal extrusion press originally installed by DOE. Extrusion operations have been relocated and the facility is vacant.

To the north of the building are two 1000-gallon above-ground propane storage tanks which were installed (December 1994) to current standards for facility heating and were also used to provide heat for the aging/annealing oven until it was shutdown in December 2001. This is the only major energy source at the facility which could significantly impact the adjacent fuel supply building. Accident analyses specifically prepared for the propane tanks are presented in Sections 3.2.1.3 and 3.2.1.4.

Nearby 300 ADP Buildings

Other nearby FSS Facility buildings were examined for potential impact to the fuel storage buildings.

The 303-F and associated 311 Tank Farm are located approximately 20 m (65 feet) south of the 3712 Building and 10 m (33 feet) west of the empty 303-G Building. Both the 303-F and 311 Tank Farm are empty with all utilities shutdown except for minimal lighting inside 303-F. Neither of these empty facilities represents any risk to the fuel storage buildings.

The 313 South Building is located approximately 24 m (80 feet) west of the 3712 Building. Its distance to the 303-B Fuel Storage Building is even greater. The 313 South Building is shutdown, unoccupied and all utilities have been disconnected except electricity for minimal lighting. There is no credible event originating in 313 South that presents a risk to either the 3712 or 303-B Fuel Storage Buildings.

The 333 Building is located approximately 27 m (90 feet) north of the 3716 Building. Although the 333 Building is the focus of future equipment disposition activities, its combustible material inventory has been significantly reduced from what it was during the time period when the building was the primary N Reactor fuel fabrication facility. Thus, the 333 Building does not represent a risk to the 3716 Building or any other fuel storage building.

The 304 Building is approximately 2 m (6.5 ft) west of the 303-B Fuel Storage Building. This empty building with all utilities disconnected does not represent any risk to this fuel storage building.

The 303-K Building, formally located approximately 22 m (73 feet) north of the 303-B Fuel Storage Building, was demolished during September 2001.

Interface Control

Because of the relative locations of the uranium storage buildings and nearby facilities under the control of other organizations, the likelihood of those organizations performing activities that could interfere with potential water outflow from the uranium storage building criticality drains, or introduce new or increased hazards, is remote. However, implementation of the interface requirements of HNF-PRO-8317, *Safety Basis Implementation and Maintenance*, provides assurance that the change control processes for those organizations will include 300 ADP personnel in the review of any proposed actions that could increase the fire risk of the uranium storage buildings or affect criticality drain function. Similarly, HNF-PRO-8371 implementation ensures that the HFD obtains 300 ADP review of any changes that could adversely affect their response to uranium storage building alarms or capability to maintain the fire protection systems of those buildings.

2.5 Relevant Operational History

2.5.1 Significant Past Events

Previous significant events in the FSS Facility included several small fires associated with the pyrophoric ignition of uranium chips and fines that occurred during the time period when the facility was fabricating fuel. These events resulted in contamination spread of varying severity within the building containing the fire and, upon occasion, significantly disrupted operations. Since fuel fabrication activities have ceased, a determined effort to remove residual uranium chips and fines from the facility was successfully completed in FY 1994. Fire risk continues to be further reduced as the uranium inventory is dispositioned and storage buildings are emptied. Past operations in the 333 Building involving beryllium have resulted in areas of localized beryllium contamination. Other FSS buildings containing lesser beryllium contamination or suspected of containing beryllium contamination include 313, 334-A, 303-F, 303-M, 304, 3712, and 3716.

2.5.2 Summary of Safety-Related Updates

In recognition of the aging electrical system in the 3716 Fuel Storage Building that had evidence of previous water stains on its electrical distribution panel, the "old" system was disconnected and replaced with a modern up-to-code system in FY 2001. Extraneous circuits were eliminated and an entirely new National Electrical Code compliant electrical system was installed to provide power to lights and the fire protection system.

2.5.3 Response to Readiness Activities and Audits

Two assessments conducted in recent years that focused on readiness to initiate uranium billet repackaging and shipping activities had no significant findings. Similarly, audits conducted to assess compliance with codes and requirements had only minor findings.

3.0 BASIS FOR INTERIM OPERATION EVALUATION

This section presents a summary of the methodology, assumptions, and results of the hazard analysis, hazard classification, and accident analyses that have been performed for the FSS Facility.

3.1 Hazard Analysis

The FSS Facility hazard analysis methodology and results are summarized in this section. The original hazard analysis (Johnson and Brehm 1994) identified hazard/energy sources, potential accident scenarios and their initiators, and preliminary assessments of event frequencies and consequences for the unmitigated hazard. That analysis was updated to reflect current conditions. Hazards were identified by form and location and represent a complete spectrum of events that could occur throughout the facility. An initial set of mitigating barriers or controls that serve to prevent or mitigate the postulated accident scenarios was identified during the hazard analysis. An assessment of event frequencies and consequences after applying the mitigating barriers or controls was also identified. The accident scenarios having significant consequences were organized into categories. A bounding accident was selected from each category for further analysis. A final set of controls was based on the accident analyses and is identified in Section 3.2.

The final hazard classification for the FSS Facility is also described in this section. A Hazard Category 3 nuclear facility has been assigned to the FSS Facility.

3.1.1 Hazard Identification

Hazardous materials and energy sources were identified and inventoried in terms of quantity, form, and location associated with the facility transitional activities, including; disposition of residual uranium inventories, removal of chemical inventories, removal and stabilization of radiological and chemical inventories, and deactivation of facility utilities and services. In addition to the hazards identification process identified in this section, the facility radiological and chemical inventory (Benecke 2003a), revised fire hazards analysis (Myott 2002), criticality safety evaluation (Schwinkendorf 1995), and the annual facility safety inspection checklists were reviewed and integrated into the hazard analysis, where appropriate.

3.1.1.1 Hazard Identification Methodology

The original hazard analysis (Johnson and Brehm 1994) included a list of hazards and energy sources used for identifying the hazards associated with the FSS Facility at the time. The hazards were grouped into general categories: shutdown tasks, chemistry, potential/kinetic energy, natural occurrences, and radiation. The shutdown tasks category has been changed to the facility category and another category, external events, has been added for this BIO. External events include: propane tank explosion/fire and events at nearby facilities.

Although aircraft impacts are normally associated with external events, this hazard has been previously identified in the original hazard analysis (Johnson and Brehm 1994) in the potential/kinetic energy group and remains there.

Facility personnel provided drawings, and walkdowns of the buildings were conducted to gain a knowledge of past operations, equipment status, and identification and location of known and suspected hazardous materials and conditions. The approach included identification of potential hazards associated with planned shutdown activities. The hazard and energy source list was used to prepare the hazard analysis that determined which hazards required further evaluation.

The hazards identified for this BIO are based on the original data identified in the original hazard analysis (Johnson and Brehm 1994), the predecessor ISB (Benecke 2000), which includes changes due to the USQ process, results of the annual facility safety inspection checklist, and discussions with knowledgeable facility personnel.

3.1.1.2 Hazard Identification Results

Since the preparation of the original hazard analysis (Johnson and Brehm 1994), the facility inventory has decreased significantly as a result of the remediation of materials. The original hazard analysis has not been updated to reflect the current inventory, but remains as a historical document. Portions of that document pertaining to the 303-B, 3712, and 3716 Buildings plus pertinent general information were considered for inclusion in the updated hazards evaluation for this BIO.

Since the original hazard analysis, the following hazards reduction has taken place:

- Removal of bulk chemical inventories
- Removal of 941 MTU billets
- Removal of 135 MTU fuel.

The remaining radiological inventory includes:

- 303-B Building: 39 MTU of unirradiated fuel elements (wrapped in plastic) taken from N Reactor that were contaminated with fission and activation products
- 3712 Building: 647 MTU of finished fuel in wooden boxes, uranium scrap and standards
- 3716 Building: 137 MTU of unfinished fuel pieces, two-thirds with capped ends, in wooden boxes.

A major portion of the inventory consists of 0.95 wt% to a maximum of 1.25 wt% U-235 enrichments now packaged in wooden boxes. Less than 80 MTU is natural or depleted uranium. Virtually all of the uranium inventory is in the form of fuel elements, some of which were partially fabricated at the time operations ceased. A portion of the fuel had been loaded into N Reactor, but was never irradiated and later returned for storage at the facility. This fuel has low-level fission and activation radionuclide surface contamination (see Table 2.2.6-1). Due to the reduction in inventory noted above, the 303-B, 3712, and 3716 Buildings are now classified as Hazard Category 3 nuclear facilities (see Section 3.1.2) and the remaining buildings in the complex are classified as Industrial.

Hazards and energy sources remaining in the facility today, natural phenomena hazards, external man-made hazards and energy sources with the potential to interact with the FSS Facility, and hazards associated with the current mission (disposition of residual uranium inventories, removal of chemical inventories, removal/stabilization of radiological and chemical contamination, and deactivation of utilities and services) are identified in Table 3.1.3-4 (at the end of this Section) in the "Hazard/Energy Source" column. These hazards and energy sources were evaluated as potential initiators to accidents as discussed in Section 3.1.3. Common industrial hazards (e.g., electrical shock, chemicals, equipment accidents, etc.) were considered only to the extent that they initiate or contribute to accidents for which institutional safety programs (e.g., industrial safety, industrial hygiene, fire protection, etc.) do not provide adequate coverage. Hazards identified as standard industrial hazards were not evaluated further.

3.1.2 Hazard Classification

A hazard classification (Benecke 2003a) has been prepared for the facility in accordance with DOE-STD-1027-92 resulting in the assignment of Hazard Category 3 nuclear facility for the FSS Facility uranium fuel storage buildings.

In developing a hazard categorization, the DOE-STD-1027-92 standard allows for the radionuclide source term quantity to be compared to the threshold values in the standard. The hazard categorization was prepared based on a conservative MAR associated with the bounding unmitigated accident for the facility using facility-specific values for individual radionuclides and comparing them with Category 2 values.

The MAR was determined for the bounding credible event, i.e., an unmitigated fire in the 3712 uranium storage building. For conservatism, the 3712 Building inventory was increased to 675 MTU. The quantity of uranium potentially capable of being oxidized and subject to dispersal in that fire was determined by first estimating the fire duration and temperature profile from the combustible material loading. Next, experimental data obtained from studies using smaller uranium pieces was extrapolated to the billet geometry to estimate the fraction of uranium in billet form that would be oxidized (Johnson 1994). This resulted in slightly less than 5% of the building inventory subject to dispersal in the unmitigated fire (see Section 3.2.1). Although this quantity can be reduced to about 0.2% for the events with "unlikely" probability that account in oxidation-resistant cladding, less probable events with potential to add combustible material are modeled as though all of the inventory were unclad billets, resulting in slightly less than 5% of the inventory being subject to dispersal. This quantity (rounded up to 5%, represented by 33.75 MTU) is the MAR and is compared to the Category 2 Threshold Quantities (TQs) in Table 3.1.2-1. Facility segmentation is permitted by DOE-STD-1027-92, as long as the hazardous material in one segment (or building) could not interact with the hazardous material in other segments (or buildings) and if no common (and credible) event initiator exists. Since the heating, ventilation, and air conditioning (HVAC), piping, fire protection (sprinkler), etc., systems are independent among the various fuel storage buildings (i.e., there are no HVAC or process piping systems in these buildings that could allow hazardous material interaction), and there is significant physical separation between the buildings, independence is demonstrated for facility segmentation purposes. The single event with potential to affect more than one uranium storage building, i.e., BLEVE of the propane tank on the north side of the 313 Building, was determined to be not credible with respect to involving more than a single building.

Table 3.1.2-1. 3712 Building Material at Risk Compared to Category 2 Values

RADIONUCLIDE	3712 BUILDING INVENTORY (Ci)	MAR (Ci) (1)	CATEGORY 2 VALUES (Ci) (2)	Ratio of MAR TQs to Cat 2 TQs
Uranium-234	391.5	19.6	2.2E + 02	8.9E-02
Uranium-235	18.2	0.9	2.4E + 02	3.8E-03
Uranium-236	31.7	1.6	5.5 E + 01	2.9E-02
Uranium-238	236.2	11.8	2.4 E + 02	4.9E-02
Technetium-99	114.8	5.7	3.8 E + 06	1.5E-06
Sum of Fractions				0.17 < 1

Based on 675 MTU in 3712 Building.
(1) Benecke, 2003a. Based on 33.75 MTU MAR.
(2) DOE, 1992c.

As shown in Table 3.1.2-1, the facility radionuclide activities associated with the predicted MAR are below the threshold values for a Category 2 facility. Also, the sum-of-fractions is much less than unity (Benecke 2003a). Therefore, the facility is assigned a final hazard categorization of Nuclear Facility Category 3. Only those buildings within the facility that store fuel materials are designated Category 3 buildings. All others are designated Industrial Buildings (see Table 2.2.1-1).

3.1.3 Hazard Evaluation

This section evaluates the hazards identified in Section 3.1.1 for the FSS Facility and develops a list of potential accidents and resulting consequences. The methodology used to classify the significance of each of the accidents and sequences that could result in potential consequences to the public, onsite worker, or environment is described, and a subset of dominant accidents selected for formal scenario development and consequence determination is presented.

3.1.3.1 Hazard Evaluation Methodology

Guidance for the preparation of this hazard analysis was taken from HNF-PRO-700 and DOE-STD-3011-94, both of which specify the application of the graded approach to the safety analysis effort. The FSS Facility is a low-complexity Hazard Category 3 nuclear facility. In addition, the FSS Facility is in the process of transitioning to permanent closure for eventual D&D. Based on this information and the above requirements, the use of the preliminary hazards analysis (PHA) technique to evaluate the major hazards is judged to be an appropriate level of analysis to fulfill the above criteria. DOE-STD-3011-94, Appendix B, "Techniques of Preliminary Hazards Analysis," (DOE 1994a) emphasizes that the BIO should make maximum use of existing analysis, and that new analysis should be prepared only where existing analyses are insufficient. To this end, the hazard analysis (Johnson and Brehm, 1994) prepared for the facility using the PHA technique was used and modified as necessary, due to facility changes over the past few years, for this BIO.

A team of knowledgeable individuals from the facility and the safety analysis organizations conducted several meetings to update the hazard analysis for this BIO. The hazard evaluation process considered a wide spectrum of events and included input from personnel from different disciplines (e.g., safety analysts, industrial safety, fire protection, engineering, and operations personnel) to provide a broad perspective on the potential hazards. Accident scenarios involving the evaluated hazards were postulated and assigned estimates for consequence and frequency based on engineering judgment using the criteria found in Tables 3.1.3-1 and 3.1.3-2. Estimates of event frequencies are primarily qualitative, and in those instances where sufficient qualitative arguments for lower frequencies could not be made, the event was classified as anticipated.

Overall, the criteria used for the original hazard analysis is consistent with criteria used in today's guidance (DOE-STD-3011-94, DOE-STD-3009-94, and DOE-RL 2002). However, the Severity Category numbering system (I, II, III, IV) used in the original hazard analysis (Johnson and Brehm 1994) has been replaced with High (I), Moderate (II), Low (III), and None (IV) Consequence. The terminology is updated in Tables 3.1.3-1 and 3.1.3-2 to reflect the current descriptions in use. The terminology revision does not invalidate use of the original hazard analysis.

Table 3.1.3-1. General Criteria for Frequency Assessment

ESTIMATED ANNUAL FREQUENCY	DESCRIPTION
Anticipated: $10^{-2}/yr \le f < 10^{-1}/yr$	Incidents that may occur several times during the lifetime of the facility.
Unlikely: $10^{-4}/yr \le f < 10^{-2}/yr$	Accidents that are not anticipated to occur during the lifetime of the facility. Natural phenomena of this probability class include: Uniform Building Code-level earthquake, 100-year flood, maximum wind gust, etc.
Extremely Unlikely: $10^{-6}/yr \le f < 10^{-4}/yr$	Accidents that will probably not occur during the lifetime of the facility. This includes the design basis accidents.
Beyond Extremely Unlikely: $f < 10^{-6}/yr$	All other accidents.

Table 3.1.3-2. General Criteria for Consequence Assessment

ESTIMATED CONSEQUENCES	DESCRIPTION
High	Considerable onsite and offsite impacts on people or the environment.
Moderate	Considerable onsite impact on people or the environment; only minor offsite impact.
Low	Minor onsite and negligible offsite impact on people or the environment.
None	Negligible onsite and offsite impact on people or the environment.

The significance of the scenarios identified in the hazard analysis for the public, onsite worker and facility worker is classified, based on their consequences and frequencies using a risk matrix (Table 3.1.3-3), as Very Serious, Serious, Marginal, or Negligible. Additional guidance from DOE-RL (DOE-RL 2002) uses a different nomenclature of I, II, III, and IV, respectively for the same risk product, and is shown in parentheses in the table. Classification of the scenarios based on assigned estimates of combined consequence and frequency allows the accident scenarios to be prioritized for further analysis. The classification is a temporary one used to bin the accident scenarios. Once the representative accident of each binned grouping has been analyzed, the resulting consequences are compared to the onsite worker and offsite public radiological risk evaluation guidelines to determine the need for controls. At this stage, the initial classification of Very Serious, Serious, Marginal, or Negligible are no longer used to classify risk to the onsite worker or offsite public. The terms however, are still used to identify associated risk to the facility worker since no equivalent radiological risk evaluation guidelines have been established. The dominant scenarios require further evaluation to determine the potential for administrative controls, compensatory or corrective measures, and/or restrictions on facility operations to reduce the risk. For lower risk scenarios, risk reduction features are specified as defense-in-depth as practical. Preventative and mitigative features to control hazards identified in the hazard analysis are carried forward for development into accident controls as required. No hazard was identified whose environmental consequence is greater than either it's corresponding radiological or industrial hazard.

Table 3.1.3-3. Hazard Severity Matrix

CONSEQUENCE	FREQUENCY OF OCCURRENCE (PER YEAR)			
	Beyond Extremely Unlikely $f < 10^{-6}$	**Extremely Unlikely $10^{-6} \le f < 10^{-4}$**	**Unlikely $10^{-4} \le f < 10^{-2}$**	**Anticipated $10^{-2} \le f < 10^{-1}$**
High	Marginal (III)	Serious (II)	Very Serious (I)	Very Serious (I)
Moderate	Negligible (IV)	Marginal (III)	Serious (II)	Very Serious (I)
Low	Negligible (IV)	Negligible (IV)	Marginal (III)	Marginal (III)

3.1.3.2 Hazard Evaluation Results

This hazard evaluation identified potential accidents and associated consequences for each of the facility hazards and energy sources, and qualitatively assigned a frequency and consequence to each event. In addition, engineered and administrative mitigating barriers or controls to prevent and mitigate the consequences of each of the postulated events were identified. The frequency and consequence were also reevaluated after applying the engineered and administrative controls. A hazard severity was assigned to each hazard based on the assigned unmitigated frequency and consequence and using Table 3.1.3-3. The hazard evaluation is documented in Table 3.1.3-4. The postulated scenarios were qualitatively evaluated to select the representative and unique potential accidents to be included in the accident analysis.

Since the preparation of the original hazard analysis (Johnson and Brehm 1994), several event scenarios associated with previous fuel fabrication activities are no longer applicable: ignition of residual uranium/Zircaloy-2 chips and fines, leakage or dryout of water in uranium/Zircaloy-2 chips and fines storage drums, and ignition of uranium/Zircaloy-2 chips and fines imbedded in concrete in a storage drum. Chips and fines are no longer present at the facility in any form, therefore; these event scenarios are no longer addressed in either of the hazard or accident analysis.

Analyses in the fire hazards analysis (Myott 2002) were examined to determine their appropriateness for defining bounding scenarios for the FSS Facility and to integrate the results into the BIO. The fire hazards analysis defines the Maximum Possible Fire Loss as that resulting from an unmitigated fire in the 3712 Building, which has the same scenario as the random fire (or seismic-induced fire) described in this BIO. The engineered and administrative controls defined in the fire hazards analysis are those summarized in Table 3.1.3-4 for several postulated fires and identified again in Sections 3.2.1 and 3.2.2. The fire hazards analysis also evaluates lesser fire consequences and develops a bounding Maximum Credible Fire Loss, which is defined as that resulting from a mitigated fire. Input from the fire protection engineering staff was provided throughout the generation of the hazard identification and evaluation table.

The primary hazards identified for the FSS Facility include radioactive material, toxic material, and numerous common industrial hazards (e.g., electric shock, biological hazards, equipment accidents). The majority of these hazards are addressed through the FSS Facility safety and health related programs, such as, Radiological Control, Hazardous Material, Occupational and Industrial Safety, Fire Protection, and Environment, Safety and Health Safety Management Programs. In addition, cross cutting programs (i.e. Work Management, Procedures, and Training) as implemented in the AJHA process under ISMS, ensures a defined work scope, hazard identification and control, work controlled in accordance with the level of risk, with feed back to improve processes.

The remaining hazards, those that have the potential to release radioactive or toxic materials to the onsite worker or the public due to a postulated accident impacting the fuel stored at the FSS Facility, can be grouped or binned into major accident categories. The accident scenarios were binned according to common release attributes to support the selection of representative accidents, i.e., those that bound a number of similar accidents of lesser consequences (e.g., the worst fire of a number of similar fires). Unique accidents are those requiring individual examination based on estimates of consequences or unique causes. Representative accidents are examined to the extent they are not bounded by unique accidents. At least one bounding accident from each of the major categories determined from the hazard analysis was selected unless the bounding consequences were low.

In summary, the hazard evaluation process identified four potential accidents resulting in Very Serious consequences, seven potential accidents with serious consequences, twenty-three potential accidents with Marginal consequences, and one potential accident with negligible consequences. Three of the four potential accidents with Very Serious consequences were all anticipated worker safety hazards with moderate consequences (injury due to energized equipment, electrical shock, and forklift accident/injury). While the worker could be injured, no radiological or toxicological release would result. These accidents were considered standard industrial hazards and were not considered or developed further. The fourth Very Serious potential accident is a fire that has been identified as a representative accident and is developed further in Section 3.2. The seven potential accidents with serious consequences included two that were considered standard industrial hazards (biological hazard and gas bottle as a missile) and not considered or developed further. The remaining five potential accidents with serious consequences are either identified as representative accidents or initiators to a representative accident and were analyzed in Section 3.2. The twenty-three potential accidents with Marginal consequences included one that was considered a standard industrial hazard (PCB spill) and was not considered or developed further. Thirteen of the potential accidents with Marginal consequences resulted in worker or localized contamination and are largely controlled by the Radiological Control Program, as well as other programs, and do not result in a radiological or toxicological release to the onsite worker or public. These scenarios were not considered or developed further. The remaining nine potential accidents with Marginal consequences are either identified as representative accidents or initiators to a representative accident and were analyzed in Section 3.2. The single potential accident with a negligible consequence (flooding affecting contamination) was not considered or developed further due to the low consequences and extremely unlikely probability of occurrence.

The hazard evaluation process was also used to identify controls that may be available to prevent or mitigate potential accidents (i.e., engineered and administrative features). These controls are identified as defense-in-depth features for the FSS Facility. Defense-in-depth features are those design features, operational controls, and key elements of institutional programs that 1) prevent or mitigate the uncontrolled release of radiological or hazardous material, 2) alert personnel of such a release, 3) or initiate recovery actions in response to such a release. The defense-in-depth concept builds layers of defense against releases of hazardous materials to reduce reliance on any one layer. There are typically multiple layers of defense in depth, with the inner layer (closest to the hazard requiring protection) relying on a high level of design quality and reliability. The inner layer also relies on competent operating personnel who are trained in operations and maintenance procedures. In the event the inner layer is compromised, and the operation progresses from the normal to the abnormal range, the next layer(s) of defense-in-depth is relied upon. This may consist of automatic systems, design features required to alert operators to action, programmatic features, and emergency response actions. Defense-in-depth features may require designation as safety-significant features. A safety significant designation is based on the severity of the event being prevented or mitigated and the number of barriers present. The lower the number of barriers, the greater reliance on a single barrier. No safety-significant defense-in-depth features have been identified for the FSS Facility. Defense-in-depth features may also require TSR coverage, if their failure constitutes a major barrier degradation or significant facility safety basis challenge. These generally are defined as resulting in significant hazardous material release to areas of personnel occupancy, or the occurrence of highly energetic events with the potential to damage multiple layers. Several defense-in-depth features have been identified for the FSS Facility. Identified defense-in-depth programs are radiation protection, fire protection, and criticality safety. Defense-in-depth design features are facility water drainage and Zircaloy-2 cladding on the fuel elements.

Specific worker safety features for the potential accidents are identified as engineered and administrative features in the mitigating barriers column of Table 3.1.3-4. Moreover, worker safety features are addressed in the many facility institutional safety programs previously discussed in this section. There are no credible non-industrial type accidents identified for the FSS Facility that have the potential to result in multiple personnel injuries or personnel death.

The final selection of controls included the evaluation of the bounding accidents and the results of the hazards analysis process to ensure that the control set covered the comprehensive hazards identified for the FSS Facility. The specific engineered features listed in Table 3.1.3-4 relied upon for the prevention or mitigation of potential accidents are described in Chapter 2.0 and Chapter 3.0, Section 3.2. The specific administrative features listed in Table 3.1.3-4 relied upon for the prevention or mitigation of potential accidents are generally described in Chapter 4.0.

Based on the hazard evaluation results, a set of three accident categories was selected for detailed analysis. This set of accidents represents all of the hazardous conditions identified for the FSS Facility. The accidents categories selected for detailed analysis are as follows:

1. Fires limited by available combustible material
2. Fires expanded by additional combustible material
3. Criticality event.

These accidents categories are developed in detail in Section 3.2, *Accident Analysis*.

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
I.	FACILITY									
A.	Sampling and Characterization (all potentially contaminated equipment, trenches, surfaces, walls, floors, and ceilings).	Mistakes in taking and handling samples release contamination.	Worker could become contaminated. Radiological/ toxicological contamination could occur locally.	Ant	L	Tools and equipment for taking samples designed to protect workers and environment.	Qualified worker. Approved sampling, handling, and disposal procedures. Radiological control program. Industrial hygienist control program.	Ant	L	Marginal (III) event. Contaminatio n controlled by 10 CFR 835, *Occupational Radiation Protection*. No further evaluation is necessary.
B.	Stabilization/ Decontaminatio n (general activities).	Failure to follow procedures and/or wear protective clothing may cause contamination of worker, clothing, equipment, and other surfaces.	Activity spreads contamination to new surfaces.	Ant	L	Tools, equipment, and clothing designed to protect worker.	Qualified worker. Stabilization activities in accordance with approved procedures. Radiological control program.	Ant	L	Marginal (III) event. Contamination controlled by 10 CFR 835, *Occupational Radiation Protection*. No further evaluation is required.

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
1.	Equipment.									
a.	Potentially contaminated or toxic oils or liquids.	Spill could occur during removal.	Radiological/ toxicological release could affect worker and local area.	Ant	L	Tools for removing oil designed to protect workers and prevent spills.	Qualified workers. Approved cleanup procedures. Radiological control program. Industrial hygienist control program.	Ant	L	Marginal (III) event. Contamination controlled by 10 CFR 835, *Occupational Radiation Protection*. No further evaluation is necessary.
2.	Building.									
a.	Remove special nuclear materials.	(See Package/Repackage & Forklift/Transport).								
b.	Remove tools, and combustible materials.	Mishandling could cause worker injury or contamination.	Workers could be injured or become contaminated.	Ant	L	Equipment design. Hand trucks, forklifts, and specialized handling equipment to protect workers.	Qualified workers. Approved procedures. Radiological control program.	Ant	L	Marginal (III) event. Contamination controlled by 10 CFR 835, *Occupational Radiation Protection*. No further evaluation is necessary.

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
c.	Electrical energy.									
1)	Energized electrical equipment.	Equipment could be started accidentally.	Worker injury could result. NOTE: No nuclear consequences.	Ant	M	Shutdown equipment locked and/or breakers racked, fuses removed from unused circuits.	Verify power off before cleaning or moving equipment. Lock and tag procedures.	Unl	L	Very serious (I) event. Standard industrial hazard. No further evaluation is necessary.
		Shock could be received while cleaning powered equipment.	Worker injury could result. NOTE: No nuclear consequences.	Ant	M	Shutdown equipment locked and/or breakers racked, fuses removed from unused circuits.	Lock and tag procedures.	Unl	L	Very serious (I) event. Standard industrial hazard. No further evaluation is necessary.
		Wiring insulation in building can be damaged by rodents or deteriorate with time. Fire is caused by shorting of exposed wire. Fire could involve uranium fuel assemblies, scrap, and unfinished fuel assemblies.	Radiological/ toxicological release could occur locally, onsite and offsite. Property damage could occur.	Unl	M	Shutdown equipment locked and/or breakers racked, fuses removed from unused circuits. Active fire detection and sprinkler systems.	Qualified worker. Lock and tag procedures. Building combustibles controlled. Fire protection systems maintained to NFPA. Radiological control program. Industrial hygienist control program.	Ext	L	Serious (II) event. Potential initiator for fire. Fire evaluated in Section 3.2.1.1, "Random Fire – 3712 Building."

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
d.	Rodent and vermin intrusion.	Spread of contamination by wildlife.	Spread of contamination to local area.	Ant	L	Building kept locked when unoccupied. Screens cover criticality drains.	Approved procedures for surveillances. Radiological control program. Biological control program.	Unl	None	Marginal (III) event. Contamination controlled by 10 CFR 835, *Occupational Radiation Protection*. No further evaluation is necessary.
		Uptake of biological hazard.	Worker illness.	Unl	M	Buildings "sealed" to restrict intrusion.	Qualified worker. Biological control program.	Unl	L	Serious (II) event. Standard industrial hazard. No further evaluation is necessary.
e.	PCBs	Removing PCBs could result in spill.	Toxicological release could affect workers and local area.	Ant	L		Qualified worker. Approved procedures for removing PCBs. Industrial hygienist control program.	Ant	L	Marginal (III) event. Standard industrial hazard. PCBs controlled by 29 CFR 1910, *Occupational Safety and Health Standards*. No further evaluation is necessary.

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
II.	CHEMISTRY									
A.	Fire.									
1.	Range.	Sparks from nearby range fire could set fires.	Radiological/ toxicological release could occur locally, onsite and offsite.	Ant	M	Buildings in a paved area. Concrete slab (303-B) roof covered with tar and gravel. 3712 and 3716 have metal roofs. Active fire detection and sprinkler systems. Nearby Hanford Fire Department.	Fire protection systems maintained to NFPA. Fire watches when fire protection system is unavailable.	Ext	L	Marginal (III) event. Potential initiator for fire. Fire evaluated in Section 3.2.1.1, "Random Fire – 3712 Building."
2.	Building. See also other fire initiators.	Fire in building could involve uranium fuel assemblies, scrap, and unfinished fuel assemblies. Initiators include accidents involving: energized electrical equipment, range fire, compressed gas bottle, forklifts, flooding, and lightning.	Radiological/ toxicological release could occur locally, onsite and offsite.	Ant	M	Active fire detection and sprinkler systems.	Building combustibles controlled. No smoking allowed in buildings. Hot work (torch cutting welding, grinding, etc.) approved permits. Fire protection systems maintained to NFPA. Radiological control program. Industrial hygienist control program.	Ext	L	Very Serious (I) event. Fire evaluated in Section 3.2.1.1, "Random Fire – 3712 Building." Representative accident.

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
B.	Bottled compressed gas. Argon, acetylene, oxygen.									
1.	Bottle dropped and/or gas regulator impacted causing gas release or leak.	Bottle becomes a missile and/or released gas overcomes worker.	Worker injuries and property damage could occur.	Unl	M	Bottled gas stored in racks outside buildings. Bottled compressed gas codes.	Maintenance of bottles and regulators in good condition with labels visible. Approved handling devices. OSHA program.	Ext	L	Serious (II) event. Standard industrial hazard. Hazard controlled by 29 CFR 1910, "Occupational Safety and Health Standards." No further evaluation is necessary.
		Fire and/or explosion occurs. Fire could involve uranium fuel assemblies, scrap, and unfinished fuel assemblies.	Radiological/ toxicological release could occur locally, onsite and offsite.	Ext	M	Active fire detection and sprinkler systems.	Building combustibles controlled. Fire protection systems maintained to NFPA. Radiological control program. Industrial hygienist control program.	Ext	L	Marginal (III) event. Potential initiator for fire. Fire evaluated in Section 3.2.1.1, "Random Fire – 3712 Building."

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
C.	Propane storage tank (propane supply to 306 W PNL Building).	No longer applicable. Tank is empty and not plumbed for service.	--	--	--	--	--	--	--	--
III.	POTENTIAL/KINETIC ENERGY									
A.	Helicopter/or plane crash.	Fire could involve uranium fuel assemblies, scrap, and unfinished fuel assemblies. Workers could be affected.	Radiological/ toxicological release could occur locally, onsite and offsite. Worker injuries could occur.	BEU	H		Radiological control program. Industrial hygienist control program.	BEU	H	Marginal (III) event. Potential initiator for fire. Aircraft crash evaluated in Section 3.2.2.2, "Aircraft Crash." Representative accident.
B.	Vehicle.	Accident could cause fire involving uranium fuel assemblies, scrap, and unfinished fuel assemblies.	Radiological/ toxicological release could occur locally, onsite and offsite.	Ext	M	Active fire detection and sprinkler systems.	Traffic at low speeds. Fire protection systems maintained to NFPA.	Ext	L	Marginal (III) event. Potential initiator for fire. Vehicle crash fire evaluated in Section 3.2.2.3, "Vehicle Crash." Representative accident.
C.	Forklift.	Propane or electric forklifts are used.								
1.	Accident.	Forklift impacts stationary object or other vehicle	Radiological/ toxicological release could occur locally,	Unl	M	Equipment designed to commercial	Qualified forklift operators. Fire protection	Ext	L	Serious (II) event. Potential

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
		causing propane release or vapor explosion, resulting fire involves uranium fuel assemblies, scrap, and unfinished fuel assemblies.	onsite and offsite.			standards. Active fire detection and sprinkler systems.	systems maintained to NFPA. Radiological control program. Industrial hygienist control program.			initiator for fire. Fire evaluated in Section 3.2.1.1, "Random Fire – 3712 Building."
2.	Accident.	Workers, doors or other vehicles/ objects could be struck by forklift.	Worker injury and/or property damage could occur.	Ant	M		Qualified forklift operators.	Ant	M	Very serious (I) event. Standard industrial hazard. No further evaluation is necessary.
3.	Dropping or impacting uranium fuel assemblies, scrap, or unfinished fuel assemblies from forklift.	Boxes could break spilling uranium fuel assemblies, scrap, or unfinished fuel assemblies.	Radiological/ toxicological contamination could occur locally.	Ant	L		Qualified forklift operators. Radiological control program. Industrial hygienist control program.	Ant	L	Marginal (III) event. Contamination controlled by 10 CFR 835, *Occupational Radiation Protection*. No further evaluation is necessary.
D.	Packaging/ Repackaging uranium fuel assemblies, scrap, and unfinished fuel assemblies.	Uranium fuel assemblies, scrap, or unfinished fuel assemblies are dropped while handling spreading contamination.	Radiological/ toxicological contamination spread could occur locally on floor and impacted objects. Worker injury could occur.	Ant	L	Certified lifting devices.	Qualified operators. Radiological control program. Industrial hygienist control program.	Ant	L	Marginal (III) event. Contamination controlled by 10 CFR 835, *Occupational Radiation Protection*. No further evaluation is

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
										necessary.
E.	Roof failure.	Roof collapse could cause injury, property and fuel damage.	Radiological/ toxicological release could occur locally. Worker injury could occur.	Unl	L		Surveillance programs for facility condition. Radiological control program. Industrial hygienist control program.	Unl	L	Marginal (III) event. Contamination controlled by 10 CFR 835, *Occupational Radiation Protection*. No further evaluation is necessary.
IV.	NATURAL OCCURRENCES									
A.	Flood.									
1.	High Water.									
a.	Affects electrical circuits.	Flooding of the buildings could initiate a fire.	Criticality could occur. Radiological/ toxicological contamination could occur locally.	Ext	M	The elevations of the floors of the fuel storage buildings are from 386.2 ft to 391.6 ft above mean sea level (MSL). The probable maximum flood is 383 ft above MSL. Active fire detection and sprinkler systems.	Criticality limits calculated on the basis that water is present as a moderator. Fire protection systems maintained to NFPA. Criticality safety program. Radiological control program.	BEU	M	Marginal (III) event. Building floor elevations above probable maximum flood elevation. Contamination controlled by 10 CFR 835, *Occupational Radiation Protection*. Potential initiator for fire. Fire evaluated in Section 3.2.1.1, "Random Fire – 3712 Building."

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
										Potential initiator for criticality event. Criticality evaluated in Section 3.2.4, "Criticality Analysis."
b.	Affects contamination.	Surface contamination flushed by flooding to surrounding area and process sewer, then process sewer goes to ground water, then to the river.	Radiological/ toxicological release could occur locally, onsite and offsite.	Ext	L	The elevations of the floors of the fuel storage buildings are from 386.2 ft to 391.6 ft above mean sea level (MSL). The probable maximum flood is 383 ft MSL. Affected buildings have flood relief ports.		BEU	L	Negligible (IV) event. Building floor elevations above probable maximum flood elevation. No further evaluation is necessary.
2.	Heavy rain (flash flood).	Rainfall could flood the building. Some drains go directly to process sewers.	Radiological/ toxicological release could occur locally, onsite and offsite.	Ant	L		Radiological control program.	Unl	L	Marginal (III) event. Contamination controlled by 10 CFR 835, *Occupational Radiation Protection*. No further evaluation is necessary.

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
B.	Seismic event.	Earthquake could cause change in fuel geometry, building damage, or injury.	Radiological/ toxicological release could occur locally, onsite and offsite. Lost-time injury could occur.	Unl	M		Radiological control program. Industrial hygienist control program. Emergency preparedness program.	Unl	M	Serious (II) event. Contamination controlled by 10 CFR 835, *Occupational Radiation Protection*.
		Earthquake could initiate a fire in building involving uranium fuel assemblies, scrap, and unfinished fuel assemblies.	Criticality could occur if fuel boxes have been misstacked. Radiological/ toxicological release could occur locally, onsite and offsite.	Ext	M	Active fire detection and sprinkler systems.	Building combustibles controlled. Fire protection systems maintained to NFPA. Criticality safety program. Radiological control program. Industrial hygienist control program. Emergency preparedness program.	BEU	M	Marginal (III) event. Potential initiator for fire. Seismic fire evaluated in Section 3.2.1.2, "Seismic-Induced Fire – 3712 Building." Representative accident. Potential initiator for criticality event. Criticality evaluated in Section 3.2.4, "Criticality Analysis."

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
C.	Wind.									
1.	Projectiles.	Missile could penetrate buildings.	Radiological/ toxicological release could occur locally. Property damage, worker injury could occur.	Unl	L	The concrete buildings would decrease impact to fuel.	Radiological control program. Industrial hygienist control program. Emergency preparedness program.	Unl	L	Marginal (III) event. Contamination controlled by 10 CFR 835, *Occupational Radiation Protection*. No further evaluation is necessary.
2.	Pressure.	Wind pressure could collapse building.	Radiological/ toxicological release could occur locally. Property damage, worker injury could occur.	Unl	L		Radiological control program. Industrial hygienist control program. Emergency preparedness program.	Unl	L	Marginal (III) event. Contamination controlled by 10 CFR 835, *Occupational Radiation Protection*. No further evaluation is necessary.
D.	Volcanic ash/snow.	Ash/snow buildup on roof causes collapse.	Radiological/ toxicological release could occur locally. Property damage, worker injury could occur.	Unl	L		Radiological control program. Industrial hygienist control program. Emergency preparedness program.	Unl	L	Marginal (III) event. Contamination controlled by 10 CFR 835, *Occupational Radiation Protection*. No further evaluation is necessary.

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
E.	Lightning.	Building struck by lightning initiating a fire in building involving uranium fuel assemblies, scrap, and unfinished fuel assemblies.	Radiological/ toxicological release could occur locally, onsite and offsite. Some damage could occur.	Unl	M	Active fire detection and sprinkler systems.	Fire protection systems maintained to NFPA. Radiological control program. Industrial hygienist control program. Emergency preparedness program.	Unl	L	Serious (II) event. Potential initiator for fire. Fire evaluated in Section 3.2.1.1, "Random Fire – 3712 Building."
V.	RADIATION									
A.	Radioactive uranium.	Exposure to uranium fuel assemblies, scrap, and unfinished fuel assemblies.	Workers in building could be exposed.	Ant	L		Qualified workers using approved procedures. Radiological control program.	Ant	L	Marginal (III) event. Worker safety issue. Controlled by 10 CFR 835, *Occupational Radiation Protection*. No further evaluation is necessary.
B.	Criticality. See possible causes above.	Mis-stacked fuel, with fire or reconfiguration, followed by moderation, then reflection. Fire is an initiator.	Criticality could occur. Fire may be present. Radiological release could occur locally, onsite and offsite.	Ext	M	Quantity and critical geometry were considered when calculating critical mass, allowable height, width and length of a stack of fissile material. Physical shape of	Criticality safety program.	BEU	M	Marginal (III) event. Evaluated in Section 3.2.4, "Criticality Analysis." Representative accident.

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
						fuel assemblies and their boxes are a natural barrier to formation of a critical geometry. Criticality drainage features.				
VI.	EXTERNAL EVENTS									
A.	Large propane storage tanks (north of 313-North Building).	Explosion and/or fire involves fuel storage buildings which could involve stored uranium fuel assemblies, scrap, and unfinished fuel assemblies.	Radiological/ toxicological release could occur locally, onsite and offsite. Worker injuries and property damage could occur.	Ext	M	Built to industrial standards. Active fire detection and sprinkler systems.	Fire protection systems maintained to NFPA. Radiological control program. Industrial hygienist control program.	Ext	L	Marginal (III) event. Propane explosion/fire evaluated in Section 3.2.1.3, "BLEVE-Induced Event." Representative accident.
B.	Nearby Facilities									
1.	3720 Central Services Laboratory.	Operations could impact fuel storage building.	3720 Building radiological/ toxicological release could occur locally and result in evacuation of the FSS. Worker injuries and property damage could occur.	N/A	None	--	--	N/A	None	No further evaluation is necessary.
2.	3720 BA Package Boiler Building.	Explosion and/or fire impacts fuel storage buildings.	Fire/explosion could involve stored uranium fuel assemblies, scrap,	Ext	M	Built to industrial standards. Active fire detection and sprinkler systems	Uranium storage building fire protection systems	Ext	L	Marginal (III) event. Similar hazards and associated

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
			and unfinished fuel assemblies. Radiological/ toxicological release could occur locally, onsite and offsite. Worker injuries and property damage could occur.			in uranium storage buildings.	maintained to NFPA.			risks evaluated in Section 3.2.2.1, "Package Boiler Related Fire."
3.	3720 BA Mobile Package Boiler Building.	Explosion and/or fire impacts fuel storage buildings.	Fire/explosion due to diesel spill could involve stored uranium fuel assemblies, scrap, and unfinished fuel assemblies. Radiological/ toxicological release could occur locally, onsite and offsite. Worker injuries and property damage could occur.	Ext	H	Built to industrial standards. Active fire detection and sprinkler systems in uranium storage buildings.	Uranium storage building fire protection systems maintained to NFPA.	Ext	L	Serious (II) event. Potential initiator for fire. Mobile package boiler fire evaluated in Section 3.2.2.1, "Package Boiler Related Fire." Representative accident.
4.	306 Metal Fabrication Development Building.	Operations could impact fuel storage building.	306 Building radiological/ toxicological release could occur locally and result in evacuation of the FSS. Worker injuries and property damage could occur.	N/A	None	--	--	N/A	None	No further evaluation is necessary.

Table 3.1.3-4. Hazard Identification and Evaluation

HAZARD/ENERGY SOURCE		POTENTIAL ACCIDENT AND SEQUENCE	TARGET/ POTENTIAL CONSEQUENCES	UNMITIGATED		MITIGATING BARRIERS		MITIGATED		COMMENTS
				F*	C*	ENGINEERED	ADMIN	F*	C*	
5.	313 Building.	Operations could impact fuel storage building.	313 Building radiological/ toxicological release could occur locally and result in evacuation of the FSS. Worker injuries and property damage could occur.	N/A	None	--	--	N/A	None	No further evaluation is necessary.
6.	300 ADP Buildings.	Operations could impact fuel storage building.	300 ADP Buildings radiological/ toxicological release could occur locally and result in evacuation of the FSS. Worker injuries and property damage could occur.	N/A	None	--	--	N/A	None	No further evaluation is necessary.

*F – Frequency (estimated annual), Ant – Anticipated, Unl – Unlikely, Ext – Extremely Unlikely, BEU – Beyond Extremely Unlikely
*C – Consequence (estimated), H – High, M – Moderate, L – Low, None

3.2 Accident Analysis

Based on the supporting analyses and the following discussion, it is concluded that storage and handling of uranium in the facility and cleanup and transition activities required for permanent closure and shutdown are within the evaluation guidelines (DOE-RL 2002). These guidelines are provided in Table 3.2-1 (below). Information from this table is used in conjunction with Table 3.1.3-3 to evaluate event consequences.

Table 3.2-1 Hanford Safety Basis Strategy Evaluation Guidelines

Consequence	Offsite Public [a, b]	Onsite Worker [a, b]
High	>25 rem TEDE >ERPG-2 / TEEL-2 Be: 25 $\mu g/m^3$ U: 1.0 mg/m^3	>100 rem TEDE >ERPG-3 / TEEL-3 Be: 100 $\mu g/m^3$ U: 10 mg/m^3 Prompt death to a facility worker
Moderate	$\geq$1 rem TEDE >ERPG-1 / TEEL-1 Be: 5.0 $\mu g/m^3$ U: 0.6 mg/m^3	$\geq$25 rem TEDE >ERPG-2 / TEEL-2 Be: 25 $\mu g/m^3$ U: 1.0 mg/m^3 Serious injury or significant radiological or chemical exposure to facility workers
Low	<Moderate consequences	<Moderate consequences

a TEDE – total effective dose equivalent.
b TEEL-1 – Temporary Emergency Exposure Level No. 1 (from Craig 2001).
TEEL-2 - Temporary Emergency Exposure Level No. 2 (from Craig 2001).
TEEL-3 - Temporary Emergency Exposure Level No. 3 (from Craig 2001).

Two categories of fires are considered, based on the hazards review presented earlier: fires limited by the currently available combustible material, and fires augmented or expanded by additional combustible material. Also, criticality events are analyzed.

3.2.1 Fires Limited by Available Combustible Material

The uranium storage buildings have combustible material inventories that are essentially limited to that represented by the wood fuel storage boxes. Potential initiators that could produce such a fire include random events (human error, equipment failure, etc.), seismic-induced fire, and BLEVE-induced fire.

3.2.1.1 Random Fire - 3712 Building

The bounding fire in the 3712 Building was initially described in the accident safety analysis (Johnson 1994) when it contained 1122 MTU. This fire, initiated by a random fire or seismic event (and limited by available combustible material), presumes a four-hour duration resulting in a total uranium oxidation time of 8 hours with the fire department not responding. The total oxidation time is based on a peak temperature of 1093°C (2000°F) followed by cool-down taken from a standard fire profile taken from the Fire Protection Handbook (NFPA 1981). This event does not take credit for actuation of the building automatic fire alarm or sprinkler system or any intervention by the HFD. The analysis used the combustible loading (wood, cardboard, plastics, etc.) associated with the specific 1122 MTU loading in the building at the time of the survey. The combustible loading provided a basis for calculating a fire load density (Btu/ft^2) which established a fire duration (4 hours) and maximum temperature (approximately 1093°C). The fire duration and temperature were then used to establish the fraction of the uranium inventory that was oxidized and subject to release. As described in Section 3.1.2, the current 3712 Building inventory is represented by 675 MTU for conservatism.

3.2.1.1.1 Storage Building Fire Probability

The probability of a fire in the uranium stoage buildings has been reconsidered (Benecke 2002). Historical review of the entire facility, including fuel-manufacturing operations, for the last 25 years results in an annual fire probability of 1.6E-01. This probability is overly conservative considering that fuel fabrication operations have ceased (previous facility fires resulted mostly from operations involving uranium chips and fines) and energy sources capable of initiating a fire have been substantially reduced. Using the methodology of Coutts 2001, the unmitigated probability of a uranium fire in the remaining uranium storage buildings (3712, 3716, 303-B) is analyzed as follows:

The frequency of a fire in a storage building (Savannah River Site, general storage) is:

$$f = 3.3E\text{-}05A$$

where A is the area of the building in m^2 (900 m^2 for the 3712 Building), and f is the fire frequency. Therefore,

$$f = 2.97E\text{-}02\ yr^{-1} \sim 3.0E\text{-}02\ yr^{-1}$$

Although this frequency is defined for "general storage buildings," it is deemed applicable to the uranium storage buildings despite the minimal fire initiation potential. Thus, the overall fire frequency in the uranium storage buildings is "anticipated" for all current and proposed activities, including fuel disposition.

3.2.1.1.2 Uranium Oxidation

Characteristics of uranium oxidation have been re-examined. For the purpose of this analysis, the median Airborne Release Fraction (ARF) and Respirable Fraction (RF) values from the DOE-HDBK-3010-94 are used to describe the burning of uranium, i.e., ARF = 1.0E-04 and RF = 1.0. Selection of the median, rather than bounding, ARF and RF values is justified because any extended oxidation period would result in the buildup of an oxide layer that would tend to block the "escape" of newly reacted oxide particles.

The accident analysis for the facility (Johnson 1994) evaluated experimental data for metallic uranium oxidation involved in the fire temperatures that would be expected in a storage building fire and developed estimates for the time versus oxidation-temperature for complete oxidation of billets. The fire time-temperature profile (the ASTM standard time-temperature curve obtained from the Fire Protection Handbook, NFPA 1981) based on the combustible material loading shows that the temperature quickly reaches about 800°C in less than 30 minutes and then rises more slowly to reach 1000°C within 2 hours. Because extrapolation of the oxidation experiments indicates that billet oxidation would occur in approximately 170 hours at both 800°C and about 1000°C (Johnson 1994), that time is used to represent oxidation behavior up to 1000°C. Based on the fire temperature being at or above 1000°C from the 2-hour mark to the 4.5-hour mark, the oxidation time associated with the peak temperature (1093°C), i.e., 124 hours (Johnson 1994), is assigned to that time period. After 4.5 hours, the fire cools to 300°C in another 3.5 hours. Although no oxidation behavior for the lower temperature range was indicated in the references cited in the accident analysis (Johnson 1994), a 200-hour oxidation period is conservatively applied to represent that temperature range because the oxidation rate is temperature dependent. Because of the mass of uranium associated with the postulated fire, it is believed that buildup of oxide "ash" would inhibit the oxidation process somewhat. Thus the fraction of billets oxidized during the fire would be conservatively represented by:

$$2\ \text{hr}/170\ \text{hr} + 2.5\ \text{hr}/124\ \text{hr} + 3.5\ \text{hr}/200\ \text{hr} = 0.0494\ \text{(Benecke 2000).}$$

$$\approx 0.05$$

However, none of the remaining uranium inventory is in billet form. Rather, essentially all of the uranium is clad with oxidation-resistant Zircaloy-2 except for a portion of the unfinished fuel in the 3716 Building, which does not have end caps. Detailed examination of potential fire scenario consequences has shown that the 3712 Building fire is the bounding scenario despite the presence of a significant quantity of fuel elements without end caps in the 3716 Building (Benecke 2003c). During the fire the oxidation-resistant Zircaloy-2 cladding provides protection for the underlying uranium unless the fuel end caps are dislodged or otherwise damaged. The predicted peak fire temperature exceeds the melting point of the braze used to join the end cap to the cladding [m. p. ~950° C. (Lustman and Kerze 1955) which is ~143° C less than the predicted peak fire temperature of 1093° C] and a subsequent tungsten inert gas (TIG) weld over the Zircaloy-2 end cap and cladding (WHC 1998). This TIG weld did incorporate a small amount of the braze material, but because the braze material is essentially Zircaloy-2 with a 5% addition of beryllium to lower its melting point, the TIG weld is expected to have a melting point higher than the braze. It is believed that not all of the end caps will be dislodged during collapse of the burning wood storage boxes in an unmitigated fire. Only if a fuel element "tips" significantly could its downward end cap become dislodged. Those end caps that stay in place will continue to prevent U oxidation and its subsequent release. Because of the close tolerance between the end cap and cladding, it is estimated that no more than 25% of all end caps fall away. End caps that remain in place result in the underlying uranium being protected from oxidation.

Determination of the quantity of uranium potentially oxidized in the bounding fire is the result of estimating the fraction of the inventory that could be exposed, i.e., not clad with Zircaloy-2 [the uranium exposure factor (EF)] and then estimating what fraction of the exposed uranium could be oxidized [the uranium oxidation rate factor (OF)]. For each consideration, these factors are applied to the previously calculated oxidation behavior ascribed to billets.

Three distinct mechanisms of uranium exposure and subsequent oxidation are believed to be possible during the unmitigated 3712 Building fire: a) end cap loss and oxidation of the exposed uranium at the fuel element ends, b) cladding damage resulting from roof collapse and oxidation of the exposed uranium, and c) oxidation of the small quantity of scrap in the facility.

As described above, the detailed fire scenario (Benecke 2002) also predicts that the oxidation rate factor to be applied to that for billets is 1/6, based on the relative values of exposed uranium area/uranium mass (assuming end caps on both ends of the fuel element are lost, for conservatism). For roof damage, the inventory fraction potentially exposed is 5%, based on the fraction of uranium estimated to be in the top layer of fuel elements and that no more than half of the top-layer fuel elements are actually struck by the collapsed roof. The oxidation rate factor for roof damage is 1/3.6 (derated to 1/3), based on only 25% of the top-quadrant of the circumferential surface area being damaged and as before, comparing the relative values of exposed uranium area/uranium mass for the damaged fuel elements vs the billets. For the scrap pieces in 3712 Building, the entire scrap inventory of 1.28 MTU is assumed to be subject to oxidation ($1.28/675 \approx 0.002$). The oxidation rate factor for this scrap is 1/4.2 (derated to 1/4), based on none of the scrap pieces having end caps and as before, comparing the relative values of exposed uranium area/uranium mass for the damaged fuel elements vs the billets. Thus, the total fraction uranium oxidized is

$$F = 0.05\,[(0.25)(1/6) + (0.05)(1/3) + (0.002)(1/4)] = 0.00294$$

3.2.1.1.3 Random Fire Radiological Consequences

Inserting these revised values for ARF, RF, and fraction billet oxidation into the equations developed in the initial hazard classification analysis, which include appropriate dose conversion factors derived from GENII computer code calculations (Johnson 1994) that predict potential radiological dose consequences, provides the following results:

Dose = Inv x OF x ARF x RF X DCF
Where Inv = 3712 Building Inventory (MTU)
OF = Oxidation Fraction
ARF = Airborne Release Fraction
RF = Respirable Fraction
DCF = Dose Conversion Factor (rem/MTU), which includes the X/Q (0.034 s/m^3 onsite and 0.0023 s/m^3 offsite), the standard man breathing rate (3.3×10^{-4} m^3/s), and a dose for one MTU of the uranium mix in the 3712 Building as defined in Table 3.1.2-1. The doses are calculated using the GENII Code, which uses ICRP-26 methodology. The use of the ICRP-68 and –71 dose conversion factors would lower the doses, but since the ICRP-26 doses are conservative and the doses are not large, the Johnson 1994 calculations are used to calculate doses.

$\text{Dose}_{\text{(onsite)}}$ = 675 MTU x 0.00294 x 1.0E-04 x 1.0 x 1.5E+03 rem/MTU = 0.30 rem

$\text{Dose}_{\text{(offsite)}}$ = 675 MTU x 0.00294 x 1.0E-04 x 1.0 x 9.6E+01 rem/MTU = 0.019 rem

However, the dose conversion factor used to calculate these consequences does not include the effects of the minor concentrations of transuranic impurities present in the recycled uranium. These impurities include ^{236}U, ^{239}Pu, ^{99}Tc, ^{327}Np, and other shorter-lived fission products that were not completely removed during the reprocessing and plutonium extraction processes. A comprehensive evaluation of the radionuclide impurities found in uranium recycled at the Hanford Site (PNNL, 2000) estimates that these impurities will increase dose consequences by 15%. Thus, the recalculated dose consequences become:

$\text{Dose}_{\text{(onsite)}}$ = 0.30 rem x 1.15 = 0.34 rem

$\text{Dose}_{\text{(offsite)}}$ = 0.019 rem x 1.15 = 0.022 rem

3.2.1.1.4 Random Fire Toxicological Consequences

Toxicological concentrations were calculated similarly using the methodology of the hazard classification analysis (Huang 1999) that incorporated values for inventory, ARF, RF, fraction inventory oxidized in 15 minutes, and dispersion coefficient (χ/Q). Note that toxicological consequences are based on the peak 15-minute concentration in contrast to extended exposure used to calculate radiological dose consequences. Thus,

$$\text{Conc} = \text{Inv} \times \text{ARF} \times \text{RF} \times 1/t \times \chi/Q$$

Where Inv = quantity of 3712 Building inventory that is oxidized. For end cap loss = (0.25)(0.25 h)/(124 h)(6); for roof failure = (0.05)(0.25 h)/(124 h)(3); for scrap oxidation = (0.002)(0.25 h)/(124 h)(4).

ARF = airborne release fraction.

RF = respirable fraction.

1/t = reciprocal time (sec^{-1}).

χ/Q = dispersion coefficient (sec/m^3). [3.4E-02 s/m^3 (onsite) and 2.3E-03 s/m^3 (offsite) per Huang 1999]

Thus, for uranium, calculated concentrations are:

$$\text{Conc}_{(\text{onsite})} = 675\ \text{MTU} \times \frac{10^9\ \text{mg}}{\text{MT}} \times \frac{0.25\ \text{h}}{124\ \text{h}} \times 1\text{E-04} \times \frac{1}{(0.25\ \text{h})(3600\ \text{s/h})} \times$$

$$3.4\text{E-02 s/m}^3 \times [0.25/6 + 0.05/3 + 0.002/4]$$

$$= 0.30\ \text{mg U/m}^3$$

$$\text{Conc}_{(\text{offsite})} = 675\ \text{MTU} \times \frac{10^9\ \text{mg}}{\text{MT}} \times \frac{0.25\ \text{h}}{124\ \text{h}} \times 1\text{E-04} \times \frac{1}{(0.25\ \text{h})(3600\ \text{s/h})} \times$$

$$2.3\text{E-03 s/m}^3 \times [0.25/6 + 0.05/3 + 0.002/4]$$

$$= 0.020\ \text{mg U/m}^3$$

Beryllium concentrations were calculated similarly. The source of beryllium is the braze ring material which is nominally Zircaloy-2 plus 5 % beryllium. The beryllium release is associated with oxidation of the braze material used to attach the end cap to the cladding and exposed uranium. Although a secondary tungsten-inert-gas (TIG) weld was performed over the braze, it is presumed that once the braze melting point is exceeded in the postulated fire, there is a potential for release.

The at-risk beryllium inventory is determined by beginning with the starting braze ring weights that were used for fabrication of the fuel elements and then making adjustments for subsequent processing and the fire scenario. Review of the specification for the braze rings (WHC 1988b) shows that the heaviest braze rings weighed 17.5 g and 9.0 g for outer and inner fuel elements, respectively. Each completed fuel assembly then was fabricated using up to 53 g of braze material. Next, the manufacturing processing following the braze operation removed approximately one-third of the braze material per process specification X-411 (WHC 1988a). The current quantity of braze associated with the 3712 Building fuel assemblies contained within 890 storage boxes is then:

890 boxes x 36 assys/box x 53 g braze/assy x kg/1000 g x 2/3 = 1132 kg

The 250 pieces of scrap fuel are conservatively assumed to possess end caps for purposes of calculating potential beryllium release, resulting in another 9 kg braze which increases the total braze inventory to 1141 kg.

Because not all of the end caps would be dislodged during collapse of the burning wood storage boxes, the quantity of beryllium at risk is further reduced. Those end caps that stay in place essentially prevent beryllium release. Because of the close tolerance between the end cap and cladding, it is estimated that no more than 25% of all end caps fall away. Finally, because the braze is essentially Zircaloy-2 plus a minor beryllium addition, braze oxidation is expected to be inhibited. Thus, it is estimated that no more than 25% of the braze material exposed would oxidize during the 15-minute period defining the peak concentration to calculate the maximum possible quantity of airborne beryllium. In the absence of ARF and RF values for beryllium, those values previously assigned to burning U, i.e., 1.0E-04 and 1.0, respectively, were applied to the beryllium. This assignment is conservative because the beryllium is a minor constituent alloyed with oxidation-resistant zirconium. An additional 10% beryllium release is added to address roof failure consequences. Then, for a postulated 3712 Building fire, calculated beryllium concentrations are:

$$Conc_{(onsite)} = 1141\text{ kg} \times \frac{10^9\,\mu g}{kg} \times 0.25\text{ (end cap loss)} \times 0.25\text{ (braze oxidation)} \times$$

$$\frac{5\%\text{ Be}}{\text{braze ring}} \times 1E\text{-}04 \times \frac{1}{(0.25\text{ h})(3600\text{ s/h})} \times 3.4E\text{-}02\text{ s/m}^3 \times 1.10$$

$$= 14.8\ \mu g\text{ Be/m}^3$$

$$Conc_{(offsite)} = 1141\text{ kg} \times \frac{10^9\,\mu g}{kg} \times 0.25\text{ (end cap loss)} \times 0.25\text{ (braze oxidation)} \times$$

$$\frac{5\%\text{ Be}}{\text{braze ring}} \times 1E\text{-}04 \times \frac{1}{(0.25\text{ h})(3600\text{ s/h})} \times 2.3E\text{-}03\text{ s/m}^3 \times 1.10$$

$$= 1.00\ \mu g\text{ Be/m}^3$$

3.2.1.1.5 Random Fire Risk and Controls

Summary of the random fire event frequency and consequences and resulting Risk Class is shown below in Table 3.2.1-1.

Table 3.2.1-1. Random Fire Risk Class

EVENT	RADIOLOGICAL CONSEQUENCES		TOXICOLOGICAL CONCENTRATION		RISK CLASS	
	Onsite[a]	**Offsite[b]**	**Onsite[a]**	**Offsite[b]**	**Onsite[a]**	**Offsite[b]**
3712 Bldg Random Fire Consequences (Anticipated)	3.4 mSv (0.34 rem) (Low)	0.22 mSv (0.022 rem) (Low)	Be: 14.8μg/m³ (Low) U: 0.30 mg/m³ (Low)	Be: 1.00 μg/m³ (Low) U: 0.020 mg/m³ (Low)	**Radiological**	
					III	III
					Toxicological	
					III	III

a Onsite – 100 m east.
b Offsite – 490 m east at adjacent river bank.

As anticipated for events involving low-enriched uranium, toxicological consequences are more severe than radiological consequences. Comparison of the potential beryllium consequences with risk evaluation guidelines (DOE-RL 2002) reveals that beryllium may represent the greatest hazard. However, it is noted that potential beryllium concentrations are substantially below the TEEL-1 (offsite) and TEEl-2 (onsite) guidelines. At Risk Class III, this event does not challenge guidelines.

Administrative controls are established in the TSR for housekeeping and on the inventories of uranium and beryllium, and combustible material associated with the fuel storage buildings to protect assumptions regarding the source term and combustible material inventory. No reliance on Safety Significant or Safety Class SSC is necessary. As defense in depth, an administrative control is established to maintain the uranium storage buildings fire protection systems.

3.2.1.2 Seismic-Induced Fire

A seismic-induced fire results from damage to the facility electrical system that initiates a fire that propagates to the fuel storage boxes.

3.2.1.2.1 Seismic-Induced Fire Probability

The seismic-induced fire probability combines the probability of an earthquake greater than UBC design criteria (1.1E-03) (Kelly 1995) and conservative engineering judgment regarding the probability of consequent fire initiation and it involving the fuel storage boxes (1.0E-02). This judgment was based on "personal experience of living in California earthquake zones where natural gas was the dominate heating fuel" (Kelly 1995) and minimal energy sources existing in the storage buildings that could initiate a fire. The lack of natural gas and minimal electrical supply to the fuel storage facilities strongly argues against fire.

3.2.1.2.2 Seismic-Induced Fire Radiological and Toxicological Consequences

Consequences of the unmitigated seismic-induced 3712 Building fire are identical to those from the random fire as described in Section 3.2.1.3 and 3.2.1.4.

3.2.1.2.3 Seismic-Induced Fire Risk and Controls

Since the probability of the seismic-induced fire also falls within the "unlikely" frequency regime, the risk associated with this event is identical to that for the random fire event. Thus, the same administrative controls that invoke housekeeping requirements and limit inventories of uranium, beryllium, and combustible material are established in the TSR. The fire protection systems are not maintained as defense-in-depth because they would not be expected to survive a seismic event.

3.2.1.3 BLEVE-Induced Event

A potential fire initiator is represented by the propane storage tanks located on the north end of the nearby 313 Building. A boiling liquid, expanding vapor explosion (BLEVE) associated with one or both of these tanks or a 300-gallon propane delivery truck could involve the 3712 Building.

3.2.1.3.1 BLEVE-Induced Fire Probability

The probability of a BLEVE at one of the two 1000-gallon propane supply tank or a 3000-gallon propane delivery truck tank at the north end of the 313 Building was evaluated as to the potential for either event to initiate a fire in either or both the 3712 or 3716 uranium fuel storage buildings. In evaluating data on BLEVEs published by the National Fire Protection Association, it was concluded that an intense heat source is necessary to initiate a BLEVE, such as a vehicle fire during filling of the tank. A 3712 Building fire initiated by a propane delivery truck BLEVE is credible [7.8E-06/yr, based on historical Hanford Site vehicle fire data and consideration of the angle subtended by the building foot print (Brehm, et al 1997)], and therefore in the "extremely unlikely" frequency regime.

The probability of fires being initiated in both the 3712 and 3716 Buildings by a delivery truck fire and subsequent BLEVE of the delivery truck propane tank is 3.2E-07 fires/year (Brehm 1997) which is not credible. Similar evaluation of a storage tank BLEVE resulting from upsets during fuel delivery resulted in a probability of 1.6E-08 fires/yr (Brehm 1997) simultaneously in the 3712 and 3716 Buildings. This event is also not credible.

3.2.1.3.2 BLEVE-Induced Fire Consequences

No additional combustible material would be added to the facility because the BLEVE fireball would not "leapfrog" the intervening 313 Building. Any fire initiated in the 3712 Building is presumed to result from hot sections of the exploding tank impacting the building. Thus, its consequences are bounded by the fire initiated from sources from within the building (Sections 3.2.1.1 and 3.2.1.2).

3.2.1.3.3 BLEVE-Induced Fire Risk and Controls

Table 3.2.1-2 provides event frequency, consequences, and Risk Class for the BLEVE-induced fire.

Table 3.2.1-2. Risk Evaluation Guidelines Comparison with BLEVE-Induced Fire Maximum Potential Consequences

EVENT	RADIOLOGICAL CONSEQUENCES		TOXICOLOGICAL CONCENTRATION		RISK CLASS	
	Onsite[a]	Offsite[b]	Onsite[a]	Offsite[b]	Onsite[a]	Offsite[b]
BLEVE Induced Fire - 3712 Bldg Consequences (Extremely Unlikely)	3.4 mSv (0.34 rem) (Low)	0.22 mSv (0.022 rem) (Low)	Be: 14.8 μg/m^3 (Low) U: 0.30 mg/m^3 (Low)	Be: 1.00 μg/m^3 (Low) U: 0.020 mg/m^3 (Low)	**Radiological** IV **Toxicological** III	 IV IV

a Onsite – 100 m east.
b Offsite – 490 m east at adjacent river bank.

Comparison of consequences with risk guidelines shows that no guidelines are challenged. No additional administrative controls beyond those provided for the random fire, i.e., housekeeping and limits on uranium, beryllium, and combustible material inventories, are necessary to be established in the TSR. Maintenance of the fire protection systems is required as defense-in-depth. At Risk Class III and IV, this event does not challenge guidelines.

3.2.1.4 Other Propane Tank Related Fires

Until the end of CY 2001, a metals fabricator utilized the large metal extrusion press located in the north end of the 313 Building as a private industry venture. Although manufacturing activities have ceased, liquefied petroleum gas (LPG) is still used to heat the building. A review of the propane tank storage and operations indicated that three propane related events warranted evaluation (1) a Boiling Liquid, Expanding Vapor Explosion (BLEVE) (presented previously in Section 3.2.1.3), (2) a propane leak and explosion/deflagration in the 313 Building, and (3) uncontrolled venting at a tank resulting in a release of combustible gas. An analysis was prepared to assess the impact of the propane tank accident events on the 3712 and 3716 fuel storage buildings (Brehm 1997). (It should be noted that the 313-N propane tank is anticipated to be taken out of service no later than the spring of 2003.)

The second accident evaluated was that of a slow propane leak inside the 313-North Building during a non-operational period. Results of this analysis indicate that a leak would have to go undetected for at least 10 hours to produce an explosion large enough to heavily damage the 3712 Building, while the 3716 Building would suffer only minimal damage (Brehm 1997). The potential for a fire being initiated in the 3712 Building as a result of a gas explosion is very small, since the flash would be of short duration. Fire initiation in the 3716 Building is not credible because of the minimal damage credited. Actual damage to either building would be considerably less than predicted by the analysis (Brehm 1997) because the presence of the 313 North Building was not considered. That building structure would absorb a substantial portion of the explosive energy, thereby reducing the damage to the 3712 and 3716 Buildings.

Evaluation of the third potential event, ignition of a venting liquefied petroleum gas storage tank, concluded that there are no hazardous consequences.

One additional LPG storage tank has been reviewed: an underground tank north of the 3712 Building and approximately 1.5 m south of the 3720 Building owned by PNNL. Inspection of this tank shows it to be empty and disconnected. The tank has not been in use for several years and is not scheduled to be placed in service.

3.2.2 Fires Expanded by Additional Combustible Material

Other credible fires are those initiated by sources outside the facility and also introduce additional combustible material to potentially increase fire severity. These include a more severe random fire because of inadvertent combustible material increases, upsets involving the package boiler unit near the 3712 Building, vehicle impact, and aircraft impact.

3.2.2.1 Fire Associated With Inadvertent Combustible Material Inventory Increase

Breakdown of controls imposed by the normal good practices to minimize combustible materials in/around the uranium storage buildings and by the 300 ADP procedure addressing uranium and combustible material inventories for those buildings could result in a more severe fire.

3.2.2.1.1 Fire Probability

Fire initiation probability is the same as for the random fire described in Section 3.2.1, i.e., 3.0E-02/yr. However, by taking credit for the normal surveillance activities designed to detect inadvertent accumulation of combustibles and the USQ process that addresses deliberate actions that may increase the combustible loading, a further reduction of 0.1 can be conservatively applied. Thus, overall fire probability is 3.0E-03.

3.2.2.1.2 Fire Consequences

Consequences of an unmitigated fire resulting from ignition and propagation of a fire that includes additional combustible materials are expected to be greater than for the random fire with fixed combustible material inventory but less than those associated with the package boiler related fire where a significant quantity of additional combustible material in the form of diesel fuel could be added. Because the existing uranium storage buildings have limited volume, the inadvertent accumulation of additional combustible material would most likely be limited to a relatively small quantity. It is recognized that the south end of the 3712 storage building is essentially empty but it is also empty with respect to uranium fuel materials except for the small quantity of scrap (1.28 MTU). Although an unmitigated fire in that portion of the facility would be expected to propagate to the north end that contains several hundred MTU, the combustible material in the south end would not contribute to the severity of the north end fire. Thus, it is conservative to estimate consequences at 50 percent greater than that for the random fire event.

3.2.2.1.3 Risk and Controls

Table 3.2.2-2 provides frequency, consequences, and risk class for a 3712 Building fire associated with inadvertent accumulation of significant additional combustible material.

Table 3.2.2-1. Inadvertent Combustible Material Inventory Increase Fire Risk Class

Event	Radiological Consequences		Toxicological Concentration		Risk Class	
	Onsite	**Offsite**	**Onsite**	**Offsite**	**Onsite**	**Offsite**
Fire Associated with inadvertent *combustible material* increase (Anticipated)	5.1 mSv (0.51 rem) *(Low)*	0.33mSv (0.033 rem) *(Low)*	Be: 22.2 μg/m³ (Low) U: 0.45 mg/m³ (Low)	Be: 1.5 μg/m³ (Low) U: 0.052 mg/m³ (Low)	Radiological: III *Toxicological*: III	Radiological: III *Toxicological*: III

a Onsite - 100 m east.
b Offsite - 490 m at adjacent river bank.

Although the toxicological guidelines are approached for the collocated worker, particularly for beryllium (22.2 μg/m³ vs the TEEL-2 limit of 25 μg/m³), all risk class values are III and the risk is acceptable. As stated above, it is necessary to invoke housekeeping and inventory controls on combustible material to reduce the event probability in the TSR. Because no credited equipment is invoked, there is no requirement for Safety Significant SSC. Maintenance of the fire protection systems is provided as defense-in-depth.

3.2.2.2 Package Boiler Related Fire

Located somewhat between the 3712 Building and the nearby 3720 Building is a natural gas-fired package boiler that produces steam for heating the 3720 Building. Upsets and accidents associated with this unit (boiler explosion, boiler annex fire, jet flame from ruptured gas pipeline) would be minimal since the distance between the two facilities exceeds the minimum separation distances calculated for these accidents (Daling and Graham 1997).

Potential use of a mobile diesel-fired package boiler when the primary natural gas fired package boiler is out of service must be considered. This unit, which has a 1000-gallon diesel tank associated with it, could theoretically add to the combustible loading of the nearby 3712 Building. Events considered were a) vehicle impact and resulting spill, and b) an upset associated with diesel transfer from the delivery truck into the package boiler tank.

3.2.2.2.1 Package Boiler Fire Probability

Vehicle Impact Event

The Washington State boiler inspector estimates that there are approximately 10 instances/year where an emergency boiler is installed. Total number of power boilers (>15 psi steam or 160 psi hot water) and fire tube boilers in the state is 3059. This number does not include industrial use hot water heaters and cast iron boilers, also licensed by the state and estimated at 8,000 – 10,000 units, which would also employ an emergency diesel-fired mobile unit if the primary unit failed (Murphy 1999). Using only the number of power boilers and fire tube boilers as the basis to ensure that backup boiler use is not underestimated translates to a probability of backup boiler installation at the 3720 BA location of 3.3E-03 per year.

Vehicle impact with the backup package boiler unit could threaten the nearby 3712 Building. The Utah Department of Transportation, Division of Traffic and Safety, Safety Studies Section (Utah 1999) reports a vehicle accident rate for 1996 of 3.17 accidents per million vehicle-miles traveled. Assuming this rate encompasses the accident rate within the fenced 300 Area of the Hanford Site where traffic moves slowly, that the effective target width of the package boiler is less than 50 ft, and that the number of vehicles passing the package boiler site is estimated at less than 25/day, an accident rate involving the package boiler is calculated by:

3E-06 acc/vehicle mi. x 25 vehicle passes/day x 50 ft x mi/5280 ft x 365 day/yr =

2.6E-04/yr

The overall probability of fire initiation resulting from vehicle impact with the emergency package boiler is then

3.3E-03 x 2.6E-04 = 8.6E-07, which although is "beyond extremely unlikely" is close to "extremely unlikely".

Diesel Delivery-Related Event

Another scenario capable of resulting in a significant diesel spill results from an upset occurring when the diesel tank is being filled. Probability of impact by the delivery truck should be enveloped by the vehicle accident rate described above. Still another scenario is a spill occurring while transferring diesel from the delivery truck to the package boiler supply tank due to either human error [frequency estimated at 1.0E-02 (Gertman 1994)] or equipment failure (frequency estimated at 1.0E-02).

3.3E-03 diesel units/yr x 1E-02 spills = 3.3E-05 fires/yr, which is "extremely unlikely."

Comparison of the distance between the package boiler and the next closest fuel storage building, i.e., the 3716 Building, showed that adequate separation exists to prevent its involvement if the mobile package boiler or fuel delivery truck were to catch fire. Calculated minimum separation distances between a larger capacity (40,000 gallons) diesel-fired package boiler and a different target facility (Marusich 1997) were scaled for the smaller diesel tank.

3.2.2.2.2 Package Boiler Fire Radiological and Toxicological Consequences

A qualitative estimate of consequences, scaled from the consequences analyzed for the random fire event, is provided. For the diesel-delivery related event, it is assumed that increased cladding damage will result even though minimal diesel would be expected to enter the facility because of its concrete curb on the perimeter of the foundation. The scenario assumes the Zircaloy-2 cladding is damaged by falling debris and all of the end caps are dislodged. Uranium oxidation is approximated by assuming that the clad fuel elements are in the form of unclad billets. Note that the fire involving only billets is predicted to consume 5% of the billets (see

Section 3.2.1.1.2). Melting of the cladding is not credible since Zircaloy-2 melts at 1849° C (UNI 1979).

Radiological consequences (including the transuranic impurity factor) are:

Dose = Inv x OF x ARF x RF x DCF x TIF

Inv = uranium inventory
OF = fraction uranium oxidized when in billet form
ARF = airborne release fraction = 1.0E-04
RF = respirable fraction = 1.0
DCF = dose conversion factor
TIF = transuranic impurity factor

$$\text{Dose}_{(\text{onsite})} = 675 \text{ MTU} \times 0.05 \times 1.0\text{E-04} \times 1.5\text{E+03 rem/MTU} \times 1.15 = 5.8 \text{ rem}$$

$$\text{Dose}_{(\text{offsite})} = 675 \text{ MTU} \times 0.05 \times 1.0\text{E-04} \times 9.6\text{E+01 rem/MTU} \times 1.15 = 0.37 \text{ rem}$$

Toxicological consequences for uranium are:

$$\text{Conc}_{(\text{onsite})} = 675 \text{ MTU} \times \frac{10^9 \text{ mg}}{\text{MT}} \times \frac{0.25 \text{ h}}{124 \text{ h}} \times 1.0\text{E-04} \times \frac{1}{(0.25 \text{ h})(3600 \text{ s/h}} \times$$

$$3.4 \text{ E-02 s/m}^3$$

$$= 5.1 \text{ mg U/m}^3$$

$$\text{Conc}_{(\text{offsite})} = 675 \text{ MTU} \times \frac{10^9 \text{ mg}}{\text{MT}} \times \frac{0.25 \text{ h}}{124 \text{ h}} \times 1.0\text{E-04} \times \frac{1}{(0.25 \text{ h})(3600 \text{ s/h}} \times$$

$$2.3\text{E-03 s/m}^3$$

$$= 0.35 \text{ mg U/m}^3$$

Toxicological consequences for beryllium are a factor of four times higher than for the random fire event because all end caps are presumed to become dislodged during the fire:

$$\text{Conc}_{(\text{onfsite})} = 14.8 \ \mu\text{g Be/m}^3 \times 4 = 59.2 \ \mu\text{g Be/m}^3$$

$$\text{Conc}_{(\text{offsite})} = 0.99 \ \mu\text{g Be/m}^3 \times 4 = 4.0 \ \mu\text{g Be/m}^3$$

3.2.2.2.3 Package Boiler Fire Risk and Controls

Table 3.2.2-2 provides frequency, consequences, and Risk Class for a 3712 Building fire resulting from an accident involving the nearby diesel-fired package boiler.

Table 3.2.2-2. Package Boiler Related Fire Risk Class

EVENT	RADIOLOGICAL CONSEQUENCES		TOXICOLOGICAL CONCENTRATION		RISK CLASS	
	Onsite[a]	Offsite[b]	Onsite[a]	Offsite[b]	Onsite[a]	Offsite[b]
Package Boiler Related Fire - 3712 Bldg Consequences (Extremely Unlikely)	58 mSv (5.8 rem) (Low)	3.7 mSv (370 mrem) (Low)	Be: 59 μg/m^3 (Mod) U: 5.1 mg/m^3 (Mod)	Be: 4.0 μg/m^3 (Low) U: 0.35 mg/m^3 (Low)	**Radiological**	
					IV	IV
					Toxicological	
					III	III

a Onsite – 100 m east.
b Offsite – 490 m east at adjacent river bank.

Comparison of consequences with risk guidelines shows that no guidelines are challenged. Being Risk Class III and IV, this event does not challenge guidelines. No additional administrative controls beyond those provided for the random fire, i.e., housekeeping and limits on uranium, beryllium, and combustible material inventories, are necessary in the TSR. As defense-in-depth, maintenance of the fire protection systems is provided.

3.2.2.3 Aircraft Crash

Although aircraft crash into the facility was not included in the original hazard analysis (Johnson and Brehm, 1994), consideration of such events is shown below. Impact by general aviation, commercial aircraft, or helicopter could add significant additional fuel to exacerbate consequences.

3.2.2.3.1 Aircraft Crash Probability

An examination of commercial, military, and pesticide/herbicide overflights of the Multi-function Waste Tank Facility (MWTF) (Muhlestein 1994) determined that aircraft crash into that facility was not credible (< 1.0E-06/yr). This conclusion is conservative with respect to the fuel storage buildings because the MWTF area is substantially larger (3.88E+05 m^2 for the MWTF vs 9.03E+02 m^2 for the 3712 Building (the largest fuel storage building). Thus, the probability for an aircraft crash into that facility would be expected to be less by the ratio of areas, i.e., 2.3E-03. Then, the probability of commercial, military, or pesticide/herbicide aircraft crash into any of the fuel storage buildings would be less than 1.2E-08/yr, or not credible.

The probability of a helicopter malfunction and subsequent crash into the 3712 Building during an over flight for the purpose of obtaining radiological surveys (presumed to be annually) was considered per the methodology of DOE-STD-3014-96, Accident Analysis for Aircraft Crash into Hazardous Facilities (DOE 1996). This standard provides a crash rate of 2.5E-05 crashes per flight, which when used in conjunction with a formula provided by the standard for calculating the effective area of the facility for impact from a helicopter (1.84E+04 ft^2), results in an estimated annual probability of 1.7E-08 for a helicopter crash into the 3712 Building (assuming two flights per year to allow for confirmatory measurements to be made and the total flight path from its takeoff/landing site covers at least a square mile of potential affected area). Thus, the crash of a helicopter into any of the fuel storage buildings while performing radiological surveys is judged not to be credible.

Intuitively, the addition of helicopter flights over the Hanford Site for emergency medical evacuation should not have any higher probability for crash into the facility than the helicopter flights for radiological surveys. Procedures for these flights prohibit flight over major Hanford facilities. Pilots receive Hanford-specific training that defines pre-established landing zones and approach paths to avoid facility over flight. Definitive "no-fly zones" are established. Depending on the location and/or patient condition, the responding helicopter may land on a Hanford roadway near the incident site. Helicopter flights will be infrequent since emergency helicopter service will be employed only to preserve human life. In most instances, ground ambulance service will suffice, particularly because the 300 Area is relatively close to a local hospital which makes travel time by ground nearly equivalent to flight time.

The DOE Standard (DOE 1996) also provides for calculating the probability of a general aircraft crash into the facility. The Standard provides a general aircraft annual crash frequency of 1.0E-04 crashes/mi^2 for the Hanford Site, which when used in conjunction with the formula to calculate the effective area of the 3712 Building for impact from general aircraft (5.57E+04 ft^2), results in an estimated annual probability of 2.0E-07 for a general aircraft crash into the 3712 Building. Even if the other two fuel storage buildings were as large as the 3712 Building, a general aircraft crash into any of them would not be credible.

3.2.2.3.2 Aircraft Crash Consequences

Consequences of an aircraft crash into the 3712 Building could easily exceed those associated with the random fire or seismic-induced fire since it is assumed that additional fuel from the aircraft would be introduced to the facility which could increase both peak fire temperature and fire duration. Also, it would be expected that the facility fire protection system would be damaged to where it became ineffective. Under normal conditions, however, the HFD would respond before these conditions were realized. Even without HFD intervention, consequences would not be expected to exceed those associated with the diesel-fired package boiler related fire (Section 3.2.2.2).

3.2.2.3.3 Aircraft Crash Risk and Controls

Table 3.2.2-3 provides event frequency, consequences, and Risk Class for a 3712 Building fire resulting from an aircraft accident.

Table 3.2.2-3. Aircraft Crash Fire Risk Class

EVENT	RADIOLOGICAL CONSEQUENCES		TOXICOLOGICAL CONCENTRATION		RISK CLASS	
	Onsite[a]	Offsite[b]	Onsite[a]	Offsite[b]	Onsite[a]	Offsite[b]
Aircraft Crash Fire - 3712 Bldg Consequences (Extremely Unlikely)	58 mSv (5.8 rem) (Low)	3.7 mSv (370 mrem) (Low)	Be: 59 μg/m^3 (Mod) U: 5.1 mg/m^3 (Mod)	Be: 4.0 μg/m^3 (Low) U: 0.35 mg/m^3 (Low)	**Radiological** IV **Toxicological** III	**Radiological** IV **Toxicological** III

a Onsite – 100 m east.
b Offsite – 490 m east at adjacent river bank.

Comparison of consequences with risk guidelines shows that no guidelines are challenged. Being Risk Class III and IV, this event does not challenge guidelines. No additional administrative controls in the TSR beyond that necessary to protect assumptions regarding source term, i.e., limits on uranium, beryllium, and combustible material inventories, are necessary.

3.2.2.4 Vehicle Crash

Vehicle crash into the facility has potential to penetrate the uranium storage area and introduce additional fuel in the form of gasoline or diesel which could result in a more severe fire than resulting from combustion of the resident combustible material.

3.2.2.4.1 Vehicle Crash Probability

Vehicle crash probability was described in Section 3.2.2.1.1. Adjusting the value calculated for vehicle impact with the diesel-fired package boiler by the relative lengths of the 3712 Building and the assumed length of the package boiler results (108 ft vs 50 ft) results in an estimated annual probability of 4.3E-04/yr for general vehicle impact with the 3712 Building. Further reduction of 0.1 is warranted because the 3712 Building is set back from the roadway by more than 50 ft with a curb at the side of the road to result in a vehicle impact frequency of 4.3E-05/yr. This frequency falls within the "extremely unlikely" regime.

3.2.2.4.2 Vehicle Crash Consequences

Any additional fuel introduced into the facility would be localized and only increase fire severity in the vicinity of a few fuel storage boxes. Overall consequences should be only slightly more than those associated with the random fire event and would certainly be bounded by the diesel-fired package boiler fire event.

3.2.2.4.3 Vehicle Crash Risk and Controls

Table 3.2.2-4 provides event frequency, consequences, and Risk Class for a fire in the 3712 Building resulting from a vehicle crash.

Table 3.2.2-4. Vehicle Crash Risk Class

EVENT	RADIOLOGICAL CONSEQUENCES		TOXICOLOGICAL CONCENTRATION		RISK CLASS	
	Onsite[a]	Offsite[b]	Onsite[a]	Offsite[b]	Onsite[a]	Offsite[b]
Vehicle Crash Fire - 3712 Bldg Consequences (Extremely Unlikely)	58 mSv (5.8 rem) (Low)	3.7mSv (370 mrem) (Low)	Be: 59 μg/m^3 (Mod) U: 5.1 mg/m^3 (Mod)	Be: 4.0 μg/m^3 (Low) U: 0.35 mg/m^3 (Low)	**Radiological** IV	**Radiological** IV
					Toxicological III	**Toxicological** IV

a Onsite – 100 m east.
b Offsite – 490 m east at adjacent river bank.

Comparison of consequences with risk guidelines shows that no guidelines are challenged. Being Risk Class III and IV, this event does not challenge guidelines. No additional administrative controls in the TSR beyond that necessary to protect assumptions regarding source term, i.e., limits on uranium, beryllium, and combustible material inventories, are necessary. Maintenance of the fire protection systems is provided as defense-in-depth.

3.2.3 Summary Fire Risk and Controls

The unmitigated radiological and toxicological consequences for the two types of fire accidents were assigned a consequence ranking of high, moderate, or low based on the guidelines for the onsite worker and offsite public identified in Table 3.2-1 (DOE-RL 2002). Using the scenario frequency and the assigned consequence ranking, a risk class can be assigned to the accidents based on the hazard severity matrix identified in Table 3.1.3-3. The scenario frequency, actual consequences, assigned consequence ranking, and risk class for both types of fire accidents are shown in Table 3.2.3-1.

Mitigation was not considered for any event except the random fire event that exceeds predicted consequences based on existing source and combustible loading because of an inadvertent increase in combustible loading. For that event, a housekeeping program to manage transient combustibles is credited to reduce the probability. An additional administrative control is established to protect assumptions regarding source term by limiting inventories of fuel and combustible materials. Another is established to maintain the criticality safety program. Additional defense-in-depth controls are established to perform fire protection system testing, inspection, and maintenance to ensure predicted availability of those systems, and to maintain the radiological control program.

Table 3.2.3-1. Summary of Risk Evaluation Guidelines Comparison with Maximum Potential Consequences

EVENT	RADIOLOGICAL CONSEQUENCES		TOXICOLOGICAL CONCENTRATION		RISK CLASS	
	Onsite[a]	**Offsite**[b]	**Onsite**[a]	**Offsite**[b]	**Onsite**[a]	**Offsite**[b]
Random Fire Consequences (Anticipated)	3.4 mSv (Low) (0.34 rem)	0.22 mSv (0.022 rem (Low)	Be: 14.8 μg/m^3 (Low) U: 0.30 mg/m^3 (Low)	Be: 1.00 μg/m^3 (Low) U: 0.020 mg/m^3 (Low)	Radiological: III Toxicological: III	Radiological: III Toxicological: III
Fire Associated with Inadvertent Combustible Material Increase (Anticipated)	5.1 mSv (0.51 rem) (Low)	0.33 mSv (0.033 rem) (Low)	Be: 22.2 μg/m^3 (Low) U: 0.45 mg/m^3 (Low)	Be: 1.5 μg/m^3 (Low) U: 0.052 mg/m^3 (Low)	Radiological: III Toxicological: III	Radiological: III Toxicological: III
Package Boiler Related Fire, Aircraft Crash, Vehicle Impact Event Consequences (Extremely Unlikely)	58 mSv (5.8 rem) (Low)	3.7 mSv (370 mrem) (Low)	Be: 59 μg/m^3 (Mod) U: 5.1 mg/m^3 (Mod)	Be: 4.0 μg/m^3 (Low) U: 0.35 mg/m^3 (Low)	Radiological: IV Toxicological: IV	Radiological: IV Toxicological: IV
BLEVE Induced Fire, Seismic Induced Fire Consequences (Extremely Unlikely)	3.4 mSv (0.34 rem) (Low)	0.22 mSv (0.022 rem) (Low)	Be: 14.8 μg/m^3 (Low) U: 0.30 mg/m^3 (Low)	Be: 1.00 μg/m^3 (Low) U: 0.020 mg/m^3 (Low)	Radiological: IV Toxicological: IV	Radiological: IV Toxicological: IV

a Onsite – 100 m east.
b Offsite – 490 m east at adjacent river bank.

All unmitigated representative accidents identified above in Table 3.2.3-1 are Risk Class III or IV. The single mitigated event, i.e., the fire associated with inadvertent combustible material increase, does not rely on any controls on SSC. Thus, no Safety Significant or Safety Class SSC is warranted.

3.2.4 Criticality Analysis

3.2.4.1 Criticality Accident Scenarios

All fissionable materials (fuel components, fuel assemblies, and scrap) are handled and stored according to Criticality Prevention Specifications (CPS) that ensure at least two unlikely and independent contingencies must occur before criticality is possible. The CPS limits consider the specific enrichment and physical characteristic of each type of fissionable material in the facility. For handling, the quantity of fissionable material is limited to the hemispherical safe mass (i.e., half the minimum mass corresponding to $k_{eff} = 0.98$). For storage, the CPS limits are based on areal density and potential moderation/reflection under accident conditions. The three fissionable material storage buildings, i.e., 303-B, 3712, and 3716, are classified as Fissionable Facilities per HNF-7098, *Criticality Safety Program*.

Use of the hemispherical safe mass limit for handling activities addresses all handling and packaging accident scenarios. The hemispherical safe mass values assume optimum spacing, moderation, and full reflection to obtain true minimum values (Schwinkendorf 2001). These conditions could conceivably be achieved by a fire that destroyed the container and resulting flooding from fire suppression efforts. Even under these conditions, the configuration is safe unless it is more than double batched. Because moderation and reflection are necessary to achieve a criticality, no human error or combination of human errors by themselves, i.e., CPS noncompliance, can result in criticality.

Storage of N Reactor fuel and feed materials has been analyzed and found to be subcritical under all credible accident scenarios (Schwinkendorf 1995). All fuel storage arrays are substantially subcritical if mis-stacked, even double stacked. Similarly, all fuel storage arrays are substantially subcritical if optimally moderated. Combining contingencies of mis-stacking and introduction of optimum moderation still produces configurations with substantial margins of subcriticality.

Criticality is possible only if at least three contingencies are exceeded (Schwinkendorf 1995). Criticality requires the following:

a) Mis-stacking: The array of fuel storage boxes is significantly mis-stacked, i.e., to where it becomes the equivalent of an infinite array of the incorrect stacking. This contingency also represents the inadvertent placement of Mark IA fuel in storage array locations designated for Mark IV fuel.

b) Reconfiguration: The array of fuel assemblies within the storage boxes collapses, resulting in a lattice of fuel assemblies that do not touch, but are in a lattice providing optimum spacing. A fire that destroyed the storage boxes could conceivably approximate this. Fuel rearrangement by improper HFD response, i.e., use of direct stream water during manual fire suppression efforts, could also occur.

c) Moderation: The collapsed array of fuel assemblies is moderated. Presumably, fire suppression efforts could approximate this condition.

d) Reflection: The moderated collapsed array is reflected. This could be achieved by water that completely covered the collapsed array. This water could also result from fire suppression efforts. Blockage of the facility drains, allowing sufficient depth to accumulate, represents the third contingency.

The unlikely contingencies are 1) mis-stacking, 2) a fire that consumed the storage containers (collapsing the array) and provided moderation through mitigation efforts, and 3) blocking of the storage building drains that allowed sufficient water accumulation to completely cover the array and provide the necessary reflection.

The Mark IA fuel assembly (the most reactive fuel assembly in the FSS Facility which consists of a 1.25% enriched "outer" combined with a 0.95% enriched "inner") bare slab height for $k_{eff} = 0.98$, i.e., the value for the collapsed and optimally moderated but unreflected fuel assemblies, is 17.3 inches. The height of the optimally spaced Mark IA slab array resulting from collapsed mis-stacked storage boxes (three high) is 13.8 inches, which is less than the height corresponding to $k_{eff} = 0.98$. (A bare slab height of 18.2 inches corresponds to $k_{eff} = 1.0$) For Mark IV fuel assemblies, a bare slab height of 23.4 inches corresponds to $k_{eff} = 0.98$. The height of the optimally spaced Mark IV slab array resulting from collapsing a mis-stacked array (four high for Mark IV) is 23.0 inches. Except for essentially infinite arrays, moderated and reflected configurations of fuel assembly components are less reactive than identical configurations of fuel assemblies. Thus, the accident conditions involving unfinished fuel are bounded by the fuel assembly analyses.

Conservatisms in the criticality calculations include:

a) Mis-stacking must involve many adjacent stacks of storage boxes. Partial mis-stacking, e.g., four out of five, results in an array well within the $k_{eff} = 0.98$ criterion.

b) No credit is taken for the neutron absorbing characteristics of the storage box metal fasteners and impurities in the wooden storage boxes.

3.2.4.2 Criticality Probability

Although criticality is possible as described above, it is not credible. Probabilities of necessary contingencies are discussed below. Although the focus of the probability analysis is on the storage mode (Kelly 1995), it also applies to the handling mode because criticality is impossible unless mishandling initially creates an ideal configuration that is subsequently subject to fire, moderation, and reflection. A facility-specific fissionable material handling procedure is in place that requires one-over-one verification that essential CPS requirements are maintained.

Mis-stacking. Criticality Prevention Specification limits on fuel storage box stack heights preclude accumulation of sufficient fissionable material that could theoretically become critical following potential subsequent events. (The most reactive Mark IA fuel assemblies are restricted to two-high stacks of storage boxes. Mark IV fuel assembly storage boxes are limited to three-high stacks. One outer fuel element may be substituted in the place of a single fuel assembly. Labeling of all containers is thoroughly verified.) Many adjacent stacks must be affected to approximate the equivalent of an infinite array. At a minimum, this corresponds to a four-by-four array that would require at least sixteen errors. All fuel movements are supervised to ensure that essential requirements of the CPS (stacking height, moving less than the hemispherical safe mass quantity, spacing and criticality drain availability) are maintained; unauthorized fuel movement is prevented by the storage buildings being locked. Periodic inspections of fuel storage facilities are performed to assure compliance with stacking requirements. Although a probability of 1.0E-04 (Kelly 1995) was assigned to this contingency based on rigorous oversight associated with all fuel movements, the more conservative value of 1.0E-02 is adopted to allow for unforeseen distractions that could accompany fuel disposition.

Reconfiguration. Removal of the storage boxes and collapse of the fuel assemblies could result only as a consequence of a fire. As described in Section 3.2.14, the probability of a random fire involving the fuel is 3.0E-03/yr. Also described previously in Section 3.2.2.4, the probability of a seismic-induced fire involving fuel is 1.1E-05/yr.

For reconfiguration to occur, fire control efforts must fail. Probability of the sprinklers failing to control the fire is estimated at 1.0E-02 based on test data and probability studies (Kelly 1995). Alternatively, improper direct stream water use by the HFD to rearrange the fuel is likewise assigned a probability of 1.0E-02, the probability of human error (Gertman, 1994).

Although fuel assembly collapse into a lattice with near optimum separation is improbable, a probability of unity was assumed for that aspect of reconfiguration because of the difficulty of assigning a specific reconfiguration mechanism.

Moderation. Fire mitigation efforts could add sufficient water to moderate the collapsed array. This corresponds to a water depth of at least 17.3 inches. Because moderation is necessary before criticality can occur, the sprinklers must activate somewhere within the storage building to provide water. Probability of the sprinklers actuating but failing to control the fire is estimated at 1.0E-02. HFD activities will not contribute to moderation because their presence would preclude water accumulation. In fact, moderation cannot occur unless the HFD fails to respond and open the storage building door. The HFD must open the storage building door to fight the fire because 303-B does not have windows and the few windows in the 3712 and 3716 Buildings are covered with heavy screens. The most straightforward path for the HFD to the fire would be to enter the building through the door. If the 3712 Building fire were confined to the north end, the HFD may choose to also cut through the roll-up doors to gain entry, which would provide another water outflow path. Kelly 1995 assigned a HFD failure-to-respond probability of 1.0E-04 based on failure rates for fire detection and alarm systems and consideration of fire truck accident on the way to fighting the fire. Considering the age of fire detection and alarm systems in these buildings and reluctance to quantify performance expectations for the HFD, this value is discounted to 1.0E-01 to ensure conservatism. For the seismic induced fire scenario, the probability is 0.5 to account for the many demands that would be made on the HFD following a seismic event and because of the likelihood of the fire suppression system water supply breaking in the vicinity of the fire.

Reflection. Adding additional water to provide reflection is necessary to achieve criticality. Drainage of fire suppression water is assured by multiple built-in floor level drains or flexible baffles at the bottom of large roll-up doors designed to drain that quantity of water that could be released by credible fire suppression efforts or broken water supply lines. Recognizing that the drains are regularly inspected to assure availability, drain failure probabilities of 1.0E-3 for the random fire event and 5.0E-1 for the seismic induced fire were assigned by Kelly 1995. Probability of drain failure is more likely following a seismic event because of the increased quantity of debris that could interfere with drain function. However, since the Kelly evaluation was completed, consideration of drain clogging by plastic pieces swept from bagged fuel assemblies and/or components or by other debris has resulted in increasing the probability of drain failure to 5.0E-01 for both scenarios.

Overall Criticality Probability. Overall probability for criticality resulting from a random fire is 3.0 E-08 (see Figure 3.2.3.2 -1). The corresponding probability for a criticality resulting from a seismic induced fire is 1.4E–08 (see Figure 3.2.3.2-2). Both values are substantially less than 1.0E-6, which is the threshold for credibility. No other scenario is postulated that could result in criticality. Therefore, a criticality detection and alarm system (CAS) is not required (DOE 2000).

3.2.4.3 Criticality Risk and Controls

The overall probability of accidental criticality is not credible (see Figures 3.2.3.2 and – 2), because of credited controls, particularly the administrative requirements of the criticality safety program. Specific reliance is placed on trained personnel following the Criticality Prevention Specifications that govern the stacking height of storage boxes of fuel, proper identification of fuel enrichment, spacing requirements, and handling limits. Thus, an administrative control to maintain the criticality safety program is included in the TSRs. Furthermore, even though the probability of personnel error has already been "derated" from 1E-04 (Kelly 1995) to 1E-02 for this evaluation, an administrative requirement for two qualified persons to participate in all activities within the storage buildings has been included in the TSRs to reduce potential error. Also, although not credited to achieve a non-credible probability, the storage buildings criticality drains are designated as a design feature.

3.2.5 Risk Summary

The consequences of accidents and events summarized in Sections 3.2.1 – 3.2.4 are based on analyses reflecting the current facility configuration and follow-on transition and shutdown activities, including uranium disposition. The accident dose consequences analysis was made using site-specific meteorology, and the applicable Hanford Environmental Dose Overview Panel (HEDOP) accepted GENII analysis code/version. Those results (Huang 1999 and Johnson 1994) have been approved by an independent HEDOP reviewer. Extensions of those analyses presented in this document have undergone formal independent peer review. Criticality calculations have been performed using modern computer codes that comply with Software Quality Assurance (SQA) requirements. Therefore, the consequences of the accidents and events are considered valid. Based on the supporting analyses and the evaluations presented in Sections 3.2.1 – 3.2.4 above, it is concluded that current and future facility operations bound by this BIO are identified as Risk Class III or IV (DOE-RL 2002). This BIO meets the safe harbor requirements of 10 CFR 830 (CFR 2001) for a hazard Category 3 nuclear facility with a limited operational life undergoing deactivation.

Figure 3.2.3.2-1. Random Fire Criticality Event Tree

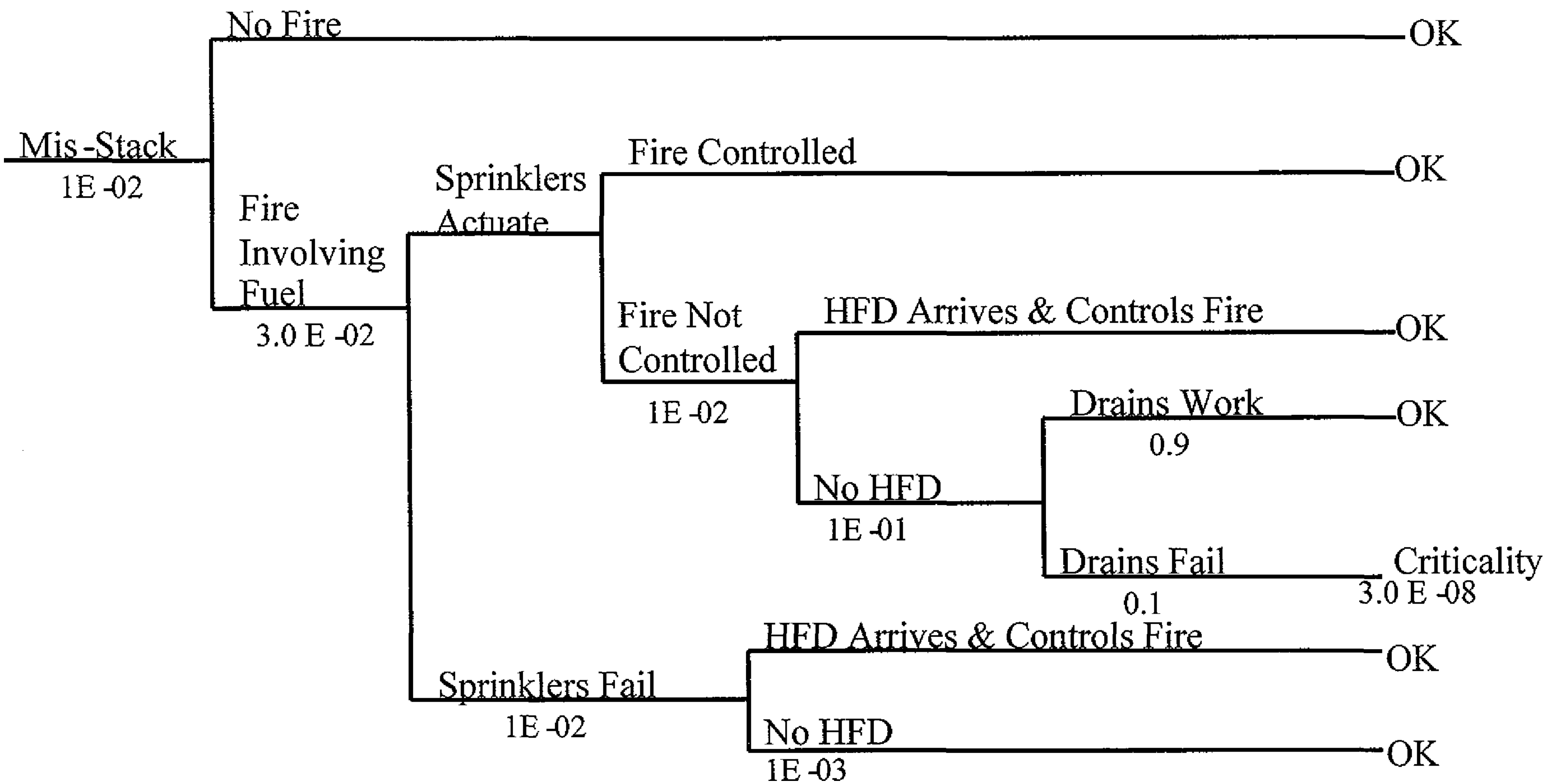


Figure 3.2.3.2-2. Seismic Induced Fire Criticality Event Tree

Error! Not a valid link.

3.3 Hazard Controls

3.3.1 Safety Structures, Systems, and Components

Accidents with consequences deserving consideration have been analyzed (Johnson 1994) and re-evaluated (see Sections 3.2.1 – 3.2.4). No structures, systems, or components must be credited to avoid challenging the evaluation guidelines. Additionally, none of the postulated accident consequences exceed the Safety Class criteria (DOE-RL 2002).

3.3.2 Design Features

Configuration features that are directed at further reducing dose consequences or reducing the probability of a criticality associated with accidents are described below.

Facility Water Drainage. (See Figures 2.2.2-2, 2.2.2-3, and 2.2.2-4). The fuel storage buildings contain features that would drain water to the outside ground and prevent accumulation of sufficient water to provide reflection of the reconfigured fuel assemblies resulting from a fire. Because this reflection represents a third contingency necessary for criticality (Schwinkendorf 1995), and the probability of criticality is essentially incredible without taking credit for the drains (Kelly 1995 and see figures 3.2.3.2-1 & -2), these configuration features are not considered to be Safety Class or Safety Significant items, but are credited as being equipment important to safety.

Zircaloy-2 Cladding. The Zircaloy-2 cladding on the fuel assemblies and components provides essentially complete oxidation protection to the underlying uranium during postulated fires except when breached. Because the cladding is an inherent feature of the fuel elements and assemblies, it does not qualify as Safety Significant or Safety Class SSC.

3.3.3 *Facility Degradation*

The facility structures, systems, components, and, particularly, some of the building roofs, have suffered some degradation. Failure of the structures and components has the potential for changing the fuel spacing, impacting the building drainage ports, and/or failing the fire protection system. The structures and components (e.g., electrical, etc.) are not Safety Class or Safety Significant for the following reasons:

- The criticality safety analysis considers optimum moderation (the potential result of structure failure damaging the fire protection system causing introduction of water, and plugging the drainage ports preventing escape of the water). However, this scenario would not consume the storage boxes to permit the reconfiguration necessary for criticality.

- The fire criticality probability analysis considers the probability of introduction of water, prevention of escape of the water, and changes in fuel storage geometry with the systems and structures not being Safety Class or Safety Significant. This analysis does presume the availability of the fire protection systems and/or HFD response to introduce water, however.

- The facilities do not have confinement systems. The structures are essentially open to the atmosphere, and their failure would not significantly change the ability to contain releases. The accident safety analysis does not take credit for confinement.

- Facility structural failure that damaged its fire protection system would initiate a fire alarm or a trouble alarm, depending on the nature of the fire protection system failure. The HFD promptly responds to all fire alarms; response to trouble alarms could be delayed several hours. Compensatory action would be implemented immediately upon recognition of system impairment.

- Age-induced degradation of the fire protection systems, including the piping that delivers water to the uranium storage buildings, could result in temporary loss of automatic fire suppression system capability. However, analysis of potential credible fires has shown that risk associated with these unmitigated fires is acceptable.

3.3.4 Control and/or Mitigation of Structure, System, and Component (SSC) Deficiencies

The storage building fire protection systems are designated as equipment important to safety and include alarms that annunciate upon water flow or system failure. The site fire protection system monitoring system features automatic trouble alarm annunciation if a particular facility system fails to "check in" on schedule (systems are designed to "check in" every 24 hours).

3.3.5 Administrative Controls

This BIO defines the safety envelope for the remainder of the facility mission until turnover for D&D.

- Despite the regular maintenance performed on the aging fire protection systems, they will continue to deteriorate. However, unmitigated fire consequences are well within guidelines.

The TSRs for operation for the facility define acceptable conditions, safe boundaries, bases thereof, and management or administrative controls required to ensure safe fuel storage and transition activities of the facility. The scope of the TSRs is limited to maintaining the safety envelope as defined by this BIO.

The content of the TSRs meet the expectations of 10 CFR 830, Subpart B, and are based on DOE Order 5480.22. The TSRs and appendices constitute an agreement or contract between DOE and Fluor Hanford regarding the safe operation of the facility. As such, the TSRs cannot be changed without the approval of the DOE Program Secretarial Officer (PSO), or designee. The scope of the TSRs is based on this facility BIO document. Although specific scenarios have not been identified, it is recognized that under emergency circumstances, it may be necessary to depart from the requirements of the administrative controls to protect workers, the public, or the environment from imminent and significant harm.

Administrative controls that provide assurance of maintaining the safety envelope are as follows. Each of these administrative controls represent a relatively low-cost measure designed to address relatively low risks.

- Limiting fuel handling to quantities less than the minimum hemispherical safe mass quantities. Anticipated uranium repackaging activities associated with uranium disposition are subject to this requirement.

- Maintaining compliance with Criticality Prevention Specifications, including performing periodic surveillance of uranium storage building drain systems.

- Maintaining control of storage building combustible material and uranium inventories.

- Maintaining the fire protection systems in the uranium storage buildings to NFPA requirements, subject to exemptions granted by DOE.

3.3.5.1 Institutional Safety Programs

Safety programs are identified in Section 4.0. The institutional safety programs described in Section 4.0 provide for worker safety under normal and anticipated upset conditions. These programs are inserted into activities identified in this document to identify and control hazards associated with normal operations. All activities are reviewed prior to implementation using the Automated Job Hazard Analysis (AJHA) process that includes worker, supervision, and subject matter experts to identify potential hazards and prescribe appropriate controls. Implicit in all the identified institutional safety programs is the requirement that activities are performed using approved procedures.

3.4 Summary

It is concluded that the risk associated with the current and planned operational mode of the facility, (uranium storage, uranium disposition, cleanup, and transition activities, etc.) are within evaluation guidelines (DOE-RL 2002). The uranium fuel storage buildings (303-B, 3712, and 3716) are assigned a hazard classification of Category 3, since the inventory available for release is less than the identified Category 2 threshold quantities (TQs), although their basic inventory exceeds category 2 TQs. The dose and toxicological consequences for the maximum credible fire have been analyzed using current Hanford accepted methods.

It is also concluded that because the probability of accidental criticality is not credible, a criticality alarm system (CAS) is not required as allowed by DOE Order 420.1 (DOE 2000).

4.0 HANFORD GENERIC AND FACILITY PROGRAMS

The Project Hanford Management System assures operation of the facility in a configuration that supports the defined safety envelope by addressing the following:

- Configuration Management
- Occurrence Reporting
- Criticality Safety
- Unreviewed Safety Question Screening and Evaluation
- Radiation Protection
- Fire Protection

Additional Project Hanford Management System Procedures assure maintenance of the facility in a configuration that supports worker safety by addressing the following:

- As Low As Reasonably Achievable (ALARA)
- Occupational and Industrial Safety
- Industrial Hygiene
- Training
- Radioactive Waste Management
- Quality Assurance
- Conduct of Operations
- Emergency Planning
- Environmental Protection
- Maintenance

Included in the institutional safety program are controls to detect and guard against toxicological threats inherent in the FSS. In particular, the low-enriched uranium and beryllium present specific risks. Bioassay and medical monitoring are conducted for personnel whose work assignments may entail potential exposure to these elements and their compounds.

The facility-specific safety and control programs included in FSP-FSS-5-35, Fuels Supply Operations Control Manual, are fully or partially responsive to the institutional control or safety requirement, DOE Order and title, and applicable Project Hanford Management Procedure(s). The degree of responsiveness is based on facility-specific needs.

The site Integrated Environment, Safety and Health Management System (ISMS) is used to integrate environmental, safety, and health standards into work management and practices at all levels of work planning and execution to protect workers, public, and the environment.

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