ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 656606

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental ○ Direct Revision ◉ Change ECN ○ Temporary ○ Standby ○ Supersedure ○ Cancel/Void ○	John Remaize, 1B300, L6-26, 372-1462	○ Yes ◉ No	1/27/2000
	6. Project Title/No./Work Order No. 101333/A060 HMK40021 Fire Hazard Analysis for Fuel Supply Shutdown Project	7. Bldg./Sys./Fac. No. 333 Building	8. Approval Designator 05
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-NR-FHA-001, Rev. 0	10. Related ECN No(s). N/A	11. Related PO No. N/A

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

13a. Description of Change

13b. Design Baseline Document? ○ Yes ○ No

- Redesignate document to HNF-SD-NR-FHA-001, Rev. 1
- Update Facility Buildings included in FHA.
- Update facility status to reflect shutdown activities.
- Assure FHA is in agreement with proposed ISB update.

Independent Design Verification performed by informal FSS Peer Review.

14a. Justification (mark one)	14b. Justification Details
Criteria Change ◉ Design Improvement ○ Environmental ○ Facility Deactivation ○ As-Found ○ Facilitate Const. ○ Const. Error/Omission ○ Design Error/Omission ○	Update facility status to reflect in-progress deactivation.

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

RW Bailey	S4-49
MW Benecke	L6-26
AM Horner	L6-57
JA Remaize	L6-26
DJ Riffe	L5-66
JM Steffen	L5-66
JR Bell	L6-57
Central Files	B1-07
DOE Reading Room	H2-53

H

RELEASE STAMP

SEP 27 2000
DATE:
STA: 15
HANFORD RELEASE
ID: 20

A-7900-013-2 (10/97)

A-7900-013-1

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): 656606

16. Design Verification Required	17. Cost Impact — ENGINEERING	17. Cost Impact — CONSTRUCTION	18. Schedule Impact (days)
(●) Yes	Additional ( ) $ ____	Additional ( ) $ ____	Improvement ( ) ____
( ) No	Savings ( ) $ ____	Savings ( ) $ ____	Delay ( ) ____

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

SDD/DD	☐	Seismic/Stress Analysis	☐	Tank Calibration Manual	☐
Functional Design Criteria	☐	Stress/Design Report	☐	Health Physics Procedure	☐
Operating Specification	☐	Interface Control Drawing	☐	Spares Multiple Unit Listing	☐
Criticality Specification	☐	Calibration Procedure	☐	Test Procedures/Specification	☐
Conceptual Design Report	☐	Installation Procedure	☐	Component Index	☐
Equipment Spec.	☐	Maintenance Procedure	☐	ASME Coded Item	☐
Const. Spec.	☐	Engineering Procedure	☐	Human Factor Consideration	☐
Procurement Spec.	☐	Operating Instruction	☐	Computer Software	☐
Vendor Information	☐	Operating Procedure	☐	Electric Circuit Schedule	☐
OM Manual	☐	Operational Safety Requirement	☐	ICRS Procedure	☐
FSAR/SAR	☐	IEFD Drawing	☐	Process Control Manual/Plan	☐
Safety Equipment List	☐	Cell Arrangement Drawing	☐	Process Flow Chart	☐
Radiation Work Permit	☐	Essential Material Specification	☐	Purchase Requisition	☐
Environmental Impact Statement	☐	Fac. Proc. Samp. Schedule	☐	Tickler File	☐
Environmental Report	☐	Inspection Plan	☐	____	☐
Environmental Permit	☐	Inventory Adjustment Request	☐	____	☐

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

Document Number/Revision	Document Number/Revision	Document Number/Revision
NONE		

21. Approvals

	Signature	Date		Signature	Date
Design Authority	JF Bares [signature]	1-28-00 [initials] 5/22/00	Design Agent		
Cog. Eng.	JA Remaize [signature]	1-28-00 [initials] 5-22-00	PE		
Cog. Mgr.	MW Benecke [signature]	1/28/00 mwb 5/24/00	QA		
QA		[initials]	Safety		
Safety	DJ Riffe [signature]	1-28-00 5-22-00	Design		
Environ.			Environ.		
Other	JR Bell [signature]	1/28/00 [initials] 5/22/00	Other		
FSS PEER REVIEW					
LR Willis	[signature]	1-28-00 [initials] 5/22/00			
JM Bishop	[signature]	1/28/00 [initials] 5/22/00	DEPARTMENT OF ENERGY		
			Signature or a Control Number that tracks the Approval Signature		
RCP SRB REVIEW			DOE-RL: 00-FTD-065		
JM Steffen	[signature]	1/28/00 [initials] 5/22/00	ADDITIONAL		

HNF-SD-NR-FHA-001
Revision 1

Fire Hazard Analysis For The Fuel Supply Shutdown Storage Buildings

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

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

Fluor Hanford
P.O. Box 1000
Richland, Washington

HNF-SD-NR-FHA-001
Revision 1
ECN 656606

Fire Hazard Analysis For The Fuel Supply Shutdown Storage Buildings

Document Type: FHA Division: RCP

J. A. Remaize
Fluor Hanford, Inc.

Date Published
September 2000

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

Project Hanford Management Contractor for the
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Fluor Hanford
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Richland, Washington

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Key Words: Fire Hazard Analysis, Safety Class systems, Critical Process Equipment

Abstract: The purpose of a fire hazards analysis (FHA) is to comprehensively assess the risk from fire and other perils within individual fire areas in a DOE facility in relation to proposed fire protection so as to ascertain whether the objectives of DOE 5480.7A, *Fire Protection*, are met. This Fire Hazards Analysis was prepared as required by HNF-PRO-350, *Fire Hazards Analysis Requirements*, (Reference 7) for a portion of the 300 Area N Reactor Fuel Fabrication and Storage Facility.

RECORD OF REVISION

RECORD OF REVISION	(1) Document Number	
	HNF-SD-NR-FHA-001	Page 1

(2) Title
Fire Hazard Analysis for the Fuel Supply Shutdown Storage Buildings

Change Control Record

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release	
		(5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Document Issued. EDT-142441, 8/1/94	J.R. Brehm	A.L. Ramble
1 RS	Complete revision update facility status to reflect in-progress deactivation. ECN-656606	J.A. Remaize JAR	M.W. Benecke MWB 9/26/05

FIRE HAZARD ANALYSIS

FOR THE

FUEL SUPPLY SHUTDOWN STORAGE BUILDINGS

Fluor Hanford Incorporated

MAY 2000

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TABLE OF CONTENTS

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FIRE HAZARD ANALYSIS FOR THE FUEL SUPPLY SHUTDOWN STORAGE BUILDINGS

1.0 INTRODUCTION

The purpose of a fire hazards analysis (FHA) is to comprehensively assess the risk from fire and other perils within individual fire areas in a DOE facility in relation to proposed fire protection so as to ascertain whether the objectives of DOE 5480.7A, *Fire Protection*, are met. This Fire Hazards Analysis was prepared as required by HNF-PRO-350, *Fire Hazards Analysis Requirements*, (Reference 7) for a portion of the 300 Area N Reactor Fuel Fabrication and Storage Facility. The current facility title is the Fuel Supply Shutdown Project (FSS). This FHA addresses the five buildings that are classified as Nuclear Hazard Category 3 Facilities. The buildings not included in this document are addressed in Fire Protection Facility Assessments per HNF-PRO-684 (Reference 18). The buildings included herein are 3712, 3716, 303-A, 303-B, and 303-G.

This FHA addresses factors common to the buildings in Sections 1.0 through 13.0, and then the specifics of each in Sections 14.0 through 19.0 on Pages 3 through 5 of each building section.

2.0 SUMMARY AND CONCLUSIONS

Analysis of the consequences and probabilities of a worst case fire for each of the buildings concluded that the 3712 Building fire would be the overall worst case for this report. The event would still be within the onsite and offsite risk guidelines specified in HNF-PRO-704, *Hazard and Accident Analysis Process* . The consequences of a fire that destroys the total value of property within the fire area were also found to be acceptable under DOE criteria with respect to property loss and programmatic impact. No life safety items were identified.

The FHA for these buildings shows that the objectives of DOE 5480.7A have been met. Meeting this Order is noted by the lack of recommendation of concerns in the report. In addition, the Maximum Possible Fire Loss (MPFL) is below the values noted in the Order.

3.0 ESSENTIAL SAFETY CLASS SYSTEMS

Although the nuclear facilities' fire protection systems are not designated as Safety Significant in the FSS Interim Safety Basis (ISB), (Reference 9), controls are established to ensure the availability of the systems.

4.0 CRITICAL PROCESS EQUIPMENT

There is no critical process equipment in any of the FSS buildings. The entire facility is in the process of shutting down and cleaning up in preparation for turnover to the Environmental Restoration Contractor (ERC) for surveillance and maintenance and eventual decontamination and decommissioning activities.

5.0 HIGH VALUE PROPERTY

For the purpose of this FHA, high value property is assumed to be a piece of equipment that has a value greater than $1,000,000. There is no equipment with this high of value.

6.0 FIRE DEPARTMENT/BRIGADE RESPONSE

The standard response to an alarm condition in the 300 Area will be from the 300 Area Fire Station. Response time is in the three to five minute range. Responses by the 300 Area Fire Station to fires within the 300 Area have shown that the present arrangement and procedure is adequate.

Current Hanford Fire Department Prefire Plans and Quick Access Prefire Plans are available for these facilities. With the exception of the 3712 Quick Access Plan, these are consistent with the assumptions of this FHA. 3712 incorrectly identifies the occupancy type and special hazards, and should be updated (Recommendation #1).

7.0 NATURAL HAZARDS IMPACT ON FIRE SAFETY

7.1 FLOODS

The floor elevations for the FSS buildings are 117.7 m to 119.4 m above mean sea level (MSL). The FSS buildings are not susceptible to catastrophic flooding even by the "probable maximum flood" postulated at 116.7 m MSL. No adverse impact to fire safety is foreseen as a result of flooding (Reference 20).

7.2 WINDS

The Pacific Northwest is one of the areas of the country with the lowest frequency of tornadoes. The entire state of Washington has an average tornado frequency of less than one per year. An analysis of the Hanford Site concludes that the probability of a tornado hitting any particular onsite facility is six chances in a million during any one year (Reference 21).

In areas of the facility damaged by the wind, fire protection system damage is also anticipated. The consequence of a reduction of fire protection capability would be bounded by the MPFL scenario. Exposure of the facility to the design basis 112.7 km/h wind is not expected to result in any unacceptable impact on the fire protection objectives.

7.3 EARTHQUAKES

Eastern Washington is a region of low-to-moderate seismic activity. Based on the seismic history since 1840, the U.S. Coast and Geodetic Survey has designated Eastern Washington as Zone 2B seismic probability, implying a potential for moderate damage from earthquakes (Reference 21).

Broken sprinkler system or supply water piping would be the most severe impact on the fire protection system. The consequences of a loss of fire protection capability due to an earthquake would be bounded by the MPFL scenario. No unacceptable impact on the fire protection objectives is expected as a result of a design basis earthquake.

8.0 RECOVERY POTENTIAL

The anticipated recovery from the MPFL would include cleanup, disposal, and relocation of any stored material. It is estimated that this could be completed within 3 to 6 months. Recovery after the Maximum Credible Fire Loss (MCFL) would be considerably less than this because the sprinkler systems would limit the loss so cleanup and repairs would be on an as needed basis.

Storage activities would not be greatly impacted by the 3 to 6 month cleanup period. Other storage buildings in the FSS complex could be utilized for storing any Special Nuclear Materials (SNM) that needed to be relocated after a fire. The FSS buildings are all scheduled to go to the Environmental Restoration Contractor (ERC) sometime in the future; none of the buildings would be replaced since a future use has not been determined. The SNM is tentatively scheduled for relocation or disposal prior to the end of CY 2000.

9.0 SECURITY AND SAFEGUARDS CONSIDERATIONS RELATED TO FIRE PROTECTION

The FSS buildings are located in the 300 Area. The responding fire department for this area is also located within the 300 Area. Access to the 300 Area is from the west (Apple Street), or from the south (Wisconsin Street). There are no additional security barriers or special coordination requirements that would hinder other Hanford Fire Department Units access to the FSS buildings.

When notified of a fire alarm, Hanford Patrol controls vehicle traffic to the alarming building to provide unobstructed access for the responding fire department units. Previous fire department responses in the 300 Area have shown that the existing procedures are adequate for fire department access to facilities within the 300 Area. Because of the nature of the material stored at the FSS (i.e., radiological, SNM), Hanford Patrol will provide security and personnel protection until such time that the area can be secured (i.e., building repair, chain link fence, relocation of material, or cleanup). The SNM is classified as Category IVD material, which requires the lowest level (i.e., property protection) of security.

10.0 POTENTIAL FOR A TOXIC, BIOLOGICAL, AND/OR RADIATION INCIDENT DUE TO A FIRE

A toxicological and radiological dose consequences analysis associated with the FSS facility in the 300 Area has been performed and is documented in HNF-SD-NR-ISB-001, Rev 1, *Interim Safety Basis for Fuel Supply Shutdown Facility.*

This report looks at the human factor of the release, while the dispersion report in Appendix A looks at the surface and soil aspect. The ISB is based on an 8 hour fire (4 hour fire and 4 hour smoldering) event in the 3712 Building. This accident is considered to be the worst case. The fire duration in this scenario is based on an actual combustible loading noted during an earlier survey (Reference 23). Because the current combustible loading and quantity of SNM has been reduced since then, the results are conservative.

The SNM [uranium (U) billets, clad fuel assemblies, clad fuel elements (scrap), and unfinished fuel elements with plastic caps] being stored in the Nuclear Category 3 Facilities (3712, 3716, 303-A, 303-B, and 303-G) will not burn without other combustibles. The actual release will occur while the U metal temperature is above 300°C. The ISB determined the toxicological and radiological consequences of a fire would remain within the risk evaluation guidelines of HNF-PRO-704 extremely unlikely events even if the sprinkler systems fail to operate. The ISB states that administrative controls are approved that maintain control of storage material combustible material and uranium inventories, maintain the automatic fire protection systems per NFPA requirements, and independent verification of component identification following fire suppression system modification and valve positions following fire suppressionsystem maintenance. DOE Order 5480.7A (Reference 2) required MPFL analysis is summarized in Section 11.2.

Fire scenarios were also analyzed for the possibility of producing a criticality in WHC-SD-NR-CSER-010, *Criticality Safety Evaluation Report for 300 Area N Reactor Fuel Fabrication and Storage Facility* . The conclusion states that there is no danger of a criticality with the amount and configuration of the present storage. The fuel storage buildings contain Design 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 (Reference 4), and the probability of criticality is essentially incredible without taking credit for the drains (Reference 8), these configuration features are not considered to be Safety Class or Significant items, but do provide additional contingency. Administrative controls are in place to ensure that the storage remains within the Criticality Prevention Specifications.

Fire fighting activities will not result in a criticality event. Virtually any action taken by the HFD to extinguish a fire within the storage buildings would include opening one ot the access doors to the affected building. The 303-A, 303-B, and 303-G storage buildings do not have windows and the few windows in 3712 and 3716 storage buildings are covered with heavy screens. The most straightforward path fot the HFD to the fire would be to enter the building through a door. If a fire started in the north end of the 3712 building, the HFD may choose to cut through the rollup doors to gain entry, which would provide another water outflow path. The accumulation of sufficient water, stacking errors, and optimum fuel configuration to cause criticality is not credible.

11.0 DAMAGE POTENTIAL

Analysis of the consequences and probabilities of a worst-case fire for each of the buildings concluded that the 3712 Building would be the overall worst case for this report. The 3712 Building contains the greatest amount of SNM storage; therefore, it poses the greatest radiological contamination potential.

The 3712 and 3716 Buildings have the greatest potential for structural failure during a fire because the construction materials would become involved in a fire early on. The 303 Buildings (A,B,G) are concrete bunkers, which could potentially withstand a 2.5 to 3-hour fire without suppression. The fire loading study indicates that the 303-B Building has the greatest amount of combustible material per square foot, but contains much less SNM than the 3712 Building.

Taking all facts into account, the 3712 Building is considered the greatest risk and poses the worst case scenario of the five FSS buildings evaluated in this FHA. The dispersion report in this FHA is based on the amount of SNM previously stored in the 3712 Building (1122 MTU). Because the 3712 Building inventory has been significantly reduced since the dispersion report was prepared (675 MTU as stated in ISB), the dispersion consequences are conservative. Even with the inventory reduction, the 3712 Building still presents the worse case. A fire in any of the other buildings would present a lower MPFL.

The cleanup cost analysis contains the following unknowns and assumptions:

1. The method used for the dispersion model contained in Appendix A was prepared prior to validation. The method has subsequently been approved. The author of the document stated that the changes to the method were minor and would not affect the conclusion in this document. Therefore the information is considered to be valid.

2. DOE Order 5484.1 requires the post accident cleanup to restore the site to "preoccurrence conditions irrespective of whether this is done in fact." This analysis instead uses cleanup criteria for release of DOE land to new ownership.

3. The cleanup protocol involves skimming topsoil in the cleanup area and transporting it to a burial trench located in the 200 Area, rather than burying the waste in low level waste containers in a designated waste repository. This may also be a liberal interpretation of requirements in DOE Order 5484.1.

4. The cleanup costs assume that surrounding buildings' interior remains uncontaminated; so, the exterior is the only consideration. This is a reasonable assumption because surrounding building supply fan systems would most likely be shut down during a prolonged fire event.

5. Due to the lack of criteria for radiological cleanup of river water, the low surface contamination expected, and the dilution effect, contamination cleanup for the Columbia River was not considered.

6. The cleanup costs does not include the decontamination of the process sewer if contamination is found.

The following conservatism was used in the dispersion model contained in Appendix A.

1. The model assumes distribution of a 50/50 mix of wood and polystyrene for fueling the fire. This conservative assumption is required for the use of the simplified hand calculation model.

2. It is a free burn or open burn model and doesn't take credit for the oxygen limiting or smoke confining potential of the building during the early fire stage.

3. The release scenario is a 4-hour fire, plus an additional 4-hour smoldering release of oxide during cooldown. The 4-hour fire was based on an actual combustible loading survey and was used in this FHA and other safety related documents as the absolute worst case baseline.

4. When the soil is removed to plow depth, the contamination level falls below the criteria for any cleanup procedures, but since the soil was picked up, it is being handled as low-level waste (LLW).

11.1 MAXIMUM CREDIBLE FIRE LOSS (MCFL)

A MCFL is defined in DOE Order 5480.7A as the value of property damage that would be expected from a fire assuming:

- Installed fire protection systems function as designed.

- The effect of emergency response is omitted except for post-fire actions such as salvage work, shutting down water systems, and restoring operation.

The 3712 Building MCFL is estimated at $250,000. The loss would be incurred from a fire involving six to eight combustible storage/shipping boxes. The fire would not be expected to exceed this amount due to the presence of a dry-pipe fire suppression system.

There would be minimal radiological contamination. This is based on the following:

- Uranium (U) will not ignite or sustain a fire on its own.
- Oxidation, which causes the radiological release, does not take place until the U reaches temperatures over 300°C).
- Standard sprinklers that activate at 100°C are installed in the FSS buildings.
- Structural integrity will be maintained, and uranium will cool faster because of the sprinklers.

There should be little, if any, contamination outside the structure, depending on the amount, if any, of water that escapes from the building. The cost would be for cleanup and storage relocation expense. Any contents in the 3712 Building lost in the fire would not be replaced. No programs would be impacted.

11.2 MAXIMUM POSSIBLE FIRE LOSS (MPFL)

A MPFL is defined in DOE Order 5480.7A as the value of property, excluding land, within a fire area, unless a fire hazard analysis demonstrates a lesser or greater loss potential. This assumes the failure of both automatic fire suppression systems and manual fire fighting efforts.

Appendix B details the cost breakdown and methodology used in determining the MPFL which is estimated to be approximately $15 million. The following is a summary of the costs and assumptions associated with the MPFL:

1. The worst case fire scenario includes the loss of the entire 3712 Building. The building has a value for the structure and content (excluding the fuel) of $426,523 with zero salvage.

2. Fire fighting cost is estimated at $500,000 due the contamination concerns.

3. The dispersion report included (Appendix A) was used as a basis for the cleanup and disposal estimate. This report uses an 8-hour accident (4-hour fire followed by 4-hours of smoldering). The cleanup cost is estimated to be $13,500,000 (1994

estimate escalated at 3% per year).

4. Cost to cleanup the Columbia River was not included because there is no guidance and except for the shoreline, cleanup would not be practical. Process sewer decontamination is also not included. Shoreline and process sewer cleanup cost is not likely to drive total cost cleanup costs to $50 million, therefore a redundant fire protection system is not required.

5. Any scenario resulting in lesser property damage would be bounded by the above fire and related fire and property loss.

6. The fire that is used in this FHA and other safety documentation for FSS is a bounding event. This fire was based on an actual combustible loading previously found in the 3712 Building.

12.0 EMERGENCY PLANNING

The subject buildings are strictly storage facilities. DOE-0223, Emergency Plan Implementing Procedures, requires that a Site Area Emergency be declared for any fire involving fuel storage containers in any fuel storage building. This declaration immediately activates responses for 300 Area personnel protection as required in DOE-0223.

13.0 SUMMARY OF FINDINGS/RECOMMENDATIONS

Recommendation #1 - The 3712 prefire plan does not reflect the current arrangement of the facility or its special hazards (the occupancy type is listed as oil storage and special hazards do not reflect uranium). Have the Prefire plan updated.
Recommendation #2 – FSP-FSS-5-35 Procedure, Section 01-04, Facility Modes should be revised to require padlock be removed and door remain unlocked when personnel enter 303-A, 303-B, 303-G and 3716 buildings.

14.0 REFERENCES

1. HNF-PRO-704, *Hazard and Accident Analysis Process*, December 1997.

2. DOE Order 5480.7A. *Fire Protection*, February 1993.

3. NFPA 101, *Life Safety Code*, 1997 edition.

4. WHC-SD-NR-CSER-010, Rev. 1, *Criticality Safety Evaluation Report for 300 Area N Reactor Fuel Fabrication and Storage Facility*, April 1995.

5. HSRCM-1, *Hanford Site Radiological Control Manual*, December 1994.

6. NFPA 80A, *Protection of Buildings from Exterior Fire Exposures*, 1996 Edition.

7. HNF-PRO-350, *Fire Hazards Analysis Requirements*, July 1997.

8. WHC-SD-NR-TI-051, *Fire Criticality Probability Analysis for 300 Area N Reactor Fuel Fabrication and Storage Facility*, February 1995.

9. HNF-SD-ISB-001, Rev. 1, *Interim Safety Basis for Fuel Supply Shutdown Facility*, September 1999 (pending approval).

10. WHC-SD-NR-TI-053, Rev 0, *Fire Loading Calculation for the 300 Area N Reactor Fuel Fabrication and Storage Facilities*, October 1993.

11. DOE-0223, *Emergency Plan Implementing Procedures*, April 1997.

12. WHC-SD-NR-RA-003, *Accident Safety Analysis N Reactor Fuel Supply Facility*, June 1993.

13. NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*, 1992 Edition.

14. NFPA 10, *Standard for Portable Fire Extinguishers*, 1994 Edition.

15. HNF-IP-0263-333, *Building Emergency Plan for the Fuel Supply Shutdown Facilities*, November 1997.

16. WHC-SD-SQA-ANAL-3001, Rev. 0, *Fire Protection Water Supply Analysis*, August 1995.

17. Letter, J. E. Mecca (RL) to President, FDH, "Devaluation of Fuel Supply Shutdown Buildings," 96-TPD-246.

18. HNF-PRO-684, Fire Protection Assessments, September, 1997

19. WHC-CM-7-5, *Environmental Compliance*, Westinghouse Hanford Company.

20. WHC-SD-PRP-HA-019. *Columbia River Flood Emergency Preparedness Hazards Assessment*, 1996.

21. PNL-6415 Rev. 5, *Hanford Site National Environmental Policy Act Characterization*, December 1992.

22. DOE Order 5484.1, *Environmental Protection, Safety, and Health Protection Information Reporting Requirements*, February 1981.

23. WHC-SD-NR-TI-053, *Fire Loading Calculations for 300 Area N Reactor Fuel*

Fabrication and Storage Facility, January 31, 1994.

3712 BUILDING

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15.0 DESCRIPTION OF CONSTRUCTION

The 3712 Building is a one-story steel frame structure with metal panel siding and roof. The floors and foundation are concrete. The steam heated forced air system is disconnected. An electrical HVAC system has been installed in the south portion of the building and the system is active during any period of extended occupancy. The building dimensions are 27.4 m by 32.9 m by 4.3 m.

Estimates for the structure and content replacement per the Richland Operations (RL) Property System, dated 9/20/99, are:

Replacement cost	$434,865.00
Content replacement cost	$ 33,090.00
Total	$467,955.00

16.0 FIRE PROTECTION FEATURES

The building is protected by a dry pipe sprinkler system (drawing H-3-9691), which alarms to the HFD. Electrical heaters provide freeze protection in the valve room. The existing suppression system is a pipe schedule installation. The spacing and amount of sprinkler heads, in conjunction with the more than adequate water supply, will have no trouble providing coverage for the 3712 Building.

Fire protection water (drawing H-3-60706, sheet 18) is provided by a 150 mm supply main fed from a 200 mm looped water main. A dual point water flow test conducted in 1995 by the HFD concluded the water supply for the 300 Area is considered adequate in its current configuration and in compliance with DOE 5480.7A and RLID 5480.7. Fire hydrant #35 is located approximately 15.2 m east of the 3712 Building.

Fire extinguishers are sized and located in the building in accordance with NFPA 10. Administrative controls are in place to prevent unauthorized entry into the 3712 Building (i.e., mode change -- see section 17 below).

17.0 DESCRIPTION OF FIRE HAZARDS

The 3712 Building is used for the storage of uranium billets and finished fuel in wooden boxes, uranium scrap and standards. Combustible material storage in the building is wooden boxes, and at the present time consists of 904 Red Shipping Boxes, 33 G4255 Billet Boxes, and 8 G4214 Scrap Boxes. A wooden box, which contains scale weights, is the only miscellaneous combustibles in the building. Transient combustibles have been removed and administrative procedures have been implemented to prevent the storage of miscellaneous combustibles.

The south portion of the building was used to support the recently completed United Kingdom (UK) packaging campaign which packaged and transferred 706 MTM of billets to the UK. The area may be used again if additional repackaging is required. The 33 boxes of billets are stored in this area.

18.0 LIFE SAFETY CONSIDERATIONS

This building is normally unoccupied and is kept locked. A Radiation Work Permit (RWP) is required to enter the north end of the building, and mode change authorized by FSS operations is required before removing the Tamper Indicating Device (TID) and unlocking the building door. The mode is changed from operational back to storage at the end of the shift. A TID is applied at that time. When unlocked, the building must be occupied by at least two authorized personnel. This is typical for each Nuclear Category 3-type building addressed in this document. Personnel entry into the 3712 Building is required only during inspection or product shipment (in and/or out), and the activities are only performed on the day shift.

The 3712 Building is classified as a Storage Occupancy in accordance with NFPA 101 Section 4-1.10. The contents are classified as ordinary hazard per Section 4-2. The building has personnel doors that can be accessed during an emergency. The hardware on the doors allows for an unobstructed exit from the inside. This complies with NFPA 101, Section 29-2.4.1. Dead-ends do not exceed 30.5 m per Section 29-2.5.4, and the travel distance to an egress is well within the 121.9 m limit per Section 29-2.6.

Emergency lighting is not required in the 3712 Building per NFPA 101, Section 29-2.9, Exception 1 and 2. There is enough light provided by the electrical lighting system and the windows to illuminate the means of egress per Section 29-2.8. No exit signs are necessary to mark the means of egress because the doors lead to the outside, and the doors are obvious and clearly identifiable per 5-10.1.2, Exception. An identified walkway from the 3712 northeast exit door directs pedestrians to an unimpeded egress. No life safety concerns exist.

19.0 EXPOSURE FIRE POTENTIAL

The 3712 Building was reviewed in accordance with NFPA 80A for exposure hazards. NFPA 80A recommends separation distances to protect a structure exposed to the radiant heat produced from a fire to another structure.

According to NFPA 80A, Section 4-4, where the exposing building or structure is protected throughout by an approved properly maintained system of automatic sprinklers of adequate design for the hazard involved, no exposure hazard is considered to exist. The 3712 Building is provided with automatic sprinkler protection, therefore, no exposure hazard is considered to exist from the 3712 Building.

The 313-S Building is located approximately 24.4 m) west of the 3712 Building. The sprinklers in this part of the building have been disconnected. Essentially combustibles except for wiring insulation have been removed. Per Table 2-2.4(a) of NFPA 80A, a "light" classification of exposure severity [0-34.4 kg/m,] is designated. The exposing face of the 313-S Building is essentially a concrete block building with two metal doors [2.4 m x 2.4 m and 0.9 m x 2.1 m on this section of the east wall]. The structure is assumed to survive the small combustible loading. However, for conservatism, the doors were assumed to fail and provide an opening for radiant exposure. The approximate percent opening on the exposing east face of the building is 3% [7.72 m^2, opening divided by 42 m x 6.1 m wall surface].

Guide numbers (GN) are obtained from NFPA 80A, Table 2-3. This table determines the separation distance necessary between buildings so that pilot ignition of the exposed building, or its contents, is unlikely, assuming no means of protection is installed in connection with either building. The GN is based on the highest ratio of width to height (42.1 m/6.1 m = 6.9 for this section of the east wall), the severity classification, and the percent opening.

From Table 2-3, the GN is 0.51. To obtain distances, the lesser dimension of width or height is multiplied by the GN then added to 1.5 m. The minimum separation distance to the east of the 313-S Building is 4.6 m, therefore, no exposure hazard is considered to exist to the 3712 Building from the 313-S Building.

The 303-G Building is located approximately 24.4 m south of the 3712 Building. The 303-G Building is sprinkled, therefore, no exposure hazard is considered to exist to the 3712 Building from the 303-G Building.

The 306-W Building is located approximately 42.7 m east of 3712. The 306-W Building is sprinkled, therefore, no exposure hazard is considered to exist to the 3712 Building from the 306-W Building.

The 3720BA, housing a natural gas package boiler unit, is located approximately 23.2 m north of the 3712 Building. The sheet metal building is 7.2 m square by 4.9 m high. Per the calculation method of NFPA 80A for a width/height ratio of 1.5, a conservative "severe" severity classification, and 100% opening resulting in a GN of 3.6, the required minimum separation distance is approximately 19.2 m. Sufficient separation exists that the 3720 BA is not considered an exposure threat to the 3712 Building.

The 3720 Building, operated and controlled by PNNL, is located approximately 30 m north of the 3712 building is fully sprinkled and, therefore, does not pose an exposure to the 3712 Building. The present arrangement is adequate.

The hazards presented by the two 1000-gallon propane tanks on the north side of the 313 Building have been analyzed and found to be acceptable (WHC-SD-FL-FA-001, Rev. 0-A). The analysis considered uncontrolled venting at the tanks, fire potential resulting from propane gas leak and subsequent explosion within the 313 Building and tank Boiling Liquid, Expanding Vapor Explosion (BLEVE).

The analysis concluded that uncontrolled venting at the tank vicinity had no consequence, that leaks and subsequent explosion within the 313 Building had potential to cause significant damage to the 3712 Building but not initiate fire in that building because the explosion would be of very short duration. Also that a BLEVE could damage the 3712 Building and potentially cause a fire initiated by hot sections of the exploding tank impacting it. However, the probability of a BLEVE initiating a fire in 3712 Building is extremely unlikely and the BLEVE would not add any additional *combustible material to the building.*

3716 BUILDING

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15.0 DESCRIPTION OF CONSTRUCTION

The 3716 Building is a one-story metal frame structure with insulated corrugated aluminum siding and roof. The structure is mounted 1.2 m above grade on a reinforced concrete wall with the reinforced concrete floor slab on grade. Inside partitions are gypsum board on wood studs. Steam and water supply for the heating and cooling systems have been disconnected; therefore, the building is unheated and uncooled. The building dimensions are 12.2 m by 24.4 m by 3.7 m.

Estimates for the structure and content replacement per the RL Property System, dated 9/20/99, are:

Replacement cost	$340,548.00
Content replacement cost	$ 15,000.00
Total	$355,548.00

16.0 FIRE PROTECTION FEATURES

The structure is protected by a dry pipe sprinkler system (drawing H-3-9286), which alarms to the HFD. The existing suppression system is a pipe schedule installation. The spacing and amount of sprinkler heads in conjunction with the water supply will provide adequate coverage for the 3716 Building.

Fire protection water (drawing H-3-60706, sheet 18) for the 3716 Building is provided by a 100 mm supply main fed from a 200 mm looped water main. A dual point water flow test conducted in 1995 by the HFD concluded the water supply for the 300 Area is considered adequate in its current configuration and in compliance with DOE 5480.7A and RLID 5480.7. Fire hydrant #35 is located approximately 27.4 m northwest of the building.

Fire extinguishers are sized and located in accordance with NFPA 10. Administrative controls are in place to prevent unauthorized entry into the 3716 Building (i.e., mode change -- see page 3712-4).

17.0 DESCRIPTION OF FIRE HAZARDS

The 3716 Building is used for the storage of unfinished fuel pieces capped with plastic caps and stored in wooden boxes. Storage in the building at the present time consists of 206 Red Shipping Boxes, 134 G4214 Scrap Boxes, and a small quantity of miscellaneous combustibles. Transient combustibles have been removed and administrative procedures have been implemented to prevent the storage of miscellaneous combustibles.

18.0 LIFE SAFETY CONSIDERATIONS

The 3716 Building is classified as a Storage Occupancy in accordance with NFPA 101, *Life Safety Code*, Section 4-1.10. The contents are classified as ordinary hazard per Section 4-2.

The 3716 Building has one door which is adequate in accordance with NFPA 101, Section 29-2.4.1, Exception 2. Dead-ends do not exceed 30.5 m, no common paths exceed 30.5 m per Section 29-2.5.4, and the travel distance to an egress is well within the 121.9 m limit per Section 29-2.6.

This building is normally unoccupied and is kept locked through use of a hasp and padlock on the outside of the access door. Personnel entry into the 3716 Building is required only during inspection or product shipment (in and/or out), and the activities are only performed on the day shift. An RWP and mode change (see page 3712-4) is required to enter the building. Recommendation #2 - the mode change procedure will require the padlock to be removed and door remain unlocked whenever personnel are in the building. This arrangement meets the requirements of NFPA 101, Section 5-2.1.5.1, as the door is locked only when the building is unoccupied (see 5-2.1.1.3). NFPA 101, Section A-5-2.1.1.3, states, "...5-2.1.1.3 and 5-2.1.5.1 permit locking of means of egress doors where a building is not considered occupied..."

Emergency lighting is not required in the 3716 Building per NFPA 101, Section 29-2.9, Exception 1 and 2. There is enough light provided by the electrical lighting system and the windows to illuminate the means of egress per Section 29-2.8. No exit signs are necessary to mark the means of egress because the door leads to the outside, and the door is obviously and clearly identifiable per 5-10.1.2, Exception. No life safety concerns exist.

19.0 EXPOSURE FIRE POTENTIAL

The 3716 Building was reviewed in accordance with NFPA 80A for exposure hazards. NFPA 80A recommends separation distances to protect a structure exposed to the radiant heat produced from a fire to another structure.

According to NFPA 80A, Section 4-4, where the exposing building or structure is protected throughout by an approved properly maintained system of automatic sprinklers of adequate design for the hazard involved, no exposure hazard is considered to exist. The 3716 Building is sprinkled, therefore, no exposure hazard is considered to exist from the 3716 Building.

The 333 Building is located approximately 27.4 m north of the 3716 Building. The 333

Building is sprinkled, therefore, no exposure hazard is considered to exist to the 3716 Building from the 333 Building.

The 306-W Building is located approximately 9.1 m south of the 3716 Building. 306-W is sprinkled, therefore, no exposure hazard is considered to exist to the 3716 Building from the 306-W Building.

The structures to the east and west, including MO-052 and the 3712 Building, are over 61 m away and are not considered exposure hazards.

The hazards presented by the two 1000-gallon propane tanks on the north side of the 313 Building have been analyzed and found to be acceptable (WHC-SD-FL-FA-001, Rev. 0-A). The analysis considered uncontrolled venting at the tank, fire potential resulting from propane gas leaks and subsequent explosion within the 313 Building, and the tank BLEVE. The analysis concluded that uncontrolled venting at the tank vicinity had no consequence, that leaks and subsequent explosion within the 313 Building had potential to cause only minimal damage to the 3716 Building but not initiate fire because of the minimal damage incurred, and that a BLEVE could damage the 3716 Building and potentially cause a fire initiated by hot sections of the exploding tank impacting it. However, the probability of a BLEVE initiating a fire in the 3716 Building is extremely unlikely and the BLEVE would not add any additional combustible material to the building.

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303-A BUILDING

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15.0 DESCRIPTION OF CONSTRUCTION

The 303-A Building is an 8.3 m by 14.6 m by 3.2 m concrete block structure with concrete foundation and floor. The roof is an 0.5 m (precast concrete slab covered with felt, tar, and gravel. It is a bunker type building with three doors and no windows.

Estimates for the structure and content replacement per the RL Property System, dated 9/20/99, are:

Replacement cost	$232,540.00
Content replacement cost	$ 0.00
Total	$232,540.00

16.0 FIRE PROTECTION FEATURES

The 303-A Building has a dry pipe sprinkler system (drawing H-3-55543) which alarms to the HFD. The existing suppression system is a pipe schedule installation. The spacing and amount of sprinkler heads in conjunction with the water supply will provide adequate coverage for the building.

Fire protection water (drawing H-3-60706, sheet 18) for the 303-A Building is provided by a 100 mm supply main fed from a 200 mm looped water main. A dual point water flow test conducted in 1995 by the HFD concluded the water supply for the 300 Area is considered adequate in its current configuration and in compliance with DOE 5480.7A and RLID 5480.7. Hydrant #16 is approximately 70.7 m southwest; #15 is approximately 46.1 m northwest of the building.
Fire extinguishers are sized and located in accordance with NFPA 10. Administrative controls are in place to prevent unauthorized entry into the 303-A Building (i.e., mode change -- see page 3712-4).

17.0 DESCRIPTION OF FIRE HAZARDS

The 303-A Building is used for the storage of finished fuel stored in wooden boxes. Storage in the building at the present time consists of 155 Red Shipping Boxes. Transient combustibles have been removed and administrative procedures have been implemented to prevent the storage of miscellaneous combustibles

18.0 LIFE SAFETY CONSIDERATIONS

The 303-A Building is classified as a Storage Occupancy in accordance with NFPA 101, *Life Safety Code*, Section 4-1.10. The contents are classified as ordinary hazard per Section 4-2.

This building is normally unoccupied and is kept locked through use of hasps and padlocks on the outside of the access doors. Personnel entry into the Building is required only during inspection or product shipment (in and/or out), and the activities are only performed on the day shift. An RWP and mode change is required to enter the building. Recommendation #2 - the mode change procedure will require the padlock to be removed and the door to remain unlocked whenever personnel enter the building. This arrangement meets the requirements of NFPA 101, Section 5-2.1.5.1, as the door is locked only when the building is unoccupied (see 5-2.1.1.3). NFPA 101, Section A-5-2.1.1.3, states, "...5-2.1.1.3 and 5-2.1.5.1 permit locking of means of egress doors where a building is not considered occupied..."

The building has three doors which are sealed with a Tamper Indicating Device (TID). Since the inspections or product shipment can be performed using just one door, normal entry is through just one door and the same door is used for each entry. This is both convenient and saves the time and effort to apply and control the TID seals. The only personnel allowed in the 303-A are familiar with the building, and the occasions for entrance are infrequent. This arrangement is adequate in accordance with NFPA 101, Section 29-2.4.1, Exception 2. Dead-ends do not exceed 30.5 m, no common paths exceed 30.5 m per Section 29-2.5.4, and the travel distance to an egress is well within the 121.9 m limit per Section 29-2.6.

Emergency lighting is not installed nor required per NFPA 101, Section 29-2.9, Exception 1. No exit signs are necessary to mark the means of egress because the exit door leads to the outside, and the exit door is obviously and clearly identifiable per 5-10.1.2, Exception. No life safety concerns exist.

19.0 EXPOSURE FIRE POTENTIAL

The 303-A Building was reviewed in accordance with NFPA 80A for exposure hazards. NFPA 80A recommends separation distances to protect a structure exposed to the radiant heat produced from a fire to another structure.

According to NFPA 80A, Section 4-4, where the exposing building or structure is protected throughout by an approved properly maintained system of automatic sprinklers of adequate design for the hazard involved, no exposure hazard is considered to exist. The 303-A Building is sprinkled, therefore, no exposure hazard is considered to exist from the 303-A Building.

The 3722 Building is located approximately 21.3 m west of the 303-A Building. The 3722

Building is sprinkled, therefore, no exposure hazard is considered to exist to the 303-A Building from the 3722 Building.

The 3717-B Building is located approximately 9.1 m south of the 303-A Building. The 3717-B Building is sprinkled, therefore, no exposure hazard is considered to exist to the 303-A Building from the 3717-B Building.

The 304 Building is located approximately 7.3 m east of the 303-A Building. The 304 Building is constructed of sheet metal and has been completely emptied of combustibles, therefore, no exposure hazard is considered to exist to the 303-A Building from the 304 Building.

The 303-K Building is located approximately 22 m to the northeast. This building is of noncombustible construction and is not an exposure hazard to the 303-A Building.

The 314 Building is located approximately 22 m to the northwest. This building is of noncombustible construction and is not an exposure to the 303-A Building. There are no structures in close proximity to the north. The present arrangement is adequate.

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303-B BUILDING

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15.0 DESCRIPTION OF CONSTRUCTION

The 303-B Building is an 8.2 m by 14.6 m by 3.2 m concrete block structure with concrete foundation and floor. The roof is a 0.5 m precast concrete slab covered with felt, tar, and gravel. It is a bunker type building with three doors and no windows.

Estimates for the structure and content replacement per the RL Property System, dated 9/20/99, are:

Replacement cost	$232,534.00
Content replacement cost	$ 0.00
Total	$232,534.00

16.0 FIRE PROTECTION FEATURES

The 303-B Building has a dry pipe sprinkler system (drawing H-3-55543) which alarms to the HFD. The existing suppression system is a pipe schedule installation. The spacing and amount of sprinkler heads in conjunction with the water supply will provide adequate coverage for the building.

Fire protection water (drawing H-3-60706, sheet 18 for the 303-B Building is provided by a 100 mm supply main fed from a 200 mm looped water main. A dual point water flow test conducted in 1995 by the HFD concluded the water supply for the 300 Area is considered adequate in its current configuration and in compliance with DOE 5480.7A and RLID 5480.7. Fire hydrants #16 and #24 are approximately 80.8 m southeast and 50.3 m west of the building, respectively.

Fire extinguishers are sized and located in accordance with NFPA 10. Administrative controls are in place to prevent unauthorized entry into the 303-B Building (i.e., mode change -- see page 3712-4).

17.0 DESCRIPTION OF FIRE HAZARDS

The 303-B Building is used for the storage of finished fuel stored in wooden boxes. Storage in the building at the present time consists of 96 Red Shipping Boxes. Transient combustibles have been removed and administrative procedures have been implemented to prevent the storage of miscellaneous combustibles.

18.0 LIFE SAFETY CONSIDERATIONS

The 303-B Building is classified as a Storage Occupancy in accordance with NFPA 101, *Life Safety Code*, Section 4-1.10. The contents are classified as ordinary hazard per Section 4-2.

This building is normally unoccupied and is kept locked through use of hasps and padlocks on the outside of the access doors. Personnel entry into the Building is required only during inspection or product shipment (in and/or out), and the activities are only performed on the day shift. An RWP and mode change is required to enter the building. Recommendation #2 - the mode change procedure will require that the padlock be removed and the door remain unlocked whenever personnel are in the building. This arrangement meets the requirements of NFPA 101, Section 5-2.1.5.1, as the door is locked only when the building is unoccupied (see 5-2.1.1.3). NFPA 101, Section A-5-2.1.1.3, states, "...5-2.1.1.3 and 5-2.1.5.1 permit locking of means of egress doors where a building is not considered occupied..."

The building has three doors which are sealed with a Tamper Indicating Device (TID). Since the inspections or product shipment can be performed using just one door, normal entry is through just one door and the same door is used for each entry. This is both convenient and saves the time and effort to apply and control the TID seals. The only personnel allowed in the 303-A are familiar with the building, and the occasions for entrance are infrequent. This arrangement is adequate in accordance with NFPA 101, Section 29-2.4.1, Exception 2. Dead-ends do not exceed 30.5 m, no common paths exceed 30.5 m per Section 29-2.5.4, and the travel distance to an egress is well within the 121.9 m limit per Section 29-2.6.

Emergency lighting is not installed nor required per NFPA 101, Section 29-2.9, Exception 1. No exit signs are necessary to mark the means of egress because the exit door leads to the outside, and the exit door is obviously and clearly identifiable per 5-10.1.2, Exception. No life safety concerns exist.

19.0 EXPOSURE FIRE POTENTIAL

The 303-B Building was reviewed in accordance with NFPA 80A for exposure hazards. NFPA 80A recommends separation distances to protect a structure exposed to the radiant heat produced from a fire to another structure.

According to NFPA 80A, Section 4-4, where the exposing building or structure is protected throughout by an approved properly maintained system of automatic sprinklers of adequate design for the hazard involved, no exposure hazard is considered to exist. The 303-B Building is sprinkled, therefore, no exposure is considered to exist from the 303-B Building.

The 304 Building is located approximately 2 m west of 303-B. The 304 Building is constructed of sheet metal and has been completely emptied of combustibles, therefore, no exposure hazard is considered to exist to the 303-B Building from the 304 Building.

The 3717-B Building is located approximately 9.1 m south of the 303-B Building. The 3717-B Building is sprinkled, therefore, no exposure hazard is considered to exist to the 303-B Building from the 3717-B Building.

The 303-K and 313 Buildings are more than 23 m to the north. Both buildings are of noncombustible construction. They do not present an exposure hazard to the 303-B Building. There are no structures in close proximity to the east. The present arrangement is adequate.

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303-G BUILDING

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15.0 DESCRIPTION OF CONSTRUCTION

The 303-G Building is an 8.2 m by 14.6 m by 3.2 m concrete block structure with concrete foundation and floor. The roof is a 0.5 m precast concrete slab covered with felt, tar, and gravel. It is a bunker type building with three doors and no windows.

Estimates for the structure and content replacement per the RL Property System, dated 9/20/99, are:

Replacement cost	$232,534.00
Content replacement cost	$ 0.00
Total	$232,534.00

16.0 FIRE PROTECTION FEATURES

The 303-G Building has a dry pipe sprinkler system (drawing H-3-55543) which alarms to the HFD. The existing suppression system is a pipe schedule installation. The spacing and amount of sprinkler heads in conjunction with the water supply will provide adequate coverage for the building.

Fire protection water (drawing H-3-60706, sheet 18) for the 303-G Building is provided by a 100 mm supply main fed from a 200 mm looped water main. A dual point water flow test conducted in 1995 by the HFD concluded the water supply for the 300 Area is considered adequate in its current configuration and in compliance with DOE 5480.7A and RLID 5480.7. Hydrant #34 is approximately 10.7 m east of the building.

Fire extinguishers are sized and located in accordance with NFPA 10. Administrative controls are in place to prevent unauthorized entry into the 303-G Building (i.e., mode change -- see page 3712-4).

17.0 DESCRIPTION OF FIRE HAZARDS

The 303-G Building is used for the storage of uranium billets stored in wooden boxes. Storage in the building at the present time consists of 286 G4255 Billet Boxes. Transient combustibles have been removed and administrative procedures have been implemented to prevent the storage of miscellaneous combustibles.

18.0 LIFE SAFETY CONSIDERATIONS

The 303-G Building is classified as a Storage Occupancy in accordance with NFPA 101, *Life Safety Code*, Section 4-1.10. The contents are classified as ordinary hazard per Section 4-2.

This building is normally unoccupied and is kept locked through use of hasps and padlocks on the outside of the access doors. Personnel entry into the Building is required only during inspection or product shipment (in and/or out), and the activities are only performed on the day shift. An RWP and mode change is required to enter the building. Recommendation #2 - the mode change procedure will require that the padlock be removed and the door remain unlocked whenever personnel are in the building. This arrangement meets the requirements of NFPA 101, Section 5-2.1.5.1, as the door is locked only when the building is unoccupied (see 5-2.1.1.3). NFPA 101, Section A-5-2.1.1.3, states, "...5-2.1.1.3 and 5-2.1.5.1 permit locking of means of egress doors where a building is not considered occupied..."

The building has three doors which are sealed with a Tamper Indicating Device (TID). Since the inspections or product shipment can be performed using just one door, normal entry is through just one door and the same door is used for each entry. This is both convenient and saves the time and effort to apply and control the TID seals. The only personnel allowed in the 303-A are familiar with the building, and the occasions for entrance are infrequent. This arrangement is adequate in accordance with NFPA 101, Section 29-2.4.1, Exception 2. Dead-ends do not exceed 30.5 m, no common paths exceed 30.5 m per Section 29-2.5.4, and the travel distance to an egress is well within the 121.9 m limit per Section 29-2.6.

Emergency lighting is not installed nor required per NFPA 101, Section 29-2.9, Exception 1. No exit signs are necessary to mark the means of egress because the exit door leads to the outside, and the exit door is obviously and clearly identifiable per 5-10.1.2, Exception. No life safety concerns exist.

19.0 EXPOSURE FIRE POTENTIAL

The 303-G Building was reviewed in accordance with NFPA 80A for exposure hazards. NFPA 80A recommends separation distances to protect a structure exposed to the radiant heat produced from this fire of another structure.

According to NFPA 80A, Section 4-4, where the exposing building or structure is protected throughout by an approved properly maintained system of automatic sprinklers of adequate design for the hazard involved, no exposure hazard is considered to exist. The 303-G Building is sprinkled, therefore, no exposure hazard is considered to exist from the 303-G Building.

The 3712, 306-W, and 303-E Buildings are located approximately 18.9 m north, 42.7 m to the east, and 27.4 m to the south, respectively, of 303-G. These buildings are sprinkled, therefore, no exposure hazard is considered to exist to the 303-G Building from these buildings.

The 311 Tank Farm is located to the west of the 303-G Building. None of the tanks pose a fire hazard. The nearest tank is located approximately 10.1 m away. The tanks are empty. The present arrangement is adequate.

APPENDIX A

DISPERSION REPORT

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ESTIMATION OF GROUND CONTAMINATION AREAS FOR A DESIGN BASIS FIRE IN THE 3712 BUILDING

D.A. Himes
11/9/93

The purpose of this analysis is to estimate the ground surface area which would require cleanup after a postulated maximum fire at the 3712 Building in the 300 Area. The 3712 Building is a one-story steel frame structure containing approximately 396 metric tons of green N-Reactor fuel and approximately 726 metric tons of unclad uranium billets [1]. This estimate will support a total fire loss estimate which includes cost of decontamination and cleanup.

Release Scenario:

The specified release scenario is a 4 hour fire which consumes the ordinary combustible inventory of the facility. As reported in Reference 2, "Unlike plutonium, uranium is difficult to ignite. The presence of an adherent, protective layer of hyperstoichiometric dioxide at the interface limits oxygen availability. The heats of reaction are lower...large pieces of uranium are very difficult to ignite: large amounts of external heat must be supplied and serious heat loss prevented." The active burning of the uranium metal is therefore assumed to cease when all the other combustibles are consumed 4 hours into the event. The material is, however, conservatively assumed to remain hot, and the release of oxide to continue, for another 4 hours.

Based on these considerations (and the assumption that the portion of the uranium which is clad in Zircaloy-2 is not at risk in the fire [1]) a total of 89.8 metric tons of uranium is specified to be oxidized and available for release over the 8 hour event [1]. Much of the oxidized metal will obviously be retained in the remains of the facility. Oxide particles small enough to be lofted in the fire plume are assumed to be transported downwind according to the continuous particle size dispersion model developed previously [3].

Release Fractions:

A considerable amount of data is available relative to the burning of uranium metal in air due to its extensive use in munitions. Data from uranium fires in air indicate a respirable release fraction ($\leq$ 10 μm AED) of around 1E-4 with a total aerosol release fraction of roughly 4E-2. This appears to be reasonably consistent with cumulative and differential release fractions for burning of general packaged contaminated waste previously developed from the data of Mishima and Schwendiman [3]. These previously developed release fractions (updated using the latest revision of Reference 2) shown in Eqs. 1 and 2 will therefore be assumed for the burning of metallic uranium. It should be remembered that the data for both uranium and packaged waste are relatively sparse and scattered. These release fractions should therefore be regarded only as rough estimates. The cumulative release fraction as a function of fall velocity is therefore assumed to be:

$$F = 5E\text{-}2\, v_g^{1.35}$$

where v_g is the gravitational drift velocity (m/s). To obtain the differential release fraction (fraction per unit velocity at v_g) we can form the derivative with respect to v_g, to yield

$$\frac{dF}{dv_g} = 6.75E\text{-}2\ v_g^{0.35}$$

It is of interest to note the fall velocity predicted by this model for a cumulative release fraction of 1. Solving Eqn. 1 for v_g given F = 1, produces a value of 9.1 m/s, corresponding to a particle size of about 300 µm or about 0.3 mm. Particles this large will probably not be lifted out of the fire, or if they are, will be deposited very close to the fire.

Source Term:

A total of 89.8 MT (8.98E+7 g) of uranium are specified to be oxidized and available for release. The uranium metal composition was specified [1] as follows:

Table 1: Uranium billet composition

Isotope	g per g of mix	Ci per g of mix	g per Ci of mix	Ci per Ci of mix
U-234	9.0E-5	5.58E-7	7.99E+1	4.95E-1
U-235	1.25E-2	2.68E-8	1.11E+4	2.37E-2
U-236	6.9E-4	4.35E-8	6.12E+2	3.86E-2
U-238	9.867E-1	3.29E-7	8.76E+5	2.92E-1
Tc-99	1.0E-5	1.70E-7	8.87E+0	1.51E-1
	1.000E+0	9.57E-7 U only	1.00E+0	1.13E-6 total

Because of the low activity of this material and the large mass inventory involved, the contamination levels will be estimated in terms of g of mix.

Description of Fire:

The 3712 Facility is an 891 m^2 one level steel frame building on a concrete slab. The fire is assumed to involve only the 3712 Facility. Consistent with normal assumptions related to general building fires, the fuel for the fire is assumed to be 50% wood and 50% plastic (modeled as polystyrene). (The uranium is not considered fuel for purposes of the fire thermal analysis.) For an open (i.e., uncontained) fire, the fuel burn rate is given by [4]:

$$\dot{M}_b = (q_{fe} + q_{fr} - q_{rr})\frac{A}{L}$$

where q_{fe} = convective heat flux = 15.5 kW/m^2
q_{fr} = radiative heat flux = 53.0 kW/m^2
q_{rr} = radiative heat loss = 15.0 kW/m^2
L = heat of formation of fuel vapor = 2.65 kJ/g
A = fire surface area

The first four parameters above, which are fuel dependent, are averages of the values for wood and polystyrene given in NUREG-1320 [4]. Evaluating the burn rate per unit area using Eqn. 3 yields the following fuel consumption rate per unit area of fire:

$$\frac{\dot{M}_b}{A} = 20.2\ g/s\ m^2$$

The rate of sensible heat production in the fire per unit area is then given by:

$$\frac{\dot{Q}_a}{A} = X_a H_t \frac{M_b}{A}$$

where X_a = heat release efficiency = 0.69
H_t = heat of combustion = 28.5 kJ/g

As before, the two parameters above are averages of the values for wood and polystyrene. The value 28.5 kJ/g for heat of combustion is essentially identical to the value 12,000 BTU/lb commonly used in fire protection studies related to general building fires. The resulting value for the sensible heat rate is:

$$\frac{\dot{Q}_a}{A} = 397\ kW/\ m^2$$

This number translates into 9.48E+4 cal/sm^2 or 35 BTU/sft^2.

The total sensible heat generation rate for purposes of calculating plume rise for this facility is then 8.45E+7 cal/s.

Plume Rise and Particle Release:
The thermal plume rise model for this fire uses the well-known "▯ law" which shows good agreement with observations for rise of a buoyant plume under stable conditions in a crosswind and for unstable conditions before turbulence has a large effect [5]. Specific forms and parameters used for the model are those used in the MACCS code [6]. For a buoyancy-dominated plume

$$h(x) = 1.6 \frac{F_b^{1/3} x^{2/3}}{u}$$

where h = plume rise (m)
F_b = initial buoyancy parameter (m^4/s^3)
x = downwind distance (m)
u = ground level wind speed (m/s)

Note that "ground level" wind speed refers to measured wind speed at some reference height, usually 10 m. For plumes with a heat capacity and mean molecular weight close to that of air, and for standard atmospheric properties, the initial buoyancy parameter is approximated by

$$F_b = 3.7E\text{-}5\, Q_H$$

where Q_H = heat rate (cal/s) = 8.45E+7 cal/s

The initial buoyancy parameter for this fire is therefore 3.13E+3 m^4/s^3. Eqn. 7 and 8 describe the initial rise of the plume. At some point the plume will become negatively buoyant and, after some over-shoot caused by momentum effects, will stabilize at the equilibrium altitude given by

$$h_E = 2.6 \left(\frac{F_b}{u_e\ s} \right)^{1/3}$$

where u_e = effective wind speed (m/s)
s = stability parameter (s^{-2})

Based on NRC recommended lapse rates for the various stability classes, the MACCS code [6] uses s = 1.27E-3 s^{-2} for Pasquill F.

Minimum vertical velocities can easily be obtained by taking the time derivative of Eqn. 7, and tend to be on the order of several meters per second. Even relatively large particles therefore tend to be entrained in the plume until it reaches its equilibrium altitude, and then to fall out of the plume and descend at their respective fall velocities while being diffused laterally and vertically by atmospheric turbulence. Particles with fall velocities greater than the minimum vertical plume velocity will fall out of the plume before it reaches equilibrium height. This material will suffer less dispersion and so will produce smaller ground fallout areas. For purposes of the model all particles with fall velocity $\leq$ 5 m/s are conservatively assumed to reach equilibrium altitude before release from the plume.

For this analysis the ground level wind speed is assumed to be 1 m/s. However, under stable conditions there is generally a substantial increase in wind speed with altitude which must be accounted for when estimating equilibrium altitude and downwind travel distances. The wind speed as a function of altitude under these conditions can be approximated by [6]

$$u(z) = u_0 \left(\frac{z}{z_0} \right)^p$$

where z = altitude (m)
u_0 = wind speed (m/s) at a reference height z_0 (usually 10 m)
p = 0.55 for Pasquill F

The effective wind speed for a plume with equilibrium height z is assumed [6] to be the mean of u (z) and u_0 (1 m/s). The effective wind speed is therefore given by

$$u_e(z) = \frac{u_0}{2} \left[1 + \left(\frac{z}{z_0} \right)^p \right]$$

Note that since u_e is a function of z, an iterative solution is required for h_E. The resulting equilibrium plume height and associated effective wind speed for this case are 235 m and 3.34 m/s, respectively.

In this model the plume reaches equilibrium height at a downwind distance d_1 from the fire. This point at elevation h_E and downwind distance d_1 is the assumed release point for all particles with a fall velocity $\leq$ 5 m/s. The particles then drift downward while travelling downwind until they hit the ground at a horizontal distance d_2 from the release point at d_1. The total horizontal distance from the fire to where the particle hits the ground is then $x = d_1 + d_2$. Once the particles hit the ground, they are assumed to stay there, i.e., there is no ground reflection. To obtain d_1 one simply solves Eqn. 7 for the distance to equilibrium height

$$d_1 = \left[\frac{u_0 h_E}{1.6 \ F_b^{1/3}} \right]^{3/2}$$

Remember that Eqn. 7 is correlated in terms of the reference (ground level) wind speed u_0. The resulting distance to the elevated release point d_1 for this case is 31.8 m.

The median horizontal distance, d_2, traveled from the elevated particle release point to the point of impact with the ground is just given by:

$$d_2 = \frac{u_e}{v_g} h_E$$

where v_g is the fall velocity of the particle and h_E is the equilibrium plume height, i.e., the assumed particle release height.

Dispersion to Ground Impact:

So far, the model has a particle being entrained in the thermal fire plume and being transported rapidly upward until the plume bends over and becomes horizontal at its equilibrium altitude. At this point the particle is released and falls downward out of the plume. The particle then falls at its characteristic velocity in a straight line until it impacts with the ground at a distance $x = d_1 + d_2$ from the fire. There is, however, a considerable amount of transverse and vertical dispersion by random air motion during the trip to the ground. This has the effect of allowing particles with a given fall velocity to land within an area of considerable size rather than at a single point. In order to estimate the size of this impact area and the distribution of material within it, a "tilted" Gaussian plume model is used. This model was developed and used successfully to predict ground contamination patterns due to the fallout from nuclear bomb tests [5].

The tilted plume model is similar to the standard Gaussian plume model with the following major differences: (1) The plume is tilted downward such that a particle traveling down the centerline of the plume is moving downward at its characteristic fall velocity; and (2) There is no ground reflection, i.e., when a particle hits the ground, it sticks and cannot reenter the

$$\frac{X}{Q} = \frac{1}{2\pi \sigma_y \sigma_z u_e} \exp\left[-\frac{y^2}{2\sigma_y^2} - \frac{\left(h_E - d_2 \frac{v_g}{u_e}\right)^2}{2\sigma_z^2} \right]$$

plume. This plume model is formulated as follows in terms of the Pasquill-Gifford sigmas:

where σ_y and σ_z are functions of $x = d_1 + d_2$. The extra factor of 2 in the denominator is due to the lack of ground reflection in this model. On the plume centerline ($y = 0$)

$$\frac{X}{Q} = \frac{1}{2\pi \sigma_y \sigma_z u_e} \exp\left[-\frac{\left(h_E - d_2 \frac{v_g}{u_e}\right)^2}{2\sigma_z^2} \right]$$

For a given particle fall velocity, v_g, the exponent terms in Eqns. 14 and 15 are maximized for $d_2 = u_e h_E / v_g$. For all practical purposes, this can be considered the point of maximum X/Q given by:

$$\left(\frac{X}{Q}\right)_{max} = \frac{1}{2\pi\,\sigma_y\,\sigma_z\,u_e}$$

The corresponding maximum ground contamination level for a release R of particles with fall velocity v_g is then just given by:

The transverse concentration profile at the downwind location $d_2 = u_e h_E / v_g$ can be generated by just substituting into Eqn. 14 to obtain

$$\frac{X}{Q} = \frac{1}{2\pi\,\sigma_y\,\sigma_z\,u_e}\,\exp\left[-\frac{y^2}{2\sigma_y^2}\right]$$

And combining with Eqn. 17 yields

$$C(y) = C_{max}\,\exp\left[-\frac{y^2}{2\sigma_y^2}\right]$$

To find the transverse distance where the concentration, C, is at some specified level, simply solve Eqn. 19 for y as follows

$$y = \sqrt{2}\,\sigma_y\left[\ln\left(\frac{C_{max}}{C}\right)\right]^{1/2}$$

For a given contamination level of concern, the maximum extent down the axis of the plume is obtained using Eqn. 17, while Eqn. 20 gives the lateral extent at any given downwind distance. These two equations can therefore be used to plot the footprint on the ground of a given contamination level of concern for particles with a fall velocity v_g.

Mapping of Ground Contamination Zones:

The object of this analysis is to map the extent of the ground contamination zone requiring cleanup. Since this facility is located within an area heavily populated with buildings and paved surfaces, two criteria are of interest: the smearable surface contamination limits given in the WHC Radiological Control Manual (WHC-CM-1-6) and the accessible soil contamination limits given in the WHC Environmental Compliance Manual (WHC-CM-7-5). The surface contamination limits would apply to building roofs, streets, sidewalks, etc.

while the soil limits would apply to any open soil areas within the Hanford site.

Table 2-3 of WHC-CM-1-6 gives bounding fixed and removable surface activities above which the surface must be posted and cleaned. For this analysis, all surface contamination is assumed to be loose (i.e., removable). The corresponding limit for uranium isotopes is 1000 dpm/100 cm^2 alpha. Tc-99 is primarily a beta emitter with a limit of 1000 dpm/100 cm^2 beta/gamma. The alpha and beta/gamma limits in Table 2-3 of WHC-CM-1-6 are to be applied independently. Using the information in Table 1, therefore, these surface activity limits correspond to 4.70E-2 g mix/m^2 for alpha and 2.65E-1 g mix/m^2 for beta/gamma, respectively. The operative limit for removable surface contamination is therefore 4.70E-2 g mix/m^2.

The bounding soil contamination for cleanup from Table 6.2 of WHC-CM-7-5 is based on material being mixed within the top 15 cm (the "plow depth") of soil which is not behind a security fence, and corresponds to a 10 mrem/yr limit from Hanford operations to the most exposed member of the public. For an acute scenario, however, the material will be on the surface of the soil. The corresponding surface area concentration therefore assumes a sample depth of 1 cm with a soil density of 1.6 g/cm^3. The bounding soil contamination levels requiring cleanup and the corresponding areal concentrations for the nuclides in the facility inventory are shown below.

Table 2: Accessible soil concentration limits from WHC-CM-7-5 with corresponding areal concentrations

Isotope	Soil Concentration Limit (pCi/g)	Areal Concentration Limit (Ci/m^2)
U-234	6.3E+2	1.01E-5
U-235	1.7E+2	2.72E-6
U-236	6.7E+2	1.07E-5
U-238	3.7E+2	5.92E-6
Tc-99	1.0E+6	1.60E-2

In determining an overall limit for a radionuclide mix, the "sum of the fractions" rule applies in this case. For 1 g of mix per m^2 of soil the fractions of the limits are shown in Table 3.

Table 3: Fractions of limits for 1 g mix/m^2 of soil

Isotope	Areal Concentration g/m^2	Areal Concentration Ci/m^2	Fraction of Limit
U-234	9.0E-5	5.58E-7	5.52E-2

U-235	1.25E-2	2.68E-8	9.85E-3
U-236	6.9E-4	4.35E-8	4.07E-3
U-238	9.867E-1	3.29E-7	5.56E-2
Tc-99	1.0E-5	1.70E-7	1.06E-5
	1.000E+0		1.25E-1

The areal concentration corresponding to the sum of the fractions equals 1 is therefore 8.02E+0 g mix/m^2. This is the operative limit for contamination of open soil areas by this particular radionuclide mix in or near the 300 Area.

Beginning with Eqn. 15 for the plume centerline Q/X, it is evident that the contamination level at x is given by

$$C_{max} = \frac{v_g R}{2\pi \sigma_y \sigma_z u_e} \exp\left[-\frac{\left(h_E - d_2 \frac{v_g}{u_e}\right)^2}{2\sigma_z^2} \right]$$

The differential ground contamination at x due to a release in the fall velocity range v_g to $v_g + dv_g$ is then

where I is the total inventory, and from Eqn. 2

$$dF = 6.75E-2\ v_g^{0.35}\ dv_g$$

Eqn. 22 then becomes

$$dC_{max} = \frac{1.07E-2\ v_g^{1.35}\ I\ dv_g}{\sigma_y \sigma_z u_e} \exp\left\{ -\frac{\left[h_E - (x - d_1)\frac{v_g}{u_e}\right]^2}{2\sigma_z^2} \right\}$$

Eqn. 24 gives the differential of ground contamination on the plume centerline at position x due to the differential release contained within the fall velocity increment dv_g at v_g. To calculate the total ground contamination on the plume centerline at position x, the contributions over the entire range of particle fall velocities must be integrated as follows:

$$C_{\max} = \frac{1.07E-2\,I}{\sigma_y \sigma_z u_e} \int_0^{v_{max}} v_g^{1.35} \exp\left\{ -\frac{\left[h_E - (x-d_1)\frac{v_g}{u_e}\right]^2}{2\sigma_z^2} \right\} dv_g$$

where v_{max} is the maximum particle fall velocity to be considered. It should be noted that for any position x only a fairly narrow range of fall velocities contribute to any significant degree. For example, the higher values of v_g can make a large contribution very close in (small x), but do not make a significant contribution for larger values of x. Conversely, the smaller particles fall further out, but do not contribute much close in. For convenience, let us write Eqn. 25 as

$$\frac{C_{\max}}{I} = \frac{1.07E-2\ \Psi(x)}{\sigma_y \sigma_z u_e}$$

where $\Psi(x)$ is the integral in Eqn. 25. Recall that I is the total releasable inventory of the material of interest at risk in the facility. The integral in Eqn. 25 represented by $\Psi(x)$ must be evaluated numerically. Eqn. 26 was evaluated from 100 m to 2200 m in increments of 100 m with the results shown in Table 4 below.

Table 4: Plume centerline maximum ground concentration values per unit inventory predicted by the continuous particle size model (Eqn. 26)

x (m)	σ_y (m)	σ_z (m)	$\Psi(x)$	C_{max}/I (1/m^2)
100	4.62	2.25	0	0
200	8.64	3.99	1.59E+0	1.49E-4
300	12.5	5.51	7.33E-1	3.43E-5
400	16.2	6.89	4.38E-1	1.26E-5
500	19.8	8.20	2.96E-1	5.87E-6
600	23.3	9.43	2.15E-1	3.15E-6
700	26.8	10.6	1.65E-1	1.87E-6
800	30.2	11.7	1.31E-1	1.19E-6
900	33.6	12.9	1.09E-1	8.10E-7
1000	37.0	13.9	9.05E-2	5.67E-7
1100	40.3	15.1	7.83E-2	4.14E-7
1200	43.6	16.1	6.74E-2	3.09E-7
1300	46.9	17.0	5.87E-2	2.37E-7
1400	50.1	17.9	5.17E-2	1.86E-7
1500	53.3	18.7	4.58E-2	1.48E-7
1600	56.5	19.5	4.09E-2	1.20E-7
1700	59.7	20.3	3.70E-2	9.83E-8

1800	62.9	21.0	3.33E-2	8.12E-8
1900	66.0	21.7	3.03E-2	6.81E-8
2000	69.1	22.3	2.75E-2	5.75E-8
2100	72.2	22.9	2.51E-2	4.89E-8
2200	75.3	23.5	2.31E-2	4.20E-8

The limits of integration on $\Psi(x)$ were 0 to 5 m/s. In reality, the larger particles would be dumping out of the plume continuously as it rises and bends over, and would thus tend to fall closer to the fire than predicted by the model. The model is thus conservative since it will tend to over-predict the distances downwind that the larger particles would be carried, and hence over-predict the area of contamination on the ground.

Lowering the upper limit of integration has the effect of causing the $\Psi(x)$ curve to fall to very low values close to the fire since this excludes the effect of the larger particles. As can be seen in Table 3 above, even 5 m/s particles have not yet hit the ground to any appreciable degree at 100 m. Making the upper limit on the integration greater than 1 m/s is obviously an extrapolation from the data underlying the differential release fraction, so results for distances closer than a few hundred meters should be viewed as a very rough (but conservative) estimate.

Using the results in Table 4, and the releasable inventory of 89.8 metric tons U, the plume centerline concentrations were calculated for various distances, and are shown in Table 4 below, and in Figure 1. The concentrations at 100 m are extrapolations from Figure 1. The corresponding oxide depth is given for information only and assumes the deposition to be in the form of UO_2 with a bulk density of 5 g/cm^3. Note that 1 g of uranium produces 1.14 g of UO_2 for purposes of calculating deposition depth.

Table 5: Ground contamination levels on the plume centerline as a function of downwind distance

x (m)	Metal Concentration (g/m2)	Oxide Depth (cm)
100	{1.80E+5}	{4.07E+0}
200	1.34E+4	3.03E-1
300	3.08E+3	6.96E-2
400	1.13E+3	2.55E-2
500	5.27E+2	1.19E-2
600	2.83E+2	6.40E-3
700	1.68E+2	3.80E-3
800	1.07E+2	2.42E-3
900	7.27E+1	1.64E-3
1000	5.09E+1	1.15E-3
1100	3.72E+1	8.41E-4
1200	2.77E+1	6.26E-4
1300	2.13E+1	4.81E-4

1400	1.67E+1	3.77E-4
1500	1.33E+1	3.01E-4
1600	1.08E+1	2.44E-4
1700	8.83E+0	2.00E-4
1800	7.29E+0	1.65E-4
1900	6.12E+0	1.38E-4
2000	5.16E+0	1.17E-4
2100	4.39E+0	9.92E-5
2200	3.77E+0	8.52E-5

For any given downwind distance x, the transverse distance, y, where a concentration level C occurs was previously derived as Eqn. 20 repeated here in the form

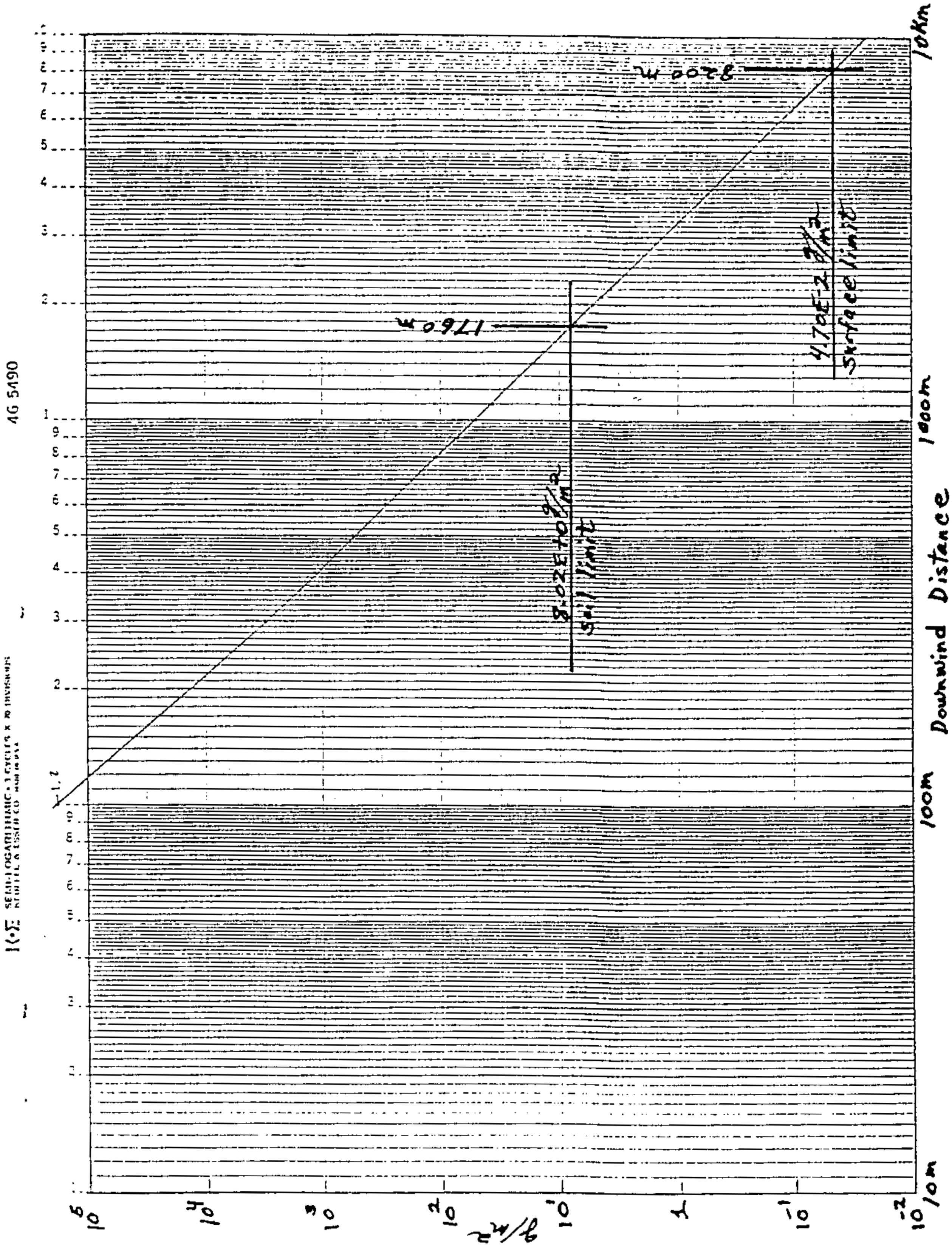

Figure 1: Maximum plume centerline ground contamination as a function of downwind distance

$$y = \sigma_y \left[2 \ln \left(\frac{C_{max}}{C} \right) \right]^{1/2}$$

Transverse distances to the maximum extent of limiting concentration levels of interest were calculated using the results shown in Table 5, and are shown in Table 6.

Table 6: Maximum lateral extents for accessible soil and smearable surface concentration limits

		y (m)	
x (m)	σ_y (m)	*soil*	*surface*
100	4.62	{20.7}	{25.4}
200	8.64	33.3	43.3
300	12.5	43.1	58.9
400	16.2	51.0	72.8
500	19.8	57.3	85.5
600	23.3	62.2	97.2
700	26.8	66.1	108.
800	30.2	68.7	119.
900	33.6	70.6	129.
1000	37.0	71.1	138.
1100	40.3	70.6	147.
1200	43.6	68.6	156.
1300	46.9	65.6	164.
1400	50.1	60.7	172.
1500	53.3	53.6	179.
1600	56.5	43.6	186.
1700	59.7	26.2	193.
1800	62.9	--	200.
1900	66.0	--	206.
2000	69.1	--	212.
2100	72.2	--	217.
2200	75.3	--	223.

These results are plotted in Figure 2. Note that the widths of the ground plumes have been magnified by a factor of 5 relative to their lengths. The areas can be approximated by using the standard formula for the area of an ellipse, i.e., πab, where a and b are the semi-axes.

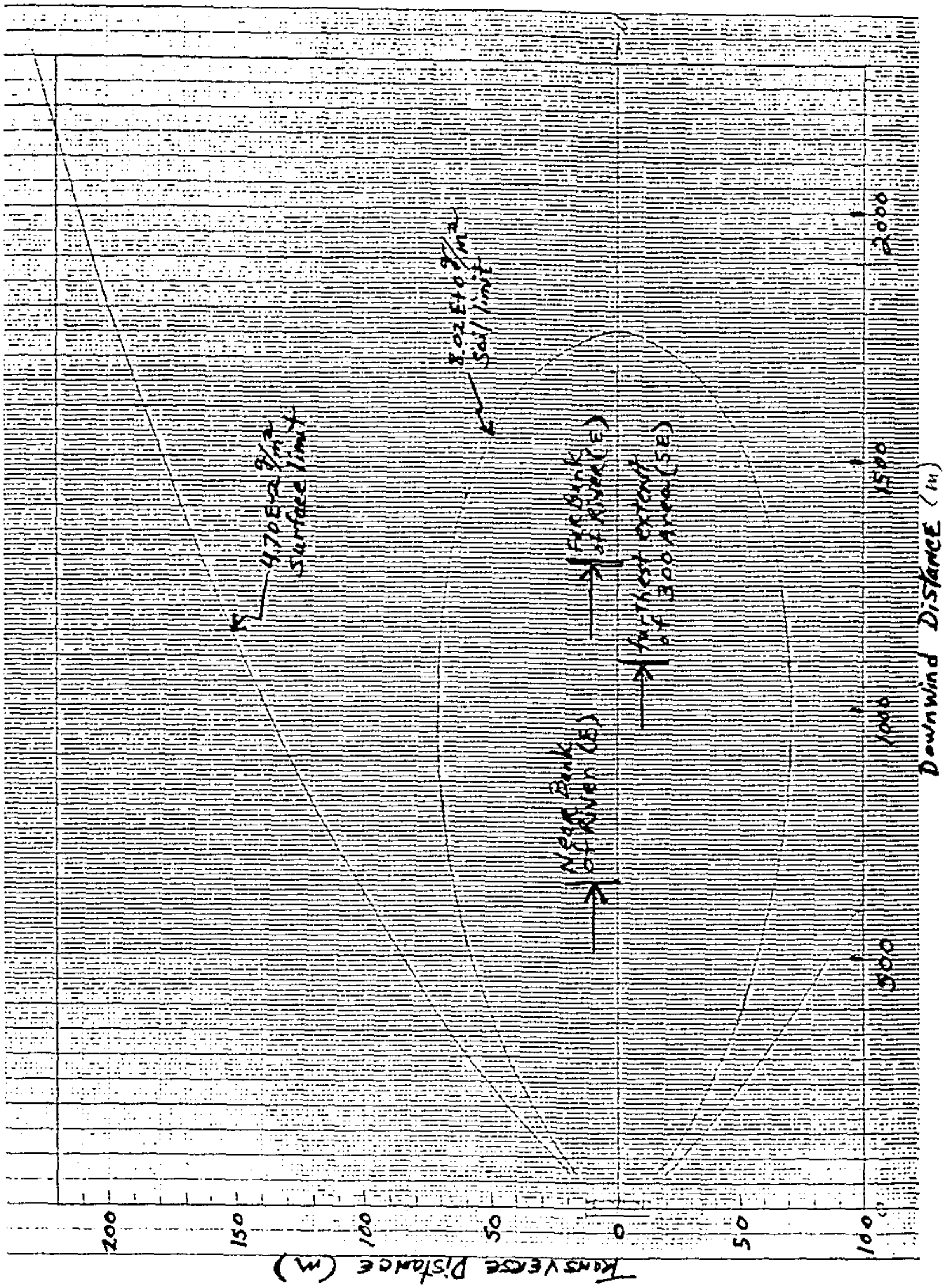

Figure 2: Ground contamination contours predicted by the continuous particle size model

The choice of Pasquill F stability with a 1 m/s reference wind speed is somewhat arbitrary. Other combinations of meteorology conditions could produce somewhat larger contaminated areas. Any difference, however, would be well within the overall uncertainty in the analysis. The release fraction function is extremely conservative in that it is based on burning highly combustible material with little or no packaging barrier, whereas in most real cases the material is only partially combustible and is contained within substantial packaging (such as 55 gallon drums). A search for "worst case" meteorology conditions would therefore produce an excessive degree of conservatism.

Conclusions:

Given the fire as described here, and a total releasable inventory of 89.8 metric tons U, this analysis predicts the following zone areas for ground contamination levels above the accessible soil concentration limits given in WHC-CM-7-5 for the 300 Area, and for smearable surface contamination greater than the limits given in WHC-CM-1-6.

The soil contamination zone has a total estimated area of 2.0E+5 m^2. If the wind direction is in an easterly sector, the soil contamination contour can cross the river as shown in Figure 2. All open soil within this contour will require cleanup and disposal.

The surface contamination contour within the 300 Area in the worst direction (SE 1100 m) has an estimated area of 1.9E+5 m^2. Horizontal surfaces out to 8.2 km, however, could be contaminated and require cleanup on a spot basis.

References:

1. DSI, J.R. Brehm to D.A. Himes, "Request for Dispersion of U from 3712 Building During Fire," October 25, 1993.
2. Jofu Mishima, Draft Recommended Values and Technical Bases for Airborne Release Fractions (ARFs), Airborne Release Rates (ARRs), and Respirable Fractions (RFs) Rev 1, Defense Programs Nuclear Facility Safety Survey, SAIC - Richland, July 27, 1993.
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4. J.E. Ayer, et al., Nuclear Fuel Cycle Facility Accident Analysis Handbook, U.S. Nuclear Regulatory Commission, NUREG-1320, May 1988.
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6. Chanin, D.I., et al., MELCOR Accident Consequence Code System (MACCS) Users Guide, Sandia National Laboratories, NUREG/CR-4691, Feb., 1990.

APPENDIX B
CALCULATIONS

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MPFL CALCULATIONS FOR THE 300 AREA N REACTOR FUEL FABRICATION AND STORAGE FACILITY

Based on the dispersion report (Appendix A) Figure 2, Pg 15 the calculated area of cleanup was 264,000 m^2. The 300 Area surface cleanup (which was considered to be completely buildings and pavement as the worst case) is 97,680 m^2. The privately owned land, on the other side of the river across from the 300 Area, requiring cleanup is 68,640 m^2. The Columbia River area needing cleanup is 97,680 m^2.

NOTE: There are many assumptions made in the dispersion report and all numbers should be regarded as highly approximate

The soil from the private land will be handled and stored as LLW; even though, the dilution of the U with the plow level amount of soil causes it to be below the cleanup criteria. The soil can not be put back into place once it has been picked up.

The cost to cleanup and stockpile the low level waste (LLW) is based on a conversation with cognizant engineers in Decommissioning Engineering. An actual 25 Acre, LLW removal project cost $550K. The $550K included samples and surveys which were required to characterize the waste. Other conditions, that this cost is based on, are: 1) The cleanup takes place in an area large enough that heavy equipment can be used, and 2) The waste is stockpiled according to present policy and not buried.

Calculation:

68,640 m^2 x 2.47^{-4} = 17 acres

By taking the ratio the $550K, actual cleanup cost for the 25 acres, with the proposed 17 acres, the bulk cleanup and stockpiling costs for the 17 acres of LLW is found to be $374K. This assumes that cleanup costs are linear.

The following calculations are based on an estimate model received from a cognizant engineer from Decommissioning Engineering. The model is attached at the end of this appendix for reference.

Calculation:

97,680 m^2 = 1,051,418 ft^2 <u>- 443,915 ft^2</u> Building area (Non-porous cleanup @ 500-ft^2/hr)
607,503 ft^2 Paved area (Porous @ 300-ft^2/hr)

Time for non-porous cleanup 888 hr

Time for porous cleanup	2,025 hr
Total hours	2,913 hr
	x $873.00/hr
Cost for time	$2,543,049.00

1-ft^3 of waste for every 300-ft^2 cleaned yields 3,505-ft^3 of waste.

At 6-ft^3 of waste per drum you get:	585 drums
	x $125.00/drum
Cost for drums	$73,125.00

Burial cost based on 7.5 ft^3/drum	4,388 ft^3
	x $183.00/$ft^3$
Cost to bury drums	$803,004.00

Based on conversations with a real estate sales person knowledgeable in farmland and the area involved in this FHA the following information was gained. Farmland with a circle is going at $3,000.00/acre if bought in parcels of 100 acres or more. The area across from the 300 Area is going for about $150,000/acre because it is being sold for custom homes and an anticipated new bridge across the river. Based on the worst case criteria $150,000 was used for the entire area.

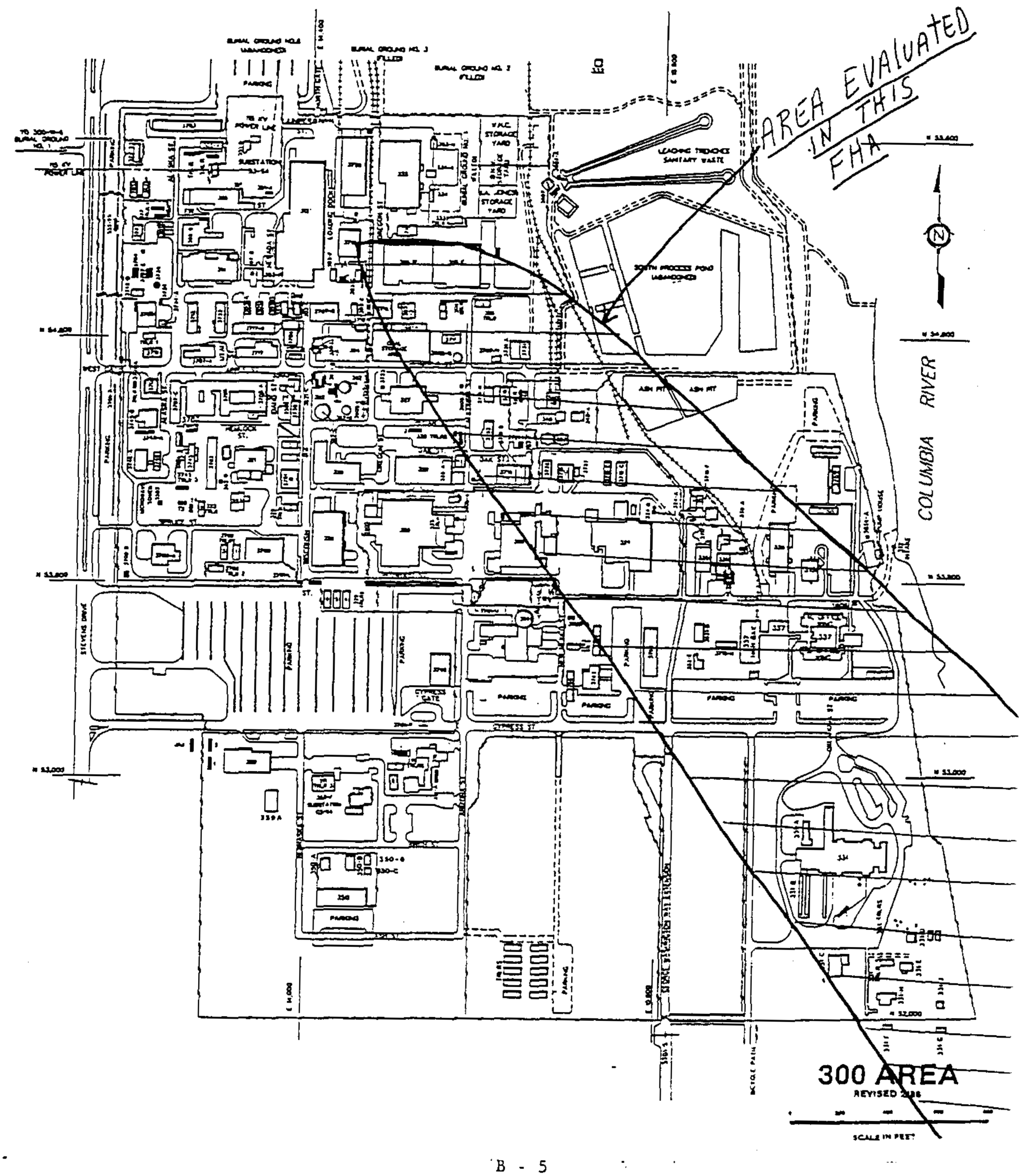
68,640 m^2 of public land yields 17 acres for a total cost of $2,550,000.

There are six or seven $300K+ homes directly across the river that would have to be purchased. Using $5 million is probably very conservative, but when talking about buying someone's home that has been contaminated with U, we would not only have to consider reimbursement of the house but also relocation and other miscellaneous items.

Since the equipment that we based this cleanup on has not been purchased, the purchase price is included as a cost to the project. The purchase price is $350K.

The value of the 3712 Building and its contents to DOE-RL according to the 8/11/93 property list is $426,030.00. This amount is taken into consideration as a loss not a replacement.

TOTAL COST IS $12,119,208.00


AREA EVALUATED IN THIS FHA
300 AREA
REVISED
SCALE IN FEET
COLUMBIA RIVER
SOUTH PROCESS POND (ABANDONED)
LEACHING TRENCHES SANITARY WASTE
ASH PIT
PARKING
CYPRESS ST
CYPRESS GATE
STEVENS DRIVE
359A
350-A
350-B
350-C
350
331
337

300 AREA BUILDINGS

303-J	3,652 ft^2
306-E	36,000 ft^2
306-T2	1,569 ft^2
306-T5	1,577 ft^2
306-T6	1,577 ft^2
306-TRLR	1,577 ft^2
306-W	31,360 ft^2
308	47,146 ft^2
315	6,110 ft^2
324	48,175 ft^2
324-T5	497 ft^2
324-T11	1,330 ft^2
324-T12	1,330 ft^2
324-T13	1,558 ft^2
324-T14	1,575 ft^2
324-T15	1,575 ft^2
324-T16	1,569 ft^2
331	36,449 ft^2
331-A	2,792 ft^2
331-B	3,381 ft^2
331-C	5,000 ft^2
331-D	1,357 ft^2
331-E	1,560 ft^2
331-F	1,120 ft^2
331-G	1,200 ft^2
331-H	2,941 ft^2
331-J	384 ft^2
331-T1	500 ft^2
331-T5	1,842 ft^2
335	7,610 ft^2
336	3,863 ft^2
337	17,088 ft^2
337-B	13,125 ft^2
338	15,680 ft^2
340	3,570 ft^2
340-A	1,366 ft^2
340-B	3,200 ft^2
352-E	16,320 ft^2
3621-D	2,560 ft^2
366-A	6,345 ft^2
3707-F	144 ft^2
3711	3,200 ft^2
3717-C	2,304 ft^2
3718	3,816 ft^2
3718-A	6,400 ft^2
3718-B	3,200 ft^2
3718-C	4,480 ft^2
3718-E	3,000 ft^2
3718-F	960 ft^2
3718-G	4,000 ft^2
3718-M	2,010 ft^2
3718-N	2,880 ft^2
3727	876 ft^2
3728	3,200 ft^2
3731	3,200 ft^2
3731-A	3,200 ft^2
3762	4,118 ft^2
3765	12,261 ft^2
3767	2,880 ft^2

TOTAL FOR BUILDING	403,559 ft^2
In Meters	37,491 m^2
10% for additional trailers	3,749 m^2
TOTAL AREA CONSIDERED IN BUILDING CLEAN UP	41,240 m^2

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BUILDING CLEANUP MODEL

A request from Cheryl F. Myott to Mike Mihalic, dated Jan. 27, 1994, to see if a cost estimate can be provided for building surface and other hard surface clean up costs, could be prepared, for surface decontamination, in the event of a fire of the 3712 Building, releasing approximately 89.8 metric tons of Uranium.

Following is a cost analysis scenario to estimate the clean up of hard surface areas, meaning, concrete, corrugated metal or transite, blacktop, or to be more specific all structural building surface areas. For this task the S/SSAP 3000 All Purpose Cleaning System was selected. This is a proven system coupled into a single mobile unit.

Following are the cost elements used, in the scenario utilizing the All Purpose Cleaning System, for hard surface decontamination.

The hourly production rate is a minimum of 300 square feet of area to a maximum of 500 square feet of area per hour.

The cost elements are	Cost By The Hour
Steam Cleaner Maintenance and fuel	$56.00
One Operator	$50.00
Three D&D Workers	$111.00
Supervisor	$55.00
Health Physics Technician	$51.00
Project Control Analyst, Project Manager, Clerical support	$87.00
Laundry Misc. hand and power tools and supplies	$20.00
Fresh air masks	$120.00
Deficiency rate	$273.00
Portable exhauster; when working inside	$50.00
Total Hourly Cost	$873.00

Assume 1-cubic foot of regulated waste, for every 300 square feet of area cleaned. The waste will be collected in a filter and packaged in 55-gallon drums for disposal. Allowing for packaging voids assume six cubic feet of waste will be packaged in each drum. The cost per drum including plastic liner, labels, material to fill voids in drum, and certified shippers documentation. Cost per drum, $125.00.

Burial costs are calculated at 7.5 cubic feet per drum. When calculating waste volumes you must make certain you allow for voids in drums, and calculate the number of drums needed, to handle the waste, to get the total cubic feet for waste burial. The burial costs by cubic foot, are as follows.

Type of waste	Cubic ft. Cost	G&A/CSP 26.5%	Total burial cost
LLW	$50.00	$14.00	$64.00
RMW	$144.00	$39.00	$183.00
TRU	$104.00	$28.00	$132.00

The burial costs for hazardous waste are calculated by container.

Hazardous	$391.00	$104.00	$495.00

This formula was prepared for rough order of magnitude estimating, Utilizing the described equipment and should not be construed as a method of estimating for conceptual estimates or any other types of estimates. However this formula may in some cases contribute to estimates at a higher level.

Cost of the truck mounted steam cleaner	$300,000
Procurement Documentation and procurement costs	$50,000