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16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 (see MRP 5.43)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

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SUPPORTING DOCUMENT

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7. Abstract

This document presents a preliminary safety evaluation for the 340 Facility Secondary Containment and Leak Containment system, Project W-302. Project W-302 will construct Building 340-C which has been designed to replace the current 340 Building and vault tank system for collection of liquid wastes from the Pacific Northwest Laboratory buildings in the 300 Area. This new nuclear facility is Hazard Category 3. The vault tank and related monitoring and control equipment are Safety Class 2 with the remainder of the structure, systems and components as Safety Class 3 or 4.

8. RELEASE STAMP

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PRELIMINARY SAFETY EVALUATION
FOR PROJECT W-302,
340 FACILITY SECONDARY CONTAINMENT
AND LEAK DETECTION

January 30, 1995

WHC-SD-W302-PSE-001 Rev.0

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CONTENTS

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LIST OF TABLES

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LIST OF ACRONYMS AND ABBREVIATIONS

AED	aerodynamic equivalent diameter
ALARA	as low as reasonably achievable
ARF	airborne release fraction
CDR	conceptual design report
CSER	criticality safety evaluation report
CWC	Central Waste Complex
DBA	design basis accident
DOE	Department of Energy
EDE	effective dose equivalent
ECN	engineering change notice
EHSC	environmental hazard safety classification
ERPG	emergency response planning guideline
FSAR	final safety analysis report
FDC	functional design criteria
HEPA	high efficiency particulate air (filter)
HVAC	heating, ventilation, and air conditioning
ISB	interim safety basis
LPG	liquified petroleum gas
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
PHA	preliminary hazards analysis
PMF	probable maximum flood
PNL	Pacific Northwest Laboratories
ppm	parts per million
PSAR	preliminary safety analysis report
PSEL	preliminary safety equipment list
PSE	preliminary safety evaluation
RCRA	Resource Conservation and Recovery Act
RF	respirable fraction
RLWS	Radioactive Liquid Waste System
RPS	retention process sewer
RQ	reportable quantities
SAR	safety analysis report
SSC	system, structure, and component
USQ	unresolved safety question
WHC	Westinghouse Hanford Company

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1.0 INTRODUCTION AND SUMMARY

1.1 INTRODUCTION

This preliminary safety evaluation (PSE) for Project W-302 is intended to fulfill the safety documentation requirements of Department of Energy (DOE) Order 4700.1, *Project Management System*, as stipulated by the Westinghouse Hanford Company (WHC) in WHC-CM-6-2, *Project Management*. The format and content of this PSE follows the guidance provided in WHC-CM-4-46, *Safety Analysis Manual*, and, to the extent possible, WHC-CM-6-32, *Safety Analysis and Engineering Work Procedures*.

The purpose of this PSE is to ensure that major safety considerations for Project W-302 are identified early in the project life cycle. Physical/industrial safety concerns (i.e., falling, noise levels, confined spaces, etc.) will be addressed in the final safety analysis report (FSAR) because WHC has institutional controls addressing worker safety and Occupational Safety and Health Administration (OSHA) issues. Based upon the design information available in the functional design criteria (FDC), this PSE addresses the following specific topics:

- Evaluation of compliance with current safety requirements and safety-related design criteria
- Facility radioactive and hazardous material inventories
- Preliminary assessment of the design's ability to adequately contain the inventories
- Risks to parent and surrounding facilities arising from construction activities
- Future safety documentation and changes to existing documentation before the start of operations
- Interfaces with related projects, facilities, and activities
- Safety related issues that must be resolved prior to the commencement of operations, with evidence that a satisfactory resolution can be reached
- Facility hazard categorization
- preliminary safety equipment list (PSEL)
- Design uncertainties related to the safe construction or operation of the facility that require further resolution.

Project W-302 is intended to provide Resource Conservation and Recovery Act (RCRA) compliant storage (greater than 90 days) for liquid mixed wastes generated by 300 Area facilities. Project W-302 will replace the existing 340 Building (and vault tanks) and conduct the following operations:

- Receipt, transfer, and storage of liquid wastes

- Neutralization of acidic or basic wastes to an approximate pH of 7.0.

The scope of the W-302 Project includes the construction and operation of an interim storage and neutralization facility for liquid mixed wastes generated in the 300 Area. The proposed facility will consist of:

- One 76 kL tank
- One 45 kL tank
- Two 19 kL tanks
- Pumps and piping for connecting to the Radioactive Liquid Waste System (RLWS) and Retention Process Sewer (RPS) systems and railcars
- Piping, pumps, and agitators for each tank
- Equipment for a pH adjusting system
- Heating ventilating and air conditioning (HVAC) system including high efficiency particulate air (HEPA) filtration
- Glovebox/hood
- Electronic control and monitoring system
- Remote surveillance system for periodic integrity checks.

When Project W-302 is completed the 340 Complex will consist of the new structure (340-C Building), the "residual" (non-vault portion) 340 Building, the 307 Basins, the 340-A Building, and the 340-B Building. The total storage capacity of liquid waste will be 159 kL in the 340-C Building and 180 kL in the 340-A Building.

While the existing buildings of the 340 Complex (340, 340-A, and 340-B) are outside the scope of Project W-302, they are all part of the same authorization basis. As such, all common cause accident conditions (which could impact existing buildings in addition to the 340-C Building) must take into account releases from all buildings. Thus, although the 340-A Building is outside of the scope of Project W-302, its contribution to the consequences of a seismic event must be considered in the input to the design of the 340-C Building. However, hazards which are present solely in existing buildings and are not common cause, are not considered in this PSE as they do not impact the design of the 340-C Building. Thus, a solid waste fire in 340-B West or a waste spill in 340-A are not analyzed because they are hazards which are present only in existing buildings. In addition, the preliminary hazards analysis (PHA) covers all buildings to ensure that hazards arising from interactions between buildings and common cause accidents are identified. Section 6.0, Safety Documentation, contains a more detailed discussion of the future and related safety documentation associated with Project W-302.

This PSE will be issued concurrently with the conceptual design report (CDR) for Project W-302. The preliminary fire hazards analysis, as required by DOE Order 5480.7A, DOE Order 6430.1A, WHC-CM-4-41, and WHC-CM-4-46, was not prepared at this time, but will be scheduled during fiscal year 1996 and completed during preparation of the advanced CDR. The control manual waiver, allowing the preliminary fire hazards analysis to be completed with the advanced CDR, is included in Appendix E.

1.2 SUMMARY

The conclusions of this PSE are:

- Project W-302 represents a hazard category 3, nuclear facility.
- The vault tanks and related monitoring and control equipment must comply with the Safety Class 2 seismic design requirements to preclude a release of radioactive waste to the environment (see Section 4.3).
- All other systems, structures, and components (SSCs) must be Safety Class 3.

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2.0 DESIGN CRITERIA

The purpose of this section is to identify the design criteria related to safety and the SSCs that are safety class items per criteria in WHC-CM-4-46, *Safety Analysis Manual*, Section 9.0, "Assigning Safety Classes to Systems, Structures, and Components."

The assumed, initial safety-related design criteria are dependent on the facility hazard category and the safety class of the new or upgraded SSCs. The accident scenarios can then be developed based on the initial design. A PHA, accident analysis, and safety classification are then completed. The design criteria are reevaluated in light of these analyses. This iterative approach leads to a final set of design criteria.

The following sections discuss the initial design criteria and safety class designations for Project W-302. The final design of this project will adequately incorporate all necessary safety-related design criteria to ensure the safe operation of the 340-C Building. The design will also address related operational safety concerns resulting from any 340-C induced impacts or changes.

2.1 DESIGN CRITERIA IDENTIFICATION

The design criteria for the 340 Complex upgrade are defined in the FDC (WHC 1994a). Applicable codes, standards, regulations, and guidelines are listed in Section 6.0 of the FDC (WHC 1994a). The design criteria that are of primary interest for this PSE effort are those that have safety implications. Of particular importance are the safety-related design criteria that should be considered for evaluating facility safety in the subsequent safety analysis reports (SARs). These design criteria are defined in DOE Order 6430.1A, *General Design Criteria*; DOE Order 5820.2A, *Radioactive Waste Management*; DOE Order 5400.5, *Radiation Protection of the Public and Environment*; DOE Order 5480.11, *Radiation Protection for Occupational Workers*; DOE Order 5480.23, *Nuclear Safety Analysis Reports*; DOE Order 5480.22, *Technical Safety Requirements*, and DOE Order 5480.7A, *Fire Protection*. The performance goals of these requirements are identified in DOE Order 6430.1A, *General Design Criteria*, and are summarized in the following list.

- Minimize the spread of radioactive and other hazardous materials within unoccupied process areas.
- Prevent, if possible, or else minimize the spread of radioactive and other hazardous materials to occupied areas.
- Minimize the release of radioactive and other hazardous materials in facility effluents during normal operations and anticipated operational occurrences.
- Limit the release of radioactive and other hazardous materials resulting from design basis accidents (DBAs), including severe natural phenomena and man-made events, in compliance with the guidelines applicable to accidental releases.

2.2 PRELIMINARY SAFETY CLASS DESIGNATION

The safety class designation for the system and components that are part of the 340 Complex upgrade, Project W-302, is determined by using the criteria provided in WHC-CM-4-46, Section 9.0. Maximum inventories of radiological materials and hazardous chemicals are determined and release scenarios are developed to evaluate the consequences of a release to the offsite public and the onsite worker, and also to evaluate any adverse environmental impact. The offsite public and onsite worker exposure to the radiological materials and hazardous chemicals is estimated as part of the accident evaluation in Section 4.0. The offsite and onsite exposures from seismic, spray leak, and fire events are evaluated. For both radiological and chemical hazards, the exposures were below established limits. Therefore, the highest safety class resulting from these exposures is Safety Class 3.

The criteria used for the environmental hazard safety classification are draft criteria in the form of a proposed revision to WHC-CM-4-46, Section 9.0. The draft criteria require a Safety Class 2 designation for environmental hazard safety classification (EHSC) values greater than 1 E+06. A Safety Class 3 designation is indicated for EHSC values less than 1 E+06, but only when hazardous materials are present in quantities greater than the regulatory reportable quantities. Appendix E contains the control manual waiver allowing the use of the new criteria.

The safety class evaluation for adverse environment impacts shows that the EHSC value exceeds the Safety Class 2 criterion of 1 E+06. The only hazard identified in Tables 4-3 and 5-1 which could result in the hypothesized loss of the entire radioactive material inventory is a seismic event. Therefore, at least one barrier which prevents or mitigates the consequences of a release during and following a seismic event must be designated as Safety Class 2. Furthermore, the designated barrier(s) must be able to fulfill their safety function when called upon without interference from Safety Class 3 or non-Safety Class 4 items.

The PSEL associated with Project W-302 is shown in Table 2-1. Because unique system or component identifiers have not yet been designated for Project W-302, the SSCs specified in Table 2-1 are stated in general terms.

Table 2.1. Preliminary Safety Equipment List

Safety system, structure, and component	WHC safety class indicated
340-C Vault tanks	2
340-C Instrumentation associated with control and/or monitoring of vault tanks.	2

According to the analysis in this PSE, all SSCs not mentioned in Table 2-1 need only be designated as Safety Class 3 or non-Safety Class 4.

3.0 HAZARDOUS MATERIAL INVENTORIES

This section identifies the inventories of hazardous materials, both toxicological and radiological, to be handled at the facility.

3.1 RADIOLOGICAL INVENTORY

For the purpose of accident analysis, the liquid waste is assumed to be predominantly water contaminated with radioisotopes in quantities shown in Table 2-1 of the 340 Complex interim safety basis (ISB) (WHC 1994b). In addition to reproducing the radioisotope inventory data from the ISB, Table 3-1 also shows the inventory in Bq/L. Note that ^{90}Y does not appear in the ISB, but is added to Table 3-1 in the same quantity as ^{90}Sr.

To simplify dose consequence calculations the inventory data in Table 3-1 may be combined with the inhalation dose conversion factors from Appendix A. This yields a total dose per unit of waste (Sv/L) for liquid waste accidents, and the dose-significant isotopes for the solid waste fire accident scenario (Section 4.2.1.3). If an isotope in Table 3-2 contributes greater than 0.1% to the total dose then that isotope is included in the dose consequence calculations for the fire scenario. The percentage that each isotope contributes to the total dose is calculated as the ratio of each isotopes dose per unit of waste to the summation of all doses per unit waste. Table 3-2 shows the results of the calculations. The dose-significant isotopes are ^{90}Sr, ^{152}Eu, ^{154}Eu, ^{238}Pu, $^{239/240}$Pu, ^{240}Pu, ^{241}Pu,and ^{241}Am.

3.2 TOXICOLOGICAL INVENTORY (HAZARDOUS CHEMICALS)

The hazardous chemicals present at the 340 Complex can be split into three groups: process chemicals, waste chemicals, and ordinary industrial chemicals. Process chemicals are those chemicals which are used in the processing activities of the facility. Waste chemicals are those chemicals which enter and leave the facility as part of a waste stream. Ordinary industrial chemicals include those chemicals used as cleaners, paints, etc., and are accepted and used by the general public.

The processing chemicals present in the 340 Complex consist of the chemicals used in the pH adjustment system and the liquified petroleum gas (LPG) used to power facility equipment (forklift). The pH adjustment system uses both an acid, assumed here to be nitric acid, and a base, assumed in the FDC to be sodium hydroxide. The FDC indicates (WHC 1994a, page 22) that up to three drums of concentrated sodium hydroxide (total of 625 L) and one drum of concentrated nitric acid (208 L) are to be stored at the facility for use in the pH adjustment system. LPG is included in the category of process chemicals to highlight its extremely flammable and explosive nature, and because of its potential impact as an accident initiator. Only one LPG tank, the one powering the forklift, is expected to be in the facility at any one time. Storage of extra LPG tanks, if any, is assumed to be outside of the facility at a distance great enough to preclude impact to any other hazardous material should an accident occur.

Waste chemicals received at the 340 Complex as part of the liquid waste stream are shown in Table 3-3 which is based on the data provided in the 340 Complex ISB (WHC 1994b).

Table 3-3 contains chemical inventory data applicable to the W-302 Project, but the data, as presented, is not conducive to accident analysis. The table predominantly shows elemental groups, but not the chemical compounds which can be expected to be found in the waste. Somewhat more information is given in Appendix D of the 340 Complex ISB (WHC 1994b). Appendix D of the ISB lists the predominant chemicals received at the 340 Complex as

Nitric acid
Sodium hydroxide
Sodium nitrate
UltimaGold (di-isopropylnaphthalene as a solvent)
Optifluor (alkylbezene as a solvent)
Sodium phosphate
Potassium persulfate
Sodium carbonate
Potassium nitrate
Potassium hydroxide
Hydrochloric acid
Sulfuric acid
Ammonium hydroxide
Oxalic acid
Dimethylsulfoxide.

The above list of chemical compounds in conjunction with the data in Table 3-3 can be used to arrive at a hypothetical chemical inventory appropriate for use in the accident consequence analyses. The greatest concentration of any elemental group in Table 3-3 is the NO_3 group, which, according to the ISB, is predominantly sodium nitrate (WHC 1994b, Appendix D). However, because nitric acid also has a nitrate group and has the most restrictive exposure criteria of any chemical compound listed above (except for sodium hydroxide), the nitrate concentration is assumed to be in the form of nitric acid. Sodium hydroxide is not used because, while its exposure criteria is at most a factor of two more restrictive than the exposure criteria for nitric acid, its concentration in the waste is approximately a factor of 80 less than the concentration of nitric acid (see Appendix B, Table B-2).

For the purposes of estimating the toxicological consequences of the spray leak, the assumption that the most toxic chemical is present in the waste in the greatest concentration effectively bounds the release of all chemicals. The nitrate concentration from Table 3-3 is 34,200 mg/L making the nitric acid concentration (multiplying by the ratio of molecular weights)

$$\left(34,200\ \frac{mg}{L}\right) \cdot \left(\frac{63}{62}\right) = 34,800\ \frac{mg}{L}\ .$$

Note that no attempt was made to balance the charges on the ionic groups listed in Table 3-3.

Ordinary industrial chemicals can be expected to be present at the facility in the form of solvents and cleaners, paints, printer toner, etc. Specific chemicals have not been identified nor are there any expected unacceptable hazards associated with these chemicals. Unless these chemicals are brought into the facility in inordinate quantities, they represent hazards which are accepted on a daily basis by the general public, and are therefore outside the scope of this PSE. If large quantities of these ordinary chemicals, or an unusual chemical, is brought into the facility, or placed in such a location so as to pose a reactivity hazard with process or waste chemicals, then this assumption must be re-evaluated.

Table 3-1. Facility Radiological Inventory.

Isotope	Accident inventory from ISB (Ci/L)	Inventory (Bq/L)	Fraction of total inventory (used in solid waste fire)
^{54}Mn	7.66 E-07	2.83 E+04	1.56 E-05
^{60}Co	1.85 E-06	6.85 E+04	3.76 E-05
^{90}Sr	1.07 E-03	3.96 E+07	2.18 E-02
^{90}Y	1.07 E-03	3.96 E+07	2.18 E-02
^{95}Zr	2.25 E-06	8.33 E+04	4.57 E-05
^{95}Nb	4.01 E-06	1.48 E+05	8.15 E-05
^{99}Tc	4.73 E-08	1.75 E+03	9.62 E-07
^{106}Ru	4.96 E-05	1.84 E+06	1.01 E-03
^{125}Sb	3.96 E-05	1.47 E+06	8.05 E-04
^{134}Cs	6.87 E-05	2.54 E+06	1.40 E-03
^{137}Cs	2.37 E-02	8.77 E+08	4.82 E-01
^{144}Ce	3.15 E-04	1.17 E+07	6.40 E-03
^{152}Eu	4.49 E-03	1.66 E+08	9.13 E-02
^{154}Eu	7.90 E-03	2.92 E+08	1.61 E-01
^{155}Eu	1.90 E-03	7.03 E+07	3.86 E-02
^{182}Ta	1.14 E-05	4.22 E+05	2.32 E-04
^{234}U	1.50 E-07	5.55 E+03	3.05 E-06
^{235}U	1.88 E-09	6.96 E+01	3.82 E-08
^{236}U	1.23 E-08	4.55 E+02	2.50 E-07
^{238}U	5.98 E-08	2.21 E+03	1.22 E-06
^{238}Pu	2.72 E-04	1.01 E+07	5.53 E-03
$^{239/240}Pu$	5.81 E-05	2.15 E+06	1.18 E-03
^{240}Pu	7.85 E-05	2.90 E+06	1.60 E-03
^{241}Pu	7.48 E-03	2.77 E+08	1.52 E-01
^{242}Pu	2.35 E-07	8.70 E+03	4.78 E-06
^{241}Am	6.26 E-04	2.32 E+07	1.27 E-02
$^{243/244}Cm$	1.67 E-06	6.18 E+04	3.40 E-05
	Total:	1.82 E+09	9.99 E-01

Table 3-2. Doses per Unit Waste and Dose-Significant Isotopes.

Isotope	Inventory from Table 3-1 (Bq/L)	Inhalation dose conversion factor (Sv/Bq)	Dose per unit of waste [used in spray leak] (Sv/L)	Percentage of total dose [used in solid waste fire] (%)
^{54}Mn	2.83 E+04	1.81 E-09	5.13 E-05	5.56 E-07
^{60}Co	6.85 E+04	5.91 E-08	4.05 E-03	4.38 E-05
^{90}Sr	3.96 E+07	3.51 E-07	1.39 E+01	1.51 E-01
^{90}Y	3.96 E+07	2.13 E-09	8.43 E-02	9.14 E-04
^{95}Zr	8.33 E+04	1.03 E-08	8.57 E-04	9.29 E-06
^{95}Nb	1.48 E+05	1.57 E-09	2.33 E-04	2.52 E-06
^{99}Tc	1.75 E+03	2.25 E-09	3.94 E-06	4.27 E-08
^{106}Ru	1.84 E+06	1.29 E-07	2.37 E-01	2.56 E-03
^{125}Sb	1.47 E+06	3.30 E-09	4.84 E-03	5.24 E-05
^{134}Cs	2.54 E+06	1.25 E-08	3.18 E-02	3.44 E-04
^{137}Cs	8.77 E+08	8.63 E-09	7.57 E+00	8.20 E-02
^{144}Ce	1.17 E+07	1.01 E-07	1.18 E+00	1.28 E-02
^{152}Eu	1.66 E+08	5.97 E-08	9.92 E+00	1.07 E-01
^{154}Eu	2.92 E+08	7.73 E-08	2.26 E+01	2.45 E-01
^{155}Eu	7.03 E+07	1.52 E-08	1.07 E+00	1.16 E-02
^{182}Ta	4.22 E+05	1.21 E-08	5.10 E-03	5.53 E-05
^{234}U	5.55 E+03	3.58 E-05	1.99 E-01	2.15 E-03
^{235}U	6.96 E+01	3.32 E-05	2.31 E-03	2.50 E-05
^{236}U	4.55 E+02	3.39 E-05	1.54 E-02	1.67 E-04
^{238}U	2.21 E+03	3.20 E-05	7.08 E-02	7.67 E-04
^{238}Pu	1.01 E+07	1.90 E-04	1.91 E+03	2.07 E+01
$^{239/240}$Pu	2.15 E+06	2.11 E-04	4.54 E+02	4.91 E+00
^{240}Pu	2.90 E+06	2.11 E-04	6.13 E+02	6.64 E+00
^{241}Pu	2.77 E+08	4.20 E-06	1.16 E+03	1.26 E+01
^{242}Pu	8.70 E+03	2.01 E-04	1.75 E+00	1.89 E-02
^{241}Am	2.32 E+07	2.17 E-04	5.03 E+03	5.45 E+01
$^{243/244}$Cm	6.18 E+04	1.47 E-04	9.08 E+00	9.84 E-02
		Total:	9.23 E+03	100.1

Table 3-3. Facility (Waste) Chemical Inventory.

Group	Maximum concentration from ISB (mg/L)
Cl	3.40 E+03
CO_2	5.30 E+02
CO_3	2.91 E+01
F	1.55 E+01
HCO_3	5.38 E+02
NO_2	3.01 E+03
NO_3	3.42 E+04
OH	4.25 E+02
PO_4	7.27 E+03
SO_4	1.61 E+02
Ag	4.40 E+00
Al	3.20 E+03
As	4.15 E+00
Ba	1.14 E+01
Cd	6.64 E+00
Cr	6.85 E+01
Hg	1.25 E-01
Na	2.07 E+03
Pb	8.72 E+00
Se	6.63 E+00

4.0 ACCIDENT EVALUATION

The purpose of this accident evaluation is to identify facility hazards, facility-specific safety features and functions, and the adequacy of the facility's design to withstand the postulated accidents. In the process of the accident evaluation, any Safety Class 1 or 2 SSCs are identified and discussed.

4.1 PRELIMINARY HAZARDS ANALYSIS

The PHA is intended to support the accident evaluation effort by identifying and evaluating facility hazards and safety features. The PHA also helps to determine the accident sequences requiring further analysis as DBAs.

In the process of evaluating hazards, the consequence and frequency definitions listed in Tables 4-1 and 4-2 are used.

The effort to develop the PHA has resulted in the creation of two PHA tables: Table 5-1 for construction activities and Table 4-3 for operating activities. A separate table for maintenance activities was attempted to identify hazards which may specifically arise during that mode of operation, such as equipment lockout or spill of cleaning chemicals. However, no additional information came to light because the PHA for operations was fairly exhaustive and the facility design does not have enough detail to meaningfully discuss maintenance.

Also in the PHA, the following mitigative/preventative features are assumed to be present for nearly all hazards. Therefore, to avoid unnecessary repetition in the tables, these features are listed below:

- Emergency response procedures
- Operating procedures
- Operator training
- Ventilation system, except for fire/explosion scenarios and scenarios where the ventilation system is bypassed (open door, toxic fumes, etc.).

In addition to the universal preventative/mitigative features listed above, the following general consequences have been identified for all hazards:

- "Interruption of Facility Operations" (only for Operations PHA) with a consequence level of IV at various frequencies
- "Loss of Equipment" (only for Construction PHA) with a consequence of IV at various frequencies.

The entry "Not Analyzed" in the consequence and frequency columns of the PHA tables indicates that analysis of the hazard is outside the scope of the PHA effort. For some entries this is because the consequences have no toxicological nor radiological ramifications and can be considered typical industrial hazards. In the case of the natural phenomena hazards of tornados, ashfall, and snowfall, there are no special DOE design requirements pertaining to WHC Safety Class 2, 3 or non-Safety Class 4 items.

Table 4-3. Facility Preliminary Hazards Analysis, Operating Mode. (14 sheets)

Hazard/energy source	Cause(s)/accident sequence	Major effects	Preventative/mitigative features		Consequence level	Annual frequency level	Comments
			Engineered	Administrative			
1 Fires and explosions	1.1 Range fire	None	1.1 A Facility is located within 300 Area where gravel and pavement preclude damage to facilities by range fires	1.1.B Emergency response procedures for local fire departments and operations personnel place the facility into a safe configuration	IV	EXTREMELY UNLIKELY	Frequency assigned on basis of fire penetrating 300 Area and impacting the 340 Complex.
	1.2 Fire in service areas of 340-C Building	Class A combustible, vehicle fuel, or LPG fire starts in service area(s) and/or sample room. Possible consequences include loss of structure, loss of ventilation system, injury to facility worker, and release of radionuclides	1.2.A Fire suppression system 1.2.B Fire alarms to Hanford Fire Department 1.2.C Portable, hand-held fire extinguishers available to attack small fires 1.2.D Ventilation system designed to stop under fire conditions	1.2.E Good housekeeping procedures reduce the amount of transient combustible material in the facility 1.2.F Strict control of combustible loadings prevents or reduces the effects of a fire	I for loss of facility III for all other effects	UNLIKELY for all effects	Fire involving contaminated solid combustibles is analyzed in Section 4.2.
	1.3 LPG explosion in service area of 340-C Building	LPG tank used to power equipment is heated in a fire and explodes and/or leaks causing vapor cloud explosion Possible consequences include injury/death to facility worker, secondary fire, release of radionuclides, and loss of structure	1.3.A Fire-suppression system keeps tank cool, or acts to extinguish fire following explosion 1.3.B See 1.2.B, C, and D 1.3.C Ventilation system operation acts to prevent build-up of flammable vapor cloud from a leaking tank 1.3.D LPG tank storage is away from buildings	1.3.E LPG tanks in buildings are limited in number to those on equipment	I for loss of facility III for all other effects	UNLIKELY for all effects	Fire involving contaminated solid combustibles is analyzed in Section 4.2.
	1.4 Fire in tank vault	Transient combustibles around tank(s) start class A fire Possible consequences includes loss of ventilation and release of radionuclides (HEPA filter fire/failure)	1.4.A Tanks and piping are resistant to the effects of small fires 1.4.B See 1.2.B and D above	1.4.C See 1.2.E and F	II for damage to facility III for release of radionuclide	EXTREMELY UNLIKELY for all effects	Frequency based on small combustible loading and large size of ventilation system.

Table 4-3. Facility Preliminary Hazards Analysis, Operating Mode. (14 sheets)

Hazard/energy source	Cause(s)/accident sequence	Major effects	Preventative/mitigative features		Consequence level	Annual frequency level	Comments
			Engineered	Administrative			
	1.5 Fire in 340-A	Transient combustibles around tank(s) start Class A fire Possible consequences include damage to facility	1.5.A See 1.4.A and 1.2.B	1.5.B See 1.2.E and F	II for damage to facility	EXTREMELY UNLIKELY	Existing 340 Complex Buildings are outside the scope of Project W-302 and this PSE. However, they are examined in this PSE to ensure that all building-to-building interactions are examined.
	1.6 Fire in 340-B West, solid waste storage	Waste container fire/explosion, transient combustible fire, or LPG fire/explosion Possible consequences include loss of ventilation system, loss of structure, and release of radionuclides	1.6.A See 1.2.A, B, C, and D and 1.3.A 1.6.B Waste drums are DOT Type A containers and resistant to the effects of small fires	1.6.C See 1.2.E and F and 1.3.C	I for loss of facility II for damage to facility III for all other effects	UNLIKELY for all effects	Existing 340 Complex Buildings are outside the scope of Project W-302 and this PSE. However, they are examined in this PSE to ensure that all building-to-building interactions are examined.
	1.7 Fire in 340-B East, railcar loadout	Transient combustibles cause Class A fire Possible consequences include loss of ventilation and release of radionuclides (HEPA filter failure/fire)	1.7.A See 1.2.B and D 1.7.B Railcar and piping in 340-B are resistant to the effects of small fires	1.7.C See 1.2.E and F 1.7.D Waste transfer operations to railcar halted under fire conditions	II for damage to facility III for all other effects	EXTREMELY UNLIKELY for all effects	Existing 340 Complex Buildings are outside the scope of Project W-302 and this PSE. However, they are examined in this PSE to ensure that all building-to-building interactions are examined.

Table 4-3. Facility Preliminary Hazards Analysis, Operating Mode. (14 sheets)

Hazard/energy source	Cause(s)/accident sequence	Major effects	Preventative/mitigative features		Consequence level	Annual frequency level	Comments
			Engineered	Administrative			
	1.8 Waste tank hydrogen explosion	Radiolytic decomposition of residual waste water (heel) generates sufficient hydrogen to form a flammable/explosive cloud Possible consequences include rupture of tank/piping, loss of ventilation, and release of radionuclides	1.8.A. Tanks are ventilated (under negative pressure) which reduces likelihood of hydrogen cloud formation 1.8.B. Tanks can withstand the effects of a deflagration/explosion 1.8.C. In-tank pumps and agitators designed to minimize residual waste left in tank 1.8.D. Tanks designed to minimize hold-up of residuals (i.e., round bottom or slanted horizontal tanks)	--	II for damage to facility III for all other effects	EXTREMELY UNLIKELY for all effects	--
	1.9 Fire in piping system	Hydrogen or flammable gas/liquid fire in piping system Possible consequences include the loss of piping and pumps, and the release of radionuclides	1.9.A New piping outside vault is double-walled	--	II for damage to facility III for all other effects	INCREDIBLE	No flammable wastes received. Generation and subsequent buildup of hydrogen is incredible.
2 Chemical Reactivity	2.1 Acids and bases from neutralization system commingle	Uncontrolled mixing of acid + base causes violent neutralization reaction Possible consequences include loss of pH adjustment system and injury/exposure to facility worker	2.1.A pH adjustment system designed to prevent mixing of reagents 2.1.B pH adjustment system designed to limit the amount of reagents present	2.1.C Spill containment kits provided to limit the spread of spilled reagents 2.1.D Inventories of reagents not allowed to accumulate	II for all effects	UNLIKELY for all effects	--

Table 4-3. Facility Preliminary Hazards Analysis, Operating Mode. (14 sheets)

Hazard/energy source	Cause(s)/accident sequence	Major effects	Preventative/mitigative features		Consequence level	Annual frequency level	Comments
			Engineered	Administrative			
	2.2 Component of liquid waste stream violently reacts with acid/base from neutralization system	Unexpected violent reaction between one or more components of the liquid waste stream with the acid/base from the pH adjustment system Possible consequences include loss of pH adjustment system, generation of toxic materials, and release of radionuclides (spill/spray)	2.2.A Piping and tanks are resistant to the effects of violent reactions	2.2.B Liquid waste stream well characterized prior to receipt 2.2.C Reactive/flammable wastes not allowed in facility	II for damage to facility III for all other effects	EXTREMELY UNLIKELY for all effects	Frequency based on condition existing and failure of several layers of controls (at generating facilities and 340 Complex).
	2.3 Internal or external corrosion of solid waste containers	Internal or external container degradation compromises container integrity Possible consequences includes release of radionuclides	2.3.A Waste drums are steel DOT Type A containers and resistant to the corrosive effects of chemicals 2.3.B Container liners used for identified potentially corrosive wastes	2.3.C Packaging requirements for corrosive wastes 2.3.D Waste containers stored in non-hostile environment (i.e. free from water, chemicals, etc.) 2.3.E Inspection requirements for waste containers 2.3.F Storage of solid waste for less than 90 days reduces the time available to realize the effects of corrosion	III	EXTREMELY UNLIKELY	Frequency based on length of time solid waste is stored (< 90 days).

Table 4-3. Facility Preliminary Hazards Analysis, Operating Mode. (14 sheets)

Hazard/energy source	Cause(s)/accident sequence	Major effects	Preventative/mitigative features: Engineered	Preventative/mitigative features: Administrative	Consequence level	Annual frequency level	Comments
	2.4 Internal or external corrosion of tank(s)	Internal or external tank degradation compromises tank integrity Possible consequences includes release of radionuclides (spill/spray)	2.4.A Tanks are resistant to corrosion 2.4.B pH neutralization system designed to eliminate acidic/basic wastes 2.4.C Tank vault sump designed to collect leaking waste and to keep water from tanks 2.4.D Tank vault surveillance camera allows visual monitoring of tank vault 2.4.E Contents of leaking tank(s) can be transferred to other tank(s) 2.4.F Sump alarm and remote indication	2.4.G Inspection requirements for tanks	III	UNLIKELY	Frequency based on failure to monitor tanks and neutralize wastes.
	2.5 Internal or external corrosion of piping or fittings	Piping/fitting corrosion causes leaks Possible consequences includes release of radionuclides to the ground or air (spill/spray)	2.5.A Piping is resistant to corrosion and buried piping is double walled 2.5.B Fittings are designed to be corrosion resistant 2.5.C See 2.4.B	2.5.D Inspection requirements for fittings and aboveground piping	III	UNLIKELY	Frequency based on failure to neutralize wastes.
	2.6 Internal or external corrosion of railcar	Internal or external corrosion of railcar causes leaks Possible consequences includes release of radionuclides (spill/spray)	2.6.A Railcar is resistant to corrosion	2.6.B Inspection requirements for railcar and railcar fittings 2.6.C Annual testing on railcars	III	EXTREMELY UNLIKELY	Existing 340 Complex Buildings are outside the scope of Project W-302 and this PSE. However, they are examined in this PSE to ensure that all building-to-building interactions are examined. Frequency based on failure to inspect railcar and neutralize waste.

Table 4-3. Facility Preliminary Hazards Analysis, Operating Mode. (14 sheets)

Hazard/energy source	Cause(s)/accident sequence	Major effects	Preventative/mitigative features		Consequence level	Annual frequency level	Comments
			Engineered	Administrative			
	2.7 Incompatible chemicals placed in same solid waste container	Two or more incompatible chemicals are placed in the same solid waste container for disposal Possible consequences include the generation of toxic fumes, initiation of a fire or explosion and subsequent release of radionuclides	2.7.A Fire suppression system (for the initiation of a fire/explosion)	2.7.B Packaging requirements for incompatible chemicals 2.7.C Limits on types and quantities of chemicals used in the facility	III for all effects	EXTREMELY UNLIKELY for all effects	Frequency based on condition existing and failure to control waste per packaging criteria.
	2.8 Incompatible chemicals placed in same liquid container (e.g., tanks)	Two or more incompatible liquid waste streams are placed into the same tank(s) Possible consequences include generation of toxic fumes, release of radionuclides (spill/spray), loss of tank(s), loss of ventilation system	2.8.A Tanks are resistant to the effects of unexpected reactions 2.8.B Tanks are designed to overflow to collection sump 2.8.C Tanks are ventilated to reduce the effects of internal pressurization	2.8.D See 2.2.B and C	II for damage to facility III for all other effects	EXTREMELY UNLIKELY for all effects	Frequency based on need for large-scale reaction.
	2.9 Incompatible chemicals placed in railcar	Liquid waste pumped into railcar which already contains an incompatible chemical Possible consequences include generation of toxic fume and release of radionuclides (spill/spray), and loss of railcar	2.9.A Railcar is resistant to the effects of violent reactions	2.9.B Inspection and sluicing requirements for railcars after each use 2.9.C See 2.2.B and C	II for damage to facility III for all other effects	EXTREMELY UNLIKELY for all effects	Existing 340 Complex Buildings are outside the scope of Project W-302 and this PSE. However, they are examined in this PSE to ensure that all building-to-building interactions are examined. Frequency based on condition existing and failure to inspect/empty railcar.

Table 4-3. Facility Preliminary Hazards Analysis, Operating Mode. (14 sheets)

Hazard/energy source	Cause(s)/accident sequence	Major effects	Preventative/mitigative features: Engineered	Preventative/mitigative features: Administrative	Consequence level	Annual frequency level	Comments
3 Potential and Kinetic Energy (no fire)	3.1 Bridge crane accident, structural failure	Crane and/or cover block drop onto tank(s), piping, pumps, waste containers, and/or control room. Possible consequences include loss of operating equipment, release of radionuclides, and death/injury to facility worker	3.1.A Bridge crane and supporting structure engineered to current structural codes and standards. 3.1.B Tanks are resistant to all but heavy direct blows from cover block or crane. 3.1.C Piping is resistant to most lighter, secondary blows. 3.1.D Tank vault has sump and sump pump for collection of spills from tank(s) 3.1.E Siting of control room and areas of heavy personnel traffic away from bridge crane operating areas, where possible.	3.1.F Surveillance and maintenance procedures ensure that the bridge crane and supporting structure is adequately maintained. 3.1.G Waste containers stored in controlled areas away from crane operations.	I for death of facility worker II for damage to facility III for all other effects	EXTREMELY UNLIKELY for all other events	Frequency based on failure of crane and hypothesized damage configuration.
	3.2 Bridge crane accident, human error	See 3.1	3.2.A See 3.1.B, C, and D	3.2.B See 3.1.F and G 3.2.C Operator certification requirements. 3.2.D Procedures for crane operations (e.g. hoisting and rigging procedures).	I for death of facility worker II for damage to facility III for all other effects	UNLIKELY for all effects	Frequency based on human error and hypothesized damage configuration.
	3.3 Container-handling equipment accident, mechanical failure	Handling equipment ruptures waste container by dropping or impacting container Possible consequences includes release of radionuclides and injury to facility worker	3.3.A Handling equipment designed to current codes and standards 3.3.B Waste containers meet DOT certification for Type A containers	3.3.C See 3.1.F for handling equipment 3.3.D See 3.2.C & D for handling equipment	III for all effects	EXTREMELY UNLIKELY	Frequency based on failure of equipment and hypothesized damage configuration.

Table 4-3. Facility Preliminary Hazards Analysis, Operating Mode. (14 sheets)

Hazard/energy source	Cause(s)/accident sequence	Major effects	Preventative/mitigative features		Consequence level	Annual frequency level	Comments
			Engineered	Administrative			
	3.4 Container-handling equipment accident, human error	See 3.3	3.4.A See 3.3.B 3.4.B Handling equipment designed to be conducive for ease of operations	3.4.C See 3.2.C & D for handling equipment	III for all effects	UNLIKELY	Frequency based on human error and hypothesized damage configuration.
	3.5 Vehicle accident, mechanical failure	Vehicle accident causes rupture of waste containers and/or above ground piping Possible consequences include release of radionuclides and injury to facility worker	3.5.A Facility designed with underground piping where possible (all areas except railcar waste transfer area) and vehicle control features, such as bollards, berms, etc. for above ground waste storage and transfer areas 3.5.B See 3.1.C and 3.3.B	3.5.C Vehicle control system, signs and markings, for areas near waste storage and transfer operations	II for injury to facility worker III for all other effects	INCREDIBLE	Frequency based on vehicle failure and hypothesized damage configuration (road, parking lot, and building arrangement not conducive for vehicle penetrating building and impacting waste).
	3.6 Vehicle accident, human error	See 3.5	3.6.A See 3.5.A 3.6.B See 3.1.C and 3.3.B	3.6.C See 3.5.C 3.6.D Vehicle operator certification required (i.e., driver's license)	II for injury to facility worker III for all other effects	EXTREMELY UNLIKELY for all effects	Frequency based on human error and hypothesized damage configuration (road, parking lot, and building arrangement not conducive for vehicle penetrating building and impacting waste).
	3.7 Facility equipment accident (hand tools, ladders, etc.)	Facility equipment strikes exposed piping and/or waste containers Possible consequences include release of radionuclides and facility worker injury	3.7.A See 3.1.B & C and 3.3.B	3.7.B See 3.1.F for facility equipment	III for all effects	EXTREMELY UNLIKELY for release of radionuclide ANTICIPATED for all other effects	--
	3.8 Railcar accident, mechanical failure	Railcar fails (weld failure, railcar tipping over, etc.) spilling contents Possible consequences include loss of railcar and release of radionuclides (spill)	3.8.A Loadout facility drains to tank(s)	3.8.B Inspection and testing requirements for railcars	II for damage to facility III for all other effects	EXTREMELY UNLIKELY for all effects	Existing 340 Complex Buildings are outside the scope of Project W-302 and this PSE. However, they are examined in this PSE to ensure that all building-to-building interactions are examined.

Table 4-3. Facility Preliminary Hazards Analysis, Operating Mode. (14 sheets)

Hazard/energy source	Cause(s)/accident sequence	Major effects	Preventative/mitigative features		Consequence level	Annual frequency level	Comments
			Engineered	Administrative			
	3.9 Railcar accident, human error	Railcar fails (impact by engine, object on rails, etc.) spilling contents Possible consequences include loss of railcar and release of radionuclides (spill)	3.9.A See 3.8.A 3.9.B Railcar designed to withstand external impacts	3.9.C Operator certification requirements for engineers	II for damage to facility III for all other effects	EXTREMELY UNLIKELY for all effects	Existing 340 Complex Buildings are outside the scope of Project W-302 and this PSE. However, they are examined in this PSE to ensure that all building-to-building interactions are examined.
	3.10 Plane crash	Plane crash impacts 340-C Building Possible consequences include loss of facility, death or injury to facility worker, and release of radionuclides	--	--	I for loss of facility or death of facility worker III for all other effects	EXTREMELY UNLIKELY for all effects	--
4 Leaks and Spills	4.1 Railcar connections not secure	Railcar connections not secure and liquid waste allowed to escape Possible consequences include release of radionuclides (spill/spray)	4.1.A Connection is covered to prevent open sprays 4.1.B Railcar designed to divert runoff from connection into railcar 4.1.C See 3.8.B	--	III	ANTICIPATED	Existing 340 Complex Buildings are outside the scope of Project W-302 and this PSE. However, they are examined in this PSE to ensure that all building-to-building interactions are examined.
	4.2 Pipe fittings not secure	Unsecured pipe fittings above or below ground allow liquid waste to escape Possible consequences includes release of radionuclides to the ground or air (spill/spray)	4.2.A Below ground piping is double walled 4.2.B Runoff from above ground fittings drains to tank(s)	4.2.C New underground piping and fittings inspected and tested prior to use	III	UNLIKELY	--

Table 4-3. Facility Preliminary Hazards Analysis, Operating Mode. (14 sheets)

Hazard/energy source	Cause(s)/accident sequence	Major effects	Preventative/mitigative features		Consequence level	Annual frequency level	Comments
			Engineered	Administrative			
	4.3 Tank(s) overflow	Tank(s) filled beyond capacity (waste pumped into wrong tank, liquid level in tank incorrect, more waste than expected, etc.) Possible consequences includes release of radionuclides (spill/spray)	4.3.A Tank system designed such that overflows are diverted to collection sump 4.3.B Liquid level detectors provide real-time feedback to operators and alarms and halt operations 4.3.C Tank runoff collected by sump and sump pump 4.3.D Sump alarm and remote indication	4.3.E Waste is well characterized before receipt (volume, etc)	III	ANTICIPATED	..
	4.4 Tank fittings not secure	Unsecured tank fittings allow liquid waste to escape Possible consequences includes release of radionuclides (spill/spray)	4.4.A Fittings are designed to divert runoff into tanks 4.4.B See 4.3.C and D	4.4.c Fittings inspected and tested prior to operations	III	UNLIKELY	..
	4.5 Pump fittings not secure	Unsecured fittings on pump allow liquid waste to escape Possible consequences include release of radionuclides (spill/spray)	4.5.A Pumps designed for radioactive liquid waste containment 4.5.B Pump runoff drains to tank(s)	4.5.C Pumps regularly maintained to prevent degradation	III	ANTICIPATED	Frequency is greater than pipe/tank fitting leaks because of relative high maintenance required for pumps.
	4.6 Piping freezes	Freezing temperatures causes above or below ground pipes to freeze and burst Possible consequences includes release of radionuclides to the ground or air (spill/spray)	4.6.A New buried piping is double walled 4.6.B Piping buried below frost line 4.6.C Pipe insulation and/or heat tape	4.6.D Standing water not allowed in above or below ground piping 4.6.E Procedures for winterization	III	UNLIKELY	..

Table 4-3. Facility Preliminary Hazards Analysis, Operating Mode. (14 sheets)

Hazard/energy source	Cause(s)/accident sequence	Major effects	Preventative/mitigative features: Engineered	Preventative/mitigative features: Administrative	Consequence level	Annual frequency level	Comments
	4.7 Railcar overflows	Railcar filled beyond capacity (liquid already in railcar, more waste than expected, etc.) Possible consequences includes release of radionuclides (spill/spray)	4.7.A Runoff at loadout facility drains to tank(s) 4.7.B Level indicators in railcar trigger alarms and halt operations	4.7.C Railcar documentation indicates capacity 4.7.D Waste shipment well characterized prior to initiation of transfer	III	UNLIKELY	Existing 340 Complex Buildings are outside the scope of Project W-302 and this PSE. However, they are examined in this PSE to ensure that all building to building interactions are examined.
	4.8 Internal flooding	Facility water line is ruptured flooding facility areas Possible consequences includes release of radionuclides (spill)	4.8.A Facility water supply limited in pressure and flow 4.8.B Tank vault sump and sump pump collect and transfer water to tank(s) 4.8.C No facility water supplied to 340-A 4.8.D 340-B facility drains to tank(s)	4.8.E Regular maintenance on water system 4.8.F Regular surveillance of remote areas with water service	IV	UNLIKELY	Consequence based on minimal impact because of vault sump and sump pump.
5 Radiation	5.1 Loss of shielding	Lack or loss of shielding (shielding walls not in place, shielding walls insufficient, railcar "shine", etc.) Possible consequence includes exposure of facility worker	5.1.A Shielding wall designed for maximum postulated inventory 5.1.B Shielding walls placed between each tank reduce overlapping fields of exposure 5.1.C Concrete cover blocks placed over tank vault 5.1.D 340-A Building is isolated from operational areas 5.1.E Railcar loadout facility has permanent concrete shielding wall 5.1.F Radiation monitors near liquid waste storage areas	5.1.G Surveillance and inspection procedures ensure that adequate shielding is available 5.1.H Operating records maintain status of waste including records of inventories	III	UNLIKELY	340-C personnel are not protected by the shield wall in the 340-B Building. Distance is the only mitigator for radiation from a "hot" railcar.

Table 4-3. Facility Preliminary Hazards Analysis, Operating Mode. (14 sheets)

Hazard/energy source	Cause(s)/accident sequence	Major effects	Preventative/mitigative features		Consequence level	Annual frequency level	Comments
			Engineered	Administrative			
	5.2 Unexpected high dose rates	Waste received with unexpectedly high dose rates Possible consequences includes exposure of facility worker	5.2.A Piping is underground except for railcar loadout 5.2.B See 5.1.B, C, D, E, and F	5.2.F Waste is well characterized prior to receipt 5.2.G Waste is sampled and tested prior to receipt 5.2.H See 5.1.H	III	UNLIKELY	--
6 Natural Phenomena	6.1 Seismic event	Seismic event Possible consequences include loss of facility and release of radionuclides (spill/spray)	6.1.A SSCs designed to withstand the effects of a seismic event 6.1.B Sump and drain systems designed to collect spilled liquids 6.1.C Tanks designed to remain upright	6.1.D Solid waste containers stacked only one high	I for loss of facility and impact to environment II for damage to facility	UNLIKELY for all effects	Frequency based on return period for earthquake with a 0.12 g horizontal ground acceleration (Section 4.2.1.1). Impact to environment based on calculations in Appendix B.
	6.2 High winds	High winds Possible consequences include loss of facility (except tank vault) and release of radionuclides (spill/spray)	6.2.A SSCs designed to resist the effects of strong winds 6.2.B Tank vault is below grade 6.2.C 340-A tanks are stainless steel and resistant to the impacts of building structural components 6.2.D Railcar is resistant to impacts 6.2.E Solid waste is contained in DOT Type A containers which are resistant to impacts 6.2.F See 6.1.C	--	I for loss of facility II for damage to facility III for all other effects	UNLIKELY for all effects	Frequency based on return period for winds strong enough to destroy the facility.

Table 4-3. Facility Preliminary Hazards Analysis, Operating Mode. (14 sheets)

Hazard/energy source	Cause(s)/accident sequence	Major effects	Preventative/mitigative features		Consequence level	Annual frequency level	Comments
			Engineered	Administrative			
	6.3 Wind-driven missiles	Wind-driven missile impacts facility Possible consequences include loss of structural confinement boundary and release of radionuclides (if solid waste or above ground liquid waste is impacted)	6.3.A SSCs are resistant to the impacts of wind-driven objects 6.3.B See 6.2.B, C, D, and E	6.3.C See 6.2.G	II for damage to facility III for all other effects	EXTREMELY UNLIKELY for release of radionuclide UNLIKELY for all other effects	--
	6.4 Flooding	Facility is flooded by Maximum Probable Flood (PMF) of the Columbia River, or subject to localized flooding Possible consequences include loss of facility and release of radionuclides (spill)	--	--	I for loss of facility and impact to the environment II for damage to facility	INCREDIBLE	The 340-C Building elevation of 117 m (384.5 ft) is higher than the PMF (CH2M Hill 1994)
	6.5 Tornado	Tornado impacts facility Possible consequences include loss of facility and release of radionuclides	6.5.A SSCs resistant to extreme winds 6.5.B See 6.2.B, C, D, E, and F	6.5.C See 6.2.G	Not analyzed	Not analyzed	Because the only Safety Class 1 or 2 item is a system for containment for the underground vault tanks for a seismic event, there is no requirement to analyze a tornado.
	6.6 Heavy snowfall	Heavy snowfall collapse structure Possible consequences include loss of facility and release of radionuclides	6.6.A Structures, systems, and components designed to withstand loads on roof 6.6.B See 6.2.B, C, D, and E	--	Not analyzed	Not analyzed	See tornado.
	6.7 Heavy ashfall	See 6.6	6.7.A See 6.6.A and 6.2.B, C, D, and E	--	Not analyzed	Not analyzed	See tornado.

Table 4-3. Facility Preliminary Hazards Analysis, Operating Mode. (14 sheets)

Hazard/energy source	Cause(s)/accident sequence	Major effects	Preventative/mitigative features		Consequence level	Annual frequency level	Comments
			Engineered	Administrative			
7 Criticality	7.1 340-A	Criticality in tank(s) Possible consequences include exposure of facility workers	--	7.1.A Limits on fissile material quantities 7.1.C Waste is well characterized prior to receipt/mixing	II	EXTREMELY UNLIKELY	Existing 340 Complex Buildings are outside the scope of Project W-302 and this PSE. However, they are examined in this PSE to ensure that all building-to-building interactions are examined.
	7.2 340-B West, solid waste storage	Criticality in solid waste storage matrix Possible consequences include exposure of facility worker	7.2.A Physical characteristics of solid waste storage matrix is not conducive for criticality	7.2.B See 7.1.A	II	INCREDIBLE	Existing 340 Complex Buildings are outside the scope of Project W-302 and this PSE. However, they are examined in this PSE to ensure that all building-to-building interactions are examined. Frequency based on small quantities of contamination and the configuration of the waste.
	7.3 340-B East, railcar loadout	Criticality in railcar Possible consequences include exposure of facility worker	--	7.3.A See 7.1.A 7.3.B Waste is well characterized prior to transfer to railcar	II	EXTREMELY UNLIKELY	Existing 340 Complex Buildings are outside the scope of Project W-302 and this PSE. However, they are examined in this PSE to ensure that all building-to-building interactions are examined.
	7.4 Tank vault	Criticality in a tank	--	7.4.A See 7.1.A, B	II	EXTREMELY UNLIKELY	Criticality safety evaluation report (CSER) for the 340 facility is currently under review (WHC 1994c).
	7.5 Service areas of new building	Criticality in sample or service area Possible consequences include exposure of facility worker	7.5.A See 7.2.A	7.5.B See 7.1.A 7.5.C Waste limited to sample quantities in these areas	II	INCREDIBLE	Frequency based on having only sample sizes of waste.

4.2 ACCIDENT ANALYSIS

This section develops and analyzes those accident sequences identified in the operations PHA table which are considered representative and/or bounding of overall facility risk, or that challenge the design of the facility. Table 4-4 shows the accidents selected for analysis and the rationale for their selection.

Some notable accidents identified in the PHA are not included in Table 4-4. These include plane crash, hydrogen explosion in a tank, spill of caustic (sodium hydroxide), spill of concentrated acid, and toxicological consequence of waste spill.

A plane crash into the 340-C structure could result in total loss of the structure and failure of the cover blocks which would impact the vault tanks. However, analysis of a seismic event already postulates the complete failure of all vault tanks and related structures in the worst configuration possible. Therefore, because the seismic event has a higher assigned frequency, it bounds plane crash accidents.

A hydrogen explosion (deflagration or detonation) in a tank is also identified in the PHA. While this could result in the loss of the tank and possibly the associated piping, little release of radioactive material could be expected. If the explosion occurred inside the tank it would result in a deflagration that could rupture the tank and fittings. Some fraction of whatever heel (residual waste) present at the bottom of the tank could be expected to be made airborne inside the tank and a smaller fraction could be released to the outside. However, that portion of the airborne material which escapes the confines of the tank is small when compared to the airborne release assumed following a seismic event or spray leak. In addition, in order for the hydrogen to build up to explosive levels, the ventilation system would have to fail for an extended period of time in one or more tanks. Therefore, it is assumed that the hydrogen explosion accident is bounded by other accidents which are analyzed.

The pH adjustment system uses both caustic (sodium hydroxide) and acid (assumed to be nitric acid) to neutralize acidic or basic waste streams. A spill of the base is not analyzed because of the extremely low vapor pressure of the solution, as it is a solid dissolved in water. In Section 3.2 the acid is assumed to be concentrated nitric acid with a partial pressure of approximately 1.3 E+00 kPa (9.65 mm Hg) at a temperature of 313 K (40 °C). A spill of the concentrated nitric acid is analyzed in Section 4.2.2.2.

The assumptions used to calculate the toxicological consequences of the spray leak are made in such a fashion so as to bound the release of all toxic chemicals in the waste. For example, the spray leak provides a much greater mechanism for aerosolization of the chemicals than a waste spill because of the extremely low vapor pressures of the chemicals in the waste solution. Thus, release calculations for any other chemicals than those in Section 4.2.2.1 are not performed.

The consequence criteria used for the accident analysis in this PSE are the safety classification criteria taken from WHC-CM-4-46, Section 9.0 and from a draft revision of that document. The revision defines new criteria for EHSC calculations which precludes a Safety Class 1 designation based solely upon environmental impacts. A control manual waiver is included in Appendix E allowing the use of the new criteria. The specific criteria used in this PSE, including the new EHSC criteria, are shown in Table 4-5.

4.2.1 Radiological Releases

The methodology for calculating dose consequences in this PSE uses the following basic equation:

$$Dose = \left(\frac{Dose}{Unit\ Waste}\right) \cdot (Volume\ of\ Waste\ Released) \cdot (ARF:RF) \cdot (Breathing\ Rate) \cdot \left(\frac{X}{Q}\right)$$

where:

Dose = dose consequence from accident
Dose per unit waste = 9.23 E+03 Sv/L from Table 3-2
Volume of waste released = inventory involved in the accident (developed in the analysis)
ARF:RF = airborne release fraction:respirable fraction
Breathing rate = 3.3 E-04 m^3/s from Appendix A
X/Q = atmospheric dispersion factor from Appendix A

4.2.1.1 Seismic event. The seismic event is the only natural phenomenon quantitatively analyzed in this PSE. The other natural phenomena identified in the PHA are bounded in both consequence (using the model below) and frequency by the seismic event. Therefore, because the exposure consequences of the seismic event result in the requirement of only Safety Class 3 items (no Safety Class 1 or 2), the other natural phenomena also only require Safety Class 3 items. For example, the analysis of the seismic event demonstrates that the structure of the new building must meet Safety Class 3 design requirements. Because the seismic event bounds the high wind (or snow loading, or ash loading, etc.), the new building must only meet the Safety Class 3 design requirements for wind loading and not the Safety Class 1 or 2 requirements.

The frequency of the seismic event postulated in this PSE is 3.3 E-03 yr^{-1} which is the frequency associated with a seismic event yielding a horizontal ground acceleration of 0.12 g at the Hanford Site. For the purposes of this PSE it is assumed that this seismic event is sufficient to fail all of the structures in the 340 Complex and result in maximum damage.

The seismic event hypothesized in this analysis is modeled such that the amount of radioactive material made airborne and released from the facility is extremely conservative. The following assumptions govern the seismic event model.

- All facility structures fail.
- Where applicable, facility structures are assumed to impact waste containers and cause maximum damage.

- At the time of the seismic event it is assumed that the vault tanks contain 121 kL of waste, with concentrations equal to those shown in Table 3-2.

- The vault tanks are assumed to rupture and allow their entire contents to flow into the vault.

- The 340-A Building tanks do not significantly contribute to the release.

- Except for the radiological EHSC calculations, no credit is given for absorption of the waste into the ground or release of the waste from the vault to the ground.

The assumption that the 340-A tanks do not significantly contribute to the release is based upon the proposed use of the tanks. The six 30 kL tanks will be used to contain RPS wastes diverted from the 307 Basins. From the 340-A tanks the waste will be transferred to the vault tanks and then to the 200 Area. The RPS waste stream, if diverted, will have an extremely low concentration of radioactive material. In addition, given the checks on the RPS waste prior to entering the 307 Basins, it is highly improbable that a divert will occur just prior to the postulated seismic event. Note that this assumption precludes storing RLWS or vault tank waste in the 340-A Building.

Using the above assumptions, an ARF, and the atmospheric dispersion factors from Appendix A, the worst-case dose consequences arising from a seismic event can be estimated.

The release fraction from the exposed waste can be estimated from the resuspension of particles from a dilute aqueous solution. The release rate of 4 E-08 per hour (respirable fraction of 1.0) for indoors, heterogeneous surfaces covered with debris (DOE 1993) is appropriate. The duration over which the release is assumed to occur is 24 hours based on guidance provided in WHC-CM-6-32, *Safety Analysis and Engineering Work Procedures*, for the completion of an FSAR. This yields a total release fraction of

$$\left(4\ E\text{-}08\ \frac{1}{hr}\right) \cdot (24\ hr) = 9.6\ E\text{-}07\ .$$

Because the resuspension from the waste is assumed to last longer than 1 hour, credit can be give for plume meander. Therefore, the dispersion factors which can be used for the seismic event can be taken from Tables A-2 for the onsite receptor and Table A-4 for the offsite receptor. For the onsite receptor at 100 m north, the dispersion factor is 1.08 E-02 s/m^3. For the offsite receptor at 345 m east, the dispersion factor is 9.73 E-04 s/m^3.

The dose per unit of waste from Table 3-2 is 9.23 E+03 Sv/L.

Using the dose consequence equation from Section 4.2.1, the onsite and offsite doses resulting from the seismic event (using the above model) are

$$Onsite\ Dose = \left(9.23E{+}03\ \frac{Sv}{L}\right) \cdot (121{,}000\ L) \cdot (9.6E{-}07) \cdot \left(3.3E{-}04\frac{m^3}{s}\right) \cdot \left(1.08E{-}02\frac{s}{m^3}\right)$$

$$= 3.8E{-}03\ Sv$$

$$Offsite\ Dose = \left(9.23E{+}03\ \frac{Sv}{L}\right) \cdot (121{,}000\ L) \cdot (9.6E{-}07) \cdot \left(3.3E{-}04\frac{m^3}{s}\right) \cdot \left(9.73E{-}04\frac{s}{m^3}\right)$$

$$= 3.4E{-}04\ Sv$$

The onsite dose is below the Safety Class 2 criteria of 5.0 E-02 Sv and the offsite dose is below the Safety Class 1 criteria of 5.0 E-03 Sv (Table 4-5). Therefore, from the standpoint of radiological dose consequences arising from a seismic event, no Safety Class 1 or 2 barriers are required.

4.2.1.2 Spray Leak. The spray leak accident scenario analyzed here could occur in several locations through out the 340 Complex. Spray leaks could occur from insecure fittings/seals or ruptured piping in locations such as the tank vault, tankcar loadout building (340-B East), pump pits, piping connections, etc. The analysis conservatively covers all of these locations and the results apply to all SSCs associated with Project W-302.

The frequency associated with the various possible spray leaks identified for the 340-C Building in the PHA in Table 4-3 range from extremely unlikely to anticipated. The most likely cause of spray leaks is insecure fittings following maintenance activities. Other causes of spray leaks could be pipe or tank degradation, equipment failure, and damage resulting from impacts to piping/equipment.

The accident scenario model presented here for the spray leak is simplistic and conservative. The following assumptions govern the accident scenario model.

- 76 kL of waste is being transferred from one storage area to another.
- 5% of the waste stream, or 3.8 kL, escapes through the breach.
- The waste stream is under sufficient pressure to cause a spray and not simply a leak.

The 76 kL volume is used as the inventory involved because of several factors associated with the design and operation of the 340 Complex. Conceptually, the upgraded 340 Complex will receive, store and/or process waste shipments (approximately 11 kL per month) in either the 45 kL or 19 kL tanks. When the waste accumulation approaches 76 kL (the capacity of a tankcar), the waste is shipped to the 200 Area, providing the most efficient use of the railcars. Thus 76 kL is a reasonable approximation of the likely maximum single transfer where there might be a spray leak.

The assumption that 5% of the waste stream is released via a spray leak is used in lieu of calculations because of the lack of design information. Given pipe sizes, pump capacities, and likely orifice sizes, the amount of waste escaping could be estimated. For comparison, the 340 Complex ISB shows calculations for a spray leak in the 340-B East Building yielding 1.9% of the liquid escaping (1,070/57,000 L).

The ARF:RF for the spray leak is 1 E-04:1.0 (DOE 1993), resulting in a total airborne, respirable release fraction of 1 E-04. This is a bounding value taken from experiments in which a dilute, aqueous solution was forced through a spray nozzle at a pressure of 1,500 kPa (215 psi).

The W-302 FDC (WHC 1994a) indicates that the transfer pumps must be able to empty a tank within 1-4 hours. The minimum release duration which can be used in conjunction with plume meander is 1 hour. Because the minimum time for transfer is 1 hour, credit may be taken for plume meander in the spray leak scenario, and the atmospheric dispersion factors in Tables A-2 and A-4 may be used.

The dose per unit of waste used is 9.23 E+03 Sv/L from Table 3-2.

Using the basic dose consequence equation in Section 4.2.1, the dose consequences arising from the spray leak are

$$Onsite\ Dose = \left(9.23E{+}03\ \frac{Sv}{L}\right) \cdot (3{,}800\ L) \cdot (1E{-}04) \cdot \left(3.3E{-}04\frac{m^3}{s}\right) \cdot \left(1.08E{-}02\frac{s}{m^3}\right)$$

$$= 1.3E{-}02\ Sv$$

$$Offsite\ Dose = \left(9.23E{+}03\ \frac{Sv}{L}\right) \cdot (3{,}800\ L) \cdot (1E{-}04) \cdot \left(3.3E{-}04\frac{m^3}{s}\right) \cdot \left(9.73E{-}04\frac{s}{m^3}\right)$$

$$= 1.1E{-}03\ Sv$$

The onsite dose is below the Safety Class 2 criteria of 5.0 E-02 Sv and the offsite dose is below the Safety Class 1 criteria of 5.0 E-03 Sv (Table 4-5). Therefore, from the standpoint of radiological dose consequences arising from a spray leak, no Safety Class 1 or 2 items are required.

4.2.1.3 Solid Waste Fire. Several possible fires involving the 340-C Building are identified in the PHA in Table 4-3. While most of these fires would result in an upset in operations or loss of the facility, this PSE is predominantly concerned with releases of hazardous materials to the environment. The tank vault has no combustible loading, and if combustibles were inadvertently introduced to the tanks, any significant accumulation of liquid waste would serve as a tremendous heat sink, reducing the effects of the fire. Therefore, the only hazardous material assumed to be impacted by the fire is the contaminated solid waste in the satellite accumulation area.

The following assumptions govern the accident scenario model for the solid waste fire.

- The fire consumes the entire contents of all solid waste containers present.
- Two 208 L drums and one wooden box are present.
- All solid waste containers are full and contain the maximum inventory, discussed below, of radioactive material.

The 340 Complex ISB indicates that the greatest amount of radioactive material in any 208 L drum generated from 1989 to 1993 was 1.1 E+08 Bq, and 2.7 E+07 Bq in any wooden box (WHC 1994b). The total amount of radioactive material present, using the assumptions given above, is 2.5 E+08 Bq. Assuming that the contamination on the solid waste has the same isotopic distribution as the liquid waste shown in Table 3-1, the amount of each dose-significant isotope can be found. Table 4-6 shows the amount of each dose-significant isotope involved in the fire in addition to the amount made airborne as respirable particles. Note that the concept of dose-significant isotopes is discussed in Section 3.2.

The ARF:RF values applicable to non-volatile radioactive particles involved in solid combustible fire vary from 1 E-02:1.0 to 5 E-04:1.0. The solid waste associated with the 340-C Building satellite accumulation area is packaged in DOT-approved shipping containers. Therefore, the value of 5 E-04:1.0 is used as this value represents the release from packaged wastes. Table 4-6 shows the amount of each dose-significant isotope made airborne and respirable using the stated release fraction and inventory assumptions.

The dose consequences resulting from the fire are calculated by multiplying the quantity made airborne and respirable from Table 4-6 by the appropriate X/Qs and unit doses from Appendix A. Table 4-7 contains the results of the calculations for the onsite receptor and Table 4-8 contains the results for the offsite receptor. Note that credit for plume meander is not taken because it cannot be shown that the release would last longer than 1 hour.

The dose consequences in Tables 4-7 and 4-8 are far below the onsite Safety Class 2 criteria of 5.0 E-02 Sv and the offsite Safety Class 1 criteria of 5.0 E-03 Sv (Table 4-5). Therefore, from the standpoint of a fire involving the solid waste, no Safety Class 1 or 2 barriers are required. Furthermore, if the release fraction of 1 E-02 were used in place of 5 E-04, the dose consequences in Tables 4-7 and 4-8 would be increased by a factor of 20. This would make the onsite dose 1.76 E-04 Sv and the offsite dose 1.6 E-05 Sv, both of which are still well below the applicable safety class criteria.

4.2.2 Toxicological Releases

As shown in Table 4-4, two toxicological release analyses are performed. The analysis of the toxicological consequences of the spray release (Section 4.2.2.1) uses the simplistic spray model developed for the radiological consequences in Section 4.2.1.2. The spill of concentrated nitric acid is analyzed in Section 4.2.2.2.

4.2.2.1 Toxicological Consequences of Spray Leak. A spray release is the resulting accident sequence identified for many hazards in the PHA in Table 4-3. In the PHA the greatest frequency assigned to any hazard resulting in a spray leak is given as "Anticipated" which defines the frequency range of 1 yr^{-1} to 1 E-02 yr^{-1}. However, for the release to occur as modeled, where nitric acid is released (see discussion below and Section 3.2) in conjunction with the transfer of 76 kL of waste, another failure must occur. The administrative control disallowing acidic waste shipments to the 200 Area, or the pH adjustment and testing equipment, must fail before the spray leak can exist as modeled. These sets of failures reduce the likelihood of the spray leak to "Unlikely" which defines the frequency range of 1 E-02 yr^{-1} to 1 E-04 yr^{-1}.

The physical model used here for the spray leak is identical to the spray release model in Section 4.2.1.2 to determine radiological dose consequences. However, the consequence criteria for toxic materials is stated in terms of concentration in air at the receptor location, instead of as the time-integrated dose for radiological materials. This requires the estimation of the release rate from the accident as opposed to the total amount released.

The following assumptions, including the portions of the spray model from Section 4.2.2 which are relevant to the calculation of toxicological consequences, govern the toxicological consequence analysis of the spray leak.

- 76 kL of waste is being transferred from one storage area to another.
- 5% of the waste stream, or 3.8 kL, escapes through the breach.
- The waste stream is under sufficient pressure to cause a spray and not simply a leak.

Using these assumptions, the concentration of the toxic material in the waste, and the flow rate of the waste, the toxicological consequences of the spray leak can be bounded.

The total flow rate of the waste as well as the resulting flow rate of the spray can be estimated from the W-302 FDC and the current operations of the 340 Complex. The FDC calls out the requirement for the transfer pumps to be able to complete a transfer of waste in 1 - 4 hours (WHC 1994a). The 340 Complex ISB indicates a waste transfer rate of 6.3 L/s which corresponds to filling a tank car (76 kL) in 3.3 hours. Because the current operations falls within the specification of the FDC and the proposed pump capacities are unknown, it is assumed that the total waste flow rate is 6.3 L/s. The flow rate of the waste as spray is equal to 5% of the total flow rate or

$$(0.05) \cdot \left(6.3 \frac{L}{s}\right) = 0.32 \frac{L}{s} .$$

With a specific gravity of 1.0 (water), this is 3.2 E+05 mg/s of waste.

The toxic material is conservatively taken to be nitric acid by using assumptions in Section 3.2. The vapor pressure of nitric acid over a solution as weak as the waste (approximately 2% using assumptions of concentration in Section 3.2) is virtually non-existent even at 313 K (40 °C). Therefore, the nitric acid flows where the waste flows and does not volatilize on its own. In looking at the data which generated the ARF:RF of 1 E-04:1.0 for the radiological release, it can be seen that the mass fraction of particles made airborne in a spray from an orifice of 0.016 mm-diameter at 350 kPa is 0.07 (Mishima, et al. 1978). It is assumed that particles greater the 100 μm aerodynamic equivalent diameter (AED) will deposit prior to being released from the facility. Thus, the mass of waste made airborne from the spray is

$$\left(3.2\ E{+}05 \frac{mg}{s}\right) \cdot (0.07) = 2.2\ E{+}04 \frac{mg}{s} .$$

The concentration of the nitric acid in the waste is 34,800 mg/L (Section 3.2). Assuming a specific gravity for the waste of 1.0 (water), this is 3.48 E-02 mg HNO_3/mg waste. Multiplying this number, which is the mass fraction of nitric acid in the waste, by the mass of waste made airborne yields the mass of nitric acid made airborne from the spray. This is

$$\left(2.2\ E{+}04 \frac{mg}{s}\right) \cdot (3.48\ E{-}02) = 770 \frac{mg\ HNO_3}{s} .$$

Using the atmospheric dispersion factor from Table A-1, the concentration at the onsite receptor location is

$$\left(770 \frac{mg}{s}\right) \cdot \left(4.21\ E{-}02 \frac{s}{m^3}\right) = 32 \frac{mg}{m^3} .$$

Using the atmospheric dispersion factor from Table A-3, the offsite receptor concentration is

$$\left(770 \frac{mg}{s}\right) \cdot \left(3.77\ E{-}03 \frac{s}{m^3}\right) = 2.9 \frac{mg}{m^3} .$$

The onsite concentration of 32 mg/m^3 is below the ERPG-3 value of 130 mg/m^3 for nitric acid, which is a Safety Class 2 criterion. The offsite consequence of 2.9 mg/m^3 is below the ERPG-2 value of 65 mg/m^3, which is a Safety Class 1 criterion. Therefore, from the standpoint of a toxic chemical release from the waste, no Safety Class 1 or 2 barriers are required.

4.2.2.2 Toxicological Consequences of Acid Spill. The spill of concentrated nitric acid (from the pH adjustment system) is modeled by the EPI computer code using the assumptions noted below. The EPI code provides chemical-specific consequence analyses of the vaporization and atmospheric transport of hazardous chemicals. The accident scenario assumptions used as input into the EPI code are listed below.

- 208 L (55 gal) of concentrated nitric acid spills onto the floor of the 340-C Building.
- The spill forms an unbound pool with an average depth of 1 cm.
- The solution is 70% by weight nitric acid, which is the typical concentration for industrial "red fuming nitric acid".
- The temperature of the spilled liquid and ambient environment is 40 °C.
- Although the concentration of the pool would decrease as the nitric acid vaporizes, the rate of vaporization is assumed to remain constant until all the nitric acid is gone.
- Vaporization and dispersion of the nitric acid occurs at a windspeed of 1 m/s and Pasquill stability class F.

The downwind concentrations and intermediate values, such as the source term, calculated by the EPI are shown in Appendix D.

The onsite concentration of 33 mg/m^3 is below the ERPG-3 value of 130 mg/m^3 for nitric acid, which is the Safety Class 2 criterion. The offsite concentration (375 m) of 3.7 mg/m^3 is below the ERPG-2 value of 65 mg/m^3 for nitric acid, which is the Safety Class 1 criterion. Therefore, from the standpoint of a concentrated nitric acid spill from the pH adjustment system, no Safety Class 1 or 2 barriers are required.

4.3 ENVIRONMENTAL HAZARD SAFETY CLASSIFICATION

The EHSC analysis is performed in Appendix B and the conclusions presented in this section. The EHSC analysis is performed in accordance with the methodology outlined in WHC-CM-4-46 for potential releases of toxic chemicals and radioactive materials.

As discussed in Section 4.2, the EHSC criteria used in this document are taken from a draft revision to WHC-CM-4-46. The new criteria, shown in Table 4-5, have already been accepted by DOE. Several control manual waivers of the current criteria have already been granted, allowing the use of the new criteria. The approved control manual waiver allowing the use of the new criteria for this PSE is included in Appendix E.

The maximum credible release of toxic chemicals, based on the seismic release model, results in an EHSC value of 2.09 E+05 which is below the Safety Class 2 threshold value of 1.0 E+06 (Table 4-5). Therefore, from the standpoint of environmental impacts from toxic chemical releases, whatever barrier(s) designated to contain the waste are not required to be Safety Class 1 or 2.

The maximum credible release of radioactive materials, also based on the seismic release model, results in an EHSC value of 1.01 E+06 (Appendix B) which exceeds the Safety Class 2 threshold value of 1 E+06 (shown in Table 4-5). This indicates the requirement for at least one Safety Class 2 barrier. Once a Safety Class 2 barrier is designated, the maximum release must be re-analyzed assuming that the designated barrier performs its stated function. If, on the basis of the new analysis, the EHSC value remains above 1 E+06 then an additional Safety Class 2 barrier must be designated. The re-analysis of the release continues, with credit being given to successive barriers as they are identified, until the EHSC value drops below 1 E+06. If only one Safety Class 2 barrier is identified and the EHSC value drops below 1 E+06, then one additional Safety Class 3 barrier must be specified to provide double containment.

According to the safety classification guidelines in WHC-CM-4-46 (WHC 1994d), the safety class designation need only apply to the specific component or function which is called upon. Because the only identified cause of the release analyzed for the vault tanks is a seismic event, whatever barrier is designated as Safety Class 2 would only have to meet the seismic qualifications for that designation. For example, the vault tanks would not have to comply with the Safety Class 2 design criteria for snow loading because the Safety Class 2 designation arises from a seismic event.

4.4 ACCIDENT ANALYSIS SUMMARY

The accidents analyzed, their potential consequences, and the relevant criteria for safety classification are presented in Table 4-9. No consequence analyzed, except for the radiological EHSC value, results in the requirement of Safety Class 1 or 2 items. The radiological EHSC value indicates the requirement of at least one Safety Class 2 barrier to prevent or mitigate the release of radioisotopes to the environment during and following the seismic event.

4.5 PRELIMINARY INVENTORY LIMIT ANALYSIS

The inventory data presented in Section 3.1, which serves as the basis for the accident analysis in this PSE, can be used to define preliminary inventory limits for the W-302 Project. Because the consequences of the accident analysis have been accounted for by the facility design, the inventory used can be applied as limits to facility operations. The limits derived in this PSE are designated as preliminary limits because they represent an initial, conservative attempt to define the safety envelope for the proposed facility. Upon closer examination in future safety documentation (Section 6.0), the limits may be revised (especially for the beta/gamma group) to allow facility operations greater flexibility in the movement and storage of the waste.

To aid in determining conservative and simplistic inventory limits, the isotopes in Table 3-1 are divided into two categories: beta/gamma (non-TRU) and alpha (TRU).

The TRU isotopes are combined in the alpha group by the plutonium equivalent-curie (PE-Ci) method outlined in WHC-EP-0063-4, *Hanford Site Solid Waste Acceptance Criteria*, Appendix C. The PE-Ci method scales all TRU isotopes to ^{239}Pu by using the listed correction factors. Using this concept, an equivalent number of curies of ^{239}Pu is determined for each TRU isotope within inventoryl. Table 4-10 shows the calculations and resulting total PE-Ci/L.

For the beta/gamma (non-TRU) isotopes there is no equivalency methodology which can be used. Therefore, the concentrations of these isotopes are summed and treated as the isotope which has the greatest unit dose in Table A-5, Appendix A. The sum of the concentrations of the beta/gamma isotopes in Table 3-1 is 4.06 E-02 Ci/L. The greatest unit dose of any isotope in Table 3-1, excluding uranium (based on the small fractions of uranium isotopes present, see Table 3-1), is from ^{90}Sr. Thus, beta/gamma is modeled as ^{90}Sr in an assumed concentration of 4.06 E-02 Ci/L.

Table 4-11 shows the beta/gamma and alpha limits associated with the maximum transfer of waste (76 kL based on the spray leak accident) and the maximum total vault storage (121 kL based on the spill accident).

The preliminary inventory limits associated with the waste transfer are used in Appendix C to determine the hazard category of Project W-302. Appendix C contains the full details of that analysis.

Table 4-1. Accident Consequence Severity Levels.

Consequence description	Severity level
May cause deaths onsite or loss of the facility/operation, major injuries or illness offsite, radiation exposure to offsite individuals in excess of annual limits, or severe impact to the environment.	I
May cause severe injury or severe occupational illness onsite, radiation exposure to onsite individuals in excess of annual limits, major damage to a facility/operation, major illness or injury offsite, exposure to offsite individuals to radiation below annual limits, or major impact to the environment.	II
May cause minor injury or minor occupational illness onsite, radiation exposure to onsite individuals below annual limits, negligible impact offsite, or minor impact to the environment. Includes as low as reasonably achievable (ALARA) considerations.	III
Will not result in injury, occupational illness, exposure onsite or offsite, or result in significant impact to the worker. Includes facility operability concerns, such as off-normal events.	IV

Table 4-2. Qualitative Accident Frequency Levels.

Frequency description	Frequency bin	Annual frequency range (yr^{-1})
An off-normal condition that individually may be expected to occur once or more during the facility lifetime.	Anticipated	10^{-2} to 1
Individually the condition is not expected to occur during the plant lifetime, but collectively events in this bin may occur several times.	Unlikely	10^{-4} to 10^{-2}
Extremely low probability conditions that are not expected to occur during the plant lifetime, but represent extreme or limiting cases of faults identified as possible. This bin includes DBAs.	Extremely Unlikely	10^{-6} to 10^{-4}
Accidents for which no credible scenario could be identified.	Incredible	$< 10^{-6}$

Table 4-4. Accidents Analyzed Quantitatively.

Accident	Rationale for further analysis
Radiological: Seismic event	Maximum spill accident, challenges primary containment (tanks) and secondary containment (sump)
Radiological: Spray leak	Maximum generation of aerosols (maximum release fraction), challenges ventilation system, multiple possible release locations
Radiological: Solid waste fire (satellite accumulation area)	Maximum fire accident, only solid waste accident
Toxicological: Spray leak	Maximum generation of aerosols, bounding analysis is only toxicological analysis performed on waste
Toxicological: Acid spill	Maximum vaporization of any hazardous chemical, only chemical spill analysis performed

Table 4-5. Safety Classification Criteria.

Dose, exposure, or value	Indicated safety class
Onsite	
> 5 rem (0.05 Sv) effective dose equivalent (EDE)	2
> ERPG-3	2
Offsite	
> 0.5 rem (0.005 Sv) EDE	1
> ERPG-2	1
Environmental Hazard Safety Classification (EHSC)	
> 1,000,000	2
< 500,000	3*

Note: EDE = effective dose equivalent
ERPG = emergency response planning guideline.
* Assigned only if hazardous materials are present in quantities greater than regulatory, reportable quantities.

Table 4-6. Quantities of Dose-Significant Isotopes in Fire Scenario.

Isotope	Fraction of each isotope in inventory (Table 3-1)	Quantity involved in fire assuming total inventory of 2.5 E+08 Bq (Bq)	Quantity made airborne and respirable assuming ARF of 5 E-04 (Bq)
^{90}Sr	2.18 E-02	5.45 E+06	2.73 E+03
^{152}Eu	9.13 E-02	2.28 E+07	1.14 E+04
^{154}Eu	1.61 E-01	4.03 E+07	2.01 E+04
^{238}Pu	5.53 E-03	1.38 E+06	6.91 E+02
$^{239/240}$Pu	1.18 E-03	2.95 E+05	1.48 E+02
^{240}Pu	1.60 E-03	4.00 E+05	2.00 E+02
^{241}Pu	1.52 E-01	3.80 E+07	1.90 E+04
^{241}Am	1.27 E-02	3.18 E+06	1.59 E+03

Table 4-7. Onsite Dose Consequences from Fire Scenario.

Isotope	Quantity made airborne and respirable (Bq)	Unit dose from Table A-5 (Sv/Bq*m^3/s)	Onsite X/Q from Table A-1 (s/m^3)	Dose consequence (Sv)
^{90}Sr	2.73 E+03	1.16 E-10	4.21 E-02	1.33 E-08
^{152}Eu	1.14 E+04	1.97 E-11	4.21 E-02	9.47 E-09
^{154}Eu	2.01 E+04	2.55 E-11	4.21 E-02	2.16 E-08
^{238}Pu	6.91 E+02	6.27 E-08	4.21 E-02	1.82 E-06
$^{239/240}$Pu	1.48 E+02	6.96 E-08	4.21 E-02	4.32 E-07
^{240}Pu	2.00 E+02	6.96 E-08	4.21 E-02	5.86 E-07
^{241}Pu	1.90 E+04	1.39 E-09	4.21 E-02	1.11 E-06
^{241}Am	1.59 E+03	7.16 E-08	4.21 E-02	4.79 E-06
			Total dose	8.78 E-06

Table 4-8. Offsite Dose Consequences from Fire Scenario.

Isotope	Quantity made airborne and respirable (Bq)	Unit dose from Table A-5 ($Sv/Bq*m^3/s$)	Offsite X/Q from Table A-3 (s/m3)	Dose consequence (Sv)
^{90}Sr	2.73 E+03	1.16 E-10	3.77 E-03	1.19 E-09
^{152}Eu	1.14 E+04	1.97 E-11	3.77 E-03	8.48 E-10
^{154}Eu	2.01 E+04	2.55 E-11	3.77 E-03	1.93 E-09
^{238}Pu	6.91 E+02	6.27 E-08	3.77 E-03	1.63 E-07
$^{239/240}Pu$	1.48 E+02	6.96 E-08	3.77 E-03	3.87 E-08
^{240}Pu	2.00 E+02	6.96 E-08	3.77 E-03	5.25 E-08
^{241}Pu	1.90 E+04	1.39 E-09	3.77 E-03	9.96 E-08
^{241}Am	1.59 E+03	7.16 E-08	3.77 E-03	4.29 E-07
			Total dose	7.87 E-07

Table 4-9. Accidents Analysis Summary.

Accident	Consequence	Criterion
Seismic event:	onsite: 3.8 E-03 Sv offsite: 3.4 E-04 Sv	>5 E-02 Sv is Safety Class 2 >5 E-03 Sv is Safety Class 1
Spray leak (rad):	onsite: 1.3 E-02 Sv offsite: 1.1 E-03 Sv	>5 E-02 Sv is Safety Class 2 >5 E-03 Sv is Safety Class 1
Solid waste fire:	onsite: 8.78 E-06 Sv offsite: 7.87 E-07 Sv	>5 E-02 Sv is Safety Class 2 >5 E-03 Sv is Safety Class 1
Spray leak (tox):	onsite: 32 mg/m^3 offsite: 2.9 mg/m^3	>ERPG-3 (130 mg/m^3) is Safety Class 2 >ERPG-2 (65 mg/m^3) is Safety Class 1
Acid spill (tox):	onsite: 33 mg/m^3 offsite: 3.7 mg/m^3	>ERPG-3 (130 mg/m^3) is Safety Class 2 >ERPG-2 (65 mg/m^3) is Safety Class 1
EHSC:	Radiological: 1.01 E+06 Toxicological: 2.09 E+05	>1 E+06 Safety Class 2 >1 E+06 Safety Class 2

Table 4-10. Plutonium Equivalent Curies per Liter for TRU Isotopes.

Isotope	Inventory from Table 3-1 (Ci/L)	Correction factors from WHC-EP-0063-4, Table C-2	Inventory (PE-Ci/L)
^{238}Pu	2.72 E-04	1/1.1	2.47 E-04
$^{239/240}$Pu	5.81 E-05	1	5.81 E-05
^{240}Pu	7.85 E-05	1	7.85 E-05
^{241}Pu	7.48 E-03	1/52	1.44 E-04
^{242}Pu	2.35 E-07	1/1.1	2.14 E-07
^{241}Am	6.26 E-04	1	6.26 E-04
$^{243/244}$Cm	1.67 E-06	1/1.9	8.79 E-07
		Total:	1.15 E-03

Table 4-11. Preliminary Inventory Limits for W-302.

Isotope	Inventory concentration (Ci/L)	Inventory limit for waste transfers (76 kL) (Ci)	Inventory limit for total vault storage (121 kL) (Ci)
Beta/gamma	4.06 E-02	3.09 E+03	4.91 E+03
Alpha	1.15 E-03	8.74 E+01	1.39 E+02

5.0 CONSTRUCTION RISKS

This section is intended to address the potential risks arising from construction activities associated with Project W-302. To this end, a PHA table (Table 5-1), similar to Table 4-3 for operations, is used to identify and evaluate construction hazards.

The construction PHA uses the same format and methodology, including definitions for qualitative frequency and consequence levels, as presented for the operations PHA in Section 4.1. The predominant construction hazards are typical of construction hazards in industry. Unlike industrial hazards, however, the possibility of unearthing buried contamination and possible impacts to adjacent nuclear buildings (340-A, 340-B, and 340 tank vault) requires the identification and evaluation of hazards.

Although several hazards are identified in the construction PHA, such as the loss of the 340-A tanks, no accident sequences are developed and quantitatively analyzed. The accident sequences analyzed in Section 4.2 bound any accidents which might occur during construction.

Table 5-1. Facility Preliminary Hazards Analysis, Construction Mode. (4 sheets)

Hazard/energy source	Cause(s)/accident sequence(s)	Major effects	Preventative/mitigative features		Consequence level	Annual frequency level	Comments
			Engineered	Administrative			
1 Fires/ Explosions	1.1 Range fire	None	1.1 A Facility is located within 300 Area where gravel and pavement preclude damage to facilities by range fires	1.1.B Emergency response procedures for local fire departments and operations personnel place the facility into a safe configuration	IV	EXTREMELY UNLIKELY	Frequency assigned on basis of fire penetrating 300 Area and impacting the 340 Complex.
	1.2 LPG explosion	LPG tank used to power equipment is heated and/or leaks and explodes Possible consequences include injury to facility worker	--	1.2.A Hanford Fire Department response 1.2.B LPG tank storage is away from operating equipment 1.2.C Inspections and testing of LPG tanks 1.2.D LPG tank storage area away from 340 Complex 1.2.E Construction site separated from 340 Complex by barriers (keeping equipment away from buildings)	Not analyzed	Not analyzed	Hazard poses no exceptional radiological or toxicological threat. Industrial accidents are covered by standard industrial safety programs.
	1.3 Vehicle or vehicle fuel fire	Vehicle operating during construction catches on fire, or diesel or gasoline spill from vehicle results in fire Possible consequences include injury to facility worker	--	1.3.A See 1.2.A 1.3.B Regular maintenance on vehicles 1.3.C See 1.2.E	Not analyzed	Not analyzed	Hazard poses no exceptional radiological or toxicological threat. Industrial accidents are covered by standard industrial safety programs.
2 Potential/ Kinetic Energy	2.1 Construction equipment failure, industrial	Construction equipment failure resulting from either mechanical deficiencies or human error (includes industrial accidents pertaining to construction activities) Possible consequences include injury to facility worker	--	2.1.A Standard industrial safety programs	Not Analyzed	Not Analyzed	Hazard poses no exceptional radiological or toxicological threat. Industrial accidents are covered by standard industrial safety programs.

Table 5-1. Facility Preliminary Hazards Analysis, Construction Mode. (4 sheets)

Hazard/energy source	Cause(s)/accident sequence(s)	Major effects	Preventative/mitigative features		Consequence level	Annual frequency level	Comments
			Engineered	Administrative			
	2.2 Construction equipment mechanical failure, adjacent facility impact	Construction equipment mechanical failure results in impact to 340-A, 340-B, and/or 340 Building plus tank vault Possible consequences include loss of facility, death/injury to facility worker, and release of radionuclides	--	2.2.A. Equipment inspection and maintenance procedures	I for loss of facility and death to facility worker II for damage to facility and injury to facility worker III for all other effects	EXTREMELY UNLIKELY	Frequency based on mechanical failure of equipment and hypothesized damage configuration.
	2.3 Construction equipment human error, adjacent facility impact	Human error results in construction equipment impact to 340-A, 340-B, and/or 340 Building plus tank vault Possible consequences include loss of facility, death/injury to facility worker, and release of radionuclides	--	2.3.A Operator certification required for operation of heavy equipment	I for loss of facility and death of facility worker II for damage to facility and injury to facility worker III for all other effects	UNLIKELY	Frequency based on human error and hypothesized damage configuration.
	2.4 Collapse of excavation area	Collapse of hole dug for new vault Possible consequences include loss of adjacent facility (340-A, 340-B, or 340 Building), death/injury to facility worker, and release of radionuclides	2.4.A Shoring to maintain integrity of pit walls	2.4.B Operator certification required for operation of heavy equipment (which might cause the failure of the shoring)	I for loss of facility and death of facility worker II for damage to facility and injury to facility worker III for all other effects	UNLIKELY	Frequency based on human error (failing shoring) and hypothesized damage configuration (proximity of pit to adjacent buildings).

Table 5-1. Facility Preliminary Hazards Analysis, Construction Mode. (4 sheets)

Hazard/energy source	Cause(s)/accident sequence(s)	Major effects	Preventative/mitigative features		Consequence level	Annual frequency level	Comments
			Engineered	Administrative			
3 Radiation	3.1 Discovery of contamination	Construction activities unexpectedly unearth contamination Possible consequences include the spread of contamination	--	3.1.A Health physics technicians monitor workers, equipment, and construction area for signs of contamination 3.1.B Testing and sampling (characterization) of construction area prior to construction 3.1.C Cessation of construction activities following discovery of unexpected contamination	III	UNLIKELY	--
	3.2 Discovery of buried equipment, components, etc.	Construction activities unexpectedly unearth buried process equipment, structural components, waste containers, etc. Possible consequences include the release of toxic materials and release of radionuclides	--	3.2.A See 3.1.A, B, and C	III	UNLIKELY	--
4 Natural Phenomena	4.1 Seismic event	Seismic event occurs during construction activities Possible consequences includes death/injury to facility worker	--	--	Not analyzed	Not analyzed	Hazard poses no exceptional radiological or toxicological threat. Industrial accidents are covered by standard industrial safety programs.
	4.2 High winds	High winds impact construction activities Possible consequences includes injury to facility worker	--	4.2.A Construction activities halt under conditions of extreme winds	Not analyzed	Not analyzed	Hazard poses no exceptional radiological or toxicological threat. Industrial accidents are covered by standard industrial safety programs.

Table 5-1. Facility Preliminary Hazards Analysis, Construction Mode. (4 sheets)

Hazard/energy source	Cause(s)/accident sequence(s)	Major effects	Preventative/mitigative features		Consequence level	Annual frequency level	Comments
			Engineered	Administrative			
	4.3 Wind-driven missiles	High winds generate wind-driven missiles Possible consequences include death/injury to facility worker and impact to 340 Complex (release of radionuclides)	4.3.A 340 Complex structures, systems, and components designed to withstand impacts	4.3.B Good housekeeping procedures reduce the materials available for missile generation 4.3.C See 4.2.A	I for death of facility worker II for injury to facility worker III for all other effects	UNLIKELY for all effects	Hazard poses no exceptional threat (beyond industrial hazards) to the construction activities. However, construction activities increase the likelihood of wind-drive missiles impacting the 340 Complex.
	4.4 Flooding	Construction area is inundated by the PMF of the Columbia River	--	--	Not Analyzed	Not analyzed	The 340-C Building elevation of 117 m (384.5 ft) is higher than the PMF (CH2M Hill 1994)
	4.5 Tornado	Tornado impacts construction area Possible consequences includes death/injury to facility worker	--	--	Not analyzed	Not analyzed	Hazard poses no exceptional radiological or toxicological threat. Industrial accidents are covered by standard industrial safety programs.
	4.6 Heavy snowfall	Snow accumulates on construction equipment and structures Possible consequences includes facility worker injury	--	--	Not analyzed	Not analyzed	Hazard poses no exceptional radiological or toxicological threat. Industrial accidents are covered by standard industrial safety programs.
	4.7 Heavy ashfall	Ash from volcanic activity accumulates on construction equipment and structures Possible consequences includes injury to facility worker	--	--	Not analyzed	Not analyzed	Hazard poses no exceptional radiological or toxicological threat. Industrial accidents are covered by standard industrial safety programs.

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6.0 SAFETY DOCUMENTATION

As a proposed nuclear facility proceeds through the design stages and into operation, DOE requirements stipulate the need for safety documentation addressing the adequacy of the design and operations. The PSE is the first safety document in the project life cycle which is intended to fulfill the requirements of the DOE orders. Ordinarily, the PSE is followed in turn by the preliminary safety analysis report (PSAR) and the FSAR.

The PSE serves as an attachment to the CDR of the project, fulfilling the functions detailed in Section 1.0. The PSE is the first formal safety analysis input into the design of the project, and serves primarily to identify major safety concerns and issues related to the project.

The PSAR serves as input into the final design of the project and must be approved by the DOE prior to the start of construction. The PSAR analyzes the definitive design of the project in detail, identifying safety class items, evaluating the adequacy of the design, identifying issues that require further resolution in the FSAR.

In the case of the 340 Complex, an ISB (currently in draft) will serve as the authorization basis until an FSAR, compliant with DOE Order 5480.23, can be completed. Project W-302 will not have an individual FSAR prior to commencement of operations, but instead the new configuration will be incorporated in the 340 Complex ISB. The new configuration will also be reflected in the new, DOE Order 5480.23-compliant FSAR for the 340 Complex.

As the project proceeds into facility operation, other specialized safety analyses may be performed and documented outside of the PSE, PSAR, and ISB. These other documents may explore specific safety issues, such as atmospheric dispersion, inventory limits, or criticality. These documents can then be used as reference material for the more formal PSE, PSAR, ISB, and FSAR.

After commencement of operations, changes in facility operating parameters or configuration require assessment for potential hazards. The unreviewed safety question (USQ) procedure provides the mechanism for screening proposed changes for impacts to facility safety. The required updates can then be incorporated into the authorization basis of the facility (i.e., the ISB or FSAR) via page changes or engineering change notices (ECNs).

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7.0 PROJECT INTERFACES

Project W-302, when completed, will serve as an upgrade to the 340 Complex. W-302 will tie into and use the existing tanks in the 340-A Building, the railroad tankcar loadout facility (340-B East), the RLWS, and the RPS. The 307 Basins (upgraded under a different project) will continue to serve for retention of potentially contaminated wastes from the RPS until that waste stream has been adequately tested. The RLWS will continue to be the primary source of waste entering the 340 Complex.

Because operations of the 340 Complex will continue essentially unaltered, except for retention of wastes for longer than 90 days, the facilities upstream and downstream will be the same as for current operations. The waste generators will continue to be the 324, 325, 326, 327, and 329 Buildings. The liquid waste will continue to be shipped to the 200 Area Tank Farms for long-term storage, and the solid waste shipped to the Central Waste Complex (CWC).

The safety documentation efforts associated with the W-302 Project will continue to be organized through the safety analysis group in the Westinghouse Hanford Company. As necessary, the safety analysis group will interface with projects, design, operations, and Pacific Northwest Laboratories (PNL) personnel to facilitate the timely completion of all requested safety documentation efforts. All efforts shall be made to simplify the anticipated incorporation of the Project W-302 safety documentation into the 340 Complex ISB or FSAR.

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8.0 ITEMS REQUIRING FURTHER RESOLUTION

8.1 PRELIMINARY HAZARDS ANALYSIS UPDATE

Future safety documentation for the W-302 Project should consider the use of a maintenance-mode PHA as detailed design emerges. This PHA, if deemed necessary or beneficial, would be in addition to updates of the existing PHAs in this PSE.

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9.0 REFERENCES

CH2M Hill 1994, *Project L045H Hanford 300 Area Treated Effluent Disposal Facility Engineering Summary Report*, CH2M Hill Company, Richland, Washington.

DOE 1993, *Recommended Values and Technical Bases for Airborne Release Fractions (ARFs), Airborne Release Rates (ARRs), and Respirable Fractions (RFs) at DOE non-Reactor Nuclear Facilities*, DOE-HDBK-0013-93,U.S. Department of Energy, Washington, D.C.

EPA 1988, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, EPA-520/1-88-020, Office of Radiation Programs, United States Environmental Protection Agency, Washington, D.C.

Mishima, et al. 1978, *Increment of Analysis An Estimate of Airborne Release of Plutonium from Babcock and Wilcox Plant as a Result of Severe Wind Hazard and Earthquake*, PNL-2812, Pacific Northwest Laboratories, Richland, Washington.

Napier, et al. 1988, *GENII - The Hanford Environmental Dosimetry Software System*, PNL-6584,Richland, Washington.

NRC 1982, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants*, Regulatory Guide 1.145, Rev 1, United States Nuclear Regulatory Commission, Washington, D.C. 20555.

NRC 1990, *MELCOR Accident Consequence Code System (MACCS), Model Description*, NUREG/CR-4691, SAND86-1562, Vol. 2, United States Nuclear Regulatory Commission, Washington, D.C. 20555.

WHC 1992, *Safety Analysis and Engineering Work Procedures*, WHC-CM-6-32, Westinghouse Hanford Company, Richland, Washington.

WHC 1993a, *GXQ Program Users' Guide*, WHC-SD-GN-SWD-30002, Westinghouse Hanford Company, Richland, Washington.

WHC 1993b, *GXQ Program Validation and Verification*, WHC-SD-GN-SWD-30003, Westinghouse Hanford Company, Richland, Washington.

WHC 1994a, *Functional Design Criteria for the 340 Radioactive Liquid Waste Storage Facility Upgrade: Project W-302*, WHC-SD-W302-FDC-001, Rev 0, Westinghouse Hanford Company, Richland, Washington.

WHC 1994b, *340 Waste Handling Facility Interim Safety Basis*, Draft, WHC-SD-WM-ISB-003, Rev 0,, Westinghouse Hanford Company, Richland, Washington.

WHC 1994c, *Criticality Safety Evaluation Report for 340 Facility*, Draft, WHC-SD-SQA-CSA-20379, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DOE Order 5400.5, *Radiation Protection of Public and Environment*, U.S. Department of Energy, Washington, D.C.

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

DOE Order 5480.11, *Radiation Protection of Occupational Worker*, U.S. Department of Energy, Washington, D.C.

DOE Order 5480.22, *Technical Safety Requirements*, U.S. Department of Energy, Washington, D.C.

DOE Order 5480.23, *Nuclear Safety Analysis Reports*, U.S. Department of Energy, Washington, D.C.

DOE Order 5820.2A, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C.

DOE Order 6430.1A, *General Design Criteria*, U.S. Department of Energy, Washington, D.C.

WHC-CM 1-3, *Management Requirements and Procedures*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-46, *Safety Analysis Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-6-2, *Project Management Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-6-32, *Safety Analysis and Engineering Work Procedures*, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A

ATMOSPHERIC DISPERSION AND UNIT DOSE CALCULATIONS

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ATMOSPHERIC DISPERSION AND UNIT DOSE CALCULATIONS

The purpose of this appendix is to support the Project W-302 PSE by providing the inputs into the accident analysis for atmospheric dispersion and unit dose consequences. In addition to the basis and results of the calculations, the methodology by which dose consequences are estimated is outlined.

For the purposes of accident analysis, dose consequences may be calculated by selecting the appropriate dispersion factor from Tables A-1 through A-4 and multiplying by the unit doses in Table A-5 and the quantity of each isotope made airborne as respirable particles.

ATMOSPHERIC DISPERSION

The dispersion model used in this analysis is the gaussian plume model with and without correction for the phenomenon of plume meander. The basic gaussian plume model is the accepted dispersion model for acute and chronic releases of hazardous materials. The gaussian model, however, yields overly conservative results for long release durations because of shifting winds within a sector. Therefore, additional calculations are made to include the use of a plume meander model to correct the gaussian model.

The gaussian and plume meander models used in this analysis are implemented by the GXQ code (WHC 1993a), using Hanford site-specific meteorology. The GXQ code uses the U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.145 (NRC 1982) methodology for estimating X/Q values. The maximum 99.5% X/Q for the sixteen compass sectors is compared to the overall average 95% X/Q and the largest of the 17 values used for the purposes of accident analysis. The GXQ code also implements the NRC plume meander model (NRC 1982), which is appropriate for release durations exceeding approximately one hour.

RECEPTOR AND DOSE ASSUMPTIONS

The maximum onsite receptor is assumed to be 100 m from the release location (WHC 1994d) for the duration of the passage of the plume. 100 m can be expected to be the point of maximum onsite dose because the release is not elevated and no plume rise is modeled nor anticipated. The onsite dispersion model results are contained in Table A-1 for the baseline X/Qs (without plume meander) and Table A-2 for the X/Qs with plume meander.

The maximum offsite receptor is assumed to be located at the Hanford Site boundary for the duration of the passage of the plume (WHC 1994d). In the sectors where the Hanford Site boundary coincides with the Columbia River, the near side of the river is used as the receptor location. The maximum offsite dose can be expected to be at the Hanford Site boundary because the release is not elevated and no plume rise is modeled nor anticipated. The offsite dispersion model results are contained in Table A-3 for the baseline X/Qs (without plume meander) and Table A-4 for the X/Qs with plume meander.

The exposure-to-dose conversion factors used in this analysis are taken from *Limiting Values of Radionuclide Intake and Air Concentrations and Dose Conversion Factors for Inhalation, Submersion, and Ingestion* (EPA 1988). The dose conversion factors reported in Table A-5 are the controlling inhalation dose conversion factors for those isotopes specified in Table 2-1 of the 340 Complex ISB (WHC 1994b). ^{90}Y, while not in Table 2-1 of the ISB, is included here as a daughter product in equilibrium with ^{90}Sr. For each isotope the controlling dose factor is reported regardless of the lung-clearance class or the maximum organ. In the cases where the dose to the maximum organ is controlling, one-tenth of the dose conversion factor is used so that organ doses may be combined with effective doses for comparison to criteria. One-tenth is used because all applicable dose criteria are multiplied by ten for comparison to maximum organ doses. Ingestion doses are not considered in this report because all criteria are applicable only to the airborne dose pathway. Submersion doses are not considered because the submersion dose pathway constitutes a negligible portion of the overall dose consequences.

The breathing rate used in this analysis, 3.3 E-04 m^3/s, is the same value as used in the GENII dosimetry code (Napier 1988). This value is the standard value used in accident analyses.

RESULTS

Tables A-1 through A-5 contain the results of the atmospheric dispersion and unit dose calculations.

Tables A-1, A-2, A-3, and A-4 contain the atmospheric dispersion factors (X/Qs) for the onsite and offsite receptors. If the release duration exceeds approximately one hour then the dispersion factors which include the effects of plume meander (Tables A-2 and A-4) should be used. Otherwise, the baseline dispersion factors (Tables A-1 and A-3) should be used. In addition, the baseline dispersion factors (Tables A-1 and A-3) should be used for all toxicological releases, regardless of release duration. In each table (A-1 through A-4) the maximum dispersion factor is denoted by an asterisk (*) indicating the value which should be used in consequence analyses.

Table A-5 contains a list of the isotopes analyzed (WHC 1994a) and their inhalation dose conversion factors (EPA 1988). The unit dose reported is the inhalation dose conversion factor times the assumed breathing rate.

Table A-1. Baseline Onsite (100 m) X/Qs (Without Plume Meander).

Sector	Wind speed (m/s)	Pasquill stability class	X/Q (s/m^3)
South	0.89	F	3.18 E-02
South-southwest	2.65	F	1.16 E-02
Southwest	7.15	F	4.39 E-03
West-southwest	0.89	C	3.88 E-03
West	0.89	E	1.51 E-02
West-northwest	2.65	G	2.90 E-02
Northwest	0.89	F	3.28 E-02
North-northwest	0.89	F	3.29 E-02
North	0.89	F	4.21 E-02*
North-northeast	2.65	G	2.89 E-02
Northeast	2.65	G	2.93 E-02
East-northeast	4.70	G	1.60 E-02
East	0.89	F	3.16 E-02
East-southeast	2.65	G	2.99 E-02
Southeast	0.89	F	3.16 E-02
South-southeast	0.89	F	3.23 E-02
95% Site-wide			3.44 E-02

* Indicates the maximum X/Q

Table A-2. Onsite (100 m) X/Qs With Plume Meander.

Sector	Windspeed (m/s)	Pasquill stability class	X/Q (s/m^3)
South	4.70	G	1.08 E-02*
South-southwest	4.70	F	4.83 E-03
Southwest	4.70	E	2.27 E-03
West-southwest	4.70	E	2.27 E-03
West	0.89	E	5.08 E-03
West-northwest	0.89	F	8.11 E-03
Northwest	0.89	F	8.54 E-03
North-northwest	0.89	F	8.41 E-03
North	7.15	G	9.90 E-03
North-northeast	0.89	F	8.30 E-03
Northeast	0.89	F	8.44 E-03
East-northeast	2.65	G	7.13 E-03
East	0.89	F	8.13 E-03
East-southeast	2.65	G	7.79 E-03
Southeast	0.89	F	8.14 E-03
South-southeast	0.89	F	8.88 E-03
95% Site-wide			8.61 E-03

* Indicates the maximum X/Q

Table A-3. Baseline Offsite X/Qs (Without Plume Meander).

Sector	Distance (m)	Wind speed (m/s)	Pasquill stability class	X/Q (s/m^3)
South	6,475	0.89	F	4.25 E-05
South-southwest	2,590	2.65	F	5.36 E-05
Southwest	3,515	7.15	F	1.32 E-05
West-southwest	3,515	4.70	E	1.01 E-05
West	6,575	0.89	E	1.88 E-05
west-northwest	28,675	2.65	G	6.02 E-06
Northwest	49,025	0.89	F	3.54 E-06
North-northwest	51,800	0.89	F	3.33 E-06
North	17,020	0.89	F	1.65 E-05
North-northeast	505	2.65	G	1.83 E-03
Northeast	505	2.65	G	1.85 E-03
East-northeast	345	4.70	G	1.90 E-03
East	345	2.65	G	3.77 E-03*
East-southeast	345	2.65	G	3.58 E-03
Southeast	535	0.89	F	1.81 E-03
South-southeast	830	0.89	F	8.89 E-04
95% Site-wide				1.51E-03

* Indicates the maximum X/Q

Table A-4. Offsite X/Qs With Plume Meander.

Sector	Distance (m)	Wind speed (m/s)	Pasquill stability class	X/Q (s/m^3)
South	6,475	0.89	F	2.95 E-05
South-southwest	2,590	2.65	F	3.37 E-05
Southwest	3,515	2.65	E	1.01 E-05
West-southwest	3,515	4.70	E	8.60 E-06
West	6,575	0.89	E	1.45 E-05
west-northwest	28,675	2.65	G	5.42 E-06
northwest	49,025	0.89	F	3.30 E-06
North-northwest	51,800	0.89	F	3.12 E-06
North	17,020	0.89	F	1.35E-05
North-northeast	505	0.89	F	5.23 E-04
Northeast	505	0.89	F	5.32 E-04
East-northeast	345	2.65	G	8.51 E-04
East	345	0.89	F	9.73 E-04*
East-southeast	345	2.65	G	9.32 E-04
Southeast	535	0.89	F	4.66 E-04
South-southeast	830	0.89	F	2.49 E-04
95% Site-wide				4.93 E-04

* Indicates the maximum X/Q

Table A-5. Unit Doses. (2 Sheets)

Isotope	Inhalation dose conversion factor (Sv/Bq)	Unit dose with breathing rate of 3.3E-04 m^3/s ($Sv/Bq*m^3/s$)
^{54}Mn	1.81 E-09	5.97 E-13
^{60}Co	5.91 E-08	1.95 E-11
^{90}Sr	3.51 E-07	1.16 E-10
^{90}Y	2.13 E-09	7.03 E-13
^{95}Zr	1.03 E-08	3.40 E-12
^{95}Nb	1.57 E-09	5.18 E-13
^{99}Tc	2.25 E-09	7.43 E-13
^{106}Ru	1.29 E-07	4.26 E-11
^{125}Sb	3.30 E-09	1.09 E-12
^{134}Cs	1.25 E-08	4.13 E-12
^{137}Cs	8.63 E-09	2.85 E-12
^{144}Ce	1.01 E-07	3.33 E-11
^{152}Eu	5.97 E-08	1.97 E-11
^{154}Eu	7.73 E-08	2.55 E-11
^{155}Eu	1.52 E-08	5.02 E-12
^{182}Ta	1.21 E-08	3.99 E-12
^{234}U	3.58 E-05	1.18 E-08
^{235}U	3.32 E-05	1.10 E-08
^{236}U	3.39 E-05	1.12 E-08
^{238}U	3.20 E-05	1.06 E-08
^{238}Pu	1.90 E-04	6.27 E-08
$^{239/240}$Pu*	2.11 E-04	6.96 E-08
^{240}Pu	2.11 E-04	6.96 E-03
^{241}Pu	4.20 E-06	1.39 E-09
^{242}Pu	2.01 E-04	6.63 E-08
^{241}Am	2.17 E-04	7.16 E-08
$^{243/244}$Cm**	1.47 E-04	4.85 E-08

* These isotopes have the same controlling dose conversion factor.
** The greater dose conversion factor is used.

```
                    GXQ Version 3.1 C
                     June 8, 1993

General Purpose Atmospheric Dispersion Code
Produced by Radiological & Toxicological Analysis
Westinghouse Hanford Company

Users Guide documented in WHC-SD-GN-SWD-3002 Rev. 0.
Validation documented in WHC-SD-GN-SWD-3003 Rev. 0.
Code Custodian is Brit E. Hey, WHC, ext. 6-2921.

Run Date = 12/16/1994
Run Time = 17: 1 20.15


INPUT ECHO:
--- W-302, Onsite, With Plume Meander  ---
c GXQ Ver. 3.1 Input File
c   mode
    1
c
c MODE CHOICE:
c mode = 1 then X/Q based on Hanford site specific meteorology
c mode = 2 then X/Q based on atmospheric stability class and wind speed
c mode = 3 then X/Q plot file is created
c
c LOGICAL CHOICES:
c   ifox  inorm icdf  ichk  isite ipop  icon
    T     F     F     F     F     F     F
c ifox  = t then joint frequency used to compute frequency to exceed X/Q
c       = f then joint frequency used to compute annual average X/Q
c inorm = t then joint frequency data is normalized (as in GENII)
c       = f then joint frequency data is un-normalized
c icdf  = t then cumulative distribution file created (CDF.OUT)
c       = f then no cumulative distribution file created
c ichk  = t then X/Q parameter print option turned on
c       = f then no parameter print
c isite = t then X/Q based on joint frequency data for all 16 sectors
c       = f then X/Q based on joint frequency data of individual sectors
c ipop  = t then X/Q is population weighted
c       = f then no population weighing
c icon  = t then X/Q is air concentration
c       = f then X/Q is integrated exposure
c
c MODEL CHOICES:
c   idep  iwake ipm   irise igrav iwash iflow iwind
    0     0     1     0     0     0     0     0
c idep  = 1 then plume depletion model turned on (Chamberlain model)
c iwake = 1 then NRC RG 1.145 building wake model turned on
c       = 2 then MACCS virtual distance building wake model turned on
c ipm   = 1 then NRC RG 1.145 plume meander model turned on
c       = 2 then 5th Power Law plume meander model turned on
```

```
c       = 3 then sector average model turned on
c irise = 1 then momentum/buoyancy plume rise model turned on, buoyancy
c           rise based on sensible heat emission
c       = 2 then momentum/buoyancy plume rise model turned on, buoyancy
c           rise based on initial plume density
c igrav = 1 then gravitational settling model turned on
c iwash = 1 then stack downwash model turned on
c iflow = 1 then sigmas adjusted for volume flow rate
c iwind = 1 then wind speed corrected for plume height
c       = 0 to turn any of the above models off
c
c PARAMETER INPUT:
c   stack          wind                          frequency
c   release        speed          mixing         to             scaling
c   height         height         height         exceed         factor
c   (m)            (m)            (m)            (%)            (?)
    0.00000E+00    1.00000E+01    1.00000E+03    5.00000E-01    1.00000E+00
c
c                                                               gravitational
c   building       building       release        deposition     settling
c   width          height         duration       velocity       velocity
c   (m)            (m)            (hr)           (m/s)          (m/s)
    0.00000E+00    0.00000E+00    1.00000E+00    1.00000E-03    1.00000E-03
c
c                  initial                       sensible
c   initial        plume                         heat
c   plume          flow           stack          emission
c   density        rate           diameter       rate
c   (g/cc)         (m3/s)         (m)            (cal/s)
    4.40000E-04    7.90000E-01    1.00000E+00    2.20000E+07
c
c RECEPTOR DEPENDENT DATA
c FOR MODE     make          RECEPTOR DEPENDENT DATA
c 1 (site specific)          sector distance z-height
c 2 (by class & wind speed) class windspeed distance offset z-height
c 3 (create plot file)       class windspeed xmax imax ymax jmax xqmin power
c
c RECEPTOR PARAMETER DESCRIPTION:
c sector = 0, 1, 2... (all, S, SSW, etc.)
c distance = meters
c class = 1, 2, 3, 4, 5, 6, 7 (P-G stability class A, B, C, D, E, F, G)
c windspeed = m/s
c offset = meters offset from plume centerline
c xmax = maximum distance to plot or calculate to (m)
c imax = distance intervals
c ymax = maximum offset to plot (m)
c jmax = offset intervals
c xqmin = minimum scaled X/Q to calculate
c power = exponent in power function step size

MODE:
Site specific X/Q calculated

LOGICAL CHOICES:
Joint frequency used to calculate X/Q based on
```

frequency of exceedance.
No normalization of joint frequency.
X/Q calculated for single sector.
Output is atmospheric dispersion coefficient.

MODELS SELECTED:
NRC RG 1.145 plume meander

WARNING/ERROR MESSAGES:

JOINT FREQUENCY DATA:
300 AREA - 10 M - Pasquill A - G (1983 - 1991 Average)
Created 8/26/92 KR

--- W-302, Onsite, With Plume Meander ---

SECTOR	DISTANCE (m)	RECEPT HEIGHT (m)	SECT. FREQ. (%)	POPULATION	TOTAL POPULATION SCALED X/Q (s/m3)	AVERAGE INDIVIDUAL SCALED X/Q (s/m3)	ATM. STAB. CLASS	WIND SPEED (m/s)
S	100	0	11.55	1	1.08E-02	1.08E-02	G	4.70
SSW	100	0	5.07	1	4.83E-03	4.83E-03	F	4.70
SW	100	0	2.39	1	2.27E-03	2.27E-03	E	4.70
WSW	100	0	1.82	1	2.27E-03	2.27E-03	E	4.70
W	100	0	4.20	1	5.08E-03	5.08E-03	E	.89
WNW	100	0	6.49	1	8.11E-03	8.11E-03	F	.89
NW	100	0	8.60	1	8.54E-03	8.54E-03	F	.89
NNW	100	0	5.97	1	8.41E-03	8.41E-03	F	.89
N	100	0	8.76	1	9.90E-03	9.90E-03	G	7.15
NNE	100	0	8.50	1	8.30E-03	8.30E-03	F	.89
NE	100	0	9.64	1	8.44E-03	8.44E-03	F	.89
ENE	100	0	6.13	1	7.13E-03	7.13E-03	G	2.65
E	100	0	4.55	1	8.13E-03	8.13E-03	F	.89
ESE	100	0	2.86	1	7.79E-03	7.79E-03	G	2.65
SE	100	0	5.20	1	8.14E-03	8.14E-03	F	.89
SSE	100	0	7.95	1	8.88E-03	8.88E-03	F	.89

Execution Time = 0 hr 0 min 1.04 sec
Stop - Program terminated.

GXQ Version 3.1 C
June 8, 1993

General Purpose Atmospheric Dispersion Code
Produced by Radiological & Toxicological Analysis
Westinghouse Hanford Company

Users Guide documented in WHC-SD-GN-SWD-3002 Rev. 0.
Validation documented in WHC-SD-GN-SWD-3003 Rev. 0.
Code Custodian is Brit E. Hey, WHC, ext. 6-2921.

Run Date = 12/17/1994
Run Time = 12:48 44.34

```
INPUT ECHO:
--- W-302, Offsite, With Plume Meander  ---
c GXQ Ver. 3.1 Input File
c   mode
    1
c
c MODE CHOICE:
c mode = 1 then X/Q based on Hanford site specific meteorology
c mode = 2 then X/Q based on atmospheric stability class and wind speed
c mode = 3 then X/Q plot file is created
c
c LOGICAL CHOICES:
c   ifox  inorm icdf  ichk  isite ipop  icon
    T     F     F     F     F     F     F
c ifox  = t then joint frequency used to compute frequency to exceed X/Q
c       = f then joint frequency used to compute annual average X/Q
c inorm = t then joint frequency data is normalized (as in GENII)
c       = f then joint frequency data is un-normalized
c icdf  = t then cumulative distribution file created (CDF.OUT)
c       = f then no cumulative distribution file created
c ichk  = t then X/Q parameter print option turned on
c       = f then no parameter print
c isite = t then X/Q based on joint frequency data for all 16 sectors
c       = f then X/Q based on joint frequency data of individual sectors
c ipop  = t then X/Q is population weighted
c       = f then no population weighing
c icon  = t then X/Q is air concentration
c       = f then X/Q is integrated exposure
c
c MODEL CHOICES:
c   idep  iwake ipm   irise igrav iwash iflow iwind
    0     0     1     0     0     0     0     0
c idep  = 1 then plume depletion model turned on (Chamberlain model)
c iwake = 1 then NRC RG 1.145 building wake model turned on
c       = 2 then MACCS virtual distance building wake model turned on
c ipm   = 1 then NRC RG 1.145 plume meander model turned on
c       = 2 then 5th Power Law plume meander model turned on
```

```
c       = 3 then sector average model turned on
c irise = 1 then momentum/buoyancy plume rise model turned on, buoyancy
c           rise based on sensible heat emission
c       = 2 then momentum/buoyancy plume rise model turned on, buoyancy
c           rise based on initial plume density
c igrav = 1 then gravitational settling model turned on
c iwash = 1 then stack downwash model turned on
c iflow = 1 then sigmas adjusted for volume flow rate
c iwind = 1 then wind speed corrected for plume height
c       = 0 to turn any of the above models off
c
c PARAMETER INPUT:
c   stack          wind                           frequency
c   release        speed          mixing          to              scaling
c   height         height         height          exceed          factor
c   (m)            (m)            (m)             (%)             (?)
    0.00000E+00    1.00000E+01    1.00000E+03     5.00000E-01     1.00000E+00
c
c                                                                 gravitational
c   building       building       release         deposition      settling
c   width          height         duration        velocity        velocity
c   (m)            (m)            (hr)            (m/s)           (m/s)
    0.00000E+00    0.00000E+00    1.00000E+00     1.00000E-03     1.00000E-03
c
c                  initial                        sensible
c   initial        plume                          heat
c   plume          flow           stack           emission
c   density        rate           diameter        rate
c   (g/cc)         (m3/s)         (m)             (cal/s)
    4.40000E-04    7.90000E-01    1.00000E+00     2.20000E+07
c
c RECEPTOR DEPENDENT DATA
c FOR MODE       make           RECEPTOR DEPENDENT DATA
c 1 (site specific)             sector distance z-height
c 2 (by class & wind speed) class Wind speed distance offset z-height

c 3 (create plot file)          class Wind speed xmax imax ymax jmax xqmin power

c
c RECEPTOR PARAMETER DESCRIPTION:
c sector = 0, 1, 2... (all, S, SSW, etc.)
c distance = meters
c class = 1, 2, 3, 4, 5, 6, 7 (P-G stability class A, B, C, D, E, F, G)
c Wind speed = m/s

c offset = meters offset from plume centerline
c xmax = maximum distance to plot or calculate to (m)
c imax = distance intervals
c ymax = maximum offset to plot (m)
c jmax = offset intervals
c xqmin = minimum scaled X/Q to calculate
c power = exponent in power function step size

MODE:
Site specific X/Q calculated
```

LOGICAL CHOICES:
Joint frequency used to calculate X/Q based on
frequency of exceedance.
No normalization of joint frequency.
X/Q calculated for single sector.
Output is atmospheric dispersion coefficient.

MODELS SELECTED:
NRC RG 1.145 plume meander

WARNING/ERROR MESSAGES:

JOINT FREQUENCY DATA:
300 AREA - 10 M - Pasquill A - G (1983 - 1991 Average)
Created 8/26/92 KR

--- W-302, Offsite, With Plume Meander ---

SECTOR	DISTANCE (m)	RECEPT HEIGHT (m)	SECT. FREQ. (%)	POPULATION	TOTAL POPULATION SCALED X/Q (s/m3)	AVERAGE INDIVIDUAL SCALED X/Q (s/m3)	ATM. STAB. CLASS	WIND SPEED (m/s)
S	6475	0	11.55	1	2.95E-05	2.95E-05	F	.89
SSW	2590	0	5.07	1	3.37E-05	3.37E-05	F	2.65
SW	3515	0	2.39	1	1.01E-05	1.01E-05	E	2.65
WSW	3515	0	1.82	1	8.60E-06	8.60E-06	E	4.70
W	6575	0	4.20	1	1.45E-05	1.45E-05	E	.89
WNW	28675	0	6.49	1	5.42E-06	5.42E-06	G	2.65
NW	49025	0	8.60	1	3.30E-06	3.30E-06	F	.89
NNW	51800	0	5.97	1	3.12E-06	3.12E-06	F	.89
N	17020	0	8.76	1	1.35E-05	1.35E-05	F	.89
NNE	505	0	8.50	1	5.23E-04	5.23E-04	F	.89
NE	505	0	9.64	1	5.32E-04	5.32E-04	F	.89
ENE	345	0	6.13	1	8.51E-04	8.51E-04	G	2.65
E	345	0	4.55	1	9.73E-04	9.73E-04	F	.89
ESE	345	0	2.86	1	9.32E-04	9.32E-04	G	2.65
SE	535	0	5.20	1	4.66E-04	4.66E-04	F	.89
SSE	830	0	7.95	1	2.49E-04	2.49E-04	F	.89

Execution Time = 0 hr 0 min 1.04 sec
Stop - Program terminated.

CHECKLIST FOR PEER REVIEW

Document Reviewed: **ATMOSPHERIC DISPERSION AND UNIT DOSE DALCULATIONS (APPENDIX A)** for project W-302 Preliminary Safety Evaluation (PSE), Mark Medsker, 12/20/94

Scope of Review: entire document

Yes	No	NA	
[ ]	[ ]	[X] *	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
[X]	[ ]	[ ]	Problem completely defined.
[ ]	[ ]	[X]	Accident scenarios developed in a clear and logical manner.
[X]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[X]	[ ]	[ ]	Computer codes and data files documented.
[X]	[ ]	[ ]	Data used in calculations explicitly stated in document.
[X]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[ ]	[ ]	[X]	Mathematical derivations checked including dimensional consistency of results.
[X]	[ ]	[ ]	Models appropriate and used within range of validity or use outside range of established validity justified.
[X]	[ ]	[ ]	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
[X]	[ ]	[ ]	Software input correct and consistent with document reviewed.
[X]	[ ]	[ ]	Software output consistent with input and with results reported in document reviewed.
[ ]	[ ]	[X]	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
[ ]	[ ]	[X]	Safety margins consistent with good engineering practices.
[X]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
[X]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.
[ ]	[ ]	[X]	Format consistent with appropriate NRC Regulatory Guide or other standards
[ ]		[X] *	Review calculations, comments, and/or notes are attached.
[X]	[ ]	[ ]	**Document approved.**

D.A. Himes [signature] 12/28/94

Reviewer (Printed Name and Signature) Date

* Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist. Such material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.

HEDOP REVIEW CHECKLIST
for
Radiological and Nonradiological Release Calculations

Document reviewed (include title or description of calculation, document number, author, and date, as applicable):

ATMOSPHERIC DISPERSION AND UNIT DOSE DALCULATIONS (APPENDIX A) for project W-302 Preliminary Safety Evaluation (PSE), Mark Medsker, 12/20/94

Submitted by: R.B. Bendixsen Date Submitted: 12/21/94

Scope of Review: entire document

YES	NO*	N/A		
[X]	[ ]	[ ]	1.	A detailed technical review and approval of the environmental transport and dose calculation portion of the analysis has been performed and documented.
[ ]	[ ]	[X]	2.	Detailed technical review(s) and approval(s) of scenario and release determinations have been performed and documented.
[ ]	[ ]	[X]	3.	HEDOP-approved code(s) were used.
[ ]	[ ]	[X]	4.	Receptor locations were selected according to HEDOP recommendations.
[X]	[ ]	[ ]	5.	All applicable environmental pathways and code options were included and are appropriate for the calculations.
[X]	[ ]	[ ]	6.	Hanford site data were used.
[X]	[ ]	[ ]	7.	Model adjustments external to the computer program were justified and performed correctly.
[X]	[ ]	[ ]	8.	The analysis is consistent with HEDOP recommendations.
[ ]		[X]	9.	Supporting notes, calculations, comments, comment resolutions, or other information is attached. (Use the "Page 1 of X" page numbering format and sign and date each added page.)
[X]	[ ]		10.	**Approval is granted on behalf of the Hanford Environmental Dose Overview Panel.**

* All "NO" responses must be explained and use of nonstandard methods justified.

D.A. Himes [signature] 12/28/94

HEDOP-Approved Reviewer (Printed Name and Signature) Date

COMMENTS (add additional signed and dated pages if necessary):

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APPENDIX B

ENVIRONMENTAL HAZARD SAFETY CLASSIFICATION

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1.0 Toxic Chemical Environmental Hazard Safety Classification

This safety class analysis uses the multiplying factor method defined in WHC-CM-4-46 (WHC 1994d). The quantities of toxic chemicals which could be present at a facility are examined in conjunction with the distances to environmental receptors to determine the need for Safety Class 1 or 2 barriers.

The quantities of toxic chemicals potentially present in the 340 Complex are given in Section 3.2. Although the data is not conducive to easy manipulation in the toxic chemical EHSC form, some conservative assumptions can be made to allow a safety class analysis.

Section 3.2, Table 3-3, lists the maximum observed concentrations of toxic chemicals received at the 340 Complex, but not in terms of distinct chemical compounds. Appendix D of the 340 Complex ISB (WHC 1994b) lists the most commonly received chemical compounds. Conservative quantities of the worst-case chemicals can be estimated by combining both lists. The list from the ISB (also reproduced in Section 3.2) is shown along with the reportable quantity (RQ) category from 40 CFR 302 and relevant comments in Table B-1.

As can be seen from Table B-1, the Cl, NO_3, OH, PO_4, and SO_4 entries in Table 3-3 can be accounted for by assuming that they are a part of the worst chemical compounds. The remainder of the non-metallic entries in Table 3-3 can be accounted for by placing them in the "LESS" environmental hazard category on the form and assuming a release amount of > 10,000 gal (maximizing the multiplying factor). The metals in Table 3-3 can be accounted for by placing them in the "MORE" environmental category on the form and assuming a release amount of > 10,000 gal (maximizing the multiplying factor). Note that no attempt was made to balance the charges of the individual chemical groups (ions) in Table 3-3.

The total quantity of each of the five assumed chemical compounds is shown in Table B-2. The volume used to determine the total quantity is 121,000 L, which is the assumed maximum credible facility loading used in the analysis of the seismic event (Section 4.2.1.1). Note that the conversion to concentration of the chemical compound from the identified chemical group involves multiplying by the ratio of the molecular weights. For example, the concentration of Cl stated in Table 3-3 is 3,400 mg/L, but the concentration of HCl is determined by

$$Conc\ HCl = (Conc\ Cl) \cdot \left(\frac{Mol\ Wt\ HCl}{Mol\ Wt\ Cl}\right)$$

$$= \left(3,400\ \frac{mg}{L}\right) \cdot \left(\frac{36.5}{35.5}\right) = 3,500\ mg/L$$

The remainder of the chemical compound concentrations are calculated in the same fashion.

Toxic Chemical Environmental Hazard Safety Classification Form

1. Material Form

   A. Is the toxic material dispersible (i.e., other than a consolidated or stabilized solid)? Dispersible materials include: liquids, sludges, gases, powders, and unconsolidated solids.

      [ ] No Stop. Associated items are Safety Class 3, other criteria permitting.

      [X] Yes Proceed.

   B. Are only inert gases (e.g., He and Ar) or other environmentally benign gases (e.g., O_2, N_2, CO_2, and CO) present?

      [ ] Yes Stop. Items related to these gases are Safety Class 3, other criteria permitting.

      [X] No Proceed.

2. Quantity of Materials Released

   A. Toxic Materials With Reportable Quantity (RQ) Values in 40 CFR Part 302

Category	Amount Released		Multiplier
X		pounds * 1	=
A		pounds * 1/10	=
B		pounds * 1/100	=
C	9.58E+03	pounds * 1/1000	= 9.58E+00
D	3.34E+03	pounds * 1/10000	= 3.34E-01
		SUM	= 9.91E+00

Multiplying Factor (MF) 2.A = SUM * 10 = 9.91E+01

   B. Toxic Materials of Regulatory/Environmental Concern and Not Listed in 40 CFR Part 302

      Note: This is not an all-inclusive list of toxic materials that are not listed in 4-CFR Part 302. Individual materials may need to be evaluated to assess their environmental hazard. Contact the Environmental Engineering or Environmental Assurance organization for assistance.

MORE Environmental Hazard Category

Compounds known to be highly environmentally persistent based on biodegradability

Metals

Polycyclic compounds (contain multiple benzene-type rings)

Halogenated hydrocarbons

Environmental pathogens (virus or bacteria), engineered organisms and recombinant deoxyribonucleic acid (DNA)

≤ 100 gal ... MF = 10
100-1,000 gal ... MF = 20
1,000 - 10,000 ... MF = 50
>10,000 gal ... MF = 100*

Quantity (MORE) = >10,000 gal
MF (MORE) = 100

LESS Environmental Hazard Category

Compounds known to be somewhat environmentally persistent based on biodegradability

Petroleum products

Paints and solvents

Pesticides, herbicides, and fungicides

≤ 100 gal ... MF = 1
100-1,000 gal ... MF = 2
1,000 - 10,000 ... MF = 5
>10,000 gal ... MF = 10*

Quantity (LESS) = >10,000 gal
MF (LESS) = 10

MF (2.B.) = MF (MORE) + MF (LESS) = 110

3. Total Quantity of Material Released = >10,000 gal

≤ 100 gal ... MF = 1
100-1,000 gal ... MF = 5
1,000 - 10,000 ... MF = 10
>10,000 gal ... MF = 100*

MF (3.) = 100

4. Proximity to Environmental Receivers

A. Depth to Aquifer = 29 ft

> 150 feet ... MF = 1
76-150 feet ...MF = 2
21-75 feet . ..MF = 5*
0-20 feet . .. MF = 10

Bottom elevation of 340-C is 376 ft. Height of high Columbia River flow (185,000 cfs) is 347 ft (CH2M Hill 1994). If it is assumed that the aquifer under 340-C is equal to the height of the river (the 340 Complex is approximately 345 m from the bank) then the distance to the aquifer is 376-347 ft = 29 ft.

MF (4.A.) = 5

B. Distance to Sensitive Surface Water = NA ft (Release is below ground)

> 2 miles .... MF = 1
1.5-2 miles .... MF = 3
2500 feet-1.5 miles .... MF = 6
1000-2500 feet .... MF = 9
500-1000 feet ....MF = 16
100-500 feet ....MF = 20
<100 feet ....MF = 25
Direct discharge to water...MF = 50

MF (4.B.) = NA

C. Distance to Offsite Boundary = NA miles (Release is below ground)

> 10 miles .... MF = 1
6-10 miles .... MF = 2
3-6 miles .... MF = 5
0-3 miles .... MF = 10

MF (4.C.) = NA

5. Carcinogenicity Modifying Factor

EPA Carcinogen Classification A,B ..... MF = 2* (Assumed)
C,D ..... MF = 1

6. Calculation of Environmental Impact for Safety Classification

EHSC = (2.A.+2.b.)(3.)(4.A.)(4.B.)(4.C.)(5.) = (99.1+110)*(100)*(5)*(NA)*(NA)*(2) = 209,000

2.0 Radioisotope Environmental Hazard Safety Classification

The quantities of radioactive materials identified in Section 3.1 are used here to determine the need for Safety Class 1 or 2 items to prevent or mitigate an insult to the environment. Table B-3 shows the isotopes, their quantities, their half-lives, and their half-life groups.

Radiological Environmental Hazard Safety Classification Form

1. Material Form

   Is the radioactive material dispersible (i.e., other than a consolidated or stabilized solid)? Dispersible materials include: liquids, sludges, gases, powders, and unconsolidated solids.

   [ ] No Stop. Associated items are Safety Class 3, other criteria permitting.

   [X] Yes Proceed.

2. Quantity of Materials Released

   Group the radioisotopes by half-life category and show the total amount (in Ci) for each category:

Group A	$T_{½}$ < 1 yr:	Amount = 169 Ci
Group B	$T_{½}$ = 1-100 yr:	Amount = 5,690 Ci
Group C	$T_{½}$ > 100 yr:	Amount = 92.3 Ci

   Cross-reference the number of Ci in each half-life group versus the half-life group to determine the appropriate multiplier(s).

	Half-Life		
Amount (Ci)	< 1 yr	1-100 yr	> 100 yr
< 1	MF = 1	MF = 10	MF = 100
1-1000	MF = 10*	MF = 100	MF = 1,000*
1000-10^5	MF = 100	MF = 1,000*	MF = 10,000
> 10^5	MF = 1,000	MF = 10,000	MF = 100,000

   MF (2.) = SUM of Multiplier(s) = 10+1000+1000 = 2010

3. Total Quantity of Material Released = > 10,000 gal

   ≤ 100 gal ... MF = 1
   100-1,000 gal ... MF = 5
   1,000 - 10,000 ... MF = 10
   >10,000 gal ... MF = 100*

   MF (3.) = 100

4. Proximity to Environmental Receivers

   A. Depth to Aquifer = 29 ft

   > 150 feet ... MF = 1
   76-150 feet ... MF = 2
   21-75 feet ... MF = 5*
   0-20 feet ... MF = 10

   Bottom elevation of 340-C is 376 ft. Height of high Columbia River flow (185,000 cfs) is 347 ft (CH2M Hill 1994). If it is assumed that the aquifer under 340-C is equal to the height of the river (the 340 Complex is approximately 345 m from the bank) then the distance to the aquifer is 376-347 ft = 29 ft.

   MF (4.A.) = 5

B. Distance to Sensitive Surface Water = NA feet (release is below ground)

> > 2500 feet .... MF = NA
> 1000-2500 feet .... MF = 9
> 500-1000 feet ....MF = 16
> 100-500 feet ....MF = 20
> <100 feet ....MF = 25
> Direct discharge to water...MF = 50

MF (4.B.) = NA

C. Distance to Offsite Boundary = NA feet (release is below ground)

> > 2500 feet .... MF = NA
> 1000-2500 feet .... MF = 5
> < 1000 feet .... MF = 10

MF (4.C.) = NA

5. Calculation of Environmental Impact for Safety Classification

EHSC = (2.)(3.)(4.A.)(4.B.)(4.C.) = (2010)*(100)*(5)*(NA)*(NA) = 1.01E+06

Notes: EHSC value > 1 E+06 indicating SC 2 requirement (see Section 4.3)

Table B-1. Chemicals Commonly Received at the 340 Complex and Their RQs.

Chemical	RQ Category	Comments
Nitric acid	C	Entire concentration of NO_3 assumed to be nitric acid
Sodium hydroxide	C	Entire concentration of OH assumed to be sodium hydroxide
Sodium nitrate	---	Treated as "LESS" environmental hazard category
UltimaGold (solvent)	---	Treated as "LESS" environmental hazard category
Optifluor (solvent)	---	Treated as "LESS" environmental hazard category
Sodium phosphate	D	Entire concentration of PO_4 assumed to be sodium phosphate (ignoring limited supply of Na)
Potassium persulfate	---	Treated as "LESS" environmental hazard category
Sodium carbonate	---	Treated as "LESS" environmental hazard category
Potassium nitrate	---	Treated as "LESS" environmental hazard category
Potassium hydroxide	C	All OH already accounted for by a category "C" chemical
Hydrochloric acid	D	Entire Cl concentration assumed to be hydrochloric acid
Sulfuric acid	C	Entire SO_4 concentration assumed to be sulfuric acid
Ammonium hydroxide	C	All OH already accounted for by a category "C" chemical
Oxalic acid	---	Treated as "LESS" environmental hazard category
Dimethylsulfate	---	Treated as "LESS" environmental hazard category

Note: RQ = reportable quantity

Table B-2. Total Chemical Compound Quantities.

Chemical Group	Concentration from Table 3-3 (mg/L)	Corres-ponding chemical compound	RQ category	Compound concentration (mg/L)	Total chemical compound in 121,000 L (mg)	Total chemical compound in 121,000 L (lb)
Cl	3.40 E+03	HCl	D	3.50 E+03	4.24 E+08	9.33 E+02
NO_3	3.42 E+04	HNO_3	C	3.48 E+04	4.20 E+09	9.27 E+03
OH	4.25 E+02	NaOH	C	1.00 E+03	1.21 E+08	2.66 E+02
PO_4	7.27 E+03	$NaPO_4$	D	9.03 E+03	1.09 E+09	2.41 E+03
SO_4	1.61 E+02	H_2SO_4	C	1.64 E+02	1.99 E+07	4.38 E+01

Total Pounds of RQ category C chemicals: 9.58 E+03
Total pounds of RQ category D chemicals: 3.34 E+03

Table B-3. Radiological Inventory.

Isotope	Inventory from Table 3-1 (Ci/L)	Total accident inventory in 121,000 L (Ci)	Half-life	Half-life group
^{54}Mn	7.66 E-07	9.27 E-02	312.5 dy	A
^{60}Co	1.85 E-06	2.24 E-01	5.271 yr	B
^{90}Sr	1.07 E-03	1.29 E+02	28.6 yr	B
^{90}Y	1.07 E-03	1.29 E+02	64.1 hr	A
^{95}Zr	2.25 E-06	2.72 E-01	64.02 dy	A
^{95}Nb	4.01 E-06	4.85 E-01	86.6 hr	A
^{95}Tc	4.73 E-08	5.72 E-03	213,000 yr	C
^{106}Ru	4.96 E-05	6.00 E+00	368.2 dy	B
^{125}Sb	3.96 E-05	4.79 E+00	2.77 yr	B
^{134}Cs	6.87 E-05	8.31 E+00	2.062 yr	B
^{137}Cs	2.37 E-02	2.87 E+03	30.17 yr	B
^{144}Ce	3.15 E-04	3.81 E+01	284.3 dy	A
^{152}Eu	4.49 E-03	5.43 E+02	13.6 yr	B
^{154}Eu	7.90 E-03	9.56 E+02	8.8 yr	B
^{155}Eu	1.90 E-03	2.30 E+02	4.96 yr	B
^{182}Ta	1.14 E-05	1.38 E+00	115 dy	A
^{234}U	1.50 E-07	1.82 E-02	244,500 yr	C
^{235}U	1.88 E-09	2.27 E-04	7.038 E+08 yr	C
^{236}U	1.23 E-08	1.49 E-03	2.3415 E+07 yr	C
^{238}U	5.98 E-08	7.24 E-03	4.468 E+09 yr	C
^{238}Pu	2.72 E-04	3.29 E+01	87.75 yr	B
$^{239/240}$Pu	5.81 E-05	7.03 E+00	24,131 yr	C
^{240}Pu	7.85 E-05	9.50 E+00	6,569 yr	C
^{241}Pu	7.48 E-03	9.05 E+02	14.4 yr	B
^{242}Pu	2.35 E-07	2.84 E-02	376,300 yr	C
^{241}Am	6.26 E-04	7.57 E+01	432.2 yr	C
$^{243/244}$Cm	1.67 E-06	2.02 E-01	18.11 yr	B

Sum of quantities of the Group A isotopes: 169 Ci
Sum of quantities of the Group B isotopes: 5,690 Ci
Sum of quantities of the Group C isotopes: 92.3 Ci

APPENDIX C

HAZARD CATEGORIZATION CALCULATIONS

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Hazard Categorization Calculations

This appendix provides the necessary analysis for the hazard categorization conclusions stated in Section 1.0. The categorization is performed in accordance with the guidelines in DOE Standard 1027-92 with the results indicating that Project W-302 is a Hazard Category 3 facility.

DOE Standard 1027-92 indicates that if the credible release fractions for a facility can be shown to be significantly different than those used in Attachment 1 (of DOE Standard 1027-92), then the threshold quantities may be divided by the ratio of the maximum credible release fraction of the facility to the one found on page A-9 of DOE Standard 1027-92. The maximum credible release fractions used in this document are significantly lower than the 1 E-03 value used in the DOE Standard. Therefore, the threshold quantities in DOE Standard 1027-92, Attachment 1 are modified to account for the reduced potential for dispersal of the radioactive material.

The maximum credible facility releases are analyzed in Section 4.0. Of the three scenarios analyzed; fire, spill, and spray leak, the fire scenario can be readily eliminated because of the very small amounts of radioactive materials involved. The spill scenario has 121 kL of waste involved with a release fraction of 9.6 E-07, while the spray leak scenario has 76 kL of waste involved with a net release fraction of 1.6 E-06 (1.9% at 1 E-04). The spray leak, when compared to the spill leak, has a factor of 1.59 less waste involved (121 kL/76 kL), but has a factor of 1.98 greater release fraction (1.6 E-06/9.6 E-07). Because the ratio of release fractions is greater than the ratio of waste involved, the spray leak scenario is bounding over the spill scenario. Thus, the hazard categorization calculations are based upon the spray leak.

The release fraction used to determine the threshold quantities in DOE Standard 1027-92 is 1 E-03 while the release fraction for the spray leak is 1.6 E-06. The threshold quantities can be divided by the ratio of the release fractions, or

$$\left(\frac{1.6\ E\text{-}06}{1\ E\text{-}03}\right) = 1.6\ E\text{-}03$$

The fourth column of Table C-1 represents the Hazard Category 2 threshold quantities corrected by the ratio of release fractions.

The inventories used to determine the hazard category are from Section 4.5. As discussed in that section, the combination of non-TRU isotopes into the beta/gamma group and TRU isotopes into the alpha group represents a conservative approach at specifying maximum facility inventories. These maximum inventories provide a simple and conservative basis for determining the facility hazard category. The inventory values are taken from Table 4-11.

Table C-1. Hazard Categorization for Project W-302.

Isotope	Inventory in 76 kL (Ci)	Category 2 threshold quantity (Ci)	Modified category 2 threshold quantity (Ci)	Ratio
Beta/gamma	3.09 E+03	2.20 E+04	1.38 E+07	2.25 E-04
Alpha	8.71 E+01	5.60 E+01	3.50 E+04	2.49 E-03
			Sum of Ratios:	2.71 E-03

Because the sum of the ratios is less than 1.0, Project W-302 is a Hazard Category 3 facility. Based on the discussion in Section 4.5, the hazard categorization calculations may need to be revised if the preliminary inventory limits are changed.

APPENDIX D

EPI CODE DATA FOR NITRIC ACID SPILL

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EPI Code Data for Nitric Acid Spill

This appendix contains the EPI code output showing the estimated consequences of the concentrated nitric acid spill postulated in Section 4.2.2.2. Below is the data summary and vaporization rate. The second page of the output shows the results of the atmospheric dispersion calculations.

Push RETURN to CONTINUE...

```
NITRIC ACID, 70%
CALCULATED EVAPORATION RATE :  1.08E+00 grams/sec ;  1.43E-01 pounds/min
```

```
                         DATA SUMMARY

QUANTITY SPILLED             :  5.50E+01 gallons
SPILL AREA                   : 2.10E+01 m^2 ;  2.26E+02 ft^2
SPILL DEPTH                  :  0.99 cm     ;  0.39 in
TIME FOR TOTAL EVAPORATION   :  3.4 days
LIQUID TEMPERATURE           :  40.0 deg. C ; 104.0 deg. F

VAPOR PRESSURE @ Liquid Temp:   9.6E+00 mm-Mercury
WIND SPEED (2 meter height) :  1.0 m/s     ;  2.2 mph
```

EPIcode 5.0 14104 1-27-1995 13:38
USER'S LIB.: NITRIC ACID, 70%
Molecular Weight: 63.02 gram/mole

TWA:	2.0 ppm	TWA:	5.2 mg/m^3
STEL:	4.0 ppm	STEL:	10.0 mg/m^3
IDLH:	100 ppm	IDLH:	260 mg/m^3
ERPG-2:	65 mg/m3	ERPG-3:	130 mg/m3

EVAPORATION RATE: 1.08E+00 grams/sec Vapor Pressure: 9.6E+00 mm-Hg

HEIGHT-EFFECTIVE:	0.0 Meters
RADIUS OF SOURCE:	2.59 meters
SURFACE WIND SPEED:	1.0 Meters/second
DEPOSITION VELOCITY:	0.000 cm/second
STABILITY CLASS:	F
TERRAIN:	STANDARD
RECEPTOR HEIGHT (z):	0 Meters

LOCATION OF MAXIMUM CONCENTRATION LEVEL
Distance: < 0.10km
Level: > 3.3E+01 mg/m^3 1.3E+01 PPM

DOWNWIND		CONCENTRATION		ARRIVAL TIME
X-km	Y-km	mg/m^3	ppm	hours:minutes
0.10	0.000	33	13	0:02
0.38	0.000	3.7	1.4	0:06

APPENDIX E

CONTROL MANUAL WAIVERS

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Control Manual Waivers

This appendix contains the two control manual waivers (WA-556 and WA-551) used in this PSE. The WA-556 waiver allows for postponement of the preliminary fire hazards analysis until the preparation of the advanced CDR. The WA-551 waiver allows use of new EHSC criteria.

CONTROLLED MANUAL WAIVER REQUEST

Date Prepared January 20, 1995 Waiver Request Number WA-556

Affected Document Identification WHC-CM-4-46, Sections 2 and 3

Waiver Time Period From 1/95 To Issuance of Advanced CDR for Project W-302

Requirements Being Waived
WHC-CM-4-46 (three places), Section 2.0, 3.1.1, paragraph beginning with "The requirements for a fire hazard analysis (FHA), - - - "; Section 2.0, Figure 2. "Project Timeline"; and Section 3.0, 4.3.2.4 "Fire hazards analysis" require issuance of a preliminary fire hazards analysis (PFHA) to support issuing a preliminary safety evaluation (PSE).

Description of Requested Waiver
Waiver the above criteria to permit sign-off of the PSE for Project W-302 without having an approved PFHA.

Initiating/Requesting Organization Solid Waste SAR Engineering, SA&NE, PSS

Requesting Organization Contact J. P. Estrellado, Jr., Manager, Solid Waste SAR Engineering

Organization Responsible for Affected Document J. L. Rathbun, Manager, Nuclear Safety Programs

Responsible Organization's Interpretive Authority J. L. Rathbun, Manager, Nuclear Safety Programs
(Contact Management Standards OR refer to Hanford Information, WHC Controlled Manuals, List of CM Manuals)

Brief Description of Affected Documents and Impacts (if applicable)

Independent safety needs a waiver to sign the PSE for Project W-302. An issued PSE is needed to support the conceptual design report (CDR) and allow the Project to be submitted to DOE for project validation.

There are two primary reasons in favor of approving this waiver:

1) The project, as scheduled, is seeking approval at this time for a CDR and planning for an advanced CDR (ACDR) during FY 1996. Thus, the project has two phases for the CDR process while the requirements specify that a safety analysis (PSE) shall include or reference a fire hazard analysis as part of the safety analysis process. For this project, because there will be two CDRs, the FHA will be issued to support the ACDR and still satisfy the requirement.

2) Project W-302 proposes a replacement vault and tank collection system that will be similar to the current vault and tank collection system. Currently, the FHA for the 340 Facility (Hughes 1994) is in the final stages of approval and is expected to be issued in the next several weeks. A review of this FHA was completed as part of the PSE and no inconsistencies exist between the PSE and the 340 Facility FHA. Therefore, it is expected that the PFHA, when issued, will also be consistent with the PSE.

Ref: Hughes, 1994, *340 Complex Fire Hazard Analysis*, Hughes Associates, Inc., Columbia Maryland.

INITIATING/REQUESTING ORGANIZATION APPROVAL

Originator: J. P. Estrellado, Jr. Date 1/20/95

Organization: Solid Waste SAR Engineering

Approved by: G. R. Franz Date 1/20/95
Cognizant Level 3 Manager

Approved per Telecon: B.A. Gilkeson 1/20/95

MANUAL APPROVAL AUTHORITY

Approved by: J. L. Rathbun Date 1/25/95
Interpretive Authority

Approved by: L. L. Reed Date 1/27/95
Level 2 Manager, Responsible Organization

for EJ Krejci FFFS 1/23/95

OTHER APPROVAL (As Required)

Approved by: Date
Contracts Administration
(Only when DOE Directives are involved)

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- Initiating/Requesting Organization Contact
- Management Standards, B4-50
- Quality Assurance, A4-79

A-6000-604 (08/94) WEF137

CONTROLLED MANUAL WAIVER REQUEST

Date Prepared January 5, 1995 Waiver Request Number WA-551

Affected Document Identification WHC-CM-4-46, Rev. 0

Waiver Time Period From 1/95 To Revised Issue

Requirements Being Waived
Chapter 9, Table 1 Safety Class Criteria 10 states SSCs whose failure result in environmental hazard safety classification (EHSC) value calculated per Appendices C and D ≥ 1,000,000 are Safety Class 1.

Description of Requested Waiver
Waiver the above criteria to permit use of draft Revision D of Chapter 9 Table 1 Safety Significant Criteria 2.b. for SSCs whose failure result in an EHSC value greater than or equal to (≥) 1,000,000.

Initiating/Requesting Organization Solid Waste SAR Engineering, SA&NE, WAE

Requesting Organization Contact J. P. Estrellado, Jr., Manager, Solid Waste SAR Engineering

Organization Responsible for Affected Document J. L. Rathbun, Manager, Nuclear Safety Programs

Responsible Organization's Interpretive Authority J. L. Rathbun, Manager, Nuclear Safety Programs
(Contact Management Standards <u>OR</u> refer to Hanford Information, WHC Controlled Manuals, List of CM Manuals)

Brief Description of Affected Documents and Impacts (if applicable)

No existing approved safety documents are impacted.

The Preliminary Safety Evaluation (PSE) (WHC-SD-W302-PSE-001) for the 340 Facility Secondary Containment and Leak Detection vault, Project W-302, in the 300 Area is being prepared for issue in February 1995. The estimated offsite and onsite releases based on the accident scenarios placed the equipment at no higher than Safety Class 3. Due to large quantity of liquid stored in the vault tanks, the estimated EHSC value was above 1,000,000 for both the radioactive and toxic materials requiring the vault to be classified as Safety Class 1. This classification is inconsistent with the criteria for onsite/offsite airborne concentrations which would only require a Safety Class 3 designation and inconsistent for a Hazard Category 3 facility.

WA-551

INITIATING/REQUESTING ORGANIZATION APPROVAL

Originator: J. P. Estrellado, Jr. Date 1/10/95

Organization: Solid Waste SAR Engineering

Approved by: E. R. Franz Date 1/10/95
Cognizant Level 3 Manager

MANUAL APPROVAL AUTHORITY

Approved by: J. L. Rathbun Date 1/25/95
Interpretive Authority

Approved by: L. L. Reed Date 1/27/95
Level 2 Manager, Responsible Organization

OTHER APPROVAL (As Required)

Approved by: Date
Contracts Administration
(Only when DOE Directives are involved)

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