

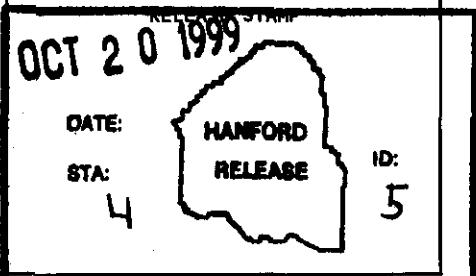
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1. ECN

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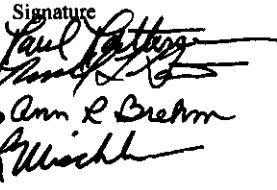
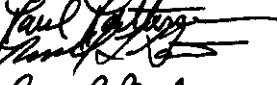
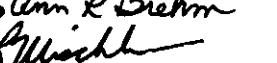
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2. ECN Category (mark one)		3. Originator's Name, Organization, MSIN, and Telephone No.		4. USQ Required?	5. Date
<input type="checkbox"/> Supplemental <input checked="" type="checkbox"/> Direct Revision <input type="checkbox"/> Change ECN <input type="checkbox"/> Temporary <input type="checkbox"/> Standby <input type="checkbox"/> Supersedure <input type="checkbox"/> Cancel/Void		P. R. Patterson/SNF-NS/R3-26 /373-1513		<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
		6. Project Title/No./Work Order No.		7. Bldg./Sys./Fac. No.	8. Approval Designator
		Spent Nuclear Fuel Project			301/311 E, S, Q
		9. Document Numbers Changed by this ECN (includes sheet no. and rev.)		10. Related ECN No(s).	11. Related PO No.
		HNF-SD-SNF-HIE-004, Rev 3		N/A	N/A
12a. Modification Work		12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condi- tion (Temp. or Standby ECN only)	
<input type="checkbox"/> Yes (fill out Blk. 12b) <input checked="" type="checkbox"/> No (NA Blks. 12b, 12c, 12d)		N/A	N/A	N/A Design Authority/Cog. Engineer Signature & Date	
				Design Authority/Cog. Engineer Signature & Date	
13a. Description of Change		13b. Design Baseline Document? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
The changes to HNF-SD-SNF-HIE-004 are used as input to the Cold Vacuum Drying Facility Final Safety Analysis Report, HNF-3553, Annex B.					
14a. Justification (mark one)					
Criteria Change <input checked="" type="checkbox"/> As-Found <input type="checkbox"/>		Design Improvement <input type="checkbox"/> Facilitate Const <input type="checkbox"/>	Environmental <input type="checkbox"/> Const. Error/Omission <input type="checkbox"/>	Facility Deactivation <input type="checkbox"/> Design Error/Omission <input type="checkbox"/>	
14b. Justification Details					
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16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)		
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	<input type="checkbox"/> Yes	Additional	<input type="checkbox"/> \$	Additional	<input type="checkbox"/> \$	Improvement	[N/A]
<input checked="" type="checkbox"/> No	Savings	<input type="checkbox"/> \$	Savings	<input type="checkbox"/> \$	Delay	<input type="checkbox"/>	
19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.							
SDD/DD	[N/A]	Seismic/Stress Analysis	[N/A]	Tank Calibration Manual	[N/A]		
Functional Design Criteria	<input type="checkbox"/>	Stress/Design Report	<input type="checkbox"/>	Health Physics Procedure	<input type="checkbox"/>		
Operating Specification	<input type="checkbox"/>	Interface Control Drawing	<input type="checkbox"/>	Spares Multiple Unit Listing	<input type="checkbox"/>		
Criticality Specification	<input type="checkbox"/>	Calibration Procedure	<input type="checkbox"/>	Test Procedures/Specification	<input type="checkbox"/>		
Conceptual Design Report	<input type="checkbox"/>	Installation Procedure	<input type="checkbox"/>	Component Index	<input type="checkbox"/>		
Equipment Spec.	<input type="checkbox"/>	Maintenance Procedure	<input type="checkbox"/>	ASME Coded Item	<input type="checkbox"/>		
Const. Spec.	<input type="checkbox"/>	Engineering Procedure	<input type="checkbox"/>	Human Factor Consideration	<input type="checkbox"/>		
Procurement Spec.	<input type="checkbox"/>	Operating Instruction	<input type="checkbox"/>	Computer Software	<input type="checkbox"/>		
Vendor Information	<input type="checkbox"/>	Operating Procedure	<input type="checkbox"/>	Electric Circuit Schedule	<input type="checkbox"/>		
OM Manual	<input type="checkbox"/>	Operational Safety Requirement	<input type="checkbox"/>	ICRS Procedure	<input type="checkbox"/>		
FSAR/SAR	<input type="checkbox"/>	IEFD Drawing	<input type="checkbox"/>	Process Control Manual/Plan	<input type="checkbox"/>		
Safety Equipment List	<input type="checkbox"/>	Cell Arrangement Drawing	<input type="checkbox"/>	Process Flow Chart	<input type="checkbox"/>		
Radiation Work Permit	<input type="checkbox"/>	Essential Material Specification	<input type="checkbox"/>	Purchase Requisition	<input type="checkbox"/>		
Environmental Impact Statement	<input type="checkbox"/>	Fac. Proc. Samp. Schedule	<input type="checkbox"/>	Tickler File	<input type="checkbox"/>		
Environmental Report	<input type="checkbox"/>	Inspection Plan	<input type="checkbox"/>		<input type="checkbox"/>		
Environmental Permit	<input type="checkbox"/>	Inventory Adjustment Request	<input type="checkbox"/>		<input type="checkbox"/>		
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Document Number/Revision	Document Number/Revision			Document Number Revision			
	N/A						
21. Approvals							
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Cog Mgr R. L. Garrett		<u>10/13/99</u>					
Safety J. R. Brehm		<u>10/13/99</u>					
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# Cold Vacuum Drying Facility Final Hazard Analysis Report

P. R. Patterson  
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**Abstract:** This report describes the methodology used in conducting the Cold Vacuum Drying Facility (CVDF) hazard Analysis to support the CVDF Final Safety Analysis Report and documents the results. The hazard analysis was performed in accordance with DOE-STD-3009-94, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports," and implements the requirements of DOE Order 5480.23, "Nuclear Safety Analysis Reports."

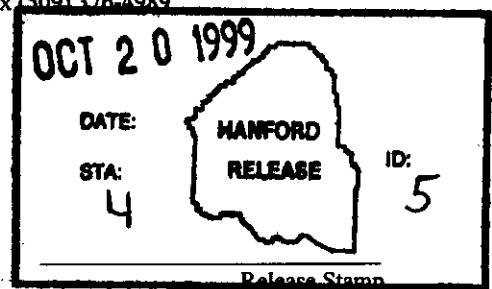
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*T. Patterson*  
Release Approval

10/19/99  
Date



**Approved for Public Release**



**COLD VACUUM DRYING FACILITY  
HAZARD ANALYSIS REPORT**

**HNF-SD-SNF-HIE-004  
Revision 4**

**October 1999**

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**LIST OF TERMS**

CVDF	Cold Vacuum Drying Facility
DOE	U.S. Department of Energy
FSAR	final safety analysis report
MCO	multi-canister overpack

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## COLD VACUUM DRYING FACILITY HAZARD ANALYSIS REPORT

### 1.0 INTRODUCTION

This report describes the methodology used in conducting the Cold Vacuum Drying Facility (CVDF) hazard analysis to support the CVDF final safety analysis report (FSAR) and documents the results. The hazard analysis was performed in accordance with the U.S. Department of Energy (DOE) standard, DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, and implements the requirements of DOE Order 5480.23, *Nuclear Safety Analysis Reports*.

The hazard analysis process identified hazardous conditions and material at risk, determined causes for potential accidents, identified preventive and mitigative features, and qualitatively estimated the frequencies and consequences of specific occurrences. The hazard analysis was performed by a team of cognizant CVDF operations and design personnel, safety analysts familiar with the CVDF, and technical experts in specialty areas. Attachment A lists the members of the hazard analysis team and describes the background and experience of each.

The material included in this report documents the final state of a nearly two-year-long process involving formal facilitated group sessions and independent hazard and accident analysis work. The hazard analysis process led to the selection of candidate accidents for further quantitative analysis. New information relative to the hazards, discovered during the accident analysis, was incorporated into the hazard analysis data in order to compile a complete profile of facility hazards. Through this process, the results of the hazard and accident analyses led directly to the identification of safety structures, systems, and components; technical safety requirements; and other controls required to protect the public, workers, and environment.

### 2.0 SCOPE OF THE HAZARD ANALYSIS

The hazard analysis documented in this report, conducted to support the CVDF FSAR, covered normal, intended, CVDF operations to remove free water from the multi-canister overpacks (MCOs) containing spent nuclear fuel. The hazard analysis process, described in Chapter 3.0, examined:

- Routine activities to maintain the facility and to prepare for processing operations
- Receiving the trailer containing the cask-MCO, moving it into one of the facility's four process bays, positioning and securing the trailer, and finalizing bay preparations for processing (processing operations are not planned in the fifth bay)

- Operations involved with venting the cask-MCO, removing the cask lid, preparing the MCO for processing, installing process equipment, and establishing process connections to the MCO
  - Process hood/seal ring
  - MCO process port connectors
  - Tempered water system
- Verification and testing of equipment and connections prior to processing
- Monitoring and controlling process operations utilizing the monitoring and control system and the safety-class instrumentation and control system during the following processing modes
  - Heatup Mode
  - Drain Mode
  - Purge/Flush Mode
  - Drying Mode
  - Proof Mode
  - Pressure Test Mode
- Establishing MCO conditions for shipping, MCO port valve leak-testing, removing the process connections, reinstalling the process port covers, draining and drying the cask, and reinstalling the cask lid
- Preparing the trailer and bay for shipping, connecting the trailer to the transporter, and releasing the cask-MCO for shipment to the Canister Storage Building.

The following key sources of information were used to evaluate the hazards:

- *HNF-3553, Spent Nuclear Fuel Project Final Safety Analysis Report*, Annex B, “Cold Vacuum Drying Facility Final Safety Analysis Report”
  - Chapters B2.0 and B4.0 for facility design and operations information
  - Chapter B3.0 for the facility radioactive materials inventory
  - Chapter B6.0 for evaluating the potential for hazards from nuclear criticality
- *SNF-4268, Fire Hazard Analysis for the Cold Vacuum Drying Facility*
- *HNF-SD-TP-SARP-017, Safety Analysis Report for Packaging, Onsite, Multi-Canister Overpack Cask*, for coverage of accidents involving the transporter and transportation cask and for definition of assumptions inherent in defining the transportation window
- *HNF-SD-SNF-SARR-005, Multi-Canister Overpack Topical Report*, for criteria and assumptions related to the MCO design

- The latest available process information as presented in SNF-2356, *Spent Nuclear Fuel Project Cold Vacuum Drying Facility Operations Manual*
- Representatives from the design authority and from facility operations for details of design, operating modes, and procedures.

### 3.0 HAZARD ANALYSIS METHODOLOGY

This section presents the methodology used to perform the CVDF hazard analysis for normal operations. The hazard identification process systematically and comprehensively identified hazards that can contribute to the uncontrolled release of radioactive or hazardous materials or that can threaten the safety of facility workers. In addition to DOE Order 5480.23 and DOE-STD-3009-94, guidance provided in HNF-PRO-704, *Hazard and Accident Analysis Process, and Guidelines for Hazard Evaluation Procedures* (AIChE 1985), was used to develop the hazard analysis process. Specifically, the analysis followed the American Institute of Chemical Engineers preliminary hazard analysis method, and included elements of the process/systems checklists and “what-if” analysis methods.

#### 3.1 HAZARD IDENTIFICATION

The hazard analysis included identification of the hazards associated with CVDF design and operations based on descriptions provided in Chapters B2.0 and B4.0 of the CVDF FSAR (HNF-3553, Annex B) on an operational flow diagram, an operating sequence contained in the operations manual, and the other referenced material (see Section 4.0). The hazard analysis team included design authorities, operations personnel and hazard and accident analysts. The team met in facilitated sessions and communicated informally throughout the process. The team defined hazards as radioactive or hazardous materials (material at risk), system or process characteristics, or energy sources that represent a potential for an accident that could have an adverse effect on facility workers, the CVDF, the environment, or the public. Table 1 summarizes the material at risk for the CVDF in terms of type, form, and quantity.

A standardized checklist, Table 2, was used to identify potentially hazardous materials and energy sources present in each of the following six facility areas:

- Administrative area (AA)
- Transfer corridor and mechanical corridor (TC)
- Process bays 2-5 (PB)
- Process bay 1 – a spare bay (SB)
- Process water room (PW)
- Outside (OU).

Figure 1 provides a simplified drawing of the CVDF.

Tables 3 through 8 show the hazard identification results for each area. Each identified hazard was assigned a unique designator to allow for tracking. The hazard identification checklists were developed by a subgroup of the hazard analysis team and reviewed and accepted by the entire team.

### 3.2 HAZARD EVALUATION

The hazard evaluation was a structured and systematic examination of the CVDF and its operations using standard industry (American Institute of Chemical Engineers) hazard evaluation techniques. The first step in the hazard evaluation, once the hazards had been identified, was to screen the potentially hazardous materials and energy sources for those that presented only standard industrial hazards. These hazards are defined in DOE-STD-3009-94 as those that "are routinely encountered in general industry and construction, and for which national consensus codes and/or standards (e.g., Occupational Safety and Health Administration, transportation safety) exist to guide safe design and operation without the need for special analysis to define safe design and/or operational parameters." Tables 9 through 14 list, by facility area, the standard industrial hazards that do not contribute to the uncontrolled release of radioactive or hazardous material. The standard industrial hazards listed are controlled through the implementation of institutional safety programs as described in the programmatic sections of the CVDF FSAR (HNF-3553, Annex B). The hazard analysis team agreed by consensus to the results of the screening for standard industrial hazard items.

Next, the team met in facilitated sessions to characterize each hazard. Hazard analysis worksheets were designed to capture the required information. Each hazard was assigned a unique identifier for tracking. Using the worksheets and the hazard summary as a guide, each hazardous condition was assessed to identify potential accidents, causes, frequencies, and consequences, and to determine a qualitative likelihood of occurrence of the initiating event and the resulting consequence. The assessment of likelihood and consequence for each hazardous condition was a collective, qualitative judgment made by the hazard analysis team. The assessment estimated the likelihoods and consequences of each hazardous condition scenario in two cases. The first case considered designed passive features only. The second case considered designed passive features as well as credited active features and administrative features.

The completed hazard analysis worksheets, included in this report in Attachment 2 as Table A2-1, show the results of the hazard evaluation as compiled by the hazard analysis team. The evaluation results are based on the hazard identification results, material-at-risk summaries, reviews of the systems designs and planned operations, existing safety documentation, and the experience of hazard analysis team members. Each column of the hazard analysis tables is explained below to aid in understanding the information contained therein.

**Location/checklist entry.** This column contains each hazard's unique identifier, which indicates the facility area, the hazard checklist category, and the specific hazard. For example, a designator of TV-F-01 would represent the truck vestibule (TV), a linear

kinetic hazard (F) from a car, truck, or bus (01). If a single hazard could result in more than one consequence, a lowercase letter is appended to the identifier (e.g., TV-F-01a, TV-F-01b).

**Hazard energy source/material.** This column further defines the specific hazard under consideration (e.g., a moving transporter).

**Hazardous condition.** This column describes the hazardous condition that the energy source or material represents (e.g., transporter collision).

**Cause.** This column identifies initiators of the potential accident (e.g., transporter collision with facility structure [the potential accident] could be caused by human error on the driver's part, by mechanical failure of the vehicle, or by misplaced equipment). Typical potential causes include equipment failures, operational errors, abnormal operating conditions, poor operating practices, and environmental conditions. The causes of a potential accident are identified to support a qualitative frequency evaluation.

**Potential accident.** This column identifies potential accidents that could result from the identified hazardous conditions (e.g., transporter collision with facility structures, systems, or components or with personnel).

**Consequence.** This column identifies the potential effects of the hazardous condition and potential accident in terms of radioactive or hazardous material releases and impact to personnel and facility systems, structures, and components.

**Credited prevention.** This column lists preventive safety features present within the facility that are credited with reducing the frequency of the hazard or accident. The credited features listed in this column (both engineered and administrative) include only the controls the accident analyst required to be implemented to support the actual accident analysis. These preventive controls (along with the mitigative controls) are those controls necessary to meet evaluation guidelines.

**Frequency code.** Two evaluations of the likelihood of occurrence of the hazardous condition and potential accident are listed in this column. The first frequency code subcolumn ranks the hazard and accident frequency by considering the impact of any passive features (e.g., structures, barriers) listed in the table but not the impact of active features or planned controls (e.g., valves, shipping restrictions). The second frequency code subcolumn ranks the hazardous condition and potential accident frequency considering all credited preventive controls, including passive controls. The assessment of likelihood was a collective, qualitative judgment made by the hazard analysis team. The likelihood assessments resulted in frequency rankings based on the initiating event frequencies and subsequent failures on a per-year basis. The qualitative criteria for likelihood assessments are as follows.

- F3 The hazardous condition based on the causes postulated is likely to occur during the facility lifetime.
- F2 The hazardous condition based on the causes postulated is foreseeable, but unlikely.
- F1 The hazardous condition based on the causes postulated is perhaps possible, but extremely unlikely.
- F0 The hazardous condition based on the causes postulated is considered too improbable to warrant further consideration.

**Credited mitigation.** This column lists mitigative safety features present within the facility that are credited with reducing the consequence of the hazard. The credited features listed in this column (both engineered and administrative) include only the controls the accident analyst required to be implemented to support the actual accident analysis. These mitigative controls (along with the preventive controls) are those controls necessary to meet evaluation guidelines. In some cases a control may reduce both the frequency and the consequence of a hazard.

**Consequence code.** Two evaluations of the potential effects of the hazardous condition on the health and safety of people and on the environment are listed in this column. The first consequence code subcolumn ranks the hazard and accident consequence by considering the impact of any passive features (e.g., structures, barriers) listed in the table but not the impact of active features or planned controls (e.g., valves, shipping restrictions). The second consequence code subcolumn ranks the hazardous condition and potential accident consequence with all credited mitigative controls, including passive controls. The assessment of the consequence for each hazardous condition was a collective, qualitative judgment made by the hazard analysis team. The qualitative criteria for consequence assessments are as follows.

- S3 On the basis of material at risk and causes postulated, there is sufficient material and release energy to affect a receptor at the nearest point of uncontrolled public access.
- S2 On the basis of material at risk and causes postulated, there is sufficient material and energy to affect an onsite receptor (collocated worker) 100 m from the source of the release.
- S1 On the basis of material at risk and causes postulated, the release is confined to the facility and affects facility workers.
- S0 On the basis of material at risk and causes postulated, there is insufficient material released to affect facility workers.

The more severe consequence categories encompass the less severe consequence categories. For example, a hazardous condition assessed as having onsite consequences (S2) is also considered to have facility worker consequences (S1).

**Defense in depth for worker safety features.** This column contains any additional controls that will reduce the likelihood or consequences even further, but no specific credit is taken for them in the quantitative analysis.

### 3.3 CANDIDATE ACCIDENT SELECTION

The hazardous conditions identified by the hazard evaluation have been used to select candidate accidents for a more detailed, quantitative analysis in the CVDF FSAR (HNF-3553, Annex B). The general selection criteria used were consistent with DOE-STD-3009-94: "The range of accident scenarios analyzed in a SAR should be such that a complete set of bounding conditions to define the envelope of accident conditions to which the operation could be subjected are evaluated and documented."

The team used the four-step process described below to identify specific hazardous conditions that, together, represented the "complete set of bounding conditions" requiring further analysis. In summary, the process involved creating representative sets (or "bins") of hazardous conditions having similar release characteristics, similar initiators, and/or similar controls, and identifying (using the Attachment A, Figure A3-1 ranking matrix) the hazardous condition that represented the most severe consequences and the highest risk in each bin. The highest ranking hazardous condition in each bin bounded the other hazardous conditions in the bin and, therefore, lead to candidate accidents needing further analysis. These hazardous conditions and candidate accidents represent the "complete set of bounding conditions" for the CVDF accident analysis.

The following four-step process was used by the evaluation team to select the CVDF bounding accidents:

1. Initial screening
2. Assignment of release attributes
3. Creation of hazardous material release bins
4. Selection of representative bounding hazardous conditions for each release attribute category.

To capture and record the relational nature of the data developed in the four steps, the results have been organized into two tables, Table A3-1 in Attachment A and Table A4-1 in Attachment B. The following sections describe each step, and identify where in Table A3-1 and Table A4-1 the related information is located.

**Initial Screening.** All hazardous conditions with a frequency of F1 (extremely unlikely) or greater and unmitigated consequences assessed as S3 (offsite consequences) or S2 (collocated worker consequences) were chosen for consideration as representative accidents. These hazardous conditions are listed in Table A3-1, with their frequency and consequence rankings listed under the column entitled "Frequency/consequence codes." There were no hazardous conditions assessed as S1 (facility worker consequences) involving radiological hazards requiring detailed accident analysis. The S1 hazardous conditions are addressed qualitatively in the CVDF FSAR (HNF-3553, Annex B). Hazard conditions having no consequences (S0) were dropped from consideration.

**Assignment of Release Attributes.** Each hazardous condition was evaluated and described in terms of certain release attributes related to uncontrolled release of the material at risk. This description was assembled to ensure that at least one candidate accident was selected to represent each unique set of release conditions. The following hazardous material release attributes were used:

- Hazardous source (Attachment A, Table A3-1)
- Hazardous conditions and initiators (Attachment A, Table A3-1).

**Creation of Hazardous Material Release Bins.** As the hazardous material release attributes were identified, each hazardous condition was assigned to a bin category. Assignment to a bin category was based upon the potential accident release characteristics, initiators, and/or proposed mitigative or preventative controls. Table A3-1 in Attachment 3 lists the bin category assignment for each hazardous condition under the "Bin" column heading. The final step in creating the release attribute bins was to assemble hazardous conditions having the same bin category into a listing. This listing is the basis for Table A4-1, in which the hazardous conditions are grouped into their bin categories under the "Candidate accident" column.

**Selection of Representative Bounding Hazardous Conditions for each Release Attribute Category.** Within each bin category, the most severe hazardous condition, considering consequences, and the highest risk accident were identified using the three-by-three likelihood and consequence ranking matrix described in DOE-STD-3009-94 (see Attachment A, Figure A3-1). In Table A4-1 of Attachment 4, the bin category hazardous conditions are listed in descending order with the highest ranking hazardous condition at the top. In each accident bin, more than one condition may have been required to provide the necessary bounding conditions for a bin. Table A4-1 identifies the bounding condition, or when necessary, bounding conditions for each bin.

Unique hazardous conditions were identified and selected as a part of the accident analysis process. However, the binning process described here provided the basis for identification and selection of those unique conditions. Briefly, at the completion of design basis accident analysis for each bin category, the results were compared with the other hazardous conditions in the original bin to ensure that no unique and unanalyzed conditions existed.

### 3.4 HAZARD ANALYSIS SUMMARY

The final list of candidate accidents includes all hazardous conditions with a frequency of F1 (extremely unlikely) or greater and whose unmitigated consequences were assessed as S3 (offsite consequences) or S2 (collocated worker consequences). Attachment 4, Table A4-1 provides the final list of candidate accidents. The table also identifies the hazardous condition, or conditions, chosen as representative and bounding of all other conditions listed in the bin.

### 4.0 REFERENCES

AIChE, 1985, *Guidelines for Hazard Evaluation Procedures*, American Institute of Chemical Engineers

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Figure 1. Main Areas of the Cold Vacuum Drying Facility.

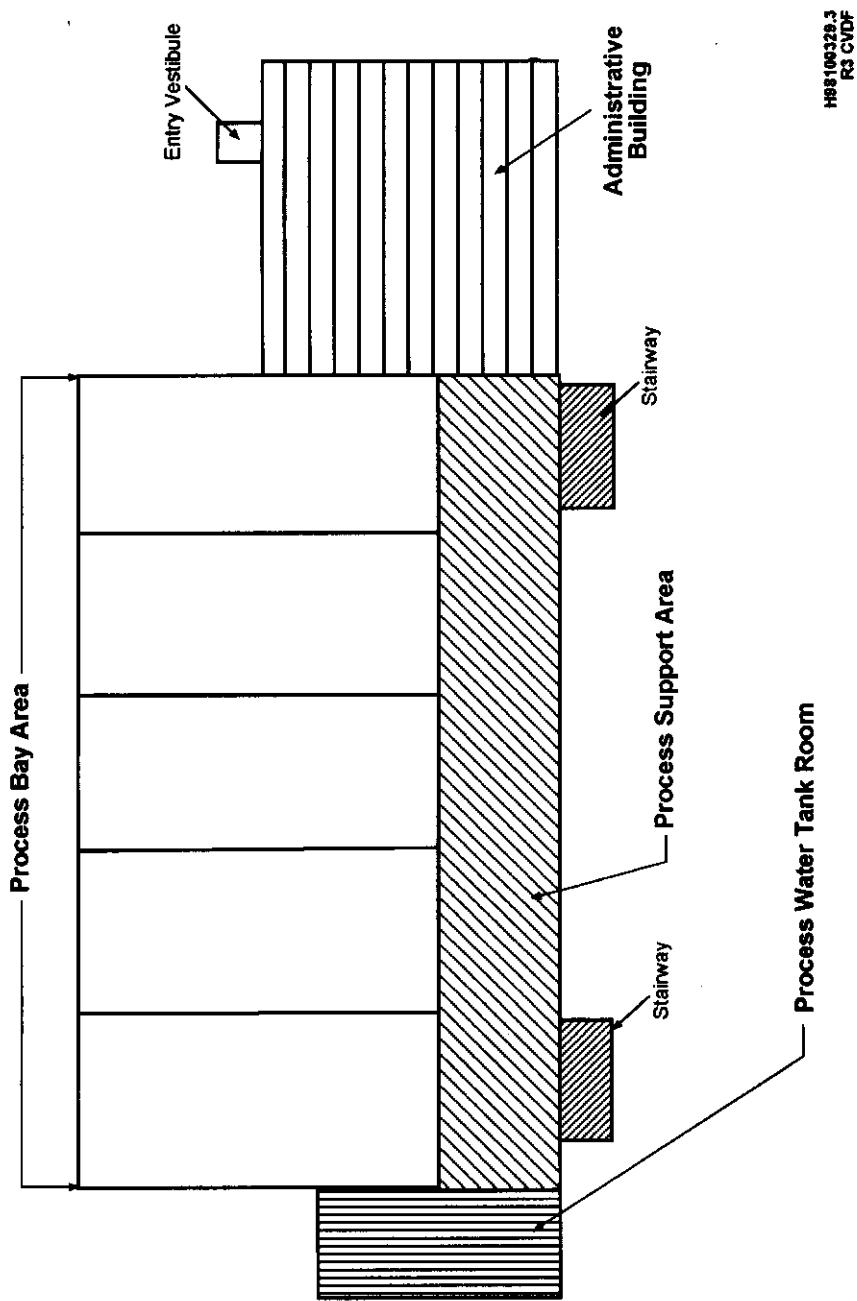


Table 1. Cold Vacuum Drying Facility Material at Risk (Type, Form, and Quantity).

Field name or location	MAR-subject	MAR-description	MAR-classification	Capacity	Material type	Physical form	Volume or activity	Transient	Quantity	Comments
Process bay	MCO in cask	SNF and particulate matter in MCO (including contaminated water)	SNF in MCO	1,000 L per MCO; consisting of five to six baskets; SNF, water MCO estimated to contain 25 kg of particulate matter after cold vacuum drying and shipping to CSB (upper bound)	Spent fuel from N Reactor (upper bound)	Solid consisting of fuel and particulate corrosion products	6.40 MTU at 26,200 Ci/MTU	Yes, particulate is transient	Upper bound mass is 6.40 MTU per MCO	
	Hydrogen gas	Combustible gas		Approximately 1 m <sup>3</sup> of hydrogen gas per MCO generated over entire CVDF process at pressures from less than 12 torr to 4 lb/in <sup>2</sup> gauge (nominal)	Hydrogen gas	Gas	Approximately 1 m <sup>3</sup> of hydrogen gas per MCO	Yes	Approximately 1 m <sup>3</sup> hydrogen gas per MCO	
	Truck fuel tank	Diesel fuel		80 gal	Fuel	Liquid	Up to 80 gal	Yes	Two tanks	
SCHe system	Helium gas cylinders	Helium		~240 ft <sup>3</sup> per cylinder 4 cylinders	Helium	Gas	~960 ft <sup>3</sup> total ~2,400 lb/in <sup>2</sup> gauge per cylinder	No		
Transfer corridor/mechanical equipment room	Particulate on HVAC filters (general and local)	Finely divided radioactive particulate from MCOs		No more than 94 g	NA	Solid	Up to 94 g	Yes, particulate is transient	94 g	
Process water conditioning room	Process water conditioning system components and piping	SNF and particulate drained from MCO		Radioactive particulate matter	Safety basis (bounding) of no more than 1.5 kg	Spent fuel from N Reactor	0.0015 MTU at 26,200 Ci/MTU	Yes, particulate is transient	Upper bound is 1.5 kg	
Outside area	Inert gas storage	Helium used to inert MCOs and overpack storage tubes	Helium	~185,000 ft <sup>3</sup> in storage tubes on trailer	Helium	Gas	~185,000 ft <sup>3</sup> (at standard temperature and pressure)	No		
	Standby power diesel supply	Diesel fuel		550 gal	Fuel	Liquid	550 gal	No	Day tank and supply tank	

CSB = Canister Storage Building.

CVDF = Cold Vacuum Drying Facility.

HVAC = heating, ventilation, and air conditioning (filter).

IM = ion exchange module.

MAR = material at risk.

MCO = multi-canister overpack.

MTU = metric ton of uranium.

NA = not applicable.

SNF = spent nuclear fuel.

Table 2. Hazardous Material/Energy Source Checklist: Example.

<b>Y N A. Electrical</b>	<b>Y N E. Kinetic - Rotational</b>	<b>Y N J. Explosives/Pyrophorics</b>	<b>Y N M. Hazardous Materials</b>
<input type="checkbox"/> 1. Battery banks <input type="checkbox"/> 2. Cable runs <input type="checkbox"/> 3. Diesel generators <input type="checkbox"/> 4. Electrical equipment <input type="checkbox"/> 5. HVAC heaters <input type="checkbox"/> 6. High voltage <input type="checkbox"/> 7. Motors <input type="checkbox"/> 8. Pumps <input type="checkbox"/> 9. Power tools <input type="checkbox"/> 10. Switchgear <input type="checkbox"/> 11. Service outlets, fittings <input type="checkbox"/> 12. Transformers <input type="checkbox"/> 13. Transmission lines <input type="checkbox"/> 14. Underground wires <input type="checkbox"/> 15. Whiring <input type="checkbox"/> 16. Other _____	<input type="checkbox"/> 1. Centrifuges <input type="checkbox"/> 2. Motors <input type="checkbox"/> 3. Pumps <input type="checkbox"/> 4. Fans <input type="checkbox"/> 5. Laundry equipment <input type="checkbox"/> 6. Shop equipment <input type="checkbox"/> 7. Other _____	<input type="checkbox"/> 1. Caps <input type="checkbox"/> 2. Primer cord <input type="checkbox"/> 3. Dynamite <input type="checkbox"/> 4. Scrub chemicals <input type="checkbox"/> 5. Dusts <input type="checkbox"/> 6. Hydrogen <input type="checkbox"/> 7. Gases, others <input type="checkbox"/> 8. Nitrates <input type="checkbox"/> 9. Peroxides <input type="checkbox"/> 10. Pu and U metal <input type="checkbox"/> 11. Sodium <input type="checkbox"/> 12. Other _____	<input type="checkbox"/> 1. Alkali metals <input type="checkbox"/> 2. Asphyxiants <input type="checkbox"/> 3. Biologicals <input type="checkbox"/> 4. Carcinogens <input type="checkbox"/> 5. Corrosives <input type="checkbox"/> 6. Oxidizers <input type="checkbox"/> 7. Toxics <input type="checkbox"/> 8. Heavy metals <input type="checkbox"/> 9. Other _____
<b>Y N B. Thermal</b>	<b>Y N G. Mass, Gravity, Height</b>	<b>Y N J. Nuclear Criticality</b>	<b>Y N N. Ionizing Radiation Sources</b>
<input type="checkbox"/> 1. Bunsen burner/hot plates <input type="checkbox"/> 2. Electrical equipment <input type="checkbox"/> 3. Furnaces/boilers/heater <input type="checkbox"/> 4. Steam lines <input type="checkbox"/> 5. Welding torch/arc <input type="checkbox"/> 6. Diesel units/fire box/exhaust line <input type="checkbox"/> 7. Radioactive decay heat <input type="checkbox"/> 8. Exposed components <input type="checkbox"/> 9. Power tools <input type="checkbox"/> 10. Convective <input type="checkbox"/> 11. Solar <input type="checkbox"/> 12. Cryogenic <input type="checkbox"/> 13. Other _____	<input type="checkbox"/> 1. Human effort <input type="checkbox"/> 2. Stairs <input type="checkbox"/> 3. Lifts and cranes <input type="checkbox"/> 4. Bucket and ladder <input type="checkbox"/> 5. Trucks <input type="checkbox"/> 6. Slings <input type="checkbox"/> 7. Hoists <input type="checkbox"/> 8. Elevators <input type="checkbox"/> 9. Jacks <input type="checkbox"/> 10. Scaffold and ladders <input type="checkbox"/> 11. Pits and excavations <input type="checkbox"/> 12. Elevated doors <input type="checkbox"/> 13. Vessels <input type="checkbox"/> 14. Other _____	<input type="checkbox"/> 1. Vaults <input type="checkbox"/> 2. Temporary storage areas <input type="checkbox"/> 3. Shipping and receiving area <input type="checkbox"/> 4. Filters <input type="checkbox"/> 5. Casks <input type="checkbox"/> 6. Burial ground <input type="checkbox"/> 7. Storage racks <input type="checkbox"/> 8. Canals and basins <input type="checkbox"/> 9. Decontamination solution <input type="checkbox"/> 10. Trucks, forklifts, dollies <input type="checkbox"/> 11. Hand cart <input type="checkbox"/> 12. Cranes/lifts <input type="checkbox"/> 13. Hot cells, assembly, inspection <input type="checkbox"/> 14. Laboratories <input type="checkbox"/> 15. Other _____	<input type="checkbox"/> 1. Fissile material <input type="checkbox"/> 2. Radiography equipment <input type="checkbox"/> 3. Radioactive material <input type="checkbox"/> 4. Radioactive sources <input type="checkbox"/> 5. Other _____
<b>Y N C. Friction</b>	<b>Y N H. Pressure - Volume</b>	<b>Y N L. Flammable Materials</b>	<b>Y N R. Natural Phenomena</b>
<input type="checkbox"/> 1. Belts <input type="checkbox"/> 2. Bearings <input type="checkbox"/> 3. Fans <input type="checkbox"/> 4. Gears <input type="checkbox"/> 5. Motors <input type="checkbox"/> 6. Power tools <input type="checkbox"/> 7. Other _____	<input type="checkbox"/> 1. Boilers <input type="checkbox"/> 2. Surge tanks <input type="checkbox"/> 3. Autoclave <input type="checkbox"/> 4. Test loops <input type="checkbox"/> 5. Gas bottles <input type="checkbox"/> 6. Pressure vessels <input type="checkbox"/> 7. Stressed members <input type="checkbox"/> 8. Gas receivers <input type="checkbox"/> 9. Vacuum <input type="checkbox"/> 10. Steam headers and lines <input type="checkbox"/> 11. Other _____	<input type="checkbox"/> 1. Packing materials <input type="checkbox"/> 2. Rags <input type="checkbox"/> 3. Gasoline <input type="checkbox"/> 4. Lube oil <input type="checkbox"/> 5. Coolant oil <input type="checkbox"/> 6. Paint solvent <input type="checkbox"/> 7. Diesel fuel <input type="checkbox"/> 8. Buildings & contents <input type="checkbox"/> 9. Trailers and contents <input type="checkbox"/> 10. Grease	<input type="checkbox"/> 1. Earthquake <input type="checkbox"/> 2. Flood <input type="checkbox"/> 3. Lightning <input type="checkbox"/> 4. Rain <input type="checkbox"/> 5. Snow, freezing weather <input type="checkbox"/> 6. Straight wind <input type="checkbox"/> 7. Dust devil <input type="checkbox"/> 8. Tornado <input type="checkbox"/> 9. Ashfall <input type="checkbox"/> 10. Range fire
<b>Y N D. Corrosives</b>			
<input type="checkbox"/> 1. Acids <input type="checkbox"/> 2. Caustics <input type="checkbox"/> 3. Natural chemicals <input type="checkbox"/> 4. Decontamination solution <input type="checkbox"/> 5. High temperature waste <input type="checkbox"/> 6. Other _____			

Table 3. Hazardous Material/Energy Source Checklist: Administrative Area (AA).

<b>Location: Administrative Area, Cold Vacuum Drying Facility</b>											
<b>Y N A. Electrical</b>	<b>Y N E. Kinetic - Rotational</b>	<b>Y N J. Explosives/Pyrophorics</b>	<b>Y N M. Hazardous Materials</b>	<b>Y N N. Ionizing Radiation Sources</b>	<b>Y N P. External Events</b>	<b>Y N Q. Vehicles in Motion (external to facility)</b>	<b>Y N R. Natural Phenomena</b>	<b>Y N S. Flammable Materials</b>	<b>Y N T. Pressure - Volume</b>	<b>Y N U. Corrosives</b>	
■ □ 1. Battery banks (UPS)	□ ■ 1. Centrifuges	□ ■ 1. Caps	■ □ 1. Alkali metals	□ ■ 1. Fissile material	■ □ 1. Explosion	■ □ 1. Airplane	■ □ 1. Earthquake	■ □ 1. Packing materials	□ ■ 1. Boilers	■ □ 1. Acids	
■ □ 2. Cable runs	■ □ 2. Motors	□ ■ 2. Primer cord	■ □ 2. Asphyxiants	□ ■ 2. Radiography equipment	■ □ 2. Fire	■ □ 2. Helicopter	■ □ 2. Flood	■ □ 2. Rags	□ ■ 2. Surge tanks	■ □ 2. Caustics	
■ □ 3. Diesel generators	■ □ 3. Pumps	□ ■ 3. Dynamite	■ □ 3. Biologicals	□ ■ 3. Radioactive material	■ □ 3. Other sites	■ □ 3. Train	■ □ 3. Lightning	■ □ 3. Gasoline	□ ■ 3. Autoclave	■ □ 3. Natural chemicals	
■ □ 4. Electrical equipment	■ □ 4. Fans	□ ■ 4. Scrub chemicals	■ □ 4. Carcinogens	□ ■ 4. Radioactive sources (sealed sources)	■ □ 4. Other	■ □ 4. Trucks, forklifts, dollies	■ □ 4. Other	■ □ 4. Lubricating oil	□ ■ 4. Test loops	■ □ 4. Oxidizers	
■ □ 5. HVAC heaters	■ □ 5. Laundry equipment	□ ■ 5. Dusts	■ □ 5. Corrosives	■ □ 5. Other	■ □ 5. Vaults	■ □ 5. Hand carry	■ □ 5. Other	■ □ 5. Paint solvent	□ ■ 5. Gas bottles (portable monitor)	■ □ 5. Stressors	
■ □ 6. High voltage	■ □ 6. Shop equipment	□ ■ 6. Hydrogen (batteries)	■ □ 6. Toxics	■ □ 6. Other	■ □ 6. Storage racks	■ □ 6. Hand carts	■ □ 6. Other	■ □ 6. Diesel fuel	□ ■ 6. Pressure vessels	■ □ 6. Gas receivers	
■ □ 7. Motors	■ □ 7. Other	□ ■ 7. Gases, others	■ □ 7. Heavy metals (mercury in relays)	■ □ 7. Other	■ □ 7. Cranes/lifts	■ □ 7. Cranes/lifts	■ □ 7. Other	■ □ 7. Paint	□ ■ 7. Stressed members	■ □ 7. Gas headers and lines	
■ □ 8. Pumps	■ □ 8. Other	□ ■ 8. Nitrates	■ □ 8. Other	■ □ 8. Other	■ □ 8. Trucks, forklifts, dollies	■ □ 8. Hand carts	■ □ 8. Other	■ □ 8. Diesel fuel	□ ■ 8. Gas bottles	■ □ 8. Other	
■ □ 9. Power tools	■ □ 9. Other	□ ■ 9. Peroxides	■ □ 9. Other	■ □ 9. Other	■ □ 9. Hand carts	■ □ 9. Hand carts	■ □ 9. Other	■ □ 9. Paint	□ ■ 9. Buildings & contents	■ □ 9. Other	
■ □ 10. Switchgear	■ □ 10. Other	□ ■ 10. Pu and U metal	■ □ 10. Other	■ □ 10. Other	■ □ 10. Hand carts	■ □ 10. Hand carts	■ □ 10. Other	■ □ 10. Paint	□ ■ 10. Trailers & contents	■ □ 10. Other	
■ □ 11. Service outlets, fittings	■ □ 11. Other	□ ■ 11. Sodium	■ □ 11. Other	■ □ 11. Other	■ □ 11. Hand carts	■ □ 11. Hand carts	■ □ 11. Other	■ □ 11. Paint	□ ■ 11. Grease	■ □ 11. Other	
■ □ 12. Transformers	■ □ 12. Other	□ ■ 12. Other	■ □ 12. Other	■ □ 12. Other	■ □ 12. Hand carts	■ □ 12. Hand carts	■ □ 12. Other	■ □ 12. Paint	□ ■ 12. Hydrogen (batteries)	■ □ 12. Other	
■ □ 13. Transmission lines	■ □ 13. Other	■ □ 13. Railroad	■ □ 13. Other	■ □ 13. Other	■ □ 13. Hand carts	■ □ 13. Hand carts	■ □ 13. Other	■ □ 13. Paint	□ ■ 13. Buildings & contents	■ □ 13. Other	
■ □ 14. Underground wires	■ □ 14. Other	■ □ 14. Obstructions	■ □ 14. Other	■ □ 14. Other	■ □ 14. Hand carts	■ □ 14. Hand carts	■ □ 14. Other	■ □ 14. Paint	□ ■ 14. Trailers & contents	■ □ 14. Other	
■ □ 15. Wiring	■ □ 15. Other	■ □ 15. Crane loads	■ □ 15. Other	■ □ 15. Other	■ □ 15. Hand carts	■ □ 15. Hand carts	■ □ 15. Other	■ □ 15. Paint	□ ■ 15. Other	■ □ 15. Other	
■ □ 16. Other	■ □ 16. Other	■ □ 16. Pressure vessel blowdown	■ □ 16. Other	■ □ 16. Other	■ □ 16. Hand carts	■ □ 16. Hand carts	■ □ 16. Other	■ □ 16. Paint	□ ■ 16. Other	■ □ 16. Other	
<b>Y N B. Thermal</b>	<b>Y N G. Mass, Gravity, Height</b>	<b>Y N K. Nuclear Criticality</b>	<b>Y N N. Ionizing Radiation Sources</b>	<b>Y N P. External Events</b>	<b>Y N Q. Vehicles in Motion (external to facility)</b>	<b>Y N R. Natural Phenomena</b>	<b>Y N S. Flammable Materials</b>	<b>Y N T. Pressure - Volume</b>	<b>Y N U. Corrosives</b>		
■ □ 1. Bunsen burner/hot plates	■ □ 1. Human effort	■ □ 1. Vaults	■ □ 1. Fissile material	■ □ 1. Explosion	■ □ 1. Airplane	■ □ 1. Earthquake	■ □ 1. Packing materials	■ □ 1. Boilers	■ □ 1. Acids		
■ □ 2. Electrical equipment	■ □ 2. Stairs	■ □ 2. Storage racks	■ □ 2. Radiography equipment	■ □ 2. Fire	■ □ 2. Helicopter	■ □ 2. Flood	■ □ 2. Rags	■ □ 2. Surge tanks	■ □ 2. Caustics		
■ □ 3. Furnaces/boilers/heater	■ □ 3. Lifts and cranes	■ □ 3. Canals and basins	■ □ 3. Radioactive material	■ □ 3. Other sites	■ □ 3. Train	■ □ 3. Lightning	■ □ 3. Gasoline	■ □ 3. Autoclave	■ □ 3. Natural chemicals		
■ □ 4. Steam lines	■ □ 4. Bucket and ladder	■ □ 4. Decon solution	■ □ 4. Radioactive sources (sealed sources)	■ □ 4. Other	■ □ 4. Trucks, forklifts, dollies	■ □ 4. Other	■ □ 4. Lubricating oil	■ □ 4. Buildings & contents	■ □ 4. Oxidizers		
■ □ 5. Welding torch/arc	■ □ 5. Trucks	■ □ 5. Decon solution	■ □ 5. Other	■ □ 5. Other	■ □ 5. Hand carts	■ □ 5. Hand carts	■ □ 5. Paint	■ □ 5. Trailers & contents	■ □ 5. Stressors		
■ □ 6. Diesel units/fire box/duct/hot air line	■ □ 6. Slings	■ □ 6. Trucks, forklifts, dollies	■ □ 6. Other	■ □ 6. Other	■ □ 6. Hand carts	■ □ 6. Hand carts	■ □ 6. Paint	■ □ 6. Gas receivers	■ □ 6. Gas headers and lines		
■ □ 7. Radioactive decay heat	■ □ 7. Hoists	■ □ 7. Cranes/lifts	■ □ 7. Other	■ □ 7. Other	■ □ 7. Hand carts	■ □ 7. Hand carts	■ □ 7. Paint	■ □ 7. Other	■ □ 7. Other		
■ □ 8. Exposed components	■ □ 8. Elevators	■ □ 8. Hand carts	■ □ 8. Other	■ □ 8. Other	■ □ 8. Hand carts	■ □ 8. Hand carts	■ □ 8. Paint	■ □ 8. Trailers & contents	■ □ 8. Other		
■ □ 9. Power tools	■ □ 9. Jacks	■ □ 9. Hand carts	■ □ 9. Other	■ □ 9. Other	■ □ 9. Hand carts	■ □ 9. Hand carts	■ □ 9. Paint	■ □ 9. Trailers & contents	■ □ 9. Other		
■ □ 10. Convective	■ □ 10. Scaffold and ladders	■ □ 10. Hand carts	■ □ 10. Other	■ □ 10. Other	■ □ 10. Hand carts	■ □ 10. Hand carts	■ □ 10. Paint	■ □ 10. Trailers & contents	■ □ 10. Other		
■ □ 11. Solar	■ □ 11. Pits and excavations	■ □ 11. Hand carts	■ □ 11. Other	■ □ 11. Other	■ □ 11. Hand carts	■ □ 11. Hand carts	■ □ 11. Paint	■ □ 11. Trailers & contents	■ □ 11. Other		
■ □ 12. Cryogenic	■ □ 12. Elevated doors	■ □ 12. Hand carts	■ □ 12. Other	■ □ 12. Other	■ □ 12. Hand carts	■ □ 12. Hand carts	■ □ 12. Paint	■ □ 12. Trailers & contents	■ □ 12. Other		
■ □ 13. Other	■ □ 13. Vessels	■ □ 13. Hand carts	■ □ 13. Other	■ □ 13. Other	■ □ 13. Hand carts	■ □ 13. Hand carts	■ □ 13. Paint	■ □ 13. Trailers & contents	■ □ 13. Other		
■ □ 14. Other	■ □ 14. Other	■ □ 14. Hand carts	■ □ 14. Other	■ □ 14. Other	■ □ 14. Hand carts	■ □ 14. Hand carts	■ □ 14. Paint	■ □ 14. Trailers & contents	■ □ 14. Other		
<b>Y N C. Friction</b>	<b>Y N H. Pressure - Volume</b>	<b>Y N J. Explosives/Pyrophorics</b>	<b>Y N K. Nuclear Criticality</b>	<b>Y N L. Flammable Materials</b>	<b>Y N M. Hazardous Materials</b>	<b>Y N N. Ionizing Radiation Sources</b>	<b>Y N P. External Events</b>	<b>Y N Q. Vehicles in Motion (external to facility)</b>	<b>Y N R. Natural Phenomena</b>	<b>Y N S. Flammable Materials</b>	
■ □ 1. Belts	■ □ 1. Boilers	■ □ 1. Caps	■ □ 1. Vaults	■ □ 1. Hand carts	■ □ 1. Alkali metals	■ □ 1. Fissile material	■ □ 1. Explosion	■ □ 1. Airplane	■ □ 1. Earthquake	■ □ 1. Packing materials	
■ □ 2. Bearings	■ □ 2. Surge tanks	■ □ 2. Filters	■ □ 2. Storage racks	■ □ 2. Hand carts	■ □ 2. Asphyxiants	■ □ 2. Radiography equipment	■ □ 2. Fire	■ □ 2. Helicopter	■ □ 2. Flood	■ □ 2. Rags	
■ □ 3. Fans	■ □ 3. Autoclave	■ □ 3. Gasoline	■ □ 3. Canals and basins	■ □ 3. Hand carts	■ □ 3. Biologicals	■ □ 3. Radioactive material	■ □ 3. Other sites	■ □ 3. Train	■ □ 3. Lightning	■ □ 3. Gasoline	
■ □ 4. Gears	■ □ 4. Test loops	■ □ 4. Lube oil	■ □ 4. Decon solution	■ □ 4. Hand carts	■ □ 4. Carcinogens	■ □ 4. Radioactive sources (sealed sources)	■ □ 4. Other	■ □ 4. Trucks, forklifts, dollies	■ □ 4. Other	■ □ 4. Lubricating oil	
■ □ 5. Motors	■ □ 5. Gas bottles (portable monitor)	■ □ 5. Paint solvent	■ □ 5. Other	■ □ 5. Hand carts	■ □ 5. Corrosives	■ □ 5. Other	■ □ 5. Other	■ □ 5. Hand carts	■ □ 5. Hand carts	■ □ 5. Paint	
■ □ 6. Power tools	■ □ 6. Pressure vessels	■ □ 6. Diesel fuel	■ □ 6. Other	■ □ 6. Hand carts	■ □ 6. Oxidizers	■ □ 6. Other	■ □ 6. Other	■ □ 6. Hand carts	■ □ 6. Hand carts	■ □ 6. Paint	
■ □ 7. Other	■ □ 7. Stressed members	■ □ 7. Paint	■ □ 7. Other	■ □ 7. Hand carts	■ □ 7. Toxics	■ □ 7. Other	■ □ 7. Other	■ □ 7. Hand carts	■ □ 7. Hand carts	■ □ 7. Paint	
<b>Y N D. Corrosives</b>	<b>Y N E. Kinetic - Rotational</b>	<b>Y N F. Kinetic - Linear</b>	<b>Y N G. Mass, Gravity, Height</b>	<b>Y N H. Pressure - Volume</b>	<b>Y N I. Explosives/Pyrophorics</b>	<b>Y N J. Explosives/Pyrophorics</b>	<b>Y N K. Nuclear Criticality</b>	<b>Y N L. Flammable Materials</b>	<b>Y N M. Hazardous Materials</b>	<b>Y N N. Ionizing Radiation Sources</b>	
■ □ 1. Acids	■ □ 1. Centrifuges	■ □ 1. Cars	■ □ 1. Caps	■ □ 1. Boilers	■ □ 1. Caps	■ □ 1. Caps	■ □ 1. Vaults	■ □ 1. Hand carts	■ □ 1. Alkali metals	■ □ 1. Fissile material	
■ □ 2. Caustics	■ □ 2. Primer cord	■ □ 2. Primer cord	■ □ 2. Filters	■ □ 2. Surge tanks	■ □ 2. Filters	■ □ 2. Filters	■ □ 2. Storage racks	■ □ 2. Hand carts	■ □ 2. Asphyxiants	■ □ 2. Radiography equipment	
■ □ 3. Natural chemicals	■ □ 3. Scrub chemicals	■ □ 3. Gasoline	■ □ 3. Gasoline	■ □ 3. Autoclave	■ □ 3. Gasoline	■ □ 3. Gasoline	■ □ 3. Canals and basins	■ □ 3. Hand carts	■ □ 3. Biologicals	■ □ 3. Radioactive material	
■ □ 4. Decon solution	■ □ 4. Dusts	■ □ 4. Lube oil	■ □ 4. Lube oil	■ □ 4. Test loops	■ □ 4. Lube oil	■ □ 4. Lube oil	■ □ 4. Decon solution	■ □ 4. Hand carts	■ □ 4. Corrosives	■ □ 4. Radioactive sources (sealed sources)	
■ □ 5. High temperature waste	■ □ 5. Oxidizers	■ □ 5. Paint solvent	■ □ 5. Paint solvent	■ □ 5. Gas bottles (portable monitor)	■ □ 5. Paint solvent	■ □ 5. Paint solvent	■ □ 5. Other	■ □ 5. Hand carts	■ □ 5. Oxidizers	■ □ 5. Radioactive sources (sealed sources)	
■ □ 6. Other	■ □ 6. Toxics	■ □ 6. Diesel fuel	■ □ 6. Diesel fuel	■ □ 6. Pressure vessels	■ □ 6. Diesel fuel	■ □ 6. Diesel fuel	■ □ 6. Other	■ □ 6. Hand carts	■ □ 6. Toxics	■ □ 6. Radioactive sources (sealed sources)	

Table 4. Hazardous Material/Energy Source Checklist: Transfer Corridor and Mechanical Corridor (TC).

Location: *Transfer Corridor and Mechanical Corridor, Cold Vacuum Drying Facility*

<b>A. Electrical</b>	<b>Y N</b>	<b>E. Kinetic - Rotational</b>	<b>Y N</b>	<b>J. Explosives/Pyrophorics</b>	<b>Y N</b>	<b>M. Hazardous Materials</b>
1. Battery banks	<input type="checkbox"/>	1. Centrifuges	<input type="checkbox"/>	1. Caps	<input type="checkbox"/>	1. Alkali metals
2. Cable runs	<input type="checkbox"/>	2. Motors	<input type="checkbox"/>	2. Primer cord	<input type="checkbox"/>	2. Asphyxiants
3. Diesel generators	<input type="checkbox"/>	3. Pumps	<input type="checkbox"/>	3. Dynamite	<input type="checkbox"/>	3. Biologicals
4. Electrical equipment	<input type="checkbox"/>	4. Fans	<input type="checkbox"/>	4. Scrub chemicals	<input type="checkbox"/>	4. Carcinogens
5. HVAC heaters	<input type="checkbox"/>	5. Laundry equipment	<input type="checkbox"/>	5. Dusts	<input type="checkbox"/>	5. Corrosives
6. High voltage	<input type="checkbox"/>	6. Shop equipment	<input type="checkbox"/>	6. Hydrogen	<input type="checkbox"/>	6. Oxidizers
7. Motors	<input type="checkbox"/>	7. Other _____	<input type="checkbox"/>	7. Gases, others	<input type="checkbox"/>	7. Toxics
8. Pumps	<input type="checkbox"/>			8. Nitrates	<input type="checkbox"/>	8. Heavy metals
9. Power tools	<input type="checkbox"/>			9. Peroxides	<input type="checkbox"/>	9. Other _____
10. Switchgear	<input type="checkbox"/>			10. Pu and U metal	<input type="checkbox"/>	
11. Service outlets, fittings	<input type="checkbox"/>	1. Cars, trucks, buses	<input type="checkbox"/>	11. Sodium	<input type="checkbox"/>	
12. Transformers	<input type="checkbox"/>	2. Forklifts, dollies, carts	<input type="checkbox"/>	12. Other _____	<input type="checkbox"/>	
13. Transmission lines	<input type="checkbox"/>	3. Railroad	<input type="checkbox"/>		<input type="checkbox"/>	1. Fissile material
14. Underground wires	<input type="checkbox"/>	4. Obstructions	<input type="checkbox"/>		<input type="checkbox"/>	2. Radiography equipment
15. Wiring	<input type="checkbox"/>	5. Crane loads	<input type="checkbox"/>		<input type="checkbox"/>	3. Radioactive material
16. Other _____	<input type="checkbox"/>	6. Pressure vessel blowdown	<input type="checkbox"/>		<input type="checkbox"/>	4. Radioactive sources
		7. Other (gas bottles)	<input type="checkbox"/>		<input type="checkbox"/>	5. Other _____
<b>B. Thermal</b>	<b>Y N</b>	<b>G. Mass, Gravity, Height</b>	<b>Y N</b>	<b>K. Nuclear Criticality</b>	<b>Y N</b>	<b>P. External Events</b>
1. Bunsen burner/hot plates	<input type="checkbox"/>	1. Human effort	<input type="checkbox"/>	1. Vaults	<input type="checkbox"/>	1. Explosion
2. Electrical equipment	<input type="checkbox"/>	2. Stairs	<input type="checkbox"/>	2. Temporary storage areas	<input type="checkbox"/>	2. Fire
3. Furnaces/boilers/heater	<input type="checkbox"/>	3. Lifts and cranes	<input type="checkbox"/>	3. Shipping and receiving area	<input type="checkbox"/>	3. Other sites
4. Steam lines	<input type="checkbox"/>	4. Bucket and ladder	<input type="checkbox"/>	4. Filters	<input type="checkbox"/>	4. Airplane
5. Welding torch/arc	<input type="checkbox"/>	5. Trucks	<input type="checkbox"/>	5. Casks	<input type="checkbox"/>	5. Helicopter
6. Diesel unit/fire box/exhaust line	<input type="checkbox"/>	6. Slings	<input type="checkbox"/>	6. Burial ground	<input type="checkbox"/>	6. Train
7. Radioactive decay heat	<input type="checkbox"/>	7. Hoists	<input type="checkbox"/>	7. Storage racks	<input type="checkbox"/>	7. Dust devil
8. Exposed components	<input type="checkbox"/>	8. Elevators	<input type="checkbox"/>	8. Canals and basins	<input type="checkbox"/>	8. Tornado
9. Power tools	<input type="checkbox"/>	9. Jacks	<input type="checkbox"/>	9. Decon solution	<input type="checkbox"/>	9. Ashfall
10. Convective	<input type="checkbox"/>	10. Scaffolding and ladders	<input type="checkbox"/>	10. Trucks, forklifts, dollies	<input type="checkbox"/>	10. Range fire
11. Solar	<input type="checkbox"/>	11. Pits and excavations	<input type="checkbox"/>	11. Hand carry	<input type="checkbox"/>	
12. Cryogenic	<input type="checkbox"/>	12. Elevated doors	<input type="checkbox"/>	12. Cranes/lifts	<input type="checkbox"/>	
13. Other _____	<input type="checkbox"/>	13. Vessels (air compressor)	<input type="checkbox"/>	13. Hot cells, assembly, inspection	<input type="checkbox"/>	
		14. Other _____	<input type="checkbox"/>	14. Laboratories	<input type="checkbox"/>	
			<input type="checkbox"/>	15. Other _____	<input type="checkbox"/>	
<b>C. Friction</b>	<b>Y N</b>	<b>H. Pressure - Volume</b>	<b>Y N</b>	<b>L. Flammable Materials</b>	<b>Y N</b>	<b>R. Natural Phenomena</b>
1. Belts	<input type="checkbox"/>	1. Boilers	<input type="checkbox"/>	1. Packing materials	<input type="checkbox"/>	1. Earthquake
2. Bearings	<input type="checkbox"/>	2. Surge tanks	<input type="checkbox"/>	2. Rags	<input type="checkbox"/>	2. Flood
3. Fans	<input type="checkbox"/>	3. Autodrive	<input type="checkbox"/>	3. Gasoline	<input type="checkbox"/>	3. Lightning
4. Gears	<input type="checkbox"/>	4. Test loops	<input type="checkbox"/>	4. Lube oil	<input type="checkbox"/>	4. Rain
5. Motors	<input type="checkbox"/>	5. Gas bottles	<input type="checkbox"/>	5. Coolant oil	<input type="checkbox"/>	5. Snow, freezing weather
6. Power tools	<input type="checkbox"/>	6. Pressure vessels	<input type="checkbox"/>	6. Paint solvent	<input type="checkbox"/>	6. Straight wind
7. Other _____	<input type="checkbox"/>	7. Stressed members	<input type="checkbox"/>	7. Diesel fuel	<input type="checkbox"/>	7. Dust devil
		8. Gas receivers	<input type="checkbox"/>	8. Buildings & contents	<input type="checkbox"/>	8. Tornado
		9. Vacuum	<input type="checkbox"/>	9. Trailers & contents	<input type="checkbox"/>	9. Ashfall
		10. Steam headers and lines	<input type="checkbox"/>	10. Range fire	<input type="checkbox"/>	
		11. Other _____	<input type="checkbox"/>		<input type="checkbox"/>	
<b>D. Corrosives</b>	<b>Y N</b>					
1. Acids	<input type="checkbox"/>					
2. Caustics	<input type="checkbox"/>					
3. Natural chemicals	<input type="checkbox"/>					
4. Decon solution	<input type="checkbox"/>					
5. High temperature waste	<input type="checkbox"/>					
6. Other _____	<input type="checkbox"/>					

Table 5. Hazardous Material/Energy Source Checklist: Process Bays 2-5 (PB).

## Location: Process Bays 2-5, Cold Vacuum Drying Facility

<b>Y N A. Electrical</b>	<b>Y N E. Kinetic - Rotational</b>	<b>Y N J. Explosives/Pyrophorics</b>	<b>Y N M. Hazardous Materials</b>
1. Battery banks 2. Cable runs 3. Diesel generators 4. Electrical equipment 5. HVAC heaters 6. High voltage 7. Motors 8. Pumps 9. Power tools 10. Switchgear 11. Service outlets, fittings 12. Transformers 13. Transmission lines 14. Underground wires 15. Wiring 16. Other _____	1. Centrifuges 2. Motors 3. Pumps 4. Fans 5. Laundry equipment 6. Shop equipment 7. Other _____	1. Caps 2. Primer cord 3. Dynamite 4. Scrub chemicals 5. Dusts 6. Hydrogen 7. Gases, others 8. Nitrates 9. Peroxides 10. Pu and U metal 11. Sodium 12. Other (uranium hydrides) _____	1. Alkali metals 2. Asphyxiants 3. Biologicals 4. Carcinogens 5. Corrosives 6. Oxidizers 7. Toxics 8. Heavy metals 9. Other _____
<b>Y N B. Thermal</b>	<b>Y N G. Mass, Gravity, Height</b>	<b>Y N K. Nuclear Criticality</b>	<b>Y N N. Ionizing Radiation Sources</b>
1. Bunsen burner/hot plates 2. Electrical equipment 3. Furnaces/Boilers/heater 4. Steam lines 5. Welding torch/arc 6. Diesel unit/fire box/exhaust line 7. Radioactive decay heat 8. Exposed components 9. Power tools 10. Convective 11. Solar 12. Cryogenic 13. Other (MCO contents) _____	1. Human effort 2. Stairs 3. Lifts and cranes 4. Bucket and ladder 5. Trucks 6. Slings 7. Hoists 8. Elevators 9. Jacks 10. Scaffold and ladders 11. Pits and excavations 12. Elevated doors 13. Vessels 14. Other (elevated platform) _____	1. Vaults 2. Temporary storage areas 3. Shipping and receiving area 4. Filters 5. Casks 6. Burial ground 7. Storage racks 8. Canals and basins 9. Decon solution 10. Trucks, forklifts, dollies 11. Hand carry 12. Cranes/lifts 13. Hot cells, assembly, inspection 14. Laboratories 15. Other (MCOs, drain lines) _____	1. Fissile material 2. Radiography equipment 3. Radioactive material 4. Radioactive sources 5. Other _____
<b>Y N C. Friction</b>	<b>Y N H. Pressure - Volume</b>	<b>Y N P. External Events</b>	<b>Y N Q. Vehicles in Motion</b> (external to facility)
1. Belts 2. Bearings 3. Fans 4. Gears 5. Motors 6. Power tools 7. Other (vehicle brakes) _____	1. Boilers 2. Surge tanks 3. Autoclave 4. Test loops 5. Gas bottles 6. Pressure vessels 7. Stressed members 8. Gas receivers 9. Vacuum 10. Steam headers and lines 11. Other (pressurized liquid/gas lines, truck tires, air ride suspension, air brakes) _____	1. Explosion 2. Fire 3. Other sites	1. Airplane 2. Helicopter 3. Train 4. Truck/bus/car
<b>Y N D. Corrosives</b>	<b>Y N L. Flammable Materials</b>	<b>Y N R. Natural Phenomena</b>	
1. Acids 2. Caustics 3. Natural chemicals 4. Decon solution 5. High temperature waste 6. Other _____	1. Packing materials 2. Rags 3. Gasoline 4. Lube oil 5. Coolant oil 6. Paint solvent 7. Diesel fuel 8. Buildings & contents 9. Trailers & contents 10. Grease	1. Earthquake 2. Flood 3. Lightning 4. Rain 5. Snow, freezing weather 6. Straight wind 7. Dust devil 8. Tornado 9. Ashfall 10. Range fire	

Table 6. Hazardous Material/Energy Source Checklist: Process Bay 1 (Spare Bay) (SB).

Location: *Process Bay 1 (Spare Bay), Cold Vacuum Drying Facility*

<b>Y N A. Electrical</b>	<b>Y N E. Kinetic - Rotational</b>	<b>Y N J. Explosives/Pyrophotics</b>	<b>Y N M. Hazardous Materials</b>
1. Battery banks	1. Centrifuges	1. Caps	1. Alkali metals
2. Cable runs	2. Motors	2. Primer cord	2. Asphyxiants
3. Diesel generators	3. Pumps	3. Dynamite	3. Biologicals
4. Electrical equipment	4. Fans	4. Scrub chemicals	4. Carcinogens
5. HVAC heaters	5. Laundry equipment	5. Dusts	5. Corrosives
6. High voltage	6. Shop equipment	6. Hydrogen	6. Oxidizers
7. Motors	7. Other _____	7. Gases, others	7. Toxics
8. Pumps		8. Nitrates	8. Heavy metals
9. Power tools		9. Peroxides	9. Other _____
10. Switchgear		10. Pu and U metal	
11. Service outlets, fittings		11. Sodium	
12. Transformers		12. Other _____	
13. Transmission lines			
14. Underground wires			
15. Wiring			
16. Other _____			
<b>Y N B. Thermal</b>	<b>Y N G. Mass, Gravity, Height</b>	<b>Y N K. Nuclear Criticality</b>	<b>Y N P. External Events</b>
1. Bunsen burner/hot plates	1. Human effort	1. Vaults	1. Explosion
2. Electrical equipment	2. Stairs	2. Temporary storage areas	2. Fire
3. Furnaces/boilers/heater	3. Lifts and cranes	3. Shipping and receiving area	3. Other sites
4. Steam lines	4. Bucket and ladder	4. Filters	
5. Welding torch/arc	5. Trucks	5. Casks	
6. Diesel unit/fire box/exhaust line	6. Slings	6. Burial ground	
7. Radioactive decay heat	7. Hoists	7. Storage racks	
Exposed components	8. Elevators	8. Canals and basins	
Power tools	9. Jacks	9. Decon solution	
Convective	10. Scaffold and ladders	10. Trucks, forklifts, dollies	
Solar	11. Pits and excavations	11. Hand cart	
Cryogenic	12. Elevated doors	12. Cranes/lifts	
Other _____	13. Vessels	13. Hot cells, assembly, inspection	
	14. Other _____	14. Laboratories	
		15. Other _____	
<b>Y N C. Friction</b>	<b>Y N H. Pressure - Volume</b>	<b>Y N L. Flammable Materials</b>	<b>Y N R. Natural Phenomena</b>
1. Belts	1. Boilers	1. Packing materials	1. Earthquake
2. Bearings	2. Surge tanks	2. Rags	2. Flood
3. Fans	3. Autodave	3. Gasoline	3. Lightning
4. Gears	4. Test loops	4. Lube oil	4. Rain
5. Motors	5. Gas bottles	5. Coolant oil	5. Snow, freezing weather
6. Power tools	6. Pressure vessels	6. Paint solvent	6. Straight wind
7. Other (vehicle brakes)	7. Stressed members	7. Diesel fuel	7. Dust devil
	8. Gas receivers	8. Buildings & contents	8. Tornado
	9. Vacuum	9. Trailers & contents	9. Ashfall
	10. Steam headers and lines	10. Grease	10. Range fire
	11. Other (truck tires, air ride suspension, air brakes)		
<b>Y N D. Corrosives</b>			
1. Acids			11. Hydrogen
2. Caustics			12. Nitric acid
3. Natural chemicals			13. Organics
4. Decon solution			14. Gases - others
5. High temperature waste			15. Liquids - others
6. Other _____			16. Other (aerosol propellant)

Table 7. Hazardous Material/Energy Source Checklist: Process Water Room (PW).

Location: *Process Water Room, Cold Vacuum Drying Facility*

<b>Y N A. Electrical</b>	<b>Y N E. Kinetic - Rotational</b>	<b>Y N J. Explosives/Pyrologics</b>	<b>Y N M. Hazardous Materials</b>
1. Battery banks 2. Cable runs 3. Diesel generators 4. Electrical equipment 5. HVAC heaters 6. High voltage 7. Motors 8. Pumps 9. Power tools 10. Switchgear 11. Service outlets, fittings 12. Transformers 13. Transmission lines 14. Underground wires 15. Wiring 16. Other _____	1. Centrifuges 2. Motors 3. Pumps 4. Fans 5. Laundry equipment 6. Shop equipment 7. Other _____	1. Caps 2. Primer cord 3. Dynamite 4. Scrub chemicals 5. Dusts 6. Hydrogen 7. Gases, others 8. Nitrates 9. Peroxides 10. Pu and U metal 11. Sodium 12. Other (uranium hydride)	1. Alkali metals 2. Asphyxiants 3. Biologicals 4. Carcinogens 5. Corrosives 6. Oxidizers 7. Toxics 8. Heavy metals 9. Other _____
<b>Y N B. Thermal</b>	<b>Y N G. Mass, Gravity, Height</b>	<b>Y N K. Nuclear Criticality</b>	<b>Y N N. Ionizing Radiation Sources</b>
1. Bunsen burner/flat plates 2. Electrical equipment 3. Furnaces/boilers/heater 4. Steam lines 5. Welding torch/arc 6. Diesel units/fire box/exhaust line 7. Radioactive decay heat 8. Exposed components 9. Power tools 10. Convective 11. Solar 12. Cryogenic 13. Other _____	1. Human effort 2. Stairs 3. Lifts and cranes 4. Bucket and ladder 5. Trucks 6. Slings 7. Hoists 8. Elevators 9. Jacks 10. Scaffolding and ladders 11. Pits and excavations 12. Elevated doors 13. Vessels 14. Other (roof hatch)	1. Vaults 2. Temporary storage areas 3. Shipping and receiving area 4. Filters 5. Casks 6. Burial ground 7. Storage racks 8. Canals and basins 9. Decon solution 10. Trucks, forklifts, dollies 11. Hand carry 12. Cranes/lifts 13. Hot cells, assembly, inspection 14. Laboratories 15. Other (tanks)	1. Fissile material 2. Radiography equipment 3. Radioactive material 4. Radioactive sources 5. Other _____
<b>Y N C. Friction</b>	<b>Y N H. Pressure - Volume</b>	<b>Y N P. External Events</b>	<b>Y N Q. Vehicles in Motion (external to facility)</b>
1. Belts 2. Bearings 3. Fans 4. Gears 5. Motors 6. Power tools 7. Other _____	1. Boilers 2. Surge tanks 3. Autoclave 4. Test loops 5. Gas bottles 6. Pressure vessels 7. Stressed members 8. Gas receivers 9. Vacuum 10. Steam headers and lines 11. Other _____	1. Explosion 2. Fire 3. Other sites	1. Airplane 2. Helicopter 3. Train 4. Truck/bus/car 5. Other _____
<b>Y N D. Corrosives</b>	<b>Y N L. Flammable Materials</b>	<b>Y N R. Natural Phenomena</b>	
1. Acids 2. Caustics 3. Natural chemicals 4. Decon solution 5. High temperature waste 6. Other _____	1. Packing materials 2. Rags 3. Gasoline 4. Lube oil 5. Coolant oil 6. Paint solvent 7. Diesel fuel 8. Buildings & contents 9. Trailers & contents 10. Grease	1. Earthquake 2. Flood 3. Lightning 4. Rain 5. Snow, freezing weather 6. Straight wind 7. Dust devil 8. Tornado 9. Ashfall 10. Range fire	

Table 8. Hazardous Material/Energy Source Checklist: Outside (OU).

## Location: Outside, Cold Vacuum Drying Facility

<b>Y N A. Electrical</b>	<b>Y N E. Kinetic - Rotational</b>	<b>Y N J. Explosives/Pyrophorics</b>	<b>Y N M. Hazardous Materials</b>
1. Battery banks 2. Cable runs 3. Diesel generators 4. Electrical equipment 5. HVAC heaters 6. High voltage 7. Motors 8. Pumps 9. Power tools 10. Switchgear 11. Service outlets, fittings 12. Transformers 13. Transmission lines 14. Underground wires 15. Wiring 16. Other _____	1. Centrifuges 2. Motors 3. Pumps 4. Fans 5. Laundry equipment 6. Shop equipment 7. Other _____	1. Caps 2. Primer cord 3. Dynamite 4. Scrub chemicals 5. Dusts 6. Hydrogen 7. Gases, others 8. Nitrates 9. Peroxides 10. Pu and U metal 11. Sodium 12. Other _____	1. Alkali metals 2. Asphyxiants 3. Biologicals 4. Carcinogens 5. Corrosives 6. Oxidizers 7. Toxics 8. Heavy metals 9. Other _____
<b>Y N B. Thermal</b>	<b>Y N G. Mass, Gravity, Height</b>	<b>Y N K. Nuclear Criticality</b>	<b>Y N P. External Events</b>
1. Bunsen burner/hot plates 2. Electrical equipment 3. Furnaces/boilers/heater 4. Steam lines 5. Welding torch/arc 6. Diesel units/fire box/exhaust line 7. Radioactive decay heat 8. Exposed components 9. Power tools 10. Convective 11. Solar 12. Cryogenic 13. Other _____	1. Human effort 2. Stairs 3. Lifts and cranes 4. Bucket and ladder 5. Trucks 6. Slings 7. Hoists 8. Elevators 9. Jacks 10. Scaffold and ladders 11. Pits and excavations 12. Elevated doors 13. Vessels 14. Other (roof) _____	1. Vaults 2. Temporary storage areas 3. Shipping and receiving area 4. Filters 5. Casks 6. Burial ground 7. Storage racks 8. Canals and basins 9. Decon solution 10. Trucks, forklifts, dollies 11. Hand cart 12. Cranes/lifts 13. Hot cells, assembly, inspection 14. Laboratories 15. Other (drain tank) _____	1. Explosion 2. Fire 3. Other sites 4. Loss of external power
<b>Y N C. Friction</b>	<b>Y N H. Pressure - Volume</b>	<b>Y N Q. Vehicles in Motion (external to facility)</b>	<b>Y N R. Natural Phenomena</b>
1. Belts 2. Bearings 3. Fans 4. Gears 5. Motors 6. Power tools 7. Other (vehicle brakes) _____	1. Boilers 2. Surge tanks 3. Autoclave 4. Test loops 5. Gas bottles 6. Pressure vessels 7. Stressed members 8. Gas receivers 9. Vacuum 10. Steam headers and lines 11. Other _____	1. Airplane 2. Helicopter 3. Train 4. Truck/bus/car 5. Other _____	1. Earthquake 2. Flood 3. Lightning 4. Rain 5. Snow, freezing weather 6. Straight wind 7. Dust devil 8. Tornado 9. Ashfall 10. Range fire
<b>Y N D. Corrosives</b>	<b>Y N L. Flammable Materials</b>		
1. Acids 2. Caustics 3. Natural chemicals 4. Decon solution 5. High temperature waste 6. Other _____	1. Packing materials 2. Rags 3. Gasoline 4. Lube oil 5. Coolant oil 6. Paint solvent 7. Diesel fuel 8. Buildings & contents 9. Trailers & contents 10. Grease 11. Hydrogen 12. Nitric acid 13. Organics 14. Gases - others 15. Liquids - others 16. Other (aerosol propellant) _____		

Table 9. Standard Industrial Hazards: Administrative Area. (2 sheets)

Hazard category	Hazard type	Hazard checklist identification number*
Electrical	Battery banks (uninterruptible power supply)	AA-A-01
	Cable runs	AA-A-02
	Electrical equipment	AA-A-04
	Motors	AA-A-07
	Power tools	AA-A-09
	Switchgear	AA-A-10
	Wiring	AA-A-15
Thermal	Bunsen burner/hot plates	AA-B-01
	Furnaces/boilers/heater	AA-B-03
	Power tools	AA-B-09
Friction	Fans	AA-C-03
	Power tools	AA-C-06
Corrosives	Acids	AA-D-01
	Caustics	AA-D-02
	Natural chemicals	AA-D-03
Kinetic - rotational	Motors	AA-E-02
	Shop equipment	AA-E-06
Kinetic - linear	Forklifts, dollies, carts	AA-F-02
Mass, gravity, height	Bucket and ladder	AA-G-04
	Jacks	AA-G-09
	Scaffold and ladders	AA-G-10
	Vessels	AA-G-13
Pressure - volume	Gas bottles (portable monitor)	AA-H-05
	Pressure vessels	AA-H-06
Explosives/pyrophorics	Scrub chemicals	AA-J-04
Hazardous materials	Alkali metals	AA-M-01
	Asphyxiants	AA-M-02
	Corrosives	AA-M-05
	Oxidizers	AA-M-06
	Toxics	AA-M-07
	Heavy metals (mercury in relays)	AA-M-08

Table 9. Standard Industrial Hazards: Administrative Area. (2 sheets)

Hazard category	Hazard type	Hazard checklist identification number*
Ionizing radiation sources	Radioactive sources (sealed sources)	AA-N-04

\*Hazard checklist identification numbers XX-Y-## represent a specific line item on a hazardous material/energy source checklist (see Table 2) where:

XX = facility area.  
 Y = hazard type.  
 ## = checklist designator.

Table 10. Standard Industrial Hazards: Transfer Corridor and Mechanical Corridor. (2 sheets)

Hazard category	Hazard type	Hazard checklist identification number*
Electrical	Cable runs	TC-A-02
	Electrical equipment	TC-A-04
	HVAC heaters	TC-A-05
	High voltage	TC-A-06
	Motors	TC-A-07
	Power tools	TC-A-09
	Switchgear	TC-A-10
	Service outlets, fittings	TC-A-11
	Transformers	TC-A-12
	Wiring	TC-A-15
Thermal	Electrical equipment	TC-B-02
	Furnaces/boilers/heater	TC-B-03
	Power tools	TC-B-09
Friction	Belts	TC-C-01
	Bearings	TC-C-02
	Fans	TC-C-03
	Gears	TC-C-04
	Motors	TC-C-05
	Power tools	TC-C-06
Corrosives	Acids	TC-D-01
	Caustics	TC-D-02
	Decon solution	TC-D-04
Kinetic - rotational	Motors	TC-E-02
	Shop equipment	TC-E-06
Mass, gravity, height	Human effort	TC-G-01
	Stairs	TC-G-02
	Bucket and ladder	TC-G-04
	Slings	TC-G-06
	Hoists	TC-G-07
	Jacks	TC-G-09
	Scaffold and ladders	TC-G-10
	Elevated doors	TC-G-12
	Vessels (air compressor)	TC-G-13

Table 10. Standard Industrial Hazards: Transfer Corridor and Mechanical Corridor. (2 sheets)

Hazard category	Hazard type	Hazard checklist identification number*
Pressure - volume	Gas bottles	TC-H-05
	Pressure vessels	TC-H-06
Explosives/pyrophorics	Scrub chemicals	TC-J-04
	Hydrogen	TC-J-06
	Gases, others	TC-J-07
Flammable Materials	Grease	TC-L-10
	Gasoline	TC-L-03
	Organics	TC-L-13
Hazardous materials	Asphyxiants	TC-M-02
	Biologicals	TC-M-03
	Carcinogens	TC-M-04
	Corrosives	TC-M-05
	Oxidizers	TC-M-06
	Toxics	TC-M-07
	Heavy metals	TC-M-08
Ionizing radiation sources	Radiography equipment	TC-N-02
	Radioactive sources	TC-N-04
Vehicles in motion (external to facility)	Train	TC-Q-03

\*Hazard checklist identification numbers XX-Y-## represent a specific line item on a hazardous material/energy source checklist (see Table 2) where:

XX = facility area.  
Y = hazard type.  
## = checklist designator.

Table 11. Standard Industrial Hazards: Process Bays 2 through 5. (2 sheets)

Hazard category	Hazard type	Hazard checklist identification number*
Electrical	Cable runs	PB-A-02
	HVAC heaters	PB-A-05
	High voltage	PB-A-06
	Motors	PB-A-07
	Pumps	PB-A-08
	Power tools	PB-A-09
	Switchgear	PB-A-10
	Service outlets, fittings	PB-A-11
	Transformers	PB-A-12
	Wiring	PB-A-15
Thermal	Welding torch/arc	PB-B-05
	Radioactive decay heat	PB-B-07
	Exposed components	PB-B-08
	Power tools	PB-B-09
	Convective	PB-B-10
Friction	Belts	PB-C-01
	Bearings	PB-C-02
	Fans	PB-C-03
	Gears	PB-C-04
	Motors	PB-C-05
	Power tools	PB-C-06
	Other (vehicle brakes)	PB-C-07
Corrosives	Acids	PB-D-01
	Caustics	PB-D-02
	Decon solution	PB-D-04
Kinetic - rotational	Motors	PB-E-02
	Pumps	PB-E-03
	Fans	PB-E-04
	Shop equipment	PB-E-06
Kinetic - linear	Obstructions	PB-F-04
	Pressure Vessel Blowdown	PB-F-06

Table 11. Standard Industrial Hazards: Process Bays 2 through 5. (2 sheets)

Hazard category	Hazard type	Hazard checklist identification number*
Mass, gravity, height	Human effort	PB-G-01
	Stairs	PB-G-02
	Lifts and cranes	PB-G-03
	Bucket and ladder	PB-G-04
	Trucks	PB-G-05
	Slings	PB-G-06
	Hoists	PB-G-07
	Jacks	PB-G-09
	Scaffold and ladders	PB-G-10
	Elevated doors	PB-G-12
Pressure - volume	Other (elevated platform)	PB-G-14
	Surge tanks	PB-H-02
	Gas bottles	PB-H-05
	Gas receivers	PB-H-08
Explosives/pyrophorics	Vacuum	PB-H-09
	Scrub chemicals	PB-J-04
Nuclear criticality	Shipping and receiving area	PB-K-03
	Trucks, forklifts, dollies	PB-K-10
Hazardous materials	Asphyxiants	PB-M-02
	Biologicals	PB-M-03
	Carcinogens	PB-M-04
	Corrosives	PB-M-05
	Oxidizers	PB-M-06
	Toxics	PB-M-07
	Heavy metals	PB-M-08
Ionizing radiation sources	Radiography equipment	PB-N-02
	Radioactive sources	PB-N-04
External events	Fire	PB-P-02

\*Hazard checklist identification numbers XX-Y-## represent a specific line item on a hazardous material/energy source checklist (see Table 2) where:

XX = facility area.

Y = hazard type.

## = checklist designator.

Table 12. Standard Industrial Hazards: Process Bay 1 (Spare Bay). (2 sheets)

Hazard category	Hazard type	Hazard checklist identification number*
Electrical	Cable runs	SB-A-02
	Electrical equipment	SB-A-04
	Motors	SB-A-07
	Pumps	SB-A-08
	Power tools	SB-A-09
	Service outlets, fittings	SB-A-11
	Wiring	SB-A-15
Thermal	Electrical equipment	SB-B-02
	Welding torch/arc	SB-B-05
	Power tools	SB-B-09
Friction	Bearings	SB-C-02
	Gears	SB-C-04
	Motors	SB-C-05
	Power tools	SB-C-06
	Other (vehicle brakes)	SB-C-07
Corrosives	Acids	SB-D-01
	Caustics	SB-D-02
	Natural chemicals	SB-D-03
	Decon solution	SB-D-04
Kinetic - rotational	Motors	SB-E-02
	Pumps	SB-E-03
	Shop equipment	SB-E-06
Kinetic - linear	Obstruction	SB-F-04
	Crane loads	SB-F-05
Mass, gravity, height	Human effort	SB-G-01
	Lifts and cranes	SB-G-03
	Bucket and ladder	SB-G-04
	Trucks	SB-G-05
	Slings	SB-G-06
	Hoists	SB-G-07
	Jacks	SB-G-09
	Scaffold and ladders	SB-G-10
	Elevated doors	SB-G-12

Table 12. Standard Industrial Hazards: Process Bay 1 (Spare Bay). (2 sheets)

Hazard category	Hazard type	Hazard checklist identification number*
Pressure - volume	Gas bottles	SB-H-05
Explosives/pyrophorics	Scrub chemicals	SB-J-04
	Hydrogen	SB-J-06
Flammable materials	Grease	SB-L-10
	Organics	SB-L-13
Hazardous materials	Asphyxiants	SB-M-02
	Biologicals	SB-M-03
	Carcinogens	SB-M-04
	Corrosives	SB-M-05
	Oxidizers	SB-M-06
	Toxics	SB-M-07
	Heavy metals	SB-M-08
Ionizing radiation sources	Radiography equipment	SB-N-02
	Radioactive sources	SB-N-04
Vehicles in motion (external to facility)	Train	SB-Q-03

\*Hazard checklist identification numbers XX-Y-## represent a specific line item on a hazardous material/energy source checklist (see Table 2) where:

XX = facility area.

Y = hazard type.

## = checklist designator.

Table 13. Standard Industrial Hazards: Process Water Room. (2 sheets)

Hazard category	Hazard type	Hazard checklist identification number*
Electrical	Cable runs	PW-A-02
	Electrical equipment	PW-A-04
	High voltage	PW-A-06
	Motors	PW-A-07
	Pumps	PW-A-08
	Power tools	PW-A-09
	Switchgear	PW-A-10
	Service outlets, fittings	PW-A-11
	Transformers	PW-A-12
Thermal	Wiring	PW-A-15
	Electrical equipment	PW-B-02
	Welding torch/arc	PW-B-05
	Radioactive decay heat	PW-B-07
	Power tools	PW-B-09
Friction	Solar	PW-B-11
	Bearings	PW-C-02
	Motors	PW-C-05
Corrosives	Power tools	PW-C-06
	Acids	PW-D-01
	Caustics	PW-D-02
Kinetic - rotational	Decon solution	PW-D-04
	Motors	PW-E-02
	Pumps	PW-E-03
Kinetic - linear	Shop equipment	PW-E-06
	Forklifts, dollies, carts	PW-F-02
	Crane loads	PW-F-05
Mass, gravity, height	Pressure vessel blowdown	PW-F-06
	Human effort	PW-G-01
	Stairs	PW-G-02
	Bucket and ladder	PW-G-04
	Slings	PW-G-06
	Hoists	PW-G-07
	Jacks	PW-G-09

Table 13. Standard Industrial Hazards: Process Water Room. (2 sheets)

Hazard category	Hazard type	Hazard checklist identification number*
Mass, gravity, height (cont.)	Scaffold and ladders	PW-G-10
	Vessels	PW-G-13
	Other (roof hatch)	PW-G-14
Pressure - volume	Test loops	PW-H-04
	Gas bottles	PW-H-05
	Pressure vessels	PW-H-06
Explosives/pyrophorics	Scrub chemicals	PW-J-04
	Gases, other	PW-J-07
Flammable materials	Packing materials	PW-L-01
	Gasoline	PW-L-03
	Lube oil	PW-L-04
	Coolant oil	PW-L-05
	Paint solvent	PW-L-06
	Grease	PW-L-10
	Organics	PW-L-13
Hazardous materials	Asphyxiants	PW-M-02
	Biologicals	PW-M-03
	Carcinogens	PW-M-04
	Corrosives	PW-M-05
	Toxics	PW-M-07
	Heavy metals	PW-M-08
Ionizing radiation sources	Radiography equipment	PW-N-02
Vehicles in motion (external to facility)	Train	PW-Q-03
Natural phenomena	Earthquake	PW-R-01

\*Hazard checklist identification numbers XX-Y-## represent a specific line item on a hazardous material/energy source checklist (see Table 2) where:

XX = facility area.  
Y = hazard type.  
## = checklist designator.

Table 14. Standard Industrial Hazards: Outside. (3 sheets)

Hazard category	Hazard type	Hazard checklist identification number
Electrical	Cable runs	OU-A-02
	Diesel generators	OU-A-03
	Electrical equipment	OU-A-04
	HVAC heaters	OU-A-05
	High voltage	OU-A-06
	Motors	OU-A-07
	Pumps	OU-A-08
	Power tools	OU-A-09
	Switchgear	OU-A-10
	Service outlets, fittings	OU-A-11
	Transformers	OU-A-12
	Transmission lines	OU-A-13
	Underground wires	OU-A-14
	Wiring	OU-A-15
Thermal	Bunsen burner/hot plates	OU-B-01
	Electrical equipment	OU-B-02
	Furnaces/boilers/heater	OU-B-03
	Welding torch/arc	OU-B-05
	Diesel units/fire box/exhaust line	OU-B-06
	Power tools	OU-B-09
	Solar	OU-B-11
Friction	Belts	OU-C-01
	Bearings	OU-C-02
	Fans	OU-C-03
	Gears	OU-C-04
	Motors	OU-C-05
	Power tools	OU-C-06
	Other (vehicle brakes)	OU-C-07
Corrosives	Acids	OU-D-01
	Caustics	OU-D-02
	Decon solution	OU-D-04

Table 14. Standard Industrial Hazards: Outside. (3 sheets)

Hazard category	Hazard type	Hazard checklist identification number
Kinetic - rotational	Motors	OU-E-02
	Pumps	OU-E-03
	Shop equipment	OU-E-06
Kinetic - linear	Forklifts, dollies, carts	OU-F-02
	Railroad	OU-F-03
	Crane loads	OU-F-05
	Pressure vessel blowdown	OU-F-06
	Other (gas bottles)	OU-F-07
Mass, gravity, height	Human effort	OU-G-01
	Lifts and cranes	OU-G-03
	Bucket and ladder	OU-G-04
	Trucks	OU-G-05
	Slings	OU-G-06
	Hoists	OU-G-07
	Jacks	OU-G-09
	Scaffold and ladders	OU-G-10
	Pits and excavations	OU-G-11
	Elevated doors	OU-G-12
	Vessels	OU-G-13
	Other (roof)	OU-G-14
Pressure - volume	Gas bottles	OU-H-05
	Pressure vessels	OU-H-06
Explosives/pyrophorics	Gases, others	OU-J-07
Flammable materials	Buildings and contents	OU-L-08
	Hydrogen	OU-L-11
Hazardous materials	Asphyxiants	OU-M-02
	Biologicals	OU-M-03
	Carcinogens	OU-M-04
	Corrosives	OU-M-05
	Oxidizers	OU-M-06
	Toxics	OU-M-07
	Heavy metals	OU-M-08

Table 14. Standard Industrial Hazards: Outside. (3 sheets)

Hazard category	Hazard type	Hazard checklist identification number
Ionizing radiation sources	Radiography equipment	OU-N-02
	Radioactive sources	OU-N-04
Vehicles in motion (external to facility)	Train	OU-Q-03

\*Hazard checklist identification numbers XX-Y-## represent a specific line item on a hazardous material/energy source checklist (see Table 2) where:

XX = facility area.

Y = hazard type.

## = checklist designator.

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**ATTACHMENT 1**

**COLD VACUUM DRYING FACILITY HAZARD  
ANALYSIS TEAM MEMBERS**

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**ATTACHMENT 1**

**COLD VACUUM DRYING FACILITY HAZARD  
ANALYSIS TEAM MEMBERS**

The key members of the Cold Vacuum Drying Facility Hazards Analysis brought to the study the following experience.

**Walter Alaconis**

B.S., General Science. Nearly 27 years of diversified nuclear safety and operations experience in the military, commercial, and U.S. Department of Energy (DOE) environments. Obtained registration with the National Registry of Radiation Protection Technologists in 1982. Over 16 years at the Hanford Site supporting major facility modifications and new facility design projects. Co-author of the Process Facility Modification Project Preliminary Safety Analysis Report. Managed the development of the Hanford Site Quality Training and Resource Center Root Cause Analysis Training Program and the Accident/Event Trending Program. Managed the Nuclear Engineering/Safety Data Management Unit for 4 years. Technical advisor to the Liquid Effluent Services Program at the Hanford Site and the Environmental Restoration Programs at the Hanford Site and DOE-Headquarters. Facilities supported at the Hanford Site include the tank farms (east), PUREX, B Plant, Plutonium Finishing Plant, Treated Effluent Disposal Facility, and Effluent Treatment Facility.

**JoAnn Brehm**

B.S., Biology, Mechanical Engineering. Twenty-two years experience in the nuclear industry, including sodium test reactor startup and operations, major DOE and international decontamination and decommissioning projects, and technology transfer. Six years direct experience in providing project management and preparing nuclear safety analysis documents for DOE facilities, including the Shippingport Station Decommissioning Project, Spent Nuclear Fuel Project, and the Waste Encapsulation and Storage Facility.

**Ralph D. Crowe**

M.S., Nuclear Engineering and Engineering Management. Over 20 years experience in the nuclear industry performing calculations using multidimensional time-dependent neutron kinetics and thermal hydraulic codes. Six years experience performing safety analysis within the DOE environment for a number of facilities, including high-level waste tanks, Plutonium Finishing Plant, and spent fuel storage.

**John J. Irwin**

B.S. Degree in Mechanical Engineering and in Aeronautical Engineering, Masters of Science Program in Mechanical Engineering. Principal Engineer at the Numatec Hanford Corporation, with 24 years experience. Formerly with Space Division of the Rockwell Corporation as a member of the technical staff. Worked as a mechanical engineer on the Space Shuttle Program, Fast Flux Test Facility (FFTF) Reactor, Fusion Materials Irradiation Test Facility, SP100 Space Reactor Test Facility, and the K Basin Spent Nuclear Fuel Project.

**Dwight E. Krahn**

B.S., General Engineering, field of specialty in Operations Research. Eight years experience in engineering and safety analysis activities. Training includes safety analysis development, root cause analysis, and risk assessment. Most recent work has been in the area of Technical Safety Requirements for the Waste Encapsulation and Storage Facility and the tank farms.

**Curt Miska**

B. S., Chemical Engineering. Seventeen years experience with Westinghouse Hanford Company/Rockwell Hanford Operations. Operations supervisor for PUREX Head End, PUREX Solvent Extraction, PUREX Plutonium Processing, and Uranium Conversion Facility (U03 Plant). Lead/cognizant process engineer for PUREX Solvent Extraction, PUREX Plutonium Processing, and B Plant cesium ion exchange systems. Currently an engineer for the Spent Nuclear Fuel Project. Developed preconceptual design concepts for potential fuel stabilization facilities. Provided technical input to DOE Spent Nuclear Fuel Programmatic Environmental Impact Statement for N Reactor fuel stabilization, including developing bases for information such as construction and operating resources and personnel required, and routine and accidental radiological and nonradiological releases. Provided major input for and coordinated completion of Dry Storage Technical Evaluation, including development of preliminary processing scheme, material balance, cycle time, and life-cycle cost estimates.

**Paul Patterson**

Senior Reactor Operator (SRO), Hanford N-Reactor. Seventeen years experience in nuclear power plant and facility operations, training, safety and procedure development. As an SRO responsibilities included maintaining reactor safety during all modes of operation from the reactor control room. A certified DOE technical trainer and oral board examiner. Instructed reactor operator and senior reactor operator candidates and facility management in reactor process operations, heat transfer and fluid flow, reactor physics fundamentals, and accident analysis and safety basis. As a consultant, facilitator, and writer supporting various Hanford Site and Idaho National Engineering Laboratory projects over the past 10 years, led safety document

and requirements processes and hazard analyses sessions; participated in operational readiness reviews; designed and developed training and qualification programs; presented specialized training programs; facilitated specialized group processes; and supported process and facility operating procedure development during final stages of engineering and facility start-up.

**Carole Pili-Vincens**

Graduate Engineer, Environment, Health and Safety; Technological Hazards Management; Reliability and Maintainability Studies. Six years experience in the nuclear industry performing safety analyses, managing a safety group, and defining safety analysis methods for French nuclear facilities (including high-level waste treatment and storage). Specialist in pyrophoricity reaction risks and environmental analyses. Two years experience performing safety and environmental analyses and assessments as a consultant for industrial facilities (chemical and oil plants).

**Richard Whitehurst**

Over 27 years experience in nuclear-related instrumentation and controls, operations, and project management. Design/project lead engineer for computer-controlled processes, including the 300 Area Treated Effluent Disposal Facility and the K East Basin monitoring and control systems. Cognizant engineer at the FFTF with direct responsibilities for a number of process systems, including safety-class systems such as Seismic Monitoring, Safe Shutdown Monitoring, and Emergency Dump Heater Exchanger Control System. Experience in operations with both the FFTF and the U.S. Nuclear Navy. Performed duties as test director and test engineer at K Basins, 300 Area Treated Effluent Disposal Facility, and the FFTF. Involved in safety equipment and procedures since 1979 at FFTF.

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**ATTACHMENT 2**

**COLD VACUUM DRYING FACILITY HAZARD ANALYSIS**

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Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 1 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Frequency		Consequence		Defense-in-depth or worker safety features
							Without prevention	With prevention	Without mitigation	With mitigation	
Administrative Area AA-F-06	Linear kinetic - other (gas bottles)	Stored gas bottles become missiles	Earthquake damage, body and hard car impact	Bottle becomes missile, damages structure and/or equipment	Personnel injury, structure and/or equipment damage to the administrative area only, no damage to SSCs	Gas bottle design includes passive orifice that restricts kinetic energy to limit velocity	F0		S1		
Administrative Area AA-J-05 and 12	Explosives / Pyrophorics - hydrogen (batteries)	Explosive gas mixtures	Batteries give off hydrogen gas	Explosion of explosive gases	Reduced capacity or loss of Administrative Area affects facility power, MCS control, and operations from control room	No credited prevention, safe process shutdown does not rely on input from the Administrative Area	F2	F2	S1	S1	
Administrative Area AA-L-01 AA-L-02 AA-L-08 AA-L-11 AA-L-16	Flammable materials - rags, paint solvent, building and contents, hydrogen from batteries, other (aerosol propellant)	Fire due to ignition	Human error Electrical shorts	Fire, heat and/or heat in the administrative area with the potential to propagate to other areas.	Reduced capacity or loss of Administrative Area affects facility power, MCS control, and operations from control room	Combustible heating requirements from the FHA <sup>a</sup> are imposed	F3	F0	S1	S1	SCC detects process upset initiating SCHe, which isolates MC0 from process piping and establishes helium supply to the MC0 Cask-MCO and SCIC confinement design
Administrative Area AA-P-01 AA-P-02 AA-P-03 AA-Q-01 AA-Q-02 AA-Q-04 AA-R-01 AA-R-10	Various external events affecting the Administrative Area, see Outside Events, Sections Q1-Q2, Q1-Q and Q1-R for discussion of these events	Thermal - welding torch/arc	High temperature	Human error during welding operations near fire protection sprinkler heads	Fire spreads	Safe process shutdown does not rely on input from the Administrative Area					Facility evacuation to protect workers
Transfer corridor, mechanical room TC-F-05	Linear kinetic - other (gas bottles)	Gas bottles used in portal monitors become missiles	Earthquake damage Valve breaks off bottle	Actuation of fire protection sprinkler(s)	Water sprays on equipment	Walls between the administrated area and the process bays are fire rated for 2 hours	F2	F2	S0	S0	Fire alarm and fire department response
Transfer corridor, mechanical room TC-F-07						Fire sprinkler system					
Transfer corridor, mechanical room TC-J-12	Explosives/ Pyrophorics - explosive gases	Explosive gas used for maintenance	Maintenance gases released to area then into ventilation system	External explosion (E.6) (gases in ventilation system)	Dispersion of HEPA filter contents	Sturdy walls (4- to 8-in.-thick concrete) between the transfer corridor and the process bays	F0				Radiactive material loading on HEPA filter is restricted
Transfer corridor, mechanical room TC-K-4	Nuclear Criticality - Filters	Fissile material scattered on HEPA filters	Fissile material released from MC0 during normal operation	Potential for criticality due to accumulation of material	High local doses to personnel	Gas bottle design includes passive orifice that restricts kinetic energy to limit velocity	F3	F2	S1	S1	Emergency response procedures and training, alarm response procedures and training

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 2 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Frequency		Consequence		Defense-in-depth or worker safety features		
							Without prevention	With prevention	Without mitigation	With mitigation			
Transfer corridor, mechanical room TC-L-01 TC-L-02 TC-L-04 TC-L-05 TC-L-06 TC-L-08 TC-L-11 TC-L-14 TC-L-15 TC-L-16	Flammable materials - resins, lubricating oil, coolant oil, paint solvent, building and contents, hydrogen, other gases and liquids, other (aerosol propellant)	Fire due to ignition	Human error (e.g., improper storage practices) Electrical shorts Propagation from other facility areas	Fire in the transfer corridor or mechanical room	Equipment and/or structural damage Personnel injury	Combustible loading requirements from the FHA* are imposed Safe process shutdown does not rely on input from the transfer corridor or mechanical room Equipment in the mechanical room required for safe shutdown is designed to environmental qualifications Fire sprinkler system	F3	F0	S1	S1	SCIC detects process upset initiating SCICs, which isolates MCO from process piping and establishes helium supply to the MCO Cask-MCO and SCIC confinement design Facility evacuation to protect workers Fire alarm and fire department response		
TC-N-02	Hazardous materials - helium as an asphyxiant			Material failure, seismic event or human error	Personnel injury	Design feature - helium system piping installed to national codes and standards	F2		S1		HEPA filters are monitored regularly and changed out according to approved facility-specific procedures		
Transfer corridor, mechanical room TC-N-03	Ionizing radiation sources - radioactive material		HEPA filter loading of radioactive material	HEPA filter failure and subsequent particulate release Inadvertent contamination spread	Radioactive particulate release through stack	Multiple HEPA filter stages exist within the local and general exhaust system No credible mechanism for complete HEPA filter loading	F1 - for failure releasing entire filter loading	F0 - for failure releasing entire filter loading	S1	S1			
Transfer corridor, mechanical room TC-P-01 TC-P-02 TC-P-03 TC-Q-01 TC-Q-02 TC-Q-04 TC-R-02 - R-10	Various external events affecting the transfer corridor or mechanical room, see Outside Events Sections OULP, OUL-Q and OUL-R, for discussion of these events												
Transfer corridor, mechanical room TC-R-01	Natural phenomena - earthquake (DBE)		Fuel reactions due to equipment damage caused by seismic event	Seismic event causes process support system or supply loss	Gaseous release (G.3) External hydrogen explosion (E.8)	Hydrogen and/or radioactive particulate release MCO and SCIC confinement design TSR - Process vent HEPA filter loading	F2	F0	HVAC systems provide confinement, dilution and filtration	S2	S1	SCIC detects process upset initiating SCICs, which isolates MCO from process piping and establishes helium supply to the MCO	
Process bays 2-5 PB-S-02a	Thermal - electrical equipment		Bay temperatures in excess of electrical equipment design limits with annulus water flow	HVAC failure causes high temperature, equipment becomes unreliable	Internal hydrogen explosion (I.2) External hydrogen explosion (E.2)	Hydrogen and/or radioactive particulate release SCIC actuates SCICs on high bay temperature SCIC establishes He flow through MCO directly to local exhaust MCO and SCIC confinement design MCO design withstands internal explosion energy	F3	F0	HVAC systems provide confinement and dilution	S2	S1		

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 3 of 22)

Checklist entry	Hazard source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Consequence			Defense-in-depth or worker safety features		
							Frequency	Without prevention	With prevention	Credited mitigation	Without mitigation	With mitigation
Process bays 2-5 PB-B-02b	Thermal - electrical equipment	Bay temperatures in excess of electrical design limits no water flow	HVAC failure Bay recirculation heaters continue to run (fail on)	Thermal runaway reaction (T-2)	High temperatures in the MCO and the potential for radioactive particle release	SCIC actuates SCHe on high bay temperature SCIC actuates SCHe on high TWS temperature SCHe establishes He flow through MCO directly to local exhaust MCO and SCHe confinement design TSR - Crane movement restricted during MCO processing TSR - Restore bay temperature to acceptable limits	F3	F0	HVAC systems provide confinement	S3	S1	HVAC maintains operating temperatures in the bay
Process bays 2-5 PB-B-03a	Thermal - heaters (tempered water heater)					SCIC detects process upset initiating SCHe, which isolates MCO from process piping and establishes helium supply to the MCO MCO and SCHe confinement design 30 lb/in <sup>2</sup> rupture disk and vent path	F3	F0	HVAC systems provide confinement and dilution 150 lb/in <sup>2</sup> rupture disk MCO design withstands internal explosion energy	S3	S1	GSHe safety-class flow instrumentation 10 lb/in <sup>2</sup> process relief valve
Process bays 2-5 PB-B-03b	Thermal - heaters (tempered water heater)					Excessive water remaining in MCO reacts with the fuel producing heat and hydrogen leading to potential hydrogen and/or radioactive particulate release Over long term, potential for release at CSB	F2	F1	HVAC systems provide confinement and dilution (Note: Pressure rebound test utilizes different instrumentation than does the tempered water system)	S2	S1	This consequence is a concern for the SAR* or the CSB FSAR. Initial pressure rebound test Final pressure rebound test
Process bays 2-5 PB-B-13a	Thermal - MCO contents < 75 °C for centerline of fuel					External hydrogen explosion (E-3) Hydrogen generation and potential for runaway at the CSB	F3	F0	HVAC systems provide confinement, filtration, and dilution PNC drain line qualification Cask/MCO design withstands internal explosion energy	S2	S1	Tempered water system

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 4 of 22)

Checklist entry	Hazard source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Consequence			Defense-in-depth or worker safety features	
							Frequency	Without prevention	With prevention		
Process bays 2-5 PB-B-13b	Thermal - MCO contents < 75 °C for centerline of fuel	High fuel temperatures react with water during drying mode or pressure rebound test	Leak back of deionized (DI) water during vacuum	Internal hydrogen explosion (I-1) External hydrogen explosion (E-4)	Fuel reaction with water produces heat and hydrogen leading to potential hydrogen and/or radioactive particulate release	SCIC detects process upset initiating SCHe, which isolates MCO from process piping and establishes helium supply to the MCO MCO and SCHe confinement design	F3	F0	HVAC systems provide confinement and dilution Cask-MCO design withstands internal explosion energy	S2	S1
Process bays 2-5 PB-B-13c	Thermal - MCO contents < 75 °C for centerline of fuel	No tempered water or low tempered water level in the annulus	Tempered water line leak or break from earthquake or operator error	External hydrogen explosion (E-4) Thermal runaway reaction (T-1, DBA) MCO Overpressurization (P-1, DBA)	Heatup increases fuel reaction with water producing more heat and hydrogen leading to potential hydrogen and/or radioactive particulate release, or thermal runaway reaction	TSR - Crane movement restricted during processing to preclude common mode failure of tempered water line SCIC detects process upset initiating SCHe, which isolates MCO from process piping and establishes helium supply to the MCO MCO and SCHe confinement design	F3	F0	HVAC systems provide confinement and dilution 150lb/in <sup>2</sup> rupture disk TW System antisiphon valves	S3	S1
Process bays 2-5 PB-B-13d	Thermal - MCO contents < 75 °C for centerline of fuel	Excessive amount of water remains in the MCO	Human error - misread instrument and positioned SCIC switch and MCO from Drying Mode to Proof Mode, or from Proof Mode to Pressure Test Mode without adequate drying	External hydrogen explosion (E-3) Thermal runaway reaction (T-1) MCO Overpressurization (P-1)	Excessive water remaining in MCO reacts with the fuel producing heat and hydrogen and/or radioactive particulate release, or thermal runaway reaction	TSR - Procedure to verify the results of the pressure rebound tests before continuing process steps	F3	F1	HVAC systems provide confinement and dilution	S3	S1
Process bays 2-5 PB-B-13e	Thermal - MCO contents < 75 °C for centerline of fuel, proof - of - dryness at CVDF	High fuel temperatures NOTE: Temperature at CVDF is important for adding helium to MCO so don't need extra gelling material added	MCO not adequately cooled (due to human error, mechanical failure, or software failure)	Higher than expected MCO temperatures, Internal hydrogen explosion in the MCO at CSB	No release, with less than 200 grams of free water, pressure created is not in excess of cask-MCO design	Initial pressure rebound test Final pressure rebound test	F2			S0	
Process bays 2-5 PB-B-13f	Thermal - MCO contents, a concern at CSB	High fuel temperatures	Inadequate cooling prior to shipping AND a failure of MCO seals allowing generated hydrogen generation to leak out to the air filled cask annulus	Hydrogen explosion in cask at CSB	Hydrogen and/or radioactive particulate release from cask	TSR - Procedure for cooling MCO and helium filling prior to shipment to CSB	F2	F1		S2	S1

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 5 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Consequence			Defense-in-depth or worker safety features	
							Frequency	Without prevention	With prevention		
Process bays 2-5 PB-F-13g	Thermal - MCO contents	High MCO temperatures on receipt	Shipping time exceeds window Improper fuel loading (insufficient fuel or improper fuel configurations) MCO water leakage	External hydrogen explosion (E.1)	Hydrogen formed in MCO explodes outside of MCO when cask-MCO is vented	TSR – Receipt transportation window Cask-MCO confinement function Cask vent orifice and interlock with HVAC for dilution	F3	F0	TSR – HVAC HEPA filter loading limit	S2	S1
Process bays 2-5 PB-F-01a	Linear kinetic - transportation cask trailer		Trailer impacts within the process bay	Human error Mechanical failure	Striking walls, personnel, outer bay doors	Bollards and other structural steel devices near the process bay doors and within the process bay protect the outer doors and the back wall of the process bay The mezzanine supports protect the process bay side wall from damage	F3	S1			
Process bays 2-5 PB-F-01b	Linear kinetic - transportation cask trailer		Trailer impacts within the process bay	Human error Mechanical failure	Striking the process skid or mezzanine supports	Damage to equipment on the process skid and subsequent release of contaminated material at levels below the administrative controls provided by the Radiation Protection and ALARA Programs. Processing is not underway during event. Personnel injury.	F3	S1	Bollards and other structural steel devices near the process bay doors and within the process bay protect the outer doors and the back wall of the process bay		
Process bays 2-5 PB-F-01c	Linear kinetic - transportation cask trailer		Trailer impacts within the process bay	Human error Mechanical failure	Damage to cask	The cask is qualified for all anticipated transport accidents, which bound the low-velocity impact associated with this hazard Personnel injury.		F0		S1	
Process bays 2-5 PB-F-01d	Linear kinetic - transportation cask trailer		Cask in trailer impacts PWC drain line within the process bay	Human error Mechanical failure	None – this collision is not physically possible due to the elevation of the drain line			F0			

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 6 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Frequency	Consequence		Defense-in-depth or worker safety features
								Without mitigation	With mitigation	
Process bays 2-5 PB-F-02a	Linear kinetic - forklifts, dollies, carts	Forklift impacts within an empty process bay, striking instrument air lines or normal helium supply, outer bay doors, electrical panel, demineralized water line, chilled water line, or adjacent bay wall affecting processing operations in other bays.	Human error Mechanical failure	Forklift do not have room to operate in bays occupied by MCO trailer. Collisions in an empty bay potentially lead to accidents in bays where process is underway.	Process upset due to loss of support system, leads to potential hydrogen formation and release, and/or radioactive particle release.	SCIC detects process upset initiating SCHe, which isolates MCO from process piping and establishes helium supply to the MCO and vent to local exhaust	F3	HVAC systems provide confinement and dilution 150 lb/in <sup>2</sup> gauge rupture disk	S3	Forklifts are operated by qualified personnel. 10 lb/in <sup>2</sup> process relief valve
Process bays 2-5 PB-F-02b	Linear kinetic - forklifts, dollies, carts	Forklift impacts MCO drain line within the process bay – bay is empty	Human error Mechanical failure	Forklift do not have room to operate in bays occupied by MCO trailer. Collisions in an empty bay potentially lead to accidents in bays where process is underway.	Damage to equipment on the process skid in the empty bay and subsequent release of contaminated material	Cask-MCO AND SCHe confinement design 30 lb/in <sup>2</sup> gauge rupture disk TSR: Receipt transportation window	F0		S1	
Process bays 2-5 PB-F-02b	Linear kinetic - forklifts, dollies, carts	Forklift impacts MCO drain line within the process bay – bay is empty	Human error Mechanical failure	Forklift do not have room to operate in bays occupied by MCO trailer. Collisions in an empty bay potentially lead to accidents in bays where process is underway.	Personnel injury Loss of power Breach confinement					
Process bays 2-5 PB-F-02b and PB-G-03a	Linear kinetic - crane loads and Load drops – Mass, gravity, height - lifts and cranes	Crane load impacts or drops striking instrument air lines or normal helium supply, electrical panel, or demineralized water line, during processing operations	Human error Mechanical failure	None – this collision is not physically possible due to the elevation of the drain line	None – this collision is not physically possible due to the elevation of the drain line	SCIC detects process upset initiating SCHe, which isolates MCO from process piping and establishes helium supply to the MCO and vent to local exhaust	F0		F0	Fork lifts do not have room to operate in bays occupied by MCO trailer.
Process bays 2-5 PB-F-06	Linear kinetic - crane loads and Load drops – Mass, gravity, height - lifts and cranes	Crane load impacts or drops striking instrument air lines or normal helium supply, electrical panel, or demineralized water line, during processing operations	Human error Mechanical failure	Process upset due to loss of support system, leads to potential hydrogen formation and release, and/or radioactive particle release.	Damage to equipment on the process skid with subsequent release of contaminated material	SCIC detects process upset initiating SCHe, which isolates MCO from process piping and establishes helium supply to the MCO and vent to local exhaust	F3	HVAC systems provide confinement and dilution 150 lb/in <sup>2</sup> gauge rupture disk Cask-MCO withstands internal explosion energy	S3	
Process bays 2-5 PB-F-07	Linear kinetic - other (gas bottles)	Earthquake, trailer impacts, forklift impacts			Personnel injury, structure and/or equipment damage					
					Gas bottle design includes passive orifice that restricts kinetic energy to limit velocity					

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 7 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Frequency	Consequence		Defense-in-depth or worker safety features	
								Without prevention	With prevention	Without mitigation	With mitigation
Process bays 2-5 PB-G-03b	Mass, gravity, height - elevated crane equipment, overhead door	Crane trolley falling from overhead railing, door falling on cask	Human error Mechanical failure	Crane hoist is connected to a cask lid which has not been unbolted from the cask and attempts to lift. Lack of maintenance on overhead protection feature causes crane supports to fail.	Crane trolley falls onto cask or MCO. Crane trolley falls onto process equipment resulting in contamination spread. Personnel injury. Door falls on cask.	Design feature - motor can't generate enough force to cause potential accident. Cask design withstands door impact.	F0	F0	HVAC systems provide confinement and filtration	S1	S1
PB-G-03c	Mass gravity height - elevated crane bed	Elevated cask lid falling could potentially damage MCO, injure personnel	Human error Mechanical failure	Elevated cask lid or process hood falls from crane onto MCO due to improper connection or equipment failure	Cask lid impacts MCO. Personnel injury	Design feature - HNF-SD-SNF-DP-007, Appendix B, "documents that the cask lid impacting the MCO from a drop in the CVDF does not result in unacceptable damage or consequences"	F2			S1	
Process bays 2-5 PB-H-03a	Pressure, volume - pressure vessels (MCO and cask)	Pressurized release of hydrogen from MCO	Failure to vent the transportation cask. Exceeding the shipping window. Improper loading at fuel retrieval (e.g., insufficient water contents, improper fuel loading, improper MCO sealing)	Pressurized release of hydrogen from the MCO during cask lid removal, or process line hook-up, with subsequent ignition	Personnel injury due to hydrogen ignition. Worker exposure to radioactive particulate		F3	F3	HVAC systems provide confinement and filtration	S1	S1
Process bays 2-5 PB-H-03b	Pressure, volume - pressure vessels	Release of cask annulus water from between the MCO and the transportation cask	Human error or mechanical failure resulting in temperate water system quick disconnect leak. Process hood seal ring deflates while TV system is under pressure, or failure of the cask drain port during shipment (undiscovered until cover port is removed)	Spray or leak of water onto the process bay floor	Surface contamination. Drainage of basin water to the process bay floor. Release of contaminated material, processing is not underway during event		F3	F3		S1	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 8 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Frequency		Consequence		Defense-in-depth or worker safety features
							Without prevention	With prevention	Without mitigation	With mitigation	
Process bays 2-5 PB-H-06c	Pressure, volume - pressure vessels	Pressurized relief from MCO	Prior to installing the process connectors and prior to heat-up, with the port valves closed and the MCO and cask both full of water, the MCO is left for an extended period of time.	Hydrogen generation pressurizes buttoned up MCO to 150 lb/in <sup>2</sup> gauge where rupture disk relieves and H <sub>2</sub> possibly ignites	Hydrogen deflagration in bay Personnel injury	MCO full of water limits the hydrogen/particulate release	F2	F2	HVAC systems provide confinement and filtration	\$1	Procedures exist for preventing long process delays - MCO is not allowed to sit in this state indefinitely.
Process bays 2-5 PB-H-06d	Pressure, volume - pressure vessels	Pressurized MCO	Human error.	Gaseous release from MCO (G-1)	Hydrogen and/or radioactive particulate release due to pressurization	MCO design withstands MCO pressurization	F3	F3	HVAC systems provide confinement and filtration	\$2	
Process bays 2-5 PB-H-06e	Pressure, volume - pressure vessels	Hydrogen formation in MCO during drain interruption prior to breakthrough	Mechanical or equipment failure in PWC room Operator error, (e.g., turning off PWC pump SCIC trip)	Hydrogen forms and collects in PWC tanks	Hydrogen formed in MCO is drawn into the PWC drain line and receiver tanks when MCO drain is restarted. Hydrogen explosion in PWC drain line or receiver tanks	TSR - drain time limit of 35 minutes TSR - shut off PWC pump (stop MCO drain) on loss of differential pressure in process water tank room TSR -- Pressure purge the MCO to dilute hydrogen	F2	F1	HVAC systems provide confinement and dilution	\$1	
Process bays 2-5 PB-H-06f	Pressure, volume - pressure vessels	Pressurized release due to hydrogen formation	Local and/or general exhaust HEPA filter fails	Gaseous release from MCO (G-1, DBA) External hydrogen explosion (E-4)	Pressurization of the MCO leads to hydrogen and/or radioactive particulate release	Cask-MCO design withstands pressurization TSR: Confinement function verified by leak testing process port connectors	F3	F2	HVAC systems provide confinement and filtration	\$2	SCIC detects process upset initiating SCIC, which isolates MCO from process piping and establishes helium supply to the MCO Tempered water system
Process bays 2-5 PB-H-06g	Pressure, volume - pressure vessels	Loss of local exhaust ventilation fans (excluding loss of power)	Random failure	Gaseous release from MCO (G-1)	Potential hydrogen and/or radioactive particulate release		F3	F3	HVAC systems provide confinement and filtration	\$2	
Process bays 2-5 PB-H-06h	Pressure, volume - pressure vessels	Dampers close	Random failure	Gaseous release from MCO (G-1)	Potential hydrogen and/or particulate release within the process bar/Potential hydrogen release into the local exhaust while not running		F3	F3	HVAC systems provide confinement and filtration	\$2	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 9 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Consequence			Defense-in-depth or worker safety features
							Frequency	Without prevention	With prevention	
Process bays 2-5 PB-H-06i	Pressure, volume - pressure vessels	Hydrogen generation within MCO	Delays in shipping MCO from CVDF accompanied by MCO leakage or human error in closing port valves	Gaseous release (G-2) External hydrogen explosion (E-4)	Hydrogen and small amounts of fission gases may be released to the cask annulus, possibly leading to a flammable atmosphere in cask annulus with subsequent explosion. Release/explosion of hydrogen and fission gasses when cask lid is vented or removed at CSB	TSR - Proof-of-dryness demonstration	F2	F2	HVAC systems provide confinement, dilution and filtration	S2
Process bays 2-5 PB-H-06j	Pressure, volume - pressure vessels	Pressurized MCO as a result of fuel reacting with contamination	Blackflow (by diffusion) of vacuum pump oil into MCO (need a pump seal failure) Condenser chilled water tank resulting in MCO by backflow	Contamination (glycol) introduced into the MCO and reacts with fuel	Fuel reacts with contamination leading to increased hydrogen formation, other gas formation or heat generation at CVDF or long term	F0	F0			S2
Process bays 2-5 PB-H-06k	Pressure, volume - pressure vessels	Fuel reacts with contaminates	Contaminated He purge gas Wrong gas hooked up He gas received out of specification, contamination in purge line not removed after maintenance	Internal hydrogen explosion (I-7) External hydrogen explosion (E-7) Thermal runaway reaction (T-5)	Hydrogen explosion or high temperatures in the MCO leading to a potential radioactive particle release	TSR - Shipment paperwork verified for gas bottle content during receipt TSR - Vendor documentation of supplied gas tests	F2	F0		S2
Process bays 2-5 PB-H-06l	Pressure, volume - pressure vessels	Uncontrolled release of water from MCO	Incorrect MCO port opened during cask loadout at K Basin, (e.g., long tube)	Spray or leak of MCO contents	Spread of contamination	F3	F3			S1
Process bays 2-5 PB-H-06m	Pressure, volume, pressure vessels - MCO	MCO drain flow reversed due to ejector malfunction	Low flow in the ejector drain causes backflow of water into drain header	Water flows back to drain header and MCO	Process delay and possible increase exposure	None - No identified mechanism to provide backflow through ejector	F0			S1
Process bays 2-5 PB-H-06n	Pressure, volume, vacuum	Water reaction with fuel	Immediately following drain, while flushing drain lines, the MCO is refilled with water	None	No consequences other than delay (introduction of water just after draining does not cause any effects)		F2			S0
Process bays 2-5 PB-H-08	Pressure, volume, vacuum	Degraded vacuum pump operations	Equipment malfunction	Thermal runaway reaction (T-2)	Heatup occurs, increasing fuelwater reaction leading to potential thermal runaway	SCIC detects process upset initiating SCHe, which isolates MCO from process piping and establishes helium supply to the MCO, (8/44) MCO and SCHe confinement design	F3	F0		S3

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 10 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention		Consequence		Defense-in-depth or worker safety features	
						Frequency	Without prevention	With prevention	Credited mitigation	Without mitigation	With mitigation
Process bays 2-5 PB-H-11a	Pressure, volume - other	Helium pressure higher than expected	Cascading failure of regulators beginning with 3000 psi regulator failure.	MCO overpressurization (P-3)	Radioactive particulate release	F2	F0			Pressure relief valve on He trailer 30 lbf/in <sup>2</sup> gauge rupture disk and vent path 150 lbf/in <sup>2</sup> gauge rupture disk SCHe vent	
Process bays 2-5 PB-H-11b	Pressure, volume - other (pressurized process lines)	Inaccurate control, unreliable valves	Contaminated air within the instrument air supply leads to conditions that allow hydrogen to form and be released from the MCO	Isolation valves do not close	Hydrogen and/or radioactive particulate release	F1	F1	HVAC systems provide confinement and dilution	S1	SCIC detects process upset initiating SCHe, which isolates MCO from process piping and establishes helium supply to the MCO MCO and SCHe confinement design	
Process bays 2-5 PB-H-11c	Pressure, volume - other (pressurized process lines)	Tempered water system lines leak	Hazard eliminated by design change -- double walled pipe							Air dryer on instrument air supply	
Process bays 2-5 PB-H-11d	Pressure, volume - other (water addition to MCO)	Water addition during drying mode or pressure rebound test	Leak back of deionized (DI) water during vacuum pump tempered water cooling water internal leak Bulk water added to hot MCO	Internal hydrogen explosion (I-1) External hydrogen explosion (E-4)	Water addition causes hydrogen formation and release in explosive mixture into local exhaust, or explosion inside the MCO	F3	F0	HVAC systems provide confinement and dilution Cask-MCO design withstands internal explosion energy	S2	S1	Tempered water system
Process bays 2-5 PB-H-11e	Pressure, volume - other (water addition to MCO)	Water addition during drying mode or pressure rebound test	Valves don't fully close due to particles, process upsets, operator error, vacuum conditions in MCO acts to draw water	Internal hydrogen explosion (I-1) External hydrogen explosion (E-4)	Water addition causes hydrogen formation and release in explosive mixture into local exhaust, or explosion inside the MCO	F3	F0	HVAC systems provide confinement and dilution Cask-MCO design withstands internal explosion energy	S2	S1	Tempered water system
Process bays 2-5 PB-H-11f	Pressure, volume - other (water addition to MCO)	Water addition after final pressure rebound test from Process Water Room through MCO drain line	Valves don't fully close due to particles, process upsets, operator error, vacuum conditions in MCO acts to draw water	Fuel and water reactions in long term storage	The final pressure rebound test closes all process valves and isolation valves. If test passes, only the normal helium supply is opened to pressurize the MCO, thus no water addition path exists.	F0					
Process bays 2-5 PB-J-06	Explosives/ pyrophorics - hydrogen	Hydrogen is a product of the MCO contents	Expected conditions within the MCO	Potential accidents are evaluated in PB-L-11	Hydrogen forms and collects due to process upsets	See PB-L-11a - L-119					

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 11 of 22)

Checklist entry	Hazard source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Frequency		Credited mitigation		Consequence		Defense-in-depth or worker safety features	
							Without prevention	With prevention	Without mitigation	With mitigation	Without mitigation	With mitigation		
Process bays 2-5 PB-J-10	Explosives/ pyrophorics - plutonium and uranium metal	Water reaction with fuel	Immediately following drain, while flushing drain lines, the MCO is refilled with water	None	No consequences (introduction of water just after draining does not cause any effects)		F2	F2	S0	S0				
Process bays 2-5 PB-J-12	Explosives / pyrophorics - other (uranium hydrides)	Uranium hydride reactions	Oxygen intrusion into the MCO through line normal supply	Internal hydrogen explosion	Hydrogen generation and sudden pressurization (a reaction, with resulting particulate release to the process bay)	F0								
Process bays 2-5 PB-K-04 PB-K-05 PB-K-15	Nuclear criticality - filters, casks, other (MCOs and drain lines)	These hazards are addressed and analyzed in the CVDF FSAR, Chapter 6.0.*												
Process bays 2-5 PB-L-01 PB-L-02 PB-L-03 PB-L-04 PB-L-05 PB-L-06 PB-L-07 PB-L-08 PB-L-09 PB-L-10 PB-L-13 PB-L-14 PB-L-15 PB-L-16	Flammable / combustible materials - rags, gasoline, lubricating oil, coolant oil, paint solvent, diesel fuel, buildings and contents, trailers and contents, grease, propane, alcohol, aerosol propellant	Ignition of flammable material within the process bays	Human error Mechanical failure Fire within the process bay with possible spread of fire into adjacent bays that are processing MCOs	Gaseous release from MCO (G 4) Internal hydrogen explosion (I-3) External hydrogen explosion (E-6) Thermal runaway reaction (T-3) MCO overpressurization (P-5)	Fire within the process bay with possible spread of fire into adjacent bays that are processing MCOs Equipment damage leading to process upsets resulting in radioactive particulate release	TSR - limits on combustible loading in bay	F2	F0	S2	S2	SCIC detects process upset initiating SCICs, which isolates MCO from process piping and establishes helium supply to the MCO Cask-MCO AND SCH <sub>He</sub> confinement design Facility evacuation to protect workers Fire protection system present in each bay Fire suppression present in all adjacent areas Fire department alarm and response Tempered water system cask annulus manual refit piping			
Process bays 2-5 PB-L-11a	Flammable materials - hydrogen	Flammable atmosphere in local exhaust ventilation system	Expected normal condition for cask venting Shipping line exceeds window	External hydrogen explosion (E-1, DBA)	Sufficient hydrogen to create a flammable atmosphere is present in the cask-MCO head spaces prior to venting, then released to local exhaust during cask vent	TSR - Receipt transportation window Cask-MCO confinement function Cask vent orifice and interlock with HVAC for dilution	F3	F0	TSR - HVAC HEPA filter loading limit HVAC system provides dilution	S2	No leak path below water line in MCO Cask vent line enters HVAC/CPV piping away from operator	S1		

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 12 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Consequence		Defense-in-depth or worker safety features		
							Frequency	Without prevention	With prevention	Without mitigation	With mitigation
Process bays 2-5 PB-L-11b	Flammable materials - hydrogen	Flammable atmosphere in process bay	Failure to isolate auxiliary vacuum pump prior to cask venting releases sufficient hydrogen to the process bay to create an explosion, gas release from MC0 may also contain radioactive particulate	Hydrogen explosion in the process bay Personnel exposure to radioactive particulate	Hydrogen deflagration in the process bay, possible radioactive particulate release to the bay Personnel injury		F2	F2	HVAC systems provide confinement and dilution	S1	S1
Process bays 2-5 PB-L-11c	Flammable materials - hydrogen	Flammable atmosphere in MC0	Failure to close the MC0 port valve after cask lid removal (at receipt at CVDF) Excessive time (>12 hr) with the MC0 port open because of processing delays	Hydrogen explosion in the process bay Personnel exposure to radioactive particulate	Hydrogen and/or radioactive particulate release to the bay Personnel injury		F2	F2	HVAC systems provide confinement and dilution	S1	S1
Process bays 2-5 PB-L-11d	Flammable materials - hydrogen	Flammable atmosphere in MC0 during draining prior to breakthrough	Process line failure or process upset causing significant air ingress into MC0, or HVAC failure	Internal hydrogen explosion (I-1) External hydrogen explosion (E-4)	Hydrogen formation leading to explosion inside the MC0, or explosion in the process lines or vent system	Cask-MC0 design withstands internal explosion energy	F2	F1	HVAC systems provide confinement, filtration, and dilution	S2	S1
Process bays 2-5 PB-L-11e	Flammable materials - hydrogen	Flammable atmosphere in or around MC0 and cask	Failure to inert MC0 Improper sealing of valve plugs with resulting air ingress Failure to cool MC0 sufficiently before shipment Inadequate vacuum drying Incomplete draining of cask annulus	External hydrogen explosion (E-4)	Hydrogen and/or radioactive particle release, or hydrogen explosion	With less than 200 grams of free water explosive mixtures of hydrogen are not formed	F2	F2		S0	S0
Process bays 2-5 PB-L-11f	Hydrogen in MC0	Hydrogen enters local vent in explosive mixtures	Manual or spurious actuation of SCIC and local exhaust not running	External hydrogen explosion (E-2)	Hydrogen and/or radioactive particle release, or hydrogen explosion		F2	F2	HVAC systems provide confinement and dilution	S2	S1
PB-L-11g	Hydrogen in MC0	SCIC actuation with leaky PWC safety-cells valves	Valve seal damage	Hydrogen explosion in the PWC drain line	Hydrogen explosion in the PWC drain line	Design includes redundant isolation valves	F2	F1	HVAC systems provide confinement and dilution	S1	S1
Process bays 2-5 PB-AM-08	Hazardous materials - heavy metals (TRU)										

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 13 of 22)

Checklist entry	Hazard source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Frequency		Consequence		Defense-in-depth or worker safety features
							Without prevention	With prevention	Without mitigation	With mitigation	
Process bays 2-5 PB-N-01	Ionizing radiation sources - fissile material	Failure of the PWC drain line in a bay with an open door while draining an upstream bay	Random failure, corrosion	Gaseous release from MC0 (G.1) Gaseous release due to purge flow entering into the drain line	Radioactive particulate release	PWC drain line in bay is qualified to withstand anticipated degradation effects such as corrosion and is located where it cannot be impacted	F2	F1	S2	S2	
Process bays 2-5 PB-N-03a	Ionizing radiation sources - radioactive material	Failure to correctly perform demineralized water rinse of PWC system drain lines and MC0 port valve	Human error after MC0 failure	Increased radiation in drain lines	Increased risk of exposure near the line		F2	F2	S1	S1	Routine radiation surveys are conducted
Process bays 2-5 PB-N-03b	Ionizing radiation sources - radioactive material	No filtration during draining					F1	F1	S1	S1	CAMS in PWC Room Routine radiation surveys are conducted
Process bays 2-5 PB-N-03c	Ionizing radiation sources - radioactive material	Contamination in lines	Human error in manufacturing MC0	Increased radioactive particulate in drain line and/or process water room	Increased risk of exposure near the line and in PWC Room		F2	F2	S1	S1	HVAC systems provide confinement and filtration Procedures Training
Process bays 2-5 PB-N-03d	Pressure, volume - other (building zone pressure boundaries)	Ventilation upsets cause movement of hazardous materials across pressure boundaries	Manual or spurious actuation of SCIC causes contamination in lines and process connector to be blown into the process bay. The process connectors are not attached to the MC0.	Radioactive particulate release to process bay	Radioactive particulate release to process bay		F3	F3	S1	S1	Procedure for processing establishes and verifies proper HVAC conditions Operators trained to procedures
						Potential contamination spread if this occurs in conjunction with other accidents					
						Potential for a differential pressure inversion with adjacent confinement zones					
						Stagnant bay					
						Failure to isolate bay ventilation before operating bay door (human error)					
						Bay door opens unintentionally, ventilation restarts accidentally, isolation not adequate (human error or mechanical failure)					
						Failure to reestablish ventilation after closing bay door					

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 14 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Consequence		
							Frequency	Without prevention	With prevention
Process bays 2-5 PB-P-02	External events - fire	Fire external to facility introduces heat and smoke, or fire enters bay igniting flammable material within the process bays	Human error Mechanical failure Natural phenomena (range file)	External hydrogen explosion (E-6) Thermal runaway reaction (T-3) MCO overpressurization (P-5)	Equipment damage leading to process upsets resulting in radioactive particulate release	The facility location is remote, reducing the likelihood of occurrence TSR - limits on combustible loading in bay	F2	F0	
Process bays 2-5 PB-R-02							S2	S2	
Process bays 2-5 PB-R-01a	Natural phenomena - earthquake (DSE)	Fuel reaction due to damage caused by seismic event	Earthquake causes equipment upset, loss of ventilation and/or trailer movement	Gaseous release (G-3) Internal hydrogen explosion (I-6) External hydrogen explosion (E-8) Thermal runaway reaction (T-6) MCO overpressurization (P-4)	Hydrogen and/or radioactive particulate release	Seismic input into SCIC initiates SCHE SCHE isolates MCO from process equipment, establishes flow through MCO and SCHE confinement design 30 lb/in <sup>2</sup> gauge rupture disk and vent path TSR - Trailer placement in bay to support seismic calculations	F0	TSR - Process vent HEPA filter loading 150 lb/in <sup>2</sup> gauge rupture disk TW annulus system HVAC systems provide confinement and dilution Cask-MCO design withstands internal explosion energy	S3
Process bay 1 (spare bay) SB-F-01a SB-F-02a	Linear kinetic - cars, trucks, buses, forklifts, dollies, carts	Vehicle impacts within the spare bay affecting spare bay only	Human error Mechanical failure	Stinking walls, personnel outer bay doors, electrical panels, demineralized water line, or chilled water line	Personnel injury Loss of power to the spare bay Shear of demineralized water and/or chilled water line may overflow the 300-gal drain tank into its concrete vault pit	Vehicles are operated by qualified personnel and enter and exit the bays according to approved procedures	F3	F3	S1

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 15 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Frequency	Consequence		Defense-in-depth or worker safety features
								Without mitigation	With mitigation	
Process bay 1 (spare bay) SB-F-01b SB-F-02b	Linear kinetic - cars, trucks, buses, forklifts, dollies, carts	Vehicle or forklift impacts within the spare bay, striking walls, instrument air lines, normal helium supply, or electrical panel affecting processing operations in other bays	Human error Mechanical failure	Internal hydrogen explosion (I-5) External hydrogen explosion (E-5) Thermal runaway reaction (T-4) MCO overpressurization (P-2)	Personnel injury (high pressure air, noise, flying debris) Hydrogen and/or radioactive particulate release Wall damage could result in a process upset in an adjacent bay (e.g., activating a seismic switch) 30 lbf/in <sup>2</sup> gauge rupture disk TSR: Crane movement restricted during MCO processing	SCIC deflects process upset initiating SCHe, which isolates MCO from process piping and establishes helium supply to the MCO Cask-MCO AND SCHe confinement design 30 lbf/in <sup>2</sup> gauge rupture disk TSR: Crane movement restricted during MCO processing	F3 F0	S3 S1	S3 S1	Forklifts are operated by qualified personnel. Asphyxiation would only be a possible problem if ventilation were off and the leak continued for several shifts. 10 lbf/in <sup>2</sup> process relief valve
Process bay 1 (spare bay) SB-F-01c SB-F-02c	Linear kinetic - cars, trucks, buses, forklifts, dollies, carts	Vehicle impacts within the spare bay	Human error Mechanical failure	Striking process (MCO drain) lines	Damage to process lines (e.g., drain lines from MCO), resulting in a liquid or particulate release into bay from MCO draining operations in other bays through the open path between floor drains	The common drain line is elevated and cannot be impacted by vehicles	F0			
Process bay 1 (spare bay) SB-F-07	Linear kinetic - other (gas bottles)	Stored gas bottles become missiles	Earthquake damage, forklift impact	Bottle may move but not enough to cause damage	Personnel injury, structure and/or equipment damage to the spare bay only, no damage to SSCs	Gas bottle design includes passive orifice that restricts kinetic energy to limit velocity	F0	S1	S1	
Process bay 1 (spare bay) SB-H-11	Pressure, volume - other	Helium pressure higher than expected	Cascading failure of regulators beginning with 3000 psi regulator failure.	Overpressurization of the drain line possibly causing water hammer and failure of the drain line in the spare bay with a resulting high-pressure helium blowdown	Particulate release NOTE: There is no HVAC system in the spare bay	Safety relief valves installed on the helium supply	F2 F0	S2 S2	S2 S2	
Process bay 1 (spare bay) SB-L-01 SB-L-02 SB-L-03 SB-L-04 SB-L-05 SB-L-06 SB-L-07 SB-L-08 SB-L-11 SB-L-14 SB-L-15 SB-L-16	Flammable materials - packing materials rags, gasoline, lubricating oil, coolant oil, paint solvent, diesel fuel, building and contents, hydrogen, propane, alcohol, other (aerosol propellant)	Ignition of flammable material within the process bay	Human error Mechanical failure	Fire within the process bay with possible spread of fire into adjacent bays that are processing MCOs	Structural damage or failure of process bay Damage to upper wall separating adjacent bays Smoke and heat in process bay Degrade the safety class seismic monitor NOTE: There is no HVAC system in the spare bay	Partitions separate the processing bays. Combustible loading requirements from the FHAs are imposed	F3 F0	S1 S1	S1 S1	Fire department will respond. Facility evacuation to protect workers. Fire protection system (sprinklers) are present in process bays. Materials are stored in accordance with applicable local, state, and federal safety requirements.
Process bay 1 (spare bay) SB-M-08	Hazardous materials - heavy metals (TRU)					Radiological guidelines are more limiting than toxicological limits, see HNF-SD-SNF-TI-059				

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 16 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Frequency		Credited mitigation		Consequence		Defense-in-depth or worker safety features	
							Without prevention	With prevention	Without mitigation	With mitigation	Without mitigation	With mitigation		
Process bay 1 (spare bay) SB-N-01	Ionizing radiation sources - fissile material	Failure of MC0 drain line downstream from MC0	Random failure, corrosion	Gaseous release from MC0 (G.1) Gaseous release due to purge flow entering into the drain line	Radioactivity release into spare bay	PVC drain line in bay is qualified to withstand anticipated degradation effects such as corrosion and is located where it cannot be impacted	F2	F1	S2	S2	S2	S2		
Process bay 1 (spare bay) SB-N-03a	Ionizing radiation sources - radioactive material	Contaminated MC0 water contents traveling PWC system drain line	Human error (vehicle impact, for example) Mechanical failure (corrosion, for example)	MC0 drain line failure	Liquid or particulate release into the spare bay	PVC drain line in bay is qualified to withstand anticipated degradation effects such as corrosion and is located where it cannot be impacted	F2	F1	S2	S2	S2	S2	PVC system interlocks only allow one MC0 draining operation to be in effect at a time, limiting the available liquid release volumes Floor drains and catch tank collect and contain released liquid.	
Process bay 1 (spare bay) SB-N-03b	Ionizing radiation sources - radioactive material	Processed PWC tank room water being transferred to tanker truck	Line break Human Error	Spray or spill of processed water to spare bay	Potential for minor contamination spread - ALARA issue only		F3		S1	S1	S1	S1		
Process bay 1 (spare bay) SB-P-01 SB-P-02 SB-P-03 SB-Q-01 SB-Q-02 SB-Q-04 SB-R-01 – R-10	Various external events affecting the spare bay, see Outside Events Sections OUP, OU-Q and OU-R for discussion of these events													
Process water room PW-F-05	Linear kinetic - other (maintenance using crane through roof hatch)	Crane hooks piping during DDM replacement	Human error	DDM replacement is not anticipated during the lifetime of the facility. Therefore, DDM removal and replacement is not within the authorization basis of this safety analysis report										
Process water room PW-F-07	Linear kinetic - other (maintenance gas bottles)	Gas bottles used for maintenance become missiles	Earthquake damage	A gas bottle may move but will not move enough to cause any damage.	Personnel injury, structure and/or equipment damage to the spare bay only, no damage to SSCs	F0		S1	S1	S1	S1	S1		
Process water room PW-G-03	Mass, gravity, height - lifts and cranes	DDM replacement requires a crane lift through a roof access panel	DDM dropped due to mechanical failure of the crane or human error	DDM replacement is not anticipated during the lifetime of the facility. Therefore, DDM removal and replacement is not within the authorization basis of this safety analysis report										
Process water room PW-G-14	Mass, gravity, height - other (roof hatch probably related to DDM replacement)	DDM replacement requires a crane lift through a roof access panel	Roof hatch dropped due to mechanical failure of the crane or human error	DDM replacement is not anticipated during the lifetime of the facility. Therefore, DDM removal and replacement is not within the authorization basis of this safety analysis report										

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 17 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Consequence		Defense-in-depth or worker safety features	
							Frequency	With prevention	Without mitigation	With mitigation
Process water room PW-H-06	Pressure in process water tanks and tanks	Spray and/or gaseous release from pressurized PWC components	Process upset, processing delay or equipment failure (pipe leaks or breaks)	Liquid spray release (L, DBA) Gaseous release (G, I)	Hydrogen and/or radioactive particulate release	F3	F3	S1	S2	PWC room designed to contain spills Leak detection is present to detect spills to the floor. CAMS are present in the room.
Process water room PW-H-11	Pressure, volume - other	Helium pressure higher than expected	Cascading failure of regulators beginning with 3000 psi regulator failure.	Overpressurization of the drain line possibly causing water hammer and failure of the drain line in the process water room with a resulting high-pressure helium blowdown	Particulate release	F2	F0	S1	S1	HVAC systems provide confinement and filtration
Process water room PW-J-06	Explosives / pyrophorics - hydrogen	Hydrogen collects in receiver tanks	Process upset or delay during MCO draining Hydrogen collects in receiver tanks Inadequate or loss of local exhaust ventilation flow	External hydrogen explosion	Hydrogen mixes with air in receiver tanks to create a flammable environment, then ignites	F1	F1	S1	S1	SCC actuates SCHe on purge time limit SCHe establishes He flow through the MCO directly to local exhaust MCO and SCHe confinement design
Process water room PW-J-10 PW-J-12	Explosives / pyrophorics - plutonium and uranium metal	Air ingress into the UX (normal operations)	Mechanical failure	UX explosion due to air-hydrides or water-hydride reactions	TSR - Pressure purge of MCO to dilute H <sub>2</sub> prior to drain TSR - 35 min. Time limit on MCO drain	F0	F0	S1	S1	The PWC drain line and receiver tank are purged with helium prior to MCO draining Room provides confinement, including general exhaust ventilation with HEPA filtration
Process water room PW-K-02 PW-K-04 PW-K-08 PW-K-15	Nuclear criticality	These hazards are addressed and analyzed in the CVDF FSAR, Chapter 6.0 and HNF-SD-SNF-CSER-006*								
Process water room PW-L-02 PW-L-08 PW-L-14 PW-L-16	Flammable materials	Ignition of flammable material within the process water room	Human error Mechanical failure	Liquid spray release as a result of fire damage to equipment (L-2)	Spray release into PWC room (process water)	Combustible loading requirements from the FFA* are imposed	F2	F2	S2	Fire protection system is present (sprinklers).

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 18 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Consequence		Defense-in-depth or worker safety features	
							Without prevention	With prevention	Without mitigation	With mitigation
Process water room PW-L-11	Flammable materials - hydrogen	Hydrogen collects in receiver tanks	Process upset or delay during MCO draining	External hydrogen explosion	Hydrogen mixes with air in receiver tanks to create a flammable environment, then ignites	TSR - Pressure purge of MCO to dilute H <sub>2</sub> prior to drain TSR - 35 min. Time limit on MCO drain	F1	F1	HVAC systems provide confinement and filtration	SCIC actuates SCIE on purge time limit SCHe establishes He flow through the MCO directly to local exhaust MCO and SCHe confinement design The PWC drain line and receiver tank are purged with helium prior to MCO draining
Process water room PW-M-08	Hazardous materials - heavy metals (TRU)		Inadequate or loss of local exhaust ventilation							
Process water room PW-N-01	Ionizing radiation sources - radioactive material			Processing upsets or delays, equipment failure, pipe break, or leaks, pump leaks	Liquid spray release (L <sub>1</sub> )	Radioactive particulate release	F3	F3	HVAC systems provide confinement and filtration in process bays	PWC room designed to contain spills Leak detection is present to detect spills to the floor. CAMs are present in the room.
Process water room PW-N-03a	Ionizing radiation sources - radioactive material			Radioactive liquid release from process water system piping and tanks		HVAC systems provide confinement and filtration in PWC room when PWC pump is operating	S2	S1	HVAC systems provide confinement and filtration in PWC room when PWC pump is operating	A survey program to periodically survey the process lines will be in place. This is primarily an ALARA concern.
Process water room PW-P-01				Direct radiation	Collection of radioactive liquid within the process tanks or lines	Normal operations	F3	F3		Area radiation monitors are provided within the PWC room.
Process water room PW-P-02										
Process water room PW-P-03										
Process water room PW-Q-01										
Process water room PW-Q-02										
Process water room PW-Q-04										
PWR-01 - R-10										
Outside OU-F-01	Linear kinetic - cars, trucks, buses (helium delivery truck)			Impact with the facility	Human error Mechanical failure	Truck strikes facility	F3	F3		Interior bay walls are 4- to 6-in.-thick concrete Rear bay walls are 8-in.-thick concrete Truck drivers are trained in the proper use of onsite vehicles.
Outside OU-K-02 OU-K-15	Nuclear criticality - temporary storage areas, other (drain tank)						S0	S0		These hazards are addressed and analyzed in the CVD FSAR, Chapter 6.0.*

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 19 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Frequency	Without prevention	With prevention	Consequence		Defense-in-depth or worker safety features
										Without mitigation	With mitigation	
Outside OLU-01 – L-07 OLU-09 OLU-10 OLU-13 – I-16	Flammable materials	Outside fires are analyzed in OLU-P-02a and OLU-P-02b	External events - explosion	Fuel truck accident / explosion Helium tank overpressure Forklift propane tank explosion	Impact on process or shutdown systems Impact on personnel	Loss of MCS in the bay Loss of power in the bay Loss of support systems in the bay Personnel injury Spread of contamination	F2	E2		\$1	\$1	HVAC systems provide confinement and filtration SCIC detects process upset initiating SCIC, which isolates MC0 from process piping and establishes helium supply to the MC0 MC0 and SCIC confinement design
Outside OLU-P-01			External events on bay walls									
Outside OLU-P-02a (related to process bays)			External events - fire	Human error Mechanical failure Natural phenomena (range file) Flammable materials ignite	Gaseous release from MC0 (G.4) External hydrogen explosion (E.6) Thermal runaway reaction (T.3) MC0 overpressurization (P.5)	Equipment damage leading to process upsets resulting in radioactive particulate release TSR – limits on combustible loading in bay	F2	F0		\$2	\$2	SCIC detects process upset initiating SCIC, which isolates MC0 from process piping and establishes helium supply to the MC0 Cask-MCO AND SCIC confinement design Facility evacuation to protect workers Fire protection system present in each bay Fire suppression present in all adjacent areas Area surrounding building is controlled to limit combustible material and plants
Outside OLU-P-02b (related to all facility areas except process bays)			External events - fire	Fire external to facility introduces heat and smoke, or fire enters bay igniting flammable material within the process bays			F2			\$1	\$1	SCIC detects process upset initiating SCIC, which isolates MC0 from process piping and establishes helium supply to the MC0 Cask-MCO AND SCIC confinement design FHA* addresses combustible limits for stored materials Facility evacuation to protect workers Fire suppression present in all adjacent areas Area surrounding building is controlled to limit combustible material and plants

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 20 of 22)

Checklist entry	Hazard source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Frequency			Consequence		Defense-in-depth or worker safety features
							Without prevention	With prevention	Credited mitigation	Without mitigation	With mitigation	
Outside OU-P-03	External events - other sites	Accident at another facility	Various (identified in each facility-specific FSAR)	None that impacts CVDF operations - analysis concludes								
OU-P-04	External events - Loss of power	Hydrogen forms	Loss of helium purge Process upsets MCO bottled up	Internal hydrogen explosion (I-5) External hydrogen explosion (E-5) Thermal runaway reaction (T-1) MCO overpressurization (P-2)	Hydrogen and/or radioactive particulate release	SCIC detects process upset initiating SCHe, which isolates MCO from process piping and establishes helium supply to the MCO	F3	F0	Standby electrical power for ventilation system HVAC systems provide confinement, dilution, and filtration	S3	S1	10 lb/in <sup>2</sup> process relief valve
Outside OU-Q-01 OU-Q-02	Vehicles in motion - airplane, helicopter	Aircraft impact	Human error Mechanical failure	Aircraft impacts facility structure and/or key process systems		SCIC and SCHe confinement design 30 lb/in <sup>2</sup> gauge rupture disk						
Outside OU-Q-04	Vehicles in motion - truck, bus, car	Impact with the facility	Human error Mechanical failure	Truck strikes facility	Facility design precludes damage to equipment required for safe shutdown from these events		F3	F0		S0	S0	Interior bay walls are 4- to 6-in.-thick concrete Rear bay walls are 8-in.-thick concrete Truck drivers are trained in the proper use of onsite vehicles.
Outside OU-R-01a	Natural phenomena - earthquake (DBE)	Fuel reaction due to damage caused by seismic event	Earthquake causes process upset, equipment damage, loss of ventilation and/or trailer movement	Gaseous release (G-3) Internal hydrogen explosion (I-6) External hydrogen explosion (E-8) Thermal runaway reaction (T-6) MCO overpressurization (P-4)	Hydrogen and/or radioactive particulate release	SCIC detects process upset initiating SCHe, which isolates MCO from process piping and establishes helium supply to the MCO and vents to local exhaust Cask-MCO design withstands internal explosion energy TSR - Trailer placement in bay to support seismic calculations	F2	F0	HVAC systems provide confinement, dilution and filtration TSR - Process vent HEPA filter bedding TWS annulus antisiphon valves and refill piping and parts	S3	S1	10 lb/in <sup>2</sup> process relief valve
Outside OU-R-01b (related to process water room)	Natural phenomena - earthquake (DBE)	Acceleration forces exerted on the facility	Earthquake causes damage to process lines or tanks	Liquid spray release (L-3)	Break in process lines or tanks causes contaminated water spray release in PWC Room		F2	F2	Seismic shutdown switch for PWC pump	S2	S1	HVAC systems provide confinement and dilution

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 21 of 22)

Checklist entry	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Frequency	Credited mitigation	Consequence		Defense-in-depth or worker safety features
									Without mitigation	With mitigation	
Outside OLR-02 OLR-04	Natural phenomena - flood, rain	Natural phenomena	Water introduction into facility	Loss of power to key facility systems causing potential for: Internal hydrogen explosion (I-5) External hydrogen explosion (E-5) Thermal runaway reaction (T-1) MCO overpressurization (P-1)	Hydrogen and/or radioactive particulate release	SCIC detects process upset initiating SCHe, which isolates MCO from process piping and establishes helium supply to the MCO MCO and SCHe confinement design SCIC fail-safe design 30 lbf/in <sup>2</sup> gauge rupture disk	F3	F0	S3	S1	Standby electrical power for ventilation system HVAC systems provide confinement and dilution 150 lbf/in <sup>2</sup> gauge rupture disk
Outside OLR-03	Natural phenomena - lightning	Natural phenomena	Electrical surge	Loss of power to key facility systems causing potential for: Internal hydrogen explosion (I-5) External hydrogen explosion (E-5) Thermal runaway reaction (T-1) MCO overpressurization (P-2)	Hydrogen and/or radioactive particulate release	Facility designed to NFPA 780 <sup>®</sup> for lightning protection. SCIC detects process upset initiating SCHe, which isolates MCO from process piping and establishes helium supply to the MCO MCO and SCHe confinement design SCIC fail-safe design 30 lbf/in <sup>2</sup> gauge rupture disk	F2	F0	S3	S1	Standby electrical power for ventilation system HVAC systems provide confinement and dilution 150 lbf/in <sup>2</sup> gauge rupture disk
Outside OLR-05	Natural phenomena - freezing weather	Low temperatures	Extreme cold weather	Loss of power	Cask annulus and MCO freezing causes loss of primary confinement leading to particulate release	Standby power	F2	F0	S2	S2	SCIC detects process upset initiating SCHe, which isolates MCO from process piping and establishes helium supply to the MCO Cask-MCO and SCIC confinement design
Outside OLR-05 OLR-09	Natural phenomena - snow, ashfall	Excessive roof loading	Natural phenomena	Roof collapse	Personnel injury Loss of ventilation Loss of MCS control Loss of power Process upsets leading to fuel reactions with air and/or water	Building designed to withstand design basis snow loads and ashfall loads	F3	F0	S3	S3	HVAC systems provide confinement, dilution and filtration Facility emergency response procedure will address loss of power in cold weather

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 22 of 22)

Checklist entry	Hazard source/ material	Hazardous condition	Cause	Potential accident	Consequence	Credited prevention	Frequency	Consequence		Defense-in-depth or worker safety features	
								Without prevention	With prevention	Without mitigation	With mitigation
Outside OU-R-06 OU-R-07 OU-R-08	Natural phenomena - straight winds, dust devils, tornados	Pressure differentials and missile strikes	Wind and loose debris	Wall or roof collapse Missile impacts upon the facility	Loss of MCS control Loss of power Damage to process systems Process upsets leading to fuel reactions with air and/or water	Facility structure is designed to withstand design basis loads	F2	F0		S3	
Outside OU-R-10	Natural phenomena - large fire										

<sup>1</sup>WHC-SD-SNF-FHA-003, 1986, Preliminary Fire Hazard Analysis for the Cold Vacuum Drying Facility, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

<sup>2</sup>HNF-SD-TP-SARP-017, 1986, Safety Analysis Report for Packaging, Onsite, Multi-Canister Overpack Cask, Rev. 1, Fluor Daniel Hanford, Incorporated, Richland, Washington.

<sup>3</sup>HNF-3553, 1989, Spent Nuclear Fuel Project Final Safety Analysis Report, Annex A, "Canister Storage Building Final Safety Analysis Report," Rev. 0, Fluor Daniel Hanford, Incorporated, Richland, Washington.

<sup>4</sup>HNF-SD-SNF-DP-007, 1997, Multi-Canister Overpack/Cask Drop Analysis File Documentation, Rev. 0, Fluor Daniel Hanford, Incorporated, Richland, Washington.

<sup>5</sup>HNF-3553, 1989, Spent Nuclear Fuel Project Final Safety Analysis Report, Annex B, "Cold Vacuum Drying Facility Final Safety Analysis Report," Rev. 0, Fluor Daniel Hanford, Incorporated, Richland, Washington.

<sup>6</sup>HNF-SD-SNF-TI-059, 1989, Discussion on the Methodology for Calculating Radiological and Toxicological Consequences for the Spent Nuclear Fuel Project at the Hanford Site, Rev. 2, Fluor Daniel Hanford, Incorporated, Richland, Washington.

<sup>7</sup>HNF-SD-SNF-CSER-006, 1988, Criticality Safety Evaluation Report for the Cold Vacuum Drying Facility's Process Water Handling System, Rev. 1, Fluor Daniel Hanford, Incorporated, Richland, Washington.

<sup>8</sup>NFPA 780, 1985, Lightning Protection Systems, National Fire Protection Association, Quincy, Massachusetts.

ALARA = as low as reasonably achievable.

CAM = continuous air monitor.

CSB = Canister Storage Building.

CVDF = Cold Vacuum Drying Facility.

DBA = design basis accident.

DBE = design basis earthquake.

FHA = fire hazard analysis.

FSAR = final safety analysis report.

GSHe = general-service helium.

HEPA = high-efficiency particulate air (filter).

HVAC = heating, ventilation, and air conditioning.

IGM = ion exchange module.

MCO = multicanister overpack.

MCS = monitoring and control system.

PWNC = process water conditioning.

SARP = safety analysis report for packaging.

SCHe = safety-class helium.

SCIC = safety-class instrumentation and control.

SSC = structure, system, and component.

TRU = transuranic.

TSR = technical safety requirement.

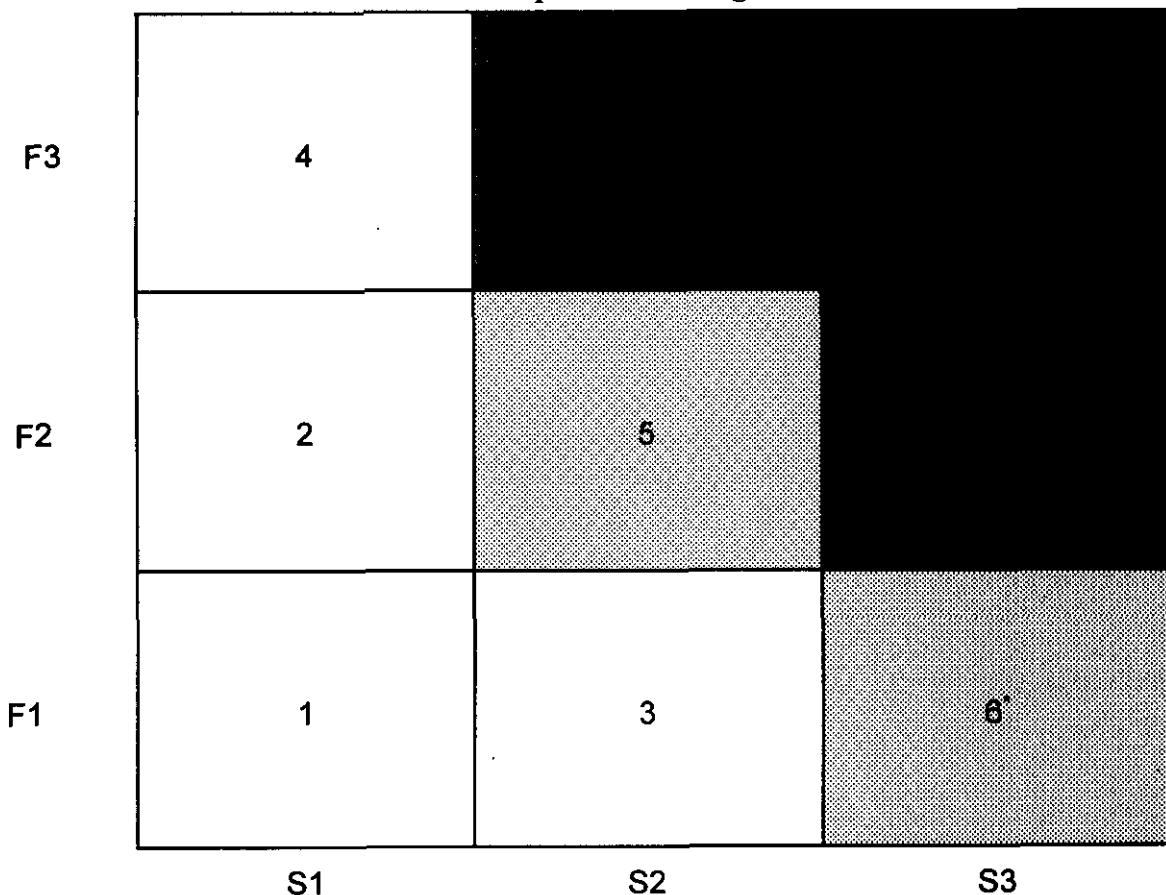
TW = tempered water.

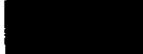
**ATTACHMENT 3**

**RELEASE CHARACTERISTICS FOR HAZARDOUS CONDITIONS  
ASSOCIATED WITH OFFSITE (SITE BOUNDARY) AND  
ONSITE (COLLOCATED WORKER) RECEPTORS**

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**Figure A3-1. Three-by-Three Likelihood and Consequence Ranking Matrix.**



 Combinations that identify situations of major concern

 Combinations that identify situations of concern

\*These situations are either prevented or mitigated by safety class features.

Table A3-1. Release Characteristics for Hazardous Conditions Associated with Offsite (Site Boundary) and Onsite (Collocated Worker) Receptors. (sheet 1 of 8)

Checklist designators	Hazard energy source	Hazardous condition and initiators)	Bin	Frequency / consequence categories	Risk ranking
TC-J-12	Explosive gases	Hydrogen deflagration inside the ventilation ducts due to collection of gases used during maintenance activity, deflagration disperses HEPA filter contents	External explosion (E.7)	F3/S2	7
TC-R-01	Natural phenomena - earthquake (equal to or less than the DBE)	Fuel reactions due to equipment damage caused by seismic event.	Gaseous releases (G.3) External hydrogen explosion (E.8)	F2/S2	5
PB-B-02a	Thermal - electrical equipment	HVAC failure causes bay temperatures in excess of electrical equipment design limits, condition occurs with annulus water flow	Internal hydrogen explosion (I.2) External hydrogen explosion (E.2)	F3/S2	7
PB-B-02b	Thermal - electric equipment	HVAC failure causes bay temperatures in excess of electrical equipment design limits, condition occurs without annulus water flow	Thermal runaway reaction (T.2)	F3/S3	9
PB-B-03a	Thermal - heaters	Tempered water heated to temperatures above 50° C from mechanical or software failure resulting in loss of tempered water heat control.	Internal hydrogen explosion (I.1) External hydrogen explosion (E.4) Thermal Runaway reaction (T.2) MCO overpressurization (P.1)	F3/S3	9
PB-B-03b	Thermal - tempered water heater	Insufficient heating of tempered water due to software failure or human error in programming resulting in inaccurate heater control leading to potential for inaccurate pressure rebound test and proof of dryness demonstration. Excessive water remains in MCO to react with fuel.	External hydrogen explosion (E.3) Hydrogen generation and potential for runaway at the CSB	F2/S2	5
PB-B-13a	Thermal - MCO contents	Process line failure, HVAC or process upset causing significant air ingress into MCO. Air ingress with high fuel temperatures present.	Internal hydrogen explosion (I.1) Gaseous release (G.1) External hydrogen explosion (E.4)	F3/S2	7

Table A3-1. Release Characteristics for Hazardous Conditions Associated with Offsite (Site Boundary) and Onsite (Collocated Worker) Receptors. (sheet 2 of 8)

Checklist designators	Hazard energy source	Hazardous condition and Initiators(s)	Bin	Frequency / consequence categories	Risk ranking
PB-B-13b	Thermal - MCO contents	Leak back of water into MCO while fuel temperatures are high. Fuel reacts with water.	Internal hydrogen explosion (I.1) External hydrogen explosion (E.4)	F3/S2	7
PB-B-13c	Thermal - MCO contents	Low tempered water level, or loss of tempered water, from cask annulus raises fuel temperatures and accelerates fuel temperature and reaction with water.	External hydrogen explosion (E.4) Thermal runaway reaction (T.1) MCO overpressurization (P.1)	F3/S3	9
PB-B-13d	Thermal - MCO contents	Hydrogen release due to excessive free water in the MCO during (or after) the proof of dryness demonstration initiated by an inadequate pressure rebound test, inadequate drying, or human error	External hydrogen explosion (E.3.) Thermal runaway reaction (T.1) MCO overpressurization (P.1)	F3/S3	9
PB-B-13g	Thermal - MCO contents	High fuel temperatures on receipt due to improper fuel loading at Basin or leakage, leads to increased water fuel reaction and increased hydrogen production, deflagration when cask is vented.	External hydrogen explosion (E.1)	F3/S2	7
PB-F-02a	Linear kinetic - forklifts, dollies, carts	Fork lift in empty bay strikes equipment causing process support system or utility system, causes process upset	Internal hydrogen explosion (I.5) External hydrogen explosion (E.5) Thermal runaway reaction (T.4) MCO overpressurization (P.2)	F3/S3	9
PB-F-05	Linear kinetic - crane loads	Crane load impacts or drops on instrument air line, normal helium supply line, electrical panel, or demin water line during processing	Gaseous release (G.1) Internal hydrogen explosion (I.5) External hydrogen explosion (E.5) Thermal runaway reaction (T.4)	F3/S3	9

Table A3-1. Release Characteristics for Hazardous Conditions Associated with Offsite (Site Boundary) and Onsite (Collocated Worker) Receptors. (sheet 3 of 8)

Checklist designators	Hazard energy source	Hazardous condition and initiator(s)	Bin	Frequency / consequence categories	Risk ranking
PB-H-06d	Pressure, volume - pressure vessels	Pressurized MCO/VPS develops small undiscovered, long term leak	Gaseous release (G.1)	F3/S2	7
PB-H-06f	Pressure, volume - pressure vessels	Pressurized releases from an MCO during vacuum drying, process line failure or HVAC failure allows air ingress	Gaseous release (G.1) External hydrogen explosion (E.4)	F3/S2	7
PB-H-06g	Pressure, volume - pressure vessels	Particulate releases from HEPA filters on the local and general exhaust ventilation systems through the exhaust stack initiated by excessive pressure differential	Gaseous release (G.1)	F3/S2	7
PB-H-06h	Pressure, volume - pressure vessels	Particulate releases within a process bay initiated by failure of ventilation ductwork or loss of ventilation fans	Gaseous release (G.1)	F3/S2	7
PB-H-06i	Pressure, volume - pressure vessels	Hydrogen generation within MCO due to excessive delays in shipping	Gaseous release (G.2) External hydrogen (E.4)	F2/S2	5
PB-H-06k	Pressurized MCO	Fuel reacts with contaminants in purge gas, or with air or other contaminants due to lack of proper purging of lines following maintenance	Internal hydrogen explosion (I.7) External hydrogen explosion (E.7) Thermal runaway reaction (T.5)	F2/S2	5
PB-H-08	Pressure, volume - vacuum	Degraded vacuum pump operation leads to increased fuel temperatures and reactions forming hydrogen	Thermal runaway reaction (T.1)	F3/S3	9
PB-H-11a	Pressure, volume - other (pressurized helium recirculation system)	Pressurized release of particulate from an MCO initiated by excessive pressure in the normal helium supply	MCO overpressurization (P.3)	F2/S2	5

Table A3-1. Release Characteristics for Hazardous Conditions Associated with Offsite (Site Boundary) and Onsite (Collocated Worker) Receptors. (sheet 4 of 8)

Checklist designators	Hazard energy source	Hazardous condition and initiator(s)	Bin	Frequency / consequence categories	Risk ranking
PB-H-11d	Pressure, volume - other (water addition to the MCO)	Water addition into MCO while drying or testing from deionized water, vacuum pump cooling water, or bulk water addition, results water fuel reaction, heat and hydrogen	Internal hydrogen explosion (I.1) External hydrogen explosion (E.4)	F3/S2	7
PB-H-11e	Pressure, volume - other (water addition to the MCO)	Water addition into MCO while drying or testing due to isolation valves not closing fully, results in water fuel reaction, heat and hydrogen	Internal hydrogen explosion (I.1) External hydrogen explosion (E.4)	F3/S2	7
PB-L-01 PB-L-02 PB-L-03 PB-L-04 PB-L-05 PB-L-06 PB-L-07 PB-L-08 PB-L-09 PB-L-10 PB-L-13 PB-L-14 PB-L-15 PB-L-16	Flammable materials	Fire in the bay damages equipment	Internal hydrogen explosion (I.3) External hydrogen explosion (E.6) Thermal runaway reaction (T.3)	F2/S2	5
PB-L-11a	Flammable materials - hydrogen	Flammable atmosphere developing in local exhaust ventilation system due to hydrogen in cask upon receipt and venting	External hydrogen explosion (E.1)	F3/S2	7
PB-L-11d	Flammable materials - hydrogen	Flammable atmosphere developing within MCO during drain prior to breakthrough with air ingress	Internal hydrogen explosion (I.1) External hydrogen explosion (E.4)	F1/S2	2

Table A3-1. Release Characteristics for Hazardous Conditions Associated with Offsite (Site Boundary) and Onsite (Collocated Worker) Receptors. (sheet 5 of 8)

Checklist designators	Hazard energy source	Hazardous condition and initiator(s)	Bin	Frequency / consequence categories	Risk ranking
PB-L-11e	Flammable materials - hydrogen	Flammable atmosphere developing around the MCO or within cask-MCO during shipping prep due to improper valve plug seating, inadequate processing, or water introduction after the proof of dryness demonstration.	External hydrogen explosion (E.4)	F2/S0	0
PB-L-11f	Flammable materials - hydrogen	Flammable atmosphere developing within the local exhaust from SCIC actuation, local exhaust not running, during heat-up and drain modes	External hydrogen explosion (E.2)	F2/S2	5
PB-N-01	Ionizing radiation sources - fissile/radioactive material	Failure of drain line in process bay with the door open while draining an upstream bay. Gaseous release due to helium purge out of break.	Gaseous Release (G.1)	F2/S2	5
PB-P-02	External events - fire	Failure of key process systems within the process bays initiated by an external fire spreading to the facility	External hydrogen explosion (E.6) Thermal runaway reaction (T.3)	F2/S2	5
PB-R-01a	Natural phenomena - earthquake	Earthquake causes process upset, equipment damage, loss of ventilation and/or trailer movement	Gaseous release (G.3) Internal hydrogen explosion (I.6) External hydrogen explosion (E.8) Thermal runaway reaction (T.6)	F2/S3	8
SB-F-01b SB-F-02b	Linear kinetic - cars, trucks, buses, forklifts, dollies, carts	Vehicle or forklift impacts equipment or structure in empty bay causing process upset or loss of utility system.	MCO overpressurization (P.4) Internal hydrogen explosion (I.5) External hydrogen explosion (E.5) Thermal runaway reaction (T.4) MCO overpressurization (P.2)	F3/S3	9

Table A3-1. Release Characteristics for Hazardous Conditions Associated with Offsite (Site Boundary) and Onsite (Collocated Worker) Receptors. (sheet 6 of 8)

Checklist designators	Hazard energy source	Hazardous condition and initiator(s)	Bin	Frequency / consequence categories	Risk ranking
SB-N-01	Ionizing radiation sources - radioactive material	Release of contaminated liquid into the spare bay to a PWC drain line failure. Gaseous release due to purge flow exiting the break.	Gaseous release (G.1)	F2/S2	5
PW-H-06	Pressure in PWC pipes and tanks	Equipment failure causes spray and/or gaseous release from PWC components	Gaseous release (G.1)	F3/S2	7
PW-L-02 PW-L-08 PW-L-14 PW-L-16	Flammable materials	Ignition of flammable materials within the PWC room results in equipment damage and leak.	Liquid spray release (L.1)	F2/S2	5
PW-N-01	Ionizing radiation sources - fissile/radioactive material	Radioactive liquid release from process PWC equipment.	Liquid spray release (L.2)	F2/S2	5
OU-P-02a	External events - fire	Fire causes equipment damage leading to process upsets	External hydrogen explosion (E.6)	F3/S2	7
OU-P-04	External events - loss of power	Loss of power causes process upsets, hydrogen forms	Thermal runaway reaction (T.3)	F3/S3	9
			Internal hydrogen explosion (I.5)		
			External hydrogen explosion (E.5)		
			Thermal runaway reaction (T.1)		
			MCO overpressurization (P.2)		

Table A3-1. Release Characteristics for Hazardous Conditions Associated with Offsite (Site Boundary) and Onsite (Collocated Worker) Receptors. (sheet 7 of 8)

Checklist designators	Hazard energy source	Hazardous condition and initiator(s)	Bin	Frequency / consequence categories	Risk ranking
OU-R-01a	Natural phenomena - DBE	Fuel reacts with water or air due to damage from earthquake	Gaseous release (G.3) Internal hydrogen explosion (I.6) External hydrogen explosion (E.8) Thermal runaway reaction (T.6) MCO overpressurization (P.4)	F2/S3	8
OU-R-01b	Natural phenomena - DBE (related to the PWC room)	Earthquake causes damage to equipments, lines or tanks	Liquid spray release (L.3)	F2/S3	8
OU-R-02 OU-R-04	Natural phenomena - Flood, rain	Water is introduced into the facility, into process bays causing system upsets	Internal hydrogen explosion (I.5) External hydrogen explosion (E.5) Thermal runaway reaction (T.1) MCO overpressurization (P.1)	F2/S3	8
OU-R-03	Natural phenomena - lightning	Lightning strike on the facility causes power loss, process upsets with hydrogen forming	Internal hydrogen explosion (I.5) External hydrogen explosion (E.5) Thermal runaway reaction (T.1) MCO overpressurization (P.2)		
OU-R-02 OU-R-04	Natural phenomena - flood, rain	Runaway reactions in multiple MCOs due to a loss of facility power initiated by water intrusion from floods or rain	Runaway reactions in multiple MCOs	S3/F2	8
OU-R-03	Natural phenomena - lightning	Runaway reactions in multiple MCOs due to a loss of facility power or process control initiated by electrical surges due to lightning	Runaway reactions in multiple MCOs	S3/F2	8

Table A3-1. Release Characteristics for Hazardous Conditions Associated with Offsite (Site Boundary) and Onsite (Collocated Worker) Receptors. (sheet 8 of 8)

Checklist designators	Hazard energy source	Hazardous condition and initiator(s)	Bin	Frequency / consequence categories	Risk ranking
OU-R-05	Natural phenomena - freezing weather	Runaway reactions in multiple MCOs due to a loss of facility power initiated by freezing weather	Runaway reactions in multiple MCOs	S3/F3	9
OU-R-05 OU-R-09	Natural phenomena - snow, ashfall	Runaway reactions in multiple MCOs due to a loss of process control and facility power initiated by snow or ashfall	Runaway reactions in multiple MCOs	S3/F3	9
OU-R-06 OU-R-07 OU-R-08	Natural phenomena - straight winds, dust devils, tornados	Runaway reactions in multiple MCOs due to a loss of facility power or process control initiated by straight winds or tornados (wind and/or missiles)	Runaway reactions in multiple MCOs	S3/F2	8
OU-R-10	Natural phenomena - range fire	Runaway reactions in multiple MCOs due to a loss of process control and facility power initiated by a range fire spreading to the facility	Runaway reactions in multiple MCOs	S3/F3	9

CSB = Canister Storage Building.

DBE = design basis earthquake.

HEPA = high-efficiency particulate air (filter).

HVAC = heating, ventilation, and air conditioning.

MCO = multi-canister overpack.

PWC = process water conditioning.

SCIC = safety-class instrumentation and control.

VPS = vacuum purge system.

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**ATTACHMENT 4**

**BINNED LISTING OF CANDIDATE ACCIDENTS  
SORTED BY RISK RANKING**

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Table A4-1. Binned Listing of Candidate Accidents Sorted by Risk Ranking. (4 sheets)

Candidate accident		Initiator type <sup>a</sup>	Frequency/consequence categories <sup>b</sup>	Hazard analysis checklist designator <sup>c</sup>
<b>Gaseous releases (Section B3.4.2.1)</b>				
G.1	Gaseous release due to process line failure or HVAC failure <sup>d</sup>	O	F3/S2	PB-B-13a PB-F-05 PB-H-06d PB-H-06f <sup>e</sup> PB-H-06g
G.2	Gaseous release due to delays in shipping from the CVDF	O	F2/S2	PB-H-06i
G.3	Gaseous release due to line break caused by a seismic event	NP	F2/S2	TC-R-01 OU-R-01a PB-R-01a
<b>Liquid releases (Section B3.4.2.2)</b>				
L.1	Spray release due to piping failures <sup>d</sup>	O, EI	F2/S2	PW-N-01 PW-H-06 <sup>d</sup>
L.2	Spray release due to fire		F2/S2	PW-L-02 PW-L-08 PW-L-14 PW-L-16
L.3	Spray release due to a seismic event	NP	F2/S2	OU-R-01b
<b>MCO external hydrogen explosions (Section B3.4.2.3)</b>				
E.1	Hydrogen explosion outside an MCO due to hydrogen generation within the cask <sup>d</sup>	O	F3/S2	PB-B-13g PB-L-11a <sup>d</sup>
E.2	Hydrogen explosion outside an MCO due to instrumentation failure	O	F3/S2	PB-B-02a PB-L-11f
E.3	Hydrogen explosion outside an MCO due to excessive water in MCO	O	F3/S2	PB-B-03b PB-B-13d
E.4	Hydrogen explosion outside an MCO due to process upset of key parameters	O, NP, EI	F3/S2	PB-B-03a PB-B-13a PB-B-13b PB-B-13c PB-H-06f PB-L-11e
E.5	Hydrogen explosion outside an MCO due to loss of support utilities	O, NP, EI	F3/S2	PB-F-02a PB-F-05 SB-F-01b SB-F-02b OU-P-04 OU-R-02 OU-R-03 OU-R-04

Table A4-1. Binned Listing of Candidate Accidents Sorted by Risk Ranking. (4 sheets)

Candidate accident		Initiator type <sup>a</sup>	Frequency/consequence categories <sup>b</sup>	Hazard analysis checklist designator <sup>c</sup>
E.6	Hydrogen explosion outside an MCO due to facility fire	O	F2/S2	PB-L-01 PB-L-02 PB-L-03 PB-L-04 PB-L-05 PB-L-06 PB-L-07 TC-J-12 PB-L-08 OU-P-02a PB-L-09
E.7	Hydrogen explosion outside an MCO due to contamination of helium supply	O	F2/S2	PB-H-06k
E.8	Hydrogen explosion outside an MCO due to line break caused by a seismic event	NP	F2/S2	TC-R-01 PB-R-01a
MCO internal hydrogen explosions (Section B3.4.2.4)				
I.1	Hydrogen explosion within an MCO due to process upset of key parameters (significant air ingress into the MCO) <sup>d</sup>	O, NP, EI	F3/S2	PB-B-03a PB-B-13a <sup>d</sup> PB-B-13b
I.2	Hydrogen explosion within an MCO due to instrumentation failure (significant air ingress into the MCO)	O	F3/S2	PB-B-02a
I.3	Hydrogen explosion within an MCO due to loss of MCO control caused by facility fire (significant air ingress into the MCO)	O	F2/S2	PB-L-01 PB-L-02 PB-L-03 PB-L-04 PB-L-05 PB-L-06 PB-L-07 PB-L-10 PB-L-13 PB-L-14 PB-L-15 PB-L-16 PB-P-02 TC-J-12 OU-P-02a PB-L-11d PB-H-11e PB-L-11d
I.4	Hydrogen explosion within an MCO due to hydride reaction	O	F0/S2	PB-J-12
I.5	Hydrogen explosion within an MCO due to loss of support utilities (significant air ingress into the MCO)	O, NP, EI	F3/S2	PB-F-02a PB-F-05 SB-F-01b SB-F-02b
I.6	Hydrogen explosion within an MCO due to line break caused by a seismic event	NP	F2/S2	PB-R-01a
I.7	Hydrogen explosion within an MCO due to contamination of helium supply	O	F2/S2	PB-H-06k

Table A4-1. Binned Listing of Candidate Accidents Sorted by Risk Ranking. (4 sheets)

Candidate accident		Initiator type <sup>a</sup>	Frequency/ consequence categories <sup>b</sup>	Hazard analysis checklist designator <sup>c</sup>
MCO thermal runaway reactions (Section B3.4.2.5)				
T.1	Thermal runaway reaction due to internal process upset of key parameters <sup>d</sup>	O, NP, EI	F3/S3	PB-B-13 <sup>c</sup> PB-B-13d PB-H-08 OU-P-04
T.2	Thermal runaway reaction in MCO due to instrumentation failure	O	F3/S3	PB-B-02b PN-B-03a
T.3	Thermal runaway reaction in MCO due to loss of MCO control caused by facility fire	O	F3/S3	PB-L-01 PB-L-02 PB-L-03 PB-L-04 PB-L-05 PB-L-06 PB-L-07 PB-L-08 PB-L-09 PB-L-10 PB-L-13 PB-L-14 PB-L-15 PB-L-16 PB-P-02 OU-P-02a
T.4	Thermal runaway reaction in MCO due to loss of support utilities	O, NP, EI	F3/S3	PB-F-02a PB-F-05 SB-F-01b SB-F-02b
T.5	Thermal runaway reaction in MCO due to contamination of helium supply	O	F2/S2	PB-H-06k
T.6	Thermal runaway reaction in MCO due to line break caused by a seismic event	NP	F2/S3	PB-R-01a OU-R-01a
MCO overpressurization (Section B3.4.2.6)				
P.1	Overpressurization due to internal process upset of key parameters <sup>d</sup>	O	F3/S3	PB-B-03a PB-B-13 <sup>c</sup> PB-B-13d
P.2	Overpressurization due to loss of support utilities	O, NP, EI	F2/S3	PB-F-02a SB-F-01b SB-F-02b OU-P-04 OU-R-03

Table A4-1. Binned Listing of Candidate Accidents Sorted by Risk Ranking. (4 sheets)

Candidate accident	Initiator type <sup>a</sup>	Frequency/consequence categories <sup>b</sup>	Hazard analysis checklist designator <sup>c</sup>
P.3 Overpressurization due to excessive helium supply pressure	O	F2/S2	PB-H-11a
P.4 Overpressurization due to a line break caused by a seismic event	NP	F2/S3	PB-R-01a

<sup>a</sup>O = operational; NP = natural phenomena; EI = externally initiated.

<sup>b</sup>S2 = Sufficient material and release energy to affect an onsite receptor (collocated worker) 100 m from the source of the release.

S3 = Sufficient material and release energy to affect a receptor at the nearest point of uncontrolled public access (Site boundary).

F0 = Beyond extremely unlikely (not credible).

F2 = Foreseeable, but unlikely.

F3 = Likely to occur during the lifetime of the facility.

<sup>c</sup>Hazard analysis checklist designators are described in Section 3.1.

<sup>d</sup>Chosen as a representative and bounding accident for further accident analysis development.

CVDF = Cold Vacuum Drying Facility.

HVAC = heating, ventilation, and air conditioning.

MCO = multi-canister overpack.