ENGINEERING CHANGE NOTICE

1. ECN 630494

Page 1 of 2

Proj.
ECN

2. ECN Category (mark one) Supplemental ☐ Direct Revision ☒ Change ECN ☐ Temporary ☐ Standby ☐ Supersedeure ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. D. W. Krahn/Nuclear Safety/ R3-15/372-3651 6. Project Title/No./Work Order No. Cold Vacuum Drying Facility Hazard Analysis Report 9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HNF-SD-SNF-HIE-004, Rev. 0	4. USQ Required? ☐ Yes ☒ No 7. Bldg./Sys./Fac. No. CVDF 10. Related ECN No(s). N/A	5. Date 2/10/98 8. Approval Designator E,S,Q 11. Related PO No. N/A
12a. Modification Work ☐ Yes (fill out Blk. 12b) ☒ No (NA Blks. 12b, 12c, 12d)	12b. Work Package No. N/A	12c. Modification Work Complete N/A Design Authority/Cog. Engineer Signature & Date	12d. Restored to Original Condition (Temp. or Standby ECN only) N/A Design Authority/Cog. Engineer Signature & Date

13a. Description of Change

13b. Design Baseline Document? ☐ Yes ☒ No

This hazard analysis has been updated to reflect continuing design progress to date. Revision 1 of this document reflects design information as provided in the *Cold Vacuum Drying Facility Safety Analysis Report, Phase II*, HNF-SD-SNF-SAR-002, Rev. 3.

14a. Justification (mark one)

Criteria Change ☐	Design Improvement ☒	Environmental ☐	Facility Deactivation ☐
As-Found ☐	Facilitate Const ☐	Const. Error/Omission ☐	Design Error/Omission ☐

14b. Justification Details

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

See Distribution Coversheet.

RELEASE STAMP	
DATE: 4	STAMP: FEB 23 1998
STA: 4	IC: 3

ENGINEERING CHANGE NOTICE

Page 2 of 2

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

630494

16. Design Verification Required

☐ Yes

☒ No

17. Cost Impact

ENGINEERING

CONSTRUCTION

Additional

☐ \$

Additional

☐ \$

Savings

☐ \$

Savings

☐ \$

18. Schedule Impact (days)

Improvement

☐

Delay

☐

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

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

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

Document Number/Revision

Document Number/Revision

Document Number/Revision

N/A

21. Approvals

Signature	Date	Signature	Date
Design Authority J. J. Irwin	2-18-98	Design Agent	
Cog. Eng. D. E. Krahn	2-11-98	PE	
Cog. Mgr. L. J. Garvin	2/10/98	QA	
QA B. R. Fillion	2/17/98	Safety	
Safety M. A. Jensen	2/11/98	Design	
Environ. J. E. Turnbaugh	2/19/98	Environ.	
Safety D. W. Bergmann	2/20/98	Other	
R. H. Meichle R N meichle	2/11/98		
C. A. Thompson	2-11-98		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

Cold Vacuum Drying Facility Hazard Analysis Report

D. E. Krahn

Fluor Daniel Northwest, Richland, WA 99352

U.S. Department of Energy Contract DE-AC06-96RL13200

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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 phase II safety analysis report (SAR), 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 U.S. Department of Energy (DOE) Order 5480.23, *Nuclear Safety Analysis Reports*.

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Release Approval

Date

Approved for Public Release

**COLD VACUUM DRYING FACILITY
HAZARD ANALYSIS REPORT**

**HNF-SD-SNF-HIE-004
Revision 1**

February 1998

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LIST OF TERMS

CVDF	Cold Vacuum Drying Facility
DOE	U.S. Department of Energy
MCO	multicanister overpack
SAR	safety analysis report

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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 phase II safety analysis report (SAR) 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 U.S. Department of Energy (DOE) Order 5480.23, *Nuclear Safety Analysis Reports*.

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2.0 SCOPE OF THE HAZARD ANALYSIS

The focused CVDF hazard analysis was based on baseline design information as presented in HNF-SD-SNF-DRD-002, *Cold Vacuum Drying Facility Design Requirements* (Irwin 1997), and HNF-1720, *CVD Preliminary Design Description Package to Support PSAR Program* (Wiemers 1997). The analysis included review of preliminary design drawings and process descriptions as well as information provided by design, operations, and safety analysis representatives. The CVDF operations considered were those involved with bringing a transportation cask containing a multicanister overpack (MCO) into the facility on a transporter through one of four process bay doors (a fifth process bay is a spare), securing the transporter in place and removing the cab, closing the process bay door and removing the cask lid, hooking the process connections to the MCO, establishing tempered cooling water flow and draining the MCO, vacuum drying the MCO, pressure testing the MCO, preparing the MCO for shipment, removing all process connections and replacing the cask lid, opening the bay doors, connecting the transporter back up to a cab and removing the transporter restraints, and turning the transportation cask over for shipment to the Canister Storage Building.

This document expands upon HNF-SD-SNF-HIE-004, Revision 0 (Pili-Vincens and Krahn 1997), the previous focused hazards analysis related to building confinement, incorporates information from a hazards and operability study (Pili-Vincens and Bajwa 1997) performed to establish safety-class system requirements, and uses information generated during a failure modes, effects, and criticality analysis performed as part of the CVDF design process. This hazard analysis will serve as a starting point for the final hazard analysis performed for the CVDF in support of the final SAR. The final hazard analysis will be based on final design information.

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3.0 HAZARD ANALYSIS METHODOLOGY

This section presents the methodology used to perform the CVDF hazard analysis. The hazard evaluation process focused on identifying hazardous conditions, determined causes and preventive and mitigative features, and qualitatively estimated the consequences and frequencies of occurrence. Results of the hazard evaluations were used to select candidate accidents for quantitative analysis to be included in the CVDF SAR.

3.1 HAZARD IDENTIFICATION

The hazard analysis included identification of the hazards associated with CVDF design and operations. Hazards were defined as material that may have a potentially adverse effect on people, the CVDF, or the environment, and as energy sources that could contribute to injury to personnel or to uncontrolled release of radioactive or hazardous material.

Hazard identification for the CVDF was based on examination of the facility design and was divided into six 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).

A standardized checklist, Figure 3-1, was used to classify potentially hazardous materials and energy sources as they were identified in each of the six areas. Identified hazards were classified by their general nature (e.g., electrical [A], thermal [B], friction [C]) and by their specific form (e.g., pumps, diesel fuel, pressure vessels, hydrogen). Figures 3-2 through 3-7 show the hazard identification results for each area.

3.2 HAZARD EVALUATION

The hazard evaluation 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 1 lists the members of the hazard analysis team and describes the background and experience of each. Information from a preliminary hazard analysis that was performed at the conceptual design stage for the facility (Garvin 1997) was used as a check for completeness.

The first step in a hazard evaluation is to screen the hazardous materials and energy sources with the potential to cause an uncontrolled release of radioactive or other hazardous material from those that present only standard industrial hazards. Standard industrial hazards are defined in

DOE-STD-3009-94 as those hazards 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." Table 3-1 provides a listing of standard industrial hazards by facility area. The table represents those checklist items from the identification process that pose only industrial safety hazards and do not contribute to the uncontrolled release of radioactive or hazardous material. Those checklist items not included in the table represent hazards requiring further characterization and evaluation as potential accident analysis candidates. (Note that checklist items retained for further evaluation may also include standard industrial hazards if those industrial hazards can also contribute to the uncontrolled release of radioactive or hazardous material.)

The industrial safety requirements for U.S. Department of Energy sites are covered by Title 29, *Code of Federal Regulations*, Part 1910, "Occupational Safety and Health Standards." The following parts of that document contain requirements that must be met to ensure workers are protected from the hazards identified in Table 3-1:

Subpart A	General
Subpart D	Walking - Working Surfaces
Subpart E	Means of Egress
Subpart F	Powered Platforms, Manlifts, and Vehicle-Mounted Work Platforms
Subpart G	Occupational Health and Environmental Control
Subpart H	Hazardous Materials
Subpart I	Personal Protective Equipment
Subpart J	General Environmental Controls
Subpart K	Medical and First Aid
Subpart L	Fire Protection
Subpart M	Compressed Gas and Compressed Air Equipment
Subpart N	Materials Handling and Storage
Subpart O	Machinery and Machine Guarding
Subpart P	Hand and Portable Powered Tools and Other Hand-Held Equipment
Subpart Q	Welding, Cutting, and Brazing
Subpart S	Electrical
Subpart Z	Toxic and Hazardous Substances.

The remaining hazards from the checklists were entered into the hazard analysis table (Attachment 2) by facility area. Using the table as a guide, the team identified and recorded each hazardous condition and the potential accidents arising from the presence of the hazardous condition, potential causes and consequences of the hazardous condition, existing design features to prevent the condition or mitigate the consequences, planned administrative features to prevent the hazardous condition or mitigate the consequences, and estimates of the likelihood and consequences of the hazardous condition. Each column of the hazard analysis table is explained below to aid in understanding the information contained therein.

The column labeled "Location/checklist entry" identifies the facility area under consideration, as well as a corresponding checklist entry designator for the specific hazard being considered. For example, a designator of PB-F-01 would represent process bays 2-5 (PB), a linear kinetic hazard (F) from a car, truck, or bus (01).

The column labeled "Operating sequence mode/block" identifies, as applicable, the process or operational step involved with the hazard being evaluated.

The column labeled "Hazard energy source/material" identifies the specific hazard under consideration within a row (e.g., a moving transport).

The column labeled "Hazardous condition" describes the hazardous condition that the energy source or material represents (e.g., a loss of control of a moving transport).

The column labeled "Cause" identifies potential initiators of the hazardous condition (e.g., a loss of control of a transport [the hazardous condition] could be caused by human error on the driver's part or by mechanical failure of the vehicle). Typical potential causes include equipment failures, operational errors, abnormal operating conditions, poor operating practices, and environmental conditions. The potential causes of a hazardous condition are identified to support a qualitative frequency evaluation.

The column labeled "Potential accident" identifies potential accidents that could result from the identified hazardous conditions (e.g., a transport striking process lines).

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

The column labeled "Safety features" lists mitigating safety features present within the facility to reduce the frequency or consequence of the hazard. Although the features listed (both engineered and administrative) include all the controls known to be present as part of the design, the accident analyst is not required to select all the controls listed when performing the actual accident analysis. The analyst will choose those controls from the list necessary to meet evaluation guidelines. The remaining items within the table represent defense-in-depth controls that will reduce the likelihood or consequences even further, but no specific credit is taken for them in the quantitative analysis.

The column labeled "Consequence category" contains an evaluation of the potential effects of the hazardous condition on the health and safety of people and on the environment. The assessment of the consequence for each hazardous condition was a collective, qualitative judgment made by the hazard analysis team. The assessment took into consideration the impact of designed passive features (e.g., structures, barriers) but not the impact of active features or planned controls (e.g., valves, shipping restrictions). 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).

The column labeled "Frequency category" contains an evaluation of the likelihood of occurrence of the hazardous condition being evaluated. The assessment of likelihood was a collective, qualitative judgment made by the hazard analysis team. The assessment took into consideration the impact of designed passive features (e.g., structures, barriers) but not the impact of active features or planned controls (e.g., valves, shipping restrictions). The likelihood assessments were based on occurrences over the facility lifetime. The qualitative criteria for likelihood assessments are as follows.

- F3 The hazardous condition based on the causes postulated is likely to occur during 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.

The column labeled "Remarks" contains any additional information relevant to the hazard being considered that the team felt should be retained for future reference.

The hazard analysis table, Attachment 2, shows the results of the hazard evaluation as compiled by the hazard analysis team.

3.3 CANDIDATE ACCIDENT SELECTION

The hazardous conditions identified by the hazard evaluation have been used to select candidate accidents for more detailed, quantitative analysis in the CVDF SAR. 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." This section describes the approach used to select candidate accidents.

The selection of candidate accidents is based on characterizing risk from, and developing controls for, a representative set of hazardous conditions. A hazardous condition is generally considered to be representative of other hazardous conditions if it has similar release characteristics and involves similar initiators. Hazardous conditions that represent the most severe consequences and the highest risk (a combination of frequency and consequences) within each set of representative hazards are selected as candidate accidents for further analysis in the SAR.

In accordance with DOE-STD-3009-94 and consistent with the graded approach, the risks of a facility may be characterized and appropriate controls developed using the detailed analysis of a representative set of hazardous conditions. The representative hazardous conditions bound conditions with lesser but similar potential consequences, represent the highest risk, or while not necessarily bounding, present some unique but important phenomenological challenge to system safety. The selection process comprised five steps:

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
5. Selection of unique hazardous conditions.

Initial Screening. All hazardous conditions whose unmitigated consequences are assessed as S3 (offsite consequences) or S2 (collocated worker consequences) are chosen for consideration for representative accident selection through a ranking of relative risk (see Attachment 3). Those assessed as S1 (facility worker consequences) do not warrant detailed accident analysis and are instead addressed qualitatively in the SAR using the hazard analysis results. Those assessed as having no consequences (S0) are dropped from consideration.

Assignment of Release Attributes. Each hazardous condition is described with certain release attributes related to uncontrolled release of the material at risk (see Attachment 3). This is

done to ensure that at least one candidate accident is selected to represent each unique set of release conditions. The hazardous material release attributes used are as follows:

- Release initiator
- Form of release.

Creation of Hazardous Material Release Bins. After the release attributes are assigned to each hazardous condition, the hazardous conditions are collected to form release categories, or "bins." Collecting hazardous conditions into bins involves grouping all hazardous conditions with common initiators and release forms and ranking them by estimated consequence and frequency. Representative and bounding accidents then can be chosen to represent all the hazardous conditions within a particular bin.

Selection of Representative Bounding Hazardous Conditions for each Release Attribute Category. Within each release attribute bin, the most severe hazardous condition, considering consequences, and the highest risk accident, based on a likelihood and consequence ranking matrix (see Attachment 3), as described in DOE-STD-3009-94, were selected. In some cases, they were the same hazardous condition. These accidents are the representative and bounding accidents selected for further, quantitative, analysis.

Selection of Unique Hazardous Conditions. Hazardous conditions were selected to represent additional unique causes within each release attribute bin. This was done to support development of controls for accidents with similar consequences but with different causes.

The final list of candidate accidents (see Attachment 4) represents all S3 (offsite) and S2 (onsite) hazardous conditions identified by the hazard analysis. These hazardous conditions are grouped by candidate accident to facilitate incorporation of the information and conclusions from the accident analysis into the hazard analysis results when considering controls and hazard classification.

Individual release bins may need to be broken into several smaller bins in the future as a result of accident analysis activities. This is often driven by a determination that a separate set of controls is necessary for hazardous conditions in the same release bin rather than those chosen for the representative and bounding accident because the chosen controls do not easily apply to the identified hazardous conditions within the set. In these cases, either a new bin will be created, with its own set of representative and bounding accidents and associated controls to reduce the likelihood or consequence of the hazards involved, or the hazardous condition will be identified as a unique accident for further development.

Figure 3-1. Hazardous Material/Energy Source Checklist: Example.

NODE: _____

Y N A. Electrical

- ☐ 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 _____

Y N B. Thermal

- ☐ 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 _____

Y N C. Friction

- ☐ 1. Belts
- ☐ 2. Bearings
- ☐ 3. Fans
- ☐ 4. Gears
- ☐ 5. Motors
- ☐ 6. Power tools
- ☐ 7. Other _____

Y N D. Corrosives

- ☐ 1. Acids
- ☐ 2. Caustics
- ☐ 3. Natural chemicals
- ☐ 4. Decontamination solution
- ☐ 5. High temperature waste
- ☐ 6. Other _____

Y N E. Kinetic - Rotational

- ☐ 1. Centrifuges
- ☐ 2. Motors
- ☐ 3. Pumps
- ☐ 4. Fans
- ☐ 5. Laundry equipment
- ☐ 6. Shop equipment
- ☐ 7. Other _____

Y N F. Kinetic - Linear

- ☐ 1. Cars, trucks, buses
- ☐ 2. Forklifts, dollies, carts
- ☐ 3. Railroad
- ☐ 4. Obstructions
- ☐ 5. Crane loads
- ☐ 6. Pressure vessel blowdown
- ☐ 7. Other _____

Y N G. Mass, Gravity, Height

- ☐ 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 _____

Y N H. Pressure - Volume

- ☐ 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 _____

Y N J. Explosives/Pyrophorics

- ☐ 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
- ☐ 13. Other _____

Y N K. Nuclear Criticality

- ☐ 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. Decontamination solution
- ☐ 10. Trucks, forklifts, dollies
- ☐ 11. Hand carry
- ☐ 12. Cranes/lifts
- ☐ 13. Hot cells, assembly, inspection
- ☐ 14. Laboratories
- ☐ 15. Other _____

Y N L. Flammable Materials

- ☐ 1. Packing materials
- ☐ 2. Rags
- ☐ 3. Gasoline
- ☐ 4. Lube oil
- ☐ 5. Coolant oil
- ☐ 6. Paint solvent
- ☐ 7. Diesel fuel
- ☐ 8. Buildings & contents
- ☐ 9. Trailers and contents
- ☐ 10. Grease
- ☐ 11. Hydrogen
- ☐ 12. Nitric acid
- ☐ 13. Organics
- ☐ 14. Gases - others
- ☐ 15. Liquids - others
- ☐ 16. Other _____

Y N M. Hazardous Materials

- ☐ 1. Alkali metals
- ☐ 2. Asphyxiants
- ☐ 3. Biologicals
- ☐ 4. Carcinogens
- ☐ 5. Corrosives
- ☐ 6. Oxidizers
- ☐ 7. Toxics
- ☐ 8. Heavy metals
- ☐ 9. Other _____

Y N N. Ionizing Radiation Sources

- ☐ 1. Fissile material
- ☐ 2. Radiography equipment
- ☐ 3. Radioactive material
- ☐ 4. Radioactive sources
- ☐ 5. Other _____

Y N P. External Events

- ☐ 1. Explosion
- ☐ 2. Fire
- ☐ 3. Other sites

Y N Q. Vehicles in Motion (external to facility)

- ☐ 1. Airplane
- ☐ 2. Helicopter
- ☐ 3. Train
- ☐ 4. Truck/bus/car
- ☐ 5. Other _____

Y N R. Natural Phenomena

- ☐ 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

Figure 3-2. Hazardous Material/Energy Source Checklist: Administrative Area.

Location: Administrative Area, Cold Vacuum Drying Facility

Y N A. Electrical

- ☐ 1. Battery banks (UPS)
- ☐ 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 _____

Y N B. Thermal

- ☐ 1. Bunsen burner/hot plates
- ☐ 2. Electrical equipment
- ☐ 3. Furnaces/boilers/heater
- ☐ 4. Steam lines
- ☐ 5. Welding torch/larc
- ☐ 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 _____

Y N C. Friction

- ☐ 1. Belts
- ☐ 2. Bearings
- ☐ 3. Fans
- ☐ 4. Gears
- ☐ 5. Motors
- ☐ 6. Power tools
- ☐ 7. Other _____

Y N D. Corrosives

- ☐ 1. Acids
- ☐ 2. Caustics
- ☐ 3. Natural chemicals
- ☐ 4. Decon solution
- ☐ 5. High temperature waste
- ☐ 6. Other _____

Y N E. Kinetic - Rotational

- ☐ 1. Centrifuges
- ☐ 2. Motors
- ☐ 3. Pumps
- ☐ 4. Fans
- ☐ 5. Laundry equipment
- ☐ 6. Shop equipment
- ☐ 7. Other _____

Y N F. Kinetic - Linear

- ☐ 1. Cars, trucks, buses
- ☐ 2. Forklifts, dollies, carts
- ☐ 3. Railroad
- ☐ 4. Obstructions
- ☐ 5. Crane loads
- ☐ 6. Pressure vessel blowdown
- ☐ 7. Other _____

Y N G. Mass, Gravity, Height

- ☐ 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 _____

Y N H. Pressure - Volume

- ☐ 1. Boilers
- ☐ 2. Surge tanks
- ☐ 3. Autoclave
- ☐ 4. Test loops
- ☐ 5. Gas bottles (portal monitor)
- ☐ 6. Pressure vessels
- ☐ 7. Stressed members
- ☐ 8. Gas receivers
- ☐ 9. Vacuum
- ☐ 10. Steam headers and lines
- ☐ 11. Other _____

Y N J. Explosives/Pyrophorics

- ☐ 1. Caps
- ☐ 2. Primer cord
- ☐ 3. Dynamite
- ☐ 4. Scrub chemicals
- ☐ 5. Dusts
- ☐ 6. Hydrogen (batteries)
- ☐ 7. Gases, others
- ☐ 8. Nitrates
- ☐ 9. Peroxides
- ☐ 10. Pu and U metal
- ☐ 11. Sodium
- ☐ 12. Other _____

Y N K. Nuclear Criticality

- ☐ 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 _____

Y N L. Flammable Materials

- ☐ 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 (batteries)
- ☐ 12. Nitric acid
- ☐ 13. Organics
- ☐ 14. Gases - others
- ☐ 15. Liquids - others
- ☐ 16. Other (aerosol propellant)

Y N M. Hazardous Materials

- ☐ 1. Alkali metals
- ☐ 2. Asphyxiants
- ☐ 3. Biologicals
- ☐ 4. Carcinogens
- ☐ 5. Corrosives
- ☐ 6. Oxidizers
- ☐ 7. Toxics
- ☐ 8. Heavy metals (mercury in relays)
- ☐ 9. Other _____

Y N N. Ionizing Radiation Sources

- ☐ 1. Fissile material
- ☐ 2. Radiography equipment
- ☐ 3. Radioactive material
- ☐ 4. Radioactive sources (sealed sources)
- ☐ 5. Other _____

Y N P. External Events

- ☐ 1. Explosion
- ☐ 2. Fire
- ☐ 3. Other sites

Y N Q. Vehicles in Motion (external to facility)

- ☐ 1. Airplane
- ☐ 2. Helicopter
- ☐ 3. Train
- ☐ 4. Truck/bus/car
- ☐ 5. Other _____

Y N R. Natural Phenomena

- ☐ 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

Figure 3-3. Hazardous Material/Energy Source Checklist: Transfer Corridor and Mechanical Corridor.

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

Y N A. Electrical

- ☐ 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 _____

Y N B. Thermal

- ☐ 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 _____

Y N C. Friction

- ☐ 1. Bolts
- ☐ 2. Bearings
- ☐ 3. Fans
- ☐ 4. Gears
- ☐ 5. Motors
- ☐ 6. Power tools
- ☐ 7. Other _____

Y N D. Corrosives

- ☐ 1. Acids
- ☐ 2. Caustics
- ☐ 3. Natural chemicals
- ☐ 4. Decon solution
- ☐ 5. High temperature waste
- ☐ 6. Other _____

Y N E. Kinetic - Rotational

- ☐ 1. Centrifuges
- ☐ 2. Motors
- ☐ 3. Pumps
- ☐ 4. Fans
- ☐ 5. Laundry equipment
- ☐ 6. Shop equipment
- ☐ 7. Other _____

Y N F. Kinetic - Linear

- ☐ 1. Cars, trucks, buses
- ☐ 2. Forklifts, dollies, carts
- ☐ 3. Railroad
- ☐ 4. Obstructions
- ☐ 5. Crane loads
- ☐ 6. Pressure vessel blowdown
- ☐ 7. Other (gas bottles)

Y N G. Mass, Gravity, Height

- ☐ 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 (air compressor)
- ☐ 14. Other _____

Y N H. Pressure - Volume

- ☐ 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 _____

Y N J. Explosives/Pyrophorics

- ☐ 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 _____

Y N K. Nuclear Criticality

- ☐ 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 _____

Y N L. Flammable Materials

- ☐ 1. Picking 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)

Y N M. Hazardous Materials

- ☐ 1. Alkali metals
- ☐ 2. Asphyxiants
- ☐ 3. Biologicals
- ☐ 4. Carcinogens
- ☐ 5. Corrosives
- ☐ 6. Oxidizers
- ☐ 7. Toxics
- ☐ 8. Heavy metals
- ☐ 9. Other _____

Y N N. Ionizing Radiation Sources

- ☐ 1. Fissile material
- ☐ 2. Radiography equipment
- ☐ 3. Radioactive material
- ☐ 4. Radioactive sources
- ☐ 5. Other _____

Y N P. External Events

- ☐ 1. Explosion
- ☐ 2. Fire
- ☐ 3. Other sites

Y N Q. Vehicles in Motion (external to facility)

- ☐ 1. Airplane
- ☐ 2. Helicopter
- ☐ 3. Train
- ☐ 4. Truck/bus/car
- ☐ 5. Other _____

Y N R. Natural Phenomena

- ☐ 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

Figure 3-4. Hazardous Material/Energy Source Checklist: Process Bays 2-5.

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

Y N A. Electrical

- ☐ 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 _____

Y N B. Thermal

- ☐ 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 (MCO contents)

Y N C. Friction

- ☐ 1. Belts
- ☐ 2. Bearings
- ☐ 3. Fans
- ☐ 4. Gears
- ☐ 5. Motors
- ☐ 6. Power tools
- ☐ 7. Other (vehicle brakes)

Y N D. Corrosives

- ☐ 1. Acids
- ☐ 2. Caustics
- ☐ 3. Natural chemicals
- ☐ 4. Decon solution
- ☐ 5. High temperature waste
- ☐ 6. Other _____

Y N E. Kinetic - Rotational

- ☐ 1. Centrifuges
- ☐ 2. Motors
- ☐ 3. Pumps
- ☐ 4. Fans
- ☐ 5. Laundry equipment
- ☐ 6. Shop equipment
- ☐ 7. Other _____

Y N F. Kinetic - Linear

- ☐ 1. Cars, trucks, buses
- ☐ 2. Forklifts, dollies, carts
- ☐ 3. Railroad
- ☐ 4. Obstructions
- ☐ 5. Crane loads
- ☐ 6. Pressure vessel blowdown
- ☐ 7. Other (gas bottles)

Y N G. Mass, Gravity, Height

- ☐ 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)

Y N H. Pressure - Volume

- ☐ 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)

Y N J. Explosives/Pyrophorics

- ☐ 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)

Y N K. Nuclear Criticality

- ☐ 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)

Y N L. Flammable Materials

- ☐ 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 (acetylene torch, propane)
- ☐ 15. Liquids - others (alcohol)
- ☐ 16. Other (aerosol propellant)

Y N M. Hazardous Materials

- ☐ 1. Alkali metals
- ☐ 2. Asphyxiants
- ☐ 3. Biologicals
- ☐ 4. Carcinogens
- ☐ 5. Corrosives
- ☐ 6. Oxidizers
- ☐ 7. Toxics
- ☐ 8. Heavy metals
- ☐ 9. Other _____

Y N N. Ionizing Radiation Sources

- ☐ 1. Fissile material
- ☐ 2. Radiography equipment
- ☐ 3. Radioactive material
- ☐ 4. Radioactive sources
- ☐ 5. Other _____

Y N P. External Events

- ☐ 1. Explosion
- ☐ 2. Fire
- ☐ 3. Other sites

Y N Q. Vehicles in Motion (external to facility)

- ☐ 1. Airplane
- ☐ 2. Helicopter
- ☐ 3. Train
- ☐ 4. Truck/bus/car
- ☐ 5. Other (mobile cranes, const. equip.)

Y N R. Natural Phenomena

- ☐ 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

Figure 3-5. Hazardous Material/Energy Source Checklist: Process Bay 1 (Spare Bay).

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

Y N A. Electrical

- ☐ ☐ 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 _____

Y N B. Thermal

- ☐ ☐ 1. Bunsen burner/hot plates
- ☐ ☐ 2. Electrical equipment
- ☐ ☐ 3. Furnaces/boilers/heater
- ☐ ☐ 4. Steam lines
- ☐ ☐ 5. Welding torch/larc
- ☐ ☐ 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 _____

Y N C. Friction

- ☐ ☐ 1. Belts
- ☐ ☐ 2. Bearings
- ☐ ☐ 3. Fans
- ☐ ☐ 4. Gears
- ☐ ☐ 5. Motors
- ☐ ☐ 6. Power tools
- ☐ ☐ 7. Other (vehicle brakes)

Y N D. Corrosives

- ☐ ☐ 1. Acids
- ☐ ☐ 2. Caustics
- ☐ ☐ 3. Natural chemicals
- ☐ ☐ 4. Decon solution
- ☐ ☐ 5. High temperature waste
- ☐ ☐ 6. Other _____

Y N E. Kinetic - Rotational

- ☐ ☐ 1. Centrifuges
- ☐ ☐ 2. Motors
- ☐ ☐ 3. Pumps
- ☐ ☐ 4. Fans
- ☐ ☐ 5. Laundry equipment
- ☐ ☐ 6. Shop equipment
- ☐ ☐ 7. Other _____

Y N F. Kinetic - Linear

- ☐ ☐ 1. Cars, trucks, buses
- ☐ ☐ 2. Forklifts, dollies, carts
- ☐ ☐ 3. Railroad
- ☐ ☐ 4. Obstructions
- ☐ ☐ 5. Crane loads
- ☐ ☐ 6. Pressure vessel blowdown
- ☐ ☐ 7. Other (gas bottle storage)

Y N G. Mass, Gravity, Height

- ☐ ☐ 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 _____

Y N H. Pressure - Volume

- ☐ ☐ 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 (truck tires, air ride suspension, air brakes)

Y N J. Explosives/Pyrophorics

- ☐ ☐ 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 _____

Y N K. Nuclear Criticality

- ☐ ☐ 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 _____

Y N L. Flammable Materials

- ☐ ☐ 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)

Y N M. Hazardous Materials

- ☐ ☐ 1. Alkali metals
- ☐ ☐ 2. Asphyxiants
- ☐ ☐ 3. Biologicals
- ☐ ☐ 4. Carcinogens
- ☐ ☐ 5. Corrosives
- ☐ ☐ 6. Oxidizers
- ☐ ☐ 7. Toxics
- ☐ ☐ 8. Heavy metals
- ☐ ☐ 9. Other _____

Y N N. Ionizing Radiation Sources

- ☐ ☐ 1. Fissile material
- ☐ ☐ 2. Radiography equipment
- ☐ ☐ 3. Radioactive material
- ☐ ☐ 4. Radioactive sources
- ☐ ☐ 5. Other _____

Y N P. External Events

- ☐ ☐ 1. Explosion
- ☐ ☐ 2. Fire
- ☐ ☐ 3. Other sites

Y N Q. Vehicles in Motion (external to facility)

- ☐ ☐ 1. Airplane
- ☐ ☐ 2. Helicopter
- ☐ ☐ 3. Train
- ☐ ☐ 4. Truck/bus/car
- ☐ ☐ 5. Other _____

Y N R. Natural Phenomena

- ☐ ☐ 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

Figure 3-6. Hazardous Material/Energy Source Checklist: Process Water Room.

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

Y N A. Electrical

- ☐ 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 _____

Y N B. Thermal

- ☐ 1. Bunsen burner/hot plates
- ☐ 2. Electrical equipment
- ☐ 3. Furnaces/boilers/heater
- ☐ 4. Steam lines
- ☐ 5. Welding torch/barc
- ☐ 6. Diesel units/fire box/exhaust line
- ☐ 7. Radioactive decay heat
- ☐ 8. Exposed components
- ☐ 9. Power tools
- ☐ 10. Convector
- ☐ 11. Solar
- ☐ 12. Cryogenic
- ☐ 13. Other _____

Y N C. Friction

- ☐ 1. Belts
- ☐ 2. Bearings
- ☐ 3. Fans
- ☐ 4. Gears
- ☐ 5. Motors
- ☐ 6. Power tools
- ☐ 7. Other _____

Y N D. Corrosives

- ☐ 1. Acids
- ☐ 2. Caustics
- ☐ 3. Natural chemicals
- ☐ 4. Decon solution
- ☐ 5. High temperature waste
- ☐ 6. Other _____

Y N E. Kinetic - Rotational

- ☐ 1. Centrifuges
- ☐ 2. Motors
- ☐ 3. Pumps
- ☐ 4. Fans
- ☐ 5. Laundry equipment
- ☐ 6. Shop equipment
- ☐ 7. Other _____

Y N F. Kinetic - Linear

- ☐ 1. Cars, trucks, buses
- ☐ 2. Forklifts, dollies, carts
- ☐ 3. Railroad
- ☐ 4. Obstructions
- ☐ 5. Crane loads
- ☐ 6. Pressure vessel blowdown
- ☐ 7. Other (gas bottles)

Y N G. Mass, Gravity, Height

- ☐ 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 hatch)

Y N H. Pressure - Volume

- ☐ 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 _____

Y N J. Explosives/Pyrophorics

- ☐ 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)

Y N K. Nuclear Criticality

- ☐ 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)

Y N L. Flammable Materials

- ☐ 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)

Y N M. Hazardous Materials

- ☐ 1. Alkali metals
- ☐ 2. Asphyxiants
- ☐ 3. Biologicals
- ☐ 4. Carcinogens
- ☐ 5. Corrosives
- ☐ 6. Oxidizers
- ☐ 7. Toxics
- ☐ 8. Heavy metals
- ☐ 9. Other _____

Y N N. Ionizing Radiation Sources

- ☐ 1. Fissile material
- ☐ 2. Radiography equipment
- ☐ 3. Radioactive material
- ☐ 4. Radioactive sources
- ☐ 5. Other _____

Y N P. External Events

- ☐ 1. Explosion
- ☐ 2. Fire
- ☐ 3. Other sites

Y N Q. Vehicles in Motion (external to facility)

- ☐ 1. Airplane
- ☐ 2. Helicopter
- ☐ 3. Train
- ☐ 4. Truck/bus/car
- ☐ 5. Other _____

Y N R. Natural Phenomena

- ☐ 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

Figure 3-7. Hazardous Material/Energy Source Checklist: Outside.

Location: Outside, Cold Vacuum Drying Facility					
Y	N	A. Electrical	1. Battery banks	☐	☐
Y	N		2. Cable runs	☐	☐
Y	N	B. Thermal	1. Burnson burner/hot plates	☐	☐
Y	N		2. Furnaces/boilers/heater	☐	☐
Y	N		3. Steam lines	☐	☐
Y	N		5. Welding torch/acetylene	☐	☐
Y	N		6. Diesel unit/offline box/exhaust line	☐	☐
Y	N		7. Radioactive decay heat	☐	☐
Y	N		8. Exposed components	☐	☐
Y	N		9. Power tools	☐	☐
Y	N		10. Connective	☐	☐
Y	N		11. Soil	☐	☐
Y	N		12. Cylindrical	☐	☐
Y	N		13. Other	☐	☐
Y	N	C. Friction	1. Belts	☐	☐
Y	N		2. Bearings	☐	☐
Y	N		3. Fans	☐	☐
Y	N		4. Gears	☐	☐
Y	N		5. Motors	☐	☐
Y	N		6. Power tools	☐	☐
Y	N		7. Other (vehicle brakes).	☐	☐
Y	N	D. Corrosives	1. Acids	☐	☐
Y	N		2. Caustics	☐	☐
Y	N		3. Natural chemicals	☐	☐
Y	N		4. Decon solution	☐	☐
Y	N		5. High temperature waste	☐	☐
Y	N		6. Other	☐	☐
Y	N	E. Kinetic - Rotational	1. Centrifuges	☐	☐
Y	N		2. Pumps	☐	☐
Y	N		3. Motors	☐	☐
Y	N		4. Fans	☐	☐
Y	N		5. Laundry equipment	☐	☐
Y	N		6. Shop equipment	☐	☐
Y	N		7. Other	☐	☐
Y	N	F. Kinetic - Linear	1. Cars, trucks, buses	☐	☐
Y	N		2. Forklifts, dollies, carts	☐	☐
Y	N		3. Railroad	☐	☐
Y	N		4. Obstructions	☐	☐
Y	N		5. Canoe loads	☐	☐
Y	N		6. Pressure vessel, blowdown	☐	☐
Y	N		7. Other (gas bottles)	☐	☐
Y	N	K. Nuclear Criticality	1. Tanks	☐	☐
Y	N		2. Temporary storage areas	☐	☐
Y	N		3. Shipping and receiving area	☐	☐
Y	N		4. Filters	☐	☐
Y	N		5. Casks	☐	☐
Y	N		6. Burial ground	☐	☐
Y	N		7. Storage racks	☐	☐
Y	N		8. Canals and basins	☐	☐
Y	N		9. Decon solution	☐	☐
Y	N		10. Trucks, forklifts, dollies	☐	☐
Y	N		11. Crane/slings	☐	☐
Y	N		13. Hot cells, assembly, inspection	☐	☐
Y	N		14. Laboratories	☐	☐
Y	N		15. Other (drain tank)	☐	☐
Y	N	L. Flammable Materials	1. Packing materials	☐	☐
Y	N		2. Rags	☐	☐
Y	N		3. Gasoline	☐	☐
Y	N		4. Lubo oil	☐	☐
Y	N		5. Coolant oil	☐	☐
Y	N		6. Paint solvent	☐	☐
Y	N		7. Diesel fuel	☐	☐
Y	N		8. Buildings & contents	☐	☐
Y	N		9. Trailers & contents	☐	☐
Y	N		10. Greases	☐	☐
Y	N		11. Hydrogen	☐	☐
Y	N		12. Nitric acid	☐	☐
Y	N		13. Organic	☐	☐
Y	N		14. Liquids - others	☐	☐
Y	N		15. Gases - others	☐	☐
Y	N		16. Other (aerosol propellant)	☐	☐
Y	N	M. Hazardous Materials	1. Alkali metals	☐	☐
Y	N		2. Asphyxiants	☐	☐
Y	N		3. Biologics	☐	☐
Y	N		4. Carcinogens	☐	☐
Y	N		5. Corrosives	☐	☐
Y	N		6. Oxidizers	☐	☐
Y	N		7. Toxics	☐	☐
Y	N		8. Heavy metals	☐	☐
Y	N		9. Other	☐	☐
Y	N	N. Ionizing Radiation Sources	1. Fissile material	☐	☐
Y	N		2. Radioactivity equipment	☐	☐
Y	N		3. Radioactive material	☐	☐
Y	N		4. Radioactive sources	☐	☐
Y	N		5. Other	☐	☐
Y	N	P. External Events	1. Explosion	☐	☐
Y	N		2. Fire	☐	☐
Y	N		3. Other sites	☐	☐
Y	N	Q. Vehicles in Motion (external to facility)	1. Airplane	☐	☐
Y	N		2. Helicopter	☐	☐
Y	N		3. Train	☐	☐
Y	N		4. Truck/bus/car	☐	☐
Y	N		5. Other	☐	☐
Y	N	R. Natural Phenomena	1. Earthquake	☐	☐
Y	N		2. Flood	☐	☐
Y	N		3. Lightning	☐	☐
Y	N		4. Rain	☐	☐
Y	N		5. Snow, freezing weather	☐	☐
Y	N		6. Straight wind	☐	☐
Y	N		7. Dust devil	☐	☐
Y	N		8. Tornado	☐	☐
Y	N		9. Ashfall	☐	☐
Y	N		10. Range fire	☐	☐

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Table 3-1. Cold Vacuum Drying Facility Standard Industrial Hazards not Contributing to Uncontrolled Radioactive or Hazardous Material Releases. (10 sheets)

Hazard category	Hazard type	Checklist designator
Administrative Area (AA)		
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-06
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
	Pressure vessel blowdown	AA-F-06
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 (portal monitor)	AA-H-05
	Pressure vessels	AA-H-06
Explosives/pyrophorics	Scrub chemicals	AA-J-04
	Hydrogen (batteries)	AA-J-06

Table 3-1. Cold Vacuum Drying Facility Standard Industrial Hazards not Contributing to Uncontrolled Radioactive or Hazardous Material Releases. (10 sheets)

Hazard category	Hazard type	Checklist designator
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
Ionizing radiation sources	Radioactive sources (sealed sources)	AA-N-04
Transfer Corridor and Mechanical Corridor (TC)		
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
Thermal	Wiring	TC-A-15
	Electrical equipment	TC-B-02
	Furnaces/boilers/heater	TC-B-03
	Welding torch/arc	TC-B-05
Friction	Power tools	TC-B-09
	Belts	TC-C-01
	Bearings	TC-C-02
	Fans	TC-C-03
	Gears	TC-C-04
	Motors	TC-C-05
Corrosives	Power tools	TC-C-06
	Acids	TC-D-01
	Caustics	TC-D-02
	Decon solution	TC-D-04

Table 3-1. Cold Vacuum Drying Facility Standard Industrial Hazards not Contributing to Uncontrolled Radioactive or Hazardous Material Releases. (10 sheets)

Hazard category	Hazard type	Checklist designer
Kinetic - rotational	Motors	TC-E-02
	Shop equipment	TC-E-06
Kinetic - linear	Forklifts, dollies, carts	TC-F-02
	Pressure vessel blowdown	TC-F-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
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
Hazardous materials	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

Table 3-1. Cold Vacuum Drying Facility Standard Industrial Hazards not Contributing to Uncontrolled Radioactive or Hazardous Material Releases. (10 sheets)

Hazard category	Hazard type	Checklist designator
Process Bays 2-5 (PB)		
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

Table 3-1. Cold Vacuum Drying Facility Standard Industrial Hazards not Contributing to Uncontrolled Radioactive or Hazardous Material Releases. (10 sheets)

Hazard category	Hazard type	Checklist designator
Mass, gravity, height	Human effort	PB-G-01
	Stairs	PB-G-02
	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
	Other (elevated platform)	PB-G-14
Pressure - volume	Surge tanks	PB-H-02
	Gas bottles	PB-H-05
	Gas receivers	PB-H-08
	Vacuum	PB-H-09
Explosives/pyrophorics	Scrub chemicals	PB-J-04
	Hydrogen	PB-J-06
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
Process Bay 1 - Spare Bay (SB)		
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

Table 3-1. Cold Vacuum Drying Facility Standard Industrial Hazards not Contributing to Uncontrolled Radioactive or Hazardous Material Releases. (10 sheets)

Hazard category	Hazard type	Checklist designator
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
Pressure - volume	Gas bottles	SB-H-05
Explosives/pyrophorics	Scrub chemicals	SB-J-04
	Hydrogen	SB-J-06

Table 3-1. Cold Vacuum Drying Facility Standard Industrial Hazards not Contributing to Uncontrolled Radioactive or Hazardous Material Releases. (10 sheets)

Hazard category	Hazard type	Checklist designator
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
Process Water Room (PW)		
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
	Wiring	PW-A-15
Thermal	Electrical equipment	PW-B-02
	Welding torch/arc	PW-B-05
	Radioactive decay heat	PW-B-07
	Power tools	PW-B-09
	Solar	PW-B-11
Friction	Bearings	PW-C-02
	Motors	PW-C-05
	Power tools	PW-C-06
Corrosives	Acids	PW-D-01
	Caustics	PW-D-02
	Decon solution	PW-D-04

Table 3-1. Cold Vacuum Drying Facility Standard Industrial Hazards not Contributing to Uncontrolled Radioactive or Hazardous Material Releases. (10 sheets)

Hazard category	Hazard type	Checklist designator
Kinetic - rotational	Motors	PW-E-02
	Pumps	PW-E-03
	Shop equipment	PW-E-06
Kinetic - linear	Forklifts, dollies, carts	PW-F-02
	Crane loads	PW-F-05
	Pressure vessel blowdown	PW-F-06
	Other (gas bottles)	PW-F-07
Mass, gravity, height	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
	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
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

Table 3-1. Cold Vacuum Drying Facility Standard Industrial Hazards not Contributing to Uncontrolled Radioactive or Hazardous Material Releases. (10 sheets)

Hazard category	Hazard type	Checklist designator
Outside (OU)		
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 3-1. Cold Vacuum Drying Facility Standard Industrial Hazards not Contributing to Uncontrolled Radioactive or Hazardous Material Releases. (10 sheets)

Hazard category	Hazard type	Checklist designator
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
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
Ionizing radiation sources	Radiography equipment	OU-N-02
	Radioactive sources	OU-N-04

4.0 REFERENCES

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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.

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 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Administrative area AA-L-01 AA-L-02 AA-L-06 AA-L-08 AA-L-11 AA-L-16	All modes	Flammable material - packing materials, rags, paint solvent, building and contents, hydrogen from batteries, other (aerosol propellant)	Fire due to ignition	Human error Electrical shorts Propagation from other facility areas	Fire in the administrative area with the potential to propagate to the transfer corridor or the process bays.	Flames, smoke, and heat in the administrative area Smoke migration into the transfer corridor and/or process bays Loss of process control (control room) Loss of facility power Personnel injury A loss of process control or power may lead to runaway reactions within the MCOs	A loss of power results in valves positioning to a safe-shutdown condition. Interlocks in the process bays place systems in a safe-shutdown configuration upon detection of unacceptable process upsets. Local process control capability exists in each process bay. Local, manual safe-shutdown control exists in each process bay. Fire protection system present in bays (sprinklers). Outer bay walls are fire rated.	FHA* addresses combustible limits for materials stored in the process bays (limits potential for fire spread). Fire department will respond.	S3	F3	
Administrative area AA-P-01	All modes	External events - explosion	External pressure on facility walls Missile impact on facility walls	Fuel truck explosion Helium tank overpressure Forklift propane tank explosion	Impact in control room impact on personnel	Personnel injury Loss of process control/runway reactions in MCOs	Pressure vessels are built to industry standards. The facility location is remote, reducing the likelihood of occurrence. Interlocks in the process bays place systems in a safe-shutdown configuration upon detection of unacceptable process upsets.	—	S3	F2	
Administrative area AA-P-02	All modes	External events - fire	Fire external to facility introduces heat and smoke.	Human error Mechanical failure	Fire spread to the administrative area	Structural damage/failure of control room. Loss of process control/runway reactions in MCOs	Fire protection system is present (sprinklers). Interlocks in the process bays place systems in a safe shutdown configuration upon detection of unacceptable process upsets.	Fire department will respond.	S3	F2	
Administrative area AA-P-03	All modes	External events - other sites	Accident at another facility (e.g., chlorine gas release from K Basins)	Various (identified in each facility-specific SAR)	Lack of operator control in the control room.	Loss of process control/runway reactions in MCOs	Interlocks in the process bays place systems in a safe-shutdown configuration upon detection of unacceptable process upsets.	—	S3	F1	
Administrative area AA-Q-01 AA-Q-02	All modes	Vehicles in motion - airplane, helicopter									This hazard is evaluated for the facility as a whole under the heading of "outside" (OU-Q-XX).
Administrative area AA-Q-03	All modes	Vehicles in motion - train									This hazard is evaluated for the facility as a whole under the heading of "outside" (OU-Q-XX).
Administrative area AA-Q-04	All modes	Vehicles in motion - truck, bus, car									This hazard is evaluated for the facility as a whole under the heading of "outside" (OU-Q-XX).

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 2 of 27)

Location/ checklist entry	Operating sequence/ mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Conseq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Administrative area AA-R-01	All modes	Natural phenomena - earthquakes (equal to or less than the DBE)	Acceleration forces exerted on the facility	Earthquake	Collapse of administrative area	Loss of control room / main process control Loss of power to the facility Personnel injury A loss of power or process control leading to runaway reactions within the MCOs	A loss of power results in valves positioning to a safe-shutdown condition. Interlocks in the process bays place the facility in a safe-shutdown condition and prevent piping or defection of unacceptable process upsets.	Workers are trained in emergency response procedures applicable to the facility and the facility is in a safe shutdown condition.	S3	F2	The administrative area is only designed to the Uniform Building Code and is not designed to "fall away" from the process bay area. The safety-class helium system can maintain its associated system without power for approximately 48 hours (the facility has a safety class helium system). The safety class operators must monitor the status of an/or change out the helium bottle.
Administrative area AA-R-02 AA-R-03 AA-R-04 AA-R-05 AA-R-06 AA-R-07 AA-R-08 AA-R-09 AA-R-10	All modes	Natural phenomena - various									These hazards are evaluated for the facility as a whole under the heading of "outside" (OUIR-XQ).
Transfer corridor (and mechanical room) TC-F-07 TC-F-09	All modes	Linear kinetic - other (gas bottles)	Gas bottles used in portal monitors become missiles	Earthquake damage	Missile enters process bay, damaging key process systems	Runaway reaction in MCO	Gas bottles are restrained in the portal monitors in accordance with standard industrial practices. Sturdy walls between the transfer corridor and the process bays reduce the likelihood of missile penetration.	-	S3	F1	
Transfer corridor (and mechanical corridor) TC-L-01 TC-L-02 TC-L-03 TC-L-04 TC-L-05 TC-L-06 TC-L-07 TC-L-08 TC-L-09 TC-L-10 TC-L-11 TC-L-12 TC-L-13 TC-L-14 TC-L-15 TC-L-16	All modes	Flammable material - packing materials, rags, gasoline, lubricating oil, coolant residuals, paint, solvent, building and contents, grease, hydrogen, organics, hydrocarbons, liquid 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 or mechanical corridors with the potential to propagate to process work task room, or the process bays.	Flames, smoke, and heat in the transfer or mechanical corridors Smoke migration into the administrative area, process water task room, and/or process bays Loss of local or general exhaust from the facility Loss of facility power, potentially resulting in runaway reactions within the MCOs Loss of normal helium supply	Outer bay walls are fire rated. Fire protection system (sprinklers) present. Isolation dampers close and isolate the process bays upon detecting fire.	FHA addresses combustible limits for materials stored in the process bays (limits potential for fire spread). Fire department will respond. Materials are stored in accordance with applicable standards and federal safety requirements.	S3	F3	
Transfer corridor (and mechanical corridor) TC-N-03	All modes	Toxizing radiation (radioactive material)	HEPA filter loading of radioactive material	Inadvertent contamination spread	HEPA filter failure and subsequent particulate release	Radioactive particulate release through stack.	Multiple HEPA filter stages exist within the local and general exhaust system.	HEPA filters are monitored regularly and changed out according to established facility- specific procedures.	S1	F2	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 3 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Transfer corridor (and mechanical TC-P-01)	All modes	External events - explosion	External pressure on facility walls Missile impact on facility walls	Fuel tank explosion Hydium tank overpressure Forklift propane tank explosion	Impact on support systems Impact on personnel	Loss of support systems/runaway reactions in MCCs Personnel injury	Pressure vessels are built to industry standards. The facility location is remote in terms of proximity to high volume traffic routes, reducing the likelihood of occurrence. Interlocks in the process bays place systems in a safe-shutdown configuration upon detection of unacceptable process upsets.	-	S3	F2	
Transfer corridor (and mechanical TC-P-02)	All modes	External events - fire	Fire external to facility introduces heat and smoke	Human error Mechanical failure	Fire spread to the transfer or mechanical corridors	Structural damage/failure of support systems Loss of process control/runaway reactions in MCCs	Interlocks in the process bays place systems in a safe-shutdown configuration upon detection of unacceptable process upsets. Fire protection system is present (sprinklers).	Fire department will respond.	S3	F2	
Transfer corridor (and mechanical TC-P-03)	All modes	External events - other slips	Accident at transfer facility (e.g., chlorine gas release from K Basing)	Various (identified in each facility-specific SAR)	None	-	-	-	S0	F1	This hazard is evaluated for the facility as a whole under the heading of "outside" (OU-C-X0).
Transfer corridor (and mechanical TC-Q-01)	All modes	Vehicles in motion - airplane, helicopter									This hazard is evaluated for the facility as a whole under the heading of "outside" (OU-C-X0).
Transfer corridor (and mechanical TC-Q-02)	All modes	Vehicles in motion - train									This hazard is evaluated for the facility as a whole under the heading of "outside" (OU-C-X0).
Transfer corridor (and mechanical TC-Q-03)	All modes	Vehicles in motion - truck, bus, car									This hazard is evaluated for the facility as a whole under the heading of "outside" (OU-C-X0).
Transfer corridor (and mechanical TC-Q-04)	All modes	Natural phenomena - earthquake (equal to or less than the DBE)	Acceleration forces exerted on the facility	Earthquake	Collapse of transfer corridor	Loss of support systems. Normal access to process bays and the process water tank room may be blocked. Particulate release from HEPA filters on the local and general exhaust ventilation systems.	Loss of power results in valves positioning to a safe-shutdown condition. Interlocks in the process bays place systems in a safe-shutdown configuration upon detection of a seismic trip or unacceptable process upsets.	Workers are trained in emergency response procedures applicable to seismic events to place the facility in a safe-shutdown condition.	S3	F2	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 4 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Transfer corridor (and mechanical corridor) TC-R-02 TC-R-03 TC-R-04 TC-R-05 TC-R-06 TC-R-07 TC-R-08 TC-R-09 TC-R-10	All modes	Natural phenomena - various									These hazards are evaluated for the facility as a whole under the heading of "outside" (OU-R-X3).
Process bays 2-5 PB-B-02	All process modes	Thermal - electrical equipment	Room temperatures in excess of electrical equipment design limits	HVAC failure Fire	Key process system failure due to unpredictable results	Loss of engineered features, leading to runaway reactions and/or hydrogen deflagrations	High bay temperatures activate an interlock to place the MCO in a safe- shutdown condition.	HVAC control system monitors bay temperatures, and will provide an alarm requiring operator response.	S3	F3	
Process bays 2-5 PB-B-03a	Process system connections and MCO heatup	Thermal - heaters	Tempered water heated to temperatures above 50 °C	Human error, selecting 75 °C setting prematurely (see PB-B-13d) Mechanical or software failure resulting in loss of heat control	Potential for a runaway corrosion reaction in the MCO if temperatures are too high	Hydrogen generation due to resulting overpressure Potential for boiling the MCO water off and melting the spent fuel	A temperature monitor and interlock exists to remove control power to the heater and the pump. The MCO is vented by means of a relief valve and rupture disk. The relief valve and process port on the MCO contain a HEPA filter. The ventilation hood over the cask provides hydrogen dilution.	Pressure relief vent connectors are manually installed on the relief valve and rupture disk to vent any releases to the local exhaust system.	S3	F3	
Process bays 2-5 PB-B-03b	Process system connections and MCO heatup	Thermal - heaters	Tempered water heated to temperatures above 100 °C	Human error, selecting 75 °C setting prematurely (see PB-B-13d) Mechanical or software failure resulting in loss of heat control	Steam generation in the tempered water system	Release due to overpressure. HEPA filter failure and particulate release	Pressure relief valve on the heater protects against significant overpressures.	—	S1 ¹	F3	"This hazard has the potential to cause serious harm to multiple workers or even cause a fatality.
Process bays 2-5 PB-B-03c	Helium recirculation, vacuum drying	Thermal - heaters	Tempered water heated to temperatures above 50 °C	Human error, selecting 75 °C setting prematurely (see PB-B-13d) Mechanical or software failure resulting in loss of heat control Low water level in the cask annulus resulting in loss of heat control	Potential for a runaway corrosion reaction in the MCO if temperatures are too high	Hydrogen generation due to resulting overpressure. Potential for melting the spent fuel	A temperature monitor and interlock exists to remove control power to the heater and the pump. (Note: lower trip set point is routinely bypassed to enter the 75 °C mode.) The MCS will not allow out of sequence operation (e.g., it will not change the heater set point during MCO draining). The MCO is vented by means of a relief valve and rupture disk. The relief valve and process port on the MCO contain a HEPA filter. The ventilation hood over the cask provides hydrogen dilution.	Administrative controls will be established for processing state changes (from 50 °C to 75 °C to cooldown). Pressure relief vent connectors are manually installed on the relief valve and rupture disk to vent any releases to the local exhaust system.	S3	F3	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 5 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bays 2-5 PB-B-03d	50 °C pressure test	Thermal - tempered water heater	Insufficient heating of tempered water	Human error (heater turned off) Mechanical or software failure resulting in loss of heat control	Inadequate hydrogen generation rate testing may result in hydrogen reaction in the MCO when heated to 75 °C.	Hydrogen generation and potential for melting the spent fuel	Each bay contains temperature and pressure monitoring instrumentation. Alternate indications of dysyness are present, such as the residual gas analyzer, the humidity sensor in the MCO duct and the temperature differential across the condenser.	Operators must perform the 50 °C pressure test, verifying that the instrumentation and procedures are adequate for the test to be effective.	S3	F3	Sensitivity analysis is required to evaluate the effects of instrumentation and procedures volume on the 3 torr pressure test.
Process bays 2-5 PB-B-13a	Helium recirculation	Thermal - MCO contents	High fuel temperatures	Air ingress into the process system	Hydrogen ignition Rapid fuel oxidation	Overpressurization of the MCO and particulate release	The system pressure is maintained positive. Interlocks isolate the MCO and initiate a safety-class helium purge upon loss of power. Hydrogen is diluted below the lower flammability limit by helium flow. The process system was procured with a 100% helium leak rate requirement.	The process system is pressure tested prior to entering the helium recirculation mode.	S3	F3	
Process bays 2-5 PB-B-13b	Vacuum drying and 50 °C pressure test	Thermal - MCO contents	High fuel temperatures	Excessive time under vacuum due to human error, or mechanical or software failure	Potential for a runaway corrosion reaction in the MCO	Hydrogen generation and release due to resulting overpressure Potential for melting the spent fuel	An interlock on the process system monitors time under vacuum and initiates a safety-class helium purge if excessive time at vacuum is detected. The MCO is vented by means of a relief valve and rupture disk. The relief valve and process port on the MCO contain a HEPA filter. The ventilation hood over the cask provides hydrogen dilution. An interlock on the process system will bring the system to acceptable process state if the process steps do not conform to the proper sequence parameters.	Pressure relief vent connectors are manually installed on the relief valve and rupture disk to vent any release to the local exhaust system.	S3	F3	
Process bays 2-5 PB-B-13c	All process modes	Thermal - MCO contents	High fuel temperatures	Low water level in the cask annulus resulting in loss of heat control	Potential for a runaway corrosion reaction in the MCO if temperatures are too high	Hydrogen generation due to resulting overpressure Potential for melting the spent fuel	A low water level alarm for the cask annulus provides indication of loss of annulus water. Standpipe and antisiphon valves prevent drainage of annulus water. The MCO is vented by means of a relief valve and rupture disk. The relief valve and process port on the MCO contain a HEPA filter. The ventilation hood over the cask provides hydrogen dilution.	Manual operator response is required upon low water level alarm. Pressure relief vent connectors are manually installed on the relief valve and rupture disk to vent any release to the local exhaust system.	S3	F3	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 6 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bays 2-5 PB-B-13d	75 °C pressure test (includes cool down)	Thermal - MCO contents	High fuel temperatures	Excessive free water remaining in the MCO (due to inadequate 50 °C test) Water introduction from the demineralized water system or condenser leak Leaks in the process system, allowing air ingress	Potential for a runaway reaction in the MCO if temperatures are too high	Hydrogen generation and release Potential for melting the spent fuel	Entering the 75 °C mode electrically interlocks (isolates) the source of demineralized water and the condenser. The process system monitors system pressure, isolating the MCO and initiating the safety-class helium purge if system pressures rise too high. An interlock on the process system will bring the system to an acceptable process condition if the process steps do not conform to the proper sequence parameters. The MCO is vented by means of a relief valve and rupture disk. The relief valve and process port on the MCO contain a HEPA filter. The ventilation hood over the cask provides hydrogen dilution.	A 50 °C pressure test prior to the 75 °C pressure test provides assurance that conditions within the MCO will not result in runaway fuel reactions if heated to 75 °C. Pressure relief vent connectors are manually installed on the relief valve and rupture disk to vent any releases to the local exhaust system.	S3	F3	
Process bays 2-5 PB-B-13e	75 °C pressure test (includes cool down)	Thermal - MCO contents	High fuel temperatures	Vacuum established in MCO (inadvertently going back to 50 °C mode)	Higher MCO temperatures	Hydrogen generation Runaway fuel reaction	The MCS will not allow out of sequence operation. The MCO is vented by means of a relief valve and rupture disk. The relief valve and process port on the MCO contain a HEPA filter. The ventilation hood over the cask provides hydrogen dilution.	Administrative controls will be established for process state changes from 75 °C mode to 50 °C mode to increase operator and management attention of this issue.	S2	F3	
Process bays 2-5 PB-B-13f	Shipment preparation	Thermal - MCO contents	High fuel temperatures	MCO not adequately cooled (due to human error, mechanical failure, or software failure)	Higher than expected MCO temperatures.	Excessive hydrogen generation rate during shipping	The MCO is vented by means of a relief valve and rupture disk. The relief valve on the MCO contains a HEPA filter. The MCS will not allow out of sequence operation.	Operators are trained in the proper process steps for MCO preparation for shipment, including MCO cool down, cask annulus draining, and MCO inerting. These steps are verified independently as part of the normal process.	NA	F3	Valve plug leak testing may be performed at K basins and/or at the CVDF. *This consequence is a concern for the SARP* or the CSB FSAR.
Process bays 2-5 PB-B-13g	Transportation cask receipt and opening	Thermal - MCO contents	High MCO temperatures	Excess shipping time beyond established window Improper loading at fuel retrieval (either insufficient water contents or improper fuel configurations) MCO water leakage	Uncovered fuel experiences heatup	Hydrogen generation and potential for melting the spent fuel	The MCO has no leak paths (e.g., valves, seals) below the water line for water to drain from the MCO.	Fuel loading procedures will be in place at K Basins. Shipping window has been established for safe transport.	S3	F3	The time for sufficient water to boil off from a water-filled MCO to achieve runaway fuel reactions is extremely long (weeks).

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 7 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bays 2-5 PB-F-01a	Transportation cask receipt and opening	Linear kinetic - transportation cask trailer	Transporter impacts within the process bay	Human error Mechanical failure	Striking walls, personnel, outer bay doors	Personnel injury	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. Painted lines on the bay floor are present to aid in guiding the transporter in correctly. Operators direct the truck driver during entry and exit.	Vehicles are operated by qualified personnel and enter and exit the bays at a slow speed.	S1	F3	Breach of building confinement in other bays is not considered possible
Process bays 2-5 PB-F-01b	Transportation cask receipt and opening	Linear kinetic - transportation cask trailer	Transporter 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 Damage to equipment on the mezzanine and subsequent release of contaminated material	The mezzanine supports protect the process skid from damage. Painted lines on the bay floor are present to aid in guiding the transporter in correctly.	Vehicles are operated by qualified personnel and enter and exit the bays at a slow speed.	S1	F3	
Process bays 2-5 PB-F-01c	Transportation cask receipt and opening	Linear kinetic - transportation cask trailer	Transporter impacts within the process bay	Human error Mechanical failure	Cask impact against structures Striking process lines	Damage to cask Damage to process lines (e.g., drain lines from MCO), resulting in a liquid and/or particulate release into bay from MCO draining operations in other bays through the open path	The cask is qualified for all anticipated transport accidents, which bound the low-velocity impact associated with this hazard. The common drain line is elevated and therefore protected from this hazard. Only the lines on the mezzanine are vulnerable. Check valves on the drain lines provide protection from liquid releases from other bays. Process water conditioning system interlocks only allow one MCO draining operation to be in effect at a time, limiting the available liquid release volumes. (Only one isolation valve from the MCO drain line, condensate drain line, or tempered water drain line may be open at any time.) Floor drains in each bay will collect any liquid spills. Painted lines on the bay floor are present to aid in guiding the transporter in correctly.	Vehicles are operated by qualified personnel and enter and exit the bays at a slow speed.	S2	F3	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 8 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bays 2-5 PB-F-02a	Transportation cask receipt and opening	Linear kinetic - forklifts, dollies, carts	Forklift impacts within the process bay	Human error Mechanical failure	Striking walls, personnel, outer bay doors, electrical panels, demineralized water line, or chilled water line	Personnel injury Loss of power to the process bay Shear of demineralized water and/or chilled water line may overflow the 300-gal drain tank into its concrete vault pit	Bollards and other structural steel devices near the process bay doors protect the outer doors. High level alarms present in drain tank. Concrete vault pit has a large (approximately 5K gal) capacity.	Vehicles are operated by qualified personnel and enter and exit the bays at a slow speed.	S1	F3	Breach of building confinement in other bays is not considered possible
Process bays 2-5 PB-F-02b	Transportation cask receipt and opening	Linear kinetic - forklifts, dollies, carts	Forklift impacts within the process bay	Human error Mechanical failure	Striking instrument air lines, normal helium supply	Personnel injury (high pressure air, noise, flying debris) Loss of instrument air or normal helium supply could result in runaway fuel reactions and hydrogen generation due to increased MCO pressure	A loss of instrument air will cause the supply and exhaust dampers to close, all COV's to go to a closed fail position, and lead the process to a safe-shutdown condition. Low pressure alarm installed on compressed air lines. Low pressure alarm installed on normal helium line.	Vehicles are operated by qualified personnel and enter and exit the bays at a slow speed.	S3	F3	Asphyxiation would only be a possible problem if ventilation were off and the leak continued for several shifts.
Process bays 2-5 PB-F-02c	Transportation cask receipt and opening	Linear kinetic - forklifts, dollies, carts	Forklift 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 Damage to equipment on the mezzanine and subsequent release of contaminated material	—	Vehicles are operated by qualified personnel and enter and exit the bays at a slow speed.	S1	F3	
Process bays 2-5 PB-F-02d	Transportation cask receipt and opening	Linear kinetic - forklifts, dollies, carts	Forklift impacts within the process 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 the floor drains	Process water conditioning system interlocks only allow one MCO draining operation to be in effect at a time, limiting the available liquid release volumes. (Only one isolation valve from the MCO drain line, condensate drain line, or tempered water drain line may be open at any time.) Check valves on the drain lines provide protection from liquid releases from other bays. The common drain line is elevated and therefore protected from this hazard. Only the lines on the mezzanine are vulnerable. Floor drains in each bay will collect any liquid spills.	Vehicles are operated by qualified personnel and enter and exit the bays at a slow speed. The catch tank is normally maintained with sufficient free space to hold the contents of the MCO drain volume.	S2	F3	Requirements for the design to eliminate the direct communication of the floor drains is being incorporated into the design requirements document.

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 9 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Conseq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bays 2-5 PB-F-05a	Transportation cask receipt and opening	Linear kinetic - crane loads	Crane loaded with cask lid or process hood impacts within the facility	Human error Mechanical failure	Sliding walls, personnel, outer bay doors, electrical panels, demineralized water line, or chilled water line	Personnel injury Loss of power to the process bay and/or demineralized water and/or chilled water line may overflow the 300-gal drain tank into its concrete main pit	High level alarms present in drain tank. Concrete vault pit has a large (approximately 5K gal) capacity.	Crane maintenance conducted according to established procedures. Crane is operated by qualified personnel following established procedures. All lifts by crane are classified as critical lifts and follow DOE guidelines for such lifts.	S1	P2	Breach of building confinement in other bays is not considered possible
Process bays 2-5 PB-F-05b	Transportation cask receipt and opening	Linear kinetic - crane loads	Crane loaded with cask lid or process hood impacts within the facility	Human error Mechanical failure	Sliding instrument air lines, normal helium supply	Personnel injury (high pressure air, noise, and flying debris) Loss of instrument air, or normal helium supply could result in unwary fuel reactions and hydrogen generation due to increased MCO pressure	A loss of instrument air will cause the supply and exhaust dampers to close, all COVs to go to a closed fail position, and lead the process to a safe-shutdown condition. Low pressure alarm installed in compressed air lines. Low pressure alarm installed in normal helium line.	Crane maintenance conducted according to established procedures. Crane is operated by qualified personnel following established procedures. All lifts by crane are classified as critical lifts and follow DOE guidelines for such lifts.	S3	P2	Asphyxiation would only be a possible problem if ventilation were off and the leak continued for several shifts.
Process bays 2-5 PB-F-05c	Transportation cask receipt and opening	Linear kinetic - crane loads	Crane loaded with cask lid or process hood impacts within the facility	Human error Mechanical failure	Sliding the process skid or mozzarine supports	Damage to equipment on the process skid and subsequent release of contaminated material Damage to equipment on the mozzarine and subsequent release of contaminated material	Process bay structure with HEPA ventilation provides building confinement.	Crane maintenance conducted according to established procedures. Crane is operated by qualified personnel following established procedures. All lifts by crane are classified as critical lifts and follow DOE guidelines for such lifts.	S1	P2	
Process bays 2-5 PB-F-05d	Transportation cask receipt and opening	Linear kinetic - crane loads	Crane loaded with cask lid or process hood impacts within the facility	Human error Mechanical failure	Sliding process (MCO drain) lines	Damage to process lines (e.g., a liquid or particulate release into bay from MCO draining operations into the common drain line with path between the floor drains	Process water conditioning system interlocks only allow one MCO draining operation to be in effect at a time, limiting the release of liquid into the common drain line. Only one isolation valve from the MCO drain line, condensate drain line, or tempered water drain line may be open at any time.) Check valves on the drain lines provide protection from liquid releases from other bays. The common drain line is elevated and therefore protected from this hazard. Only the lines on the mozzarine are vulnerable. Floor drains in each bay will collect any liquid spills. Process bay structure with HEPA ventilation provides building confinement.	Crane maintenance conducted according to established procedures. Crane is operated by qualified personnel following established procedures. All lifts by crane are classified as critical lifts and follow DOE guidelines for such lifts.	S2	P2	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 10 of 27)

Location/ checklist entry	Operating sequence model/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Conseq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bays 2-5 PB-F-07a	All modes	Linear kinetic - other (gas bottles)	Helium gas cylinders are damaged and become missiles	Earthquake, transporter impacts, forklift impacts	Gas bottles strikes bay process systems in current bay or adjacent bays	Runaway reaction in MCO	Helium cylinders are physically anchored to the process bay wall with seismic restraints, reducing the likelihood of massive hazards from impact	The safety-class helium canisters are stored correctly in areas where the transporter cannot impact them.	S3	F2	Seismic restraints are no longer part of the CVDF design, shown here is no need for seismic restraints based on transporter placement.
Process bays 2-5 PB-F-07b	Shipping preparation	Linear kinetic - other	Trailer movement while partially restrained	Human error (one seismic restraint left hooked up)	Crack tip-over process systems	Damage to cask and MCO Damage to bay systems Damage to other bays	The cask and the MCO are designed to withstand tipping (refer to the transportation SREP).	Personnel are trained to facility- specific procedures on the removal of seismic restraints.	-	-	
Process bays 2-5 PB-G-05a	Transportation and opening	Mass, gravity, height - bins and cranes	Elevated cask lid or process hood	Human error Mechanical failure (line break)	Drop of cask lid or process hood, impacting floor or processing systems	Process system damage and subsequent release of contaminated material	Process bay structure with HEPA containment.	Crane maintenance is conducted according to established procedures.	S1	F2	
Process bays 2-5 PB-G-05b	Transportation and opening	Mass, gravity, height - bins and cranes	Elevated cask lid or process hood	Human error Mechanical failure (line break)	Drop of cask lid or process hood, impacting floor or processing systems	Damage to the cask lid or process hood, resulting in spillage	-	Crane maintenance is conducted according to established procedures.	S0	F2	
Process bays 2-5 PB-G-05c	Transportation and opening	Mass, gravity, height - elevated crane trolley	Crane trolley falling	Human error Mechanical failure	Crane hoist is connected to transportation cask and attempts to lift.	Process system damage due to resulting contamination spread	Process bay structure with HEPA containment.	Personnel are trained in the proper use of the crane and the correct procedure for processing, and follow established procedures for same.	S1	F3	
Process bays 2-5 PB-F-06a	Transportation and opening	Pressure, volume - transportation cask (MCO and cask)	Pressurized release of hydrogen from MCO	Failure to vent the transportation cask, due to human error Excess external temperature Exceeding the shipping window Improper loading at lateral lateral (either insufficient water level or incorrect fuel configuration)	Pressurized release of hydrogen from the MCO during cask lid removal, process line hook-up, or inter-ventilation action	Personnel injury due to hydrogen ignition	-	Personnel trained in the correct process steps prior to connecting process lines (including required actions for MCOs that have transport windows).	S1	F3	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 11 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bays 2-5 PB-H-06b	Process system connections and MCO heatup	Pressure, volume - pressure vessels	Release of annulus water between the MCO and the transportation cask	Human error or mechanical failure resulting in a poor connection to the tempered water system. Mechanical failure of the drain port during shipment (undiscovered until cover port is removed)	Spray or leak of basin water onto the process bay floor	Surface contamination Drainage of basin water to the process bay floor	Floor drains in the process bays collect liquid releases and route them to a drain tank. The male end of the connectors, which are less likely to have leaks than female connections, for the tempered water system connections are on the transportation cask. Process bay structure with HEPA ventilation provides building confinement.	The cask loading process uses a system to maintain clean water in the cask, minimizing the expected contamination.	S1	F3	
Process bays 2-5 PB-H-06c	Process system connections and MCO heatup	Pressure, volume - pressure vessels	Pressurized relief from MCO	MCO is isolated for pressure testing, and remains in that configuration too long (human error) Tempered water temperatures too high Helium pressure too high	Hydrogen generation and resulting pressurized release from MCO	External hydrogen deflagration resulting in personnel injury	The MCO is vented by means of a relief valve and rupture disk. The relief valve and process port on the MCO contain a HEPA filter. Process bay structure with HEPA ventilation provides building confinement.	Pressure relief vent connectors are manually installed on the relief valve and rupture disk to vent any releases to the local exhaust system. Procedures exist for preventing long process delays - fuel is not allowed to sit in this state indefinitely.	S1	F3	This hazard has the potential to cause serious harm to multiple workers or even cause a fatality.
Process bays 2-5 PB-H-06d	MCO draining with back flowing helium	Pressure, volume - pressure vessels	Pressurized MCO	Random line failure Normal helium supply is at excessive pressure Process delays Human error (isolating the MCO by manually closing the process port isolation valve) Seismic forces shear process lines (low pressure)	Pressurized release of particulate material within the MCO	Particulate release	A lack of helium flow through the MCO will trigger an interlock that will initiate a safety-class helium purge system. Process bay structure with HEPA ventilation provides building confinement. A pressure relief valve exists in the helium supply system. A HEPA-filtered pressure relief valve is located on the MCO to protect from overpressure. A rupture disk on the MCO protects the MCO from failure due to high pressure. Floor drains collect liquid spills and direct them to a catch tank.	—	S2	F3	Small leaks from the process system could go unnoticed (mistaken as the normal, expected pressure bleed to the local exhaust)
Process bays 2-5 PB-H-06e	MCO draining	Pressure, volume - pressure vessels	Pressurized MCO	High tempered water temperatures cause increased fuel reactions	Heatup of the spent nuclear fuel	Resultant runaway fuel reaction within the MCO Minor possibility of a hydrogen deflagration	A temperature interlock exists to remove control power to the heater and the pump. The process system monitors system pressure, isolating the MCO and initiating the safety-class helium purge if system pressures rise too high.	—	S3	F3	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 12 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bays 2-5 PB-H-06f	Vacuum drying	Pressure, volume - pressure vessels	Pressurized releases due to hydrogen generation	Loss of purge system path System leaks Demineralized water introduction and condenser leak	Air or water ingress causes increased hydrogen buildup and the creation of potentially flammable atmospheres.	Possibility of a hydrogen deflagration Particulate release	The process system contains an interlock that will detect a loss of purge, isolating the MCO and activating a safety-class helium purge.	The process path will be pressurized prior to beginning this process step to demonstrate its integrity.	S3	F3	
Process bays 2-5 PB-H-06g	All modes	Pressure, volume - pressure vessels	Local exhaust HEPA filter fails	Random failure	MCO exhaust is drawn through the exhaust stack	Potential particulate release outside the facility	—	—	S2	F3	
Process bays 2-5 PB-H-06h	All modes	Pressure, volume - pressure vessels	Local exhaust ventilation duct work fails Loss of local exhaust ventilation fans	Random failure	MCO exhaust is released to one or more process bays	Potential hydrogen and/or particulate release within the process bay	MCO is HEPA filtered. Local exhaust ventilation system has redundant fans.	—	S2	F3	Small leaks from the process system could go unnoticed (mistaken as the normal, expected 'pressure bleed to the local exhaust).
Process bays 2-5 PB-H-06i	Shipment preparation	Pressure, volume - pressure vessels	Hydrogen generation within MCO	Isolation of MCO over a long period (tempered water may still be present) - transportation window not yet started Process delays (such as bolts locking up as the cask lid is being replaced)	MCO pressurization before or during transportation window	Hydrogen and small amounts of fission gas may be released, possibly leading to a flammable atmosphere Radioactive particulate release Personnel contamination Personnel injury Drain lines communicate directly, such that the potential for contamination spread to other bays due to pressure differentials is possible	MCO pressure relief valve is equipped with HEPA filter. Process bay structure with HEPA ventilation provides building confinement.	The MCO isolation valves should not be closed until the MCO is cooled to an acceptable temperature. The MCO should not be isolated until the facility is prepared to begin preparations for shipment. The transportation window should begin upon either 1) tempered water removal or 2) isolation of the MCO. Recovery plans are in place for anticipated process upsets. 'Long' shipping window allows ample time (days) for recovery and reduces the potential for a pressurized release.	S2	F3	Some project information suggests that the window will not start until the cooling tempered water is removed. This is not a desirable situation.
Process bays 2-5 PB-H-06j	All processing modes	Pressure, volume - pressure vessels	Pressurized MCO	Backflow of vacuum pump oil into MCO Vacuum pump chilled water internal leak resulting in glycol contamination of MCO fuel Condenser leak on helium recirculation resulting in glycol contamination of MCO fuel	Contamination (oil/glycol) introduced into the MCO	MCO pressurization prior to the end of the shipping window due to increased radiolytic hydrogen production MCO pressurization during CSB staging or storage due to increased radiolytic hydrogen production	The vacuum pump and the condenser are designed such that no single failure can result in contamination leaks into the process system.	—	NA*	F2	*Consequence occurs at the CSB.

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 13 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bays 2-5 PB-H-08k	All modes	Pressurized MCO	Inappropriate purge gas used for processing operations	Wrong gas hooked into helium supply lines and/or air at vents filling the bottles incorrectly Purge gas mixture off of oxygen content Purge gas contaminated with oil or moisture	MCO reactions with inappropriate purge gas or contaminated helium	Hydrogen deflagration Runaway fuel reactions	-	The facility quality assurance program will include requirements that all safety and health contents are adequate for their need. Stringent operating procedures are followed for tube failure hook-up.	S3	F2	
Process bays 2-5 PB-H-08l	Transportation cask receipt and opening	Pressure, volume - pressure vessels	Uncontrolled release of water from MCO	Incorrect MCO port opened during cask receipt. (e.g., long tube)	Spray or leak of MCO contents	Spread of contamination	-	K Basins personnel are trained in the proper cask loadout procedures at K Basins.	S1	F3	
Process bays 2-5 PB-H-08m	MCO draining	Pressure, volume, pressure vessels	MCO drain flow misdirected due to plugged gector	Debris pulled into effector from floor of bay and plugging effector vent.	Liquids from PWC system ejected from relief valve and/or the rupture disk	Spread of contamination	CMAs are provided within the process bays.	Procedure is followed to stop the process operations.	S1	F3	
Process bays 2-5 PB-H-11a	Helium recirculation	Pressure, volume - other (pressurized helium recirculation system)	Pressurized normal helium supply system	Failure of first or second pressure regulator on normal helium supply	Overpressurization of the MCO with a high-pressure helium blowdown	Particulate release to the process bay	Safety relief valves installed on the helium supply. HEPA-filtered local and general exhaust ventilation system is in place. Process bay structure with HEPA ventilation provides building confinement.	-	S2	F1	A pedigree pressure relief valve may make this scenario less likely. This design may show that this is already an inherently safe system.
Process bays 2-5 PB-H-11b	All processing modes	Pressure, volume - other (pressurized process lines)	Inaccurate instrumentation and control unreliable valves	Contaminated air infiltration plus air instrument air supply	Undesirable conditions due to inaccurate instrumentation and control or unacceptable valve arrangements	Hydrogen deflagration Runaway fuel reactions	The instrumentation and control system is designed for safety and safe failure considerations. An air dryer exists on the instrument air supply. Process bay structure with HEPA ventilation provides building confinement.	-	S3	F1	
Process bays 2-5 PB-H-11c	All processing modes	Pressure, volume - other (pressurized process lines)	Overpressurization of deionitized water line, chilled water line, or tempered water line	Human error Mechanical failure	Pressurized liquid release	Low-level contamination release	Pressure controlled of the tempered water system reduces the likelihood of excessive pressure in the process lines. Drains in the floor of the process bay collect spills. HEPA-filtered local and general exhaust ventilation system is in place. Process bay structure with HEPA ventilation provides building confinement.	-	S1	F1	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 14 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bays 2-5 PB-H-11d	All modes	Pressure, volume - other (building zoned pressure boundaries)	Movement of hazardous materials across pressure boundaries	Failure to isolate bay ventilation before opening bay door (human error) Bay door opens unintentionally, ventilation restarted accidentally, isolation not adequate (human error or mechanical failure) Failure to reestablish ventilation after closing bay door	Loss of confinement zones (ventilation flow contrary to expected norms), potential differential pressure inversions Stagnant bay	Potential contamination spread if this occurs in conjunction with other accidents	An alarm is activated upon loss of confinement within a process bay.	Bay ventilation is isolated from ventilation system while the bay door is open. The bay door will be closed before processing begins.	S0	F3	This situation could exacerbate other accidents.
Process bays 2-5 PB-J-10	MCO draining (water flush of drain line)	Explosives/ pyrophorics - plutonium and uranium metal	Water introduced into MCO	MCO HEPA filter flow is insufficient to maintain adequate MCO pressure, causing the flush of the MCO drain lines to result in water additions to the MCO	Potential for reactions due to the introduction of oxygen with water in the MCO, with a resulting runaway fuel reaction	No consequences (introduction of water just after draining does not cause any effects)	Process bay structure with HEPA ventilation provides building confinement.	-	S0	F2	
Process bays 2-5 PB-J-12	Vacuum drying	Explosives / pyrophorics - other (uranium hydrides)	Uranium hydride reactions	Oxygen intrusion into the MCO	A line break in the helium recirculation line while the system is under vacuum results in air ingress into the MCO before the isolation interlocks, which sense pressurizations of the system, can react to isolate the MCO	Hydrogen generation and sudden pressurization (a pulse) due to a hydride-oxygen reaction, with resulting particulate release to the process bay	HEPA-filtered general and local exhaust ventilation systems are in place. Process bay structure with HEPA ventilation provides building confinement.	-	S3	F2	
Process bays 2-5 PB-K-03 PB-K-04 PB-K-05 PB-K-10 PB-K-15	All modes	Nuclear criticality - shipping and receiving area, filters, casks, trucks, forklifts, dollies, other (MCOs and drain lines)									These hazards are addressed in the CVDF SAR, Chapter 6.0. ⁶
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	All modes	Flammable materials - packing materials, rags, gasoline, lubricating oil, coolant oil, paint solvent, diesel fuel, buildings and contents, trailers and contents, grease, organics, 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	Structural damage or failure of process bay Damage to upper wall separating adjacent bays Smoke and heat in process bay with possible spread into adjacent bays (which may be processing MCOs) Potential for a differential pressure inversion with adjacent confinement zones	Partitions separate the processing bays (the lower two-thirds of the partition is a 2-hr rated fire wall). The transportation cask acts as a heat shield to protect the MCO from fire damage. Fire protection system is present (sprinklers).	Combustible loading will be controlled to the fire hazards analysis' limits. The transporter cab does not completely enter the process bay, reducing the potential for a liquid spill in the bay. The transporter cab is removed promptly, reducing the potential for a spill due to its limited presence. Fire department will respond.	S3	F2	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 15 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Conseq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bays 2-5 PBL-11a	Transportation cask receipt and opening	Flammable materials - hydrogen	Flammable atmosphere in local exhaust ventilation system	Cask pressure relief to local exhaust ventilation system to prevent overpressure (normal operational step)	Sufficient hydrogen to create a flammable atmosphere is present in the cask headspace when cask pressure is relieved to the local exhaust ventilation system	Hydrogen deflagration, possibly falling HEPA filters in the ventilation system	Orifice in the vent line limits the flow rate of hydrogen into the local exhaust ventilation system. Sufficient ventilation flow will dilute hydrogen concentrations below the lower flammability limit.	-	S2	F3	
Process bays 2-5 PBL-11b	MCO draining	Flammable materials - hydrogen	Flammable atmosphere in MCO	Leaks in the system allowing air ingress while draining to the process water conditioning tank	Loss of purge flow results in air ingress into the process system and/or MCO and results in the generation of flammable atmospheres	Hydrogen deflagration within the MCO and/or process system	A pressure indicator on the short tube of the MCO, as well as a flow indicator and timer in the process system, will isolate the MCO and initiate a safety-class helium purge upon detection of loss of pressure, upon detection of loss of pressure.	The MCO is purged prior to draining.	S3	F3	
Process bays 2-5 PBL-11c	MCO draining	Flammable materials - hydrogen	Flammable atmosphere in MCO	Loss of pressure due to the vacuum pump or ejector Loss of pressure due to a plugged short process tube	Air ingress into the process system and/or MCO results in the generation of flammable atmospheres	Hydrogen deflagration within the MCO and/or process system	A pressure indicator on the short tube of the MCO, as well as a flow indicator and timer in the process system, will isolate the MCO and initiate a safety-class helium purge upon detection of loss of minimum flow for minimum time.	The MCO is purged prior to draining.	S3	F3	
Process bays 2-5 PBL-11d	Helium recirculation	Flammable materials - hydrogen	Flammable atmosphere in MCO	Leaks in the system Loss of pressure due to the vacuum pump or ejector	Air ingress mixing with hydrogen resulting in flammable mixtures	Hydrogen deflagration within the MCO and/or process system	The process system has interlocks that will detect a loss of pressure and will isolate the MCO and initiate a safety-class helium purge. System is pressurized; any initial leakage will be out of the system, not in.	-	S3	F3	
Process bays 2-5 PBL-11a	Vacuum drying	Flammable materials - hydrogen	Flammable atmosphere in MCO	Leaks in the system Loss of purge path	Loss of purge flow results in air ingress into the process system and/or MCO and results in the generation of flammable atmospheres	Hydrogen deflagration within the MCO and/or process system	A pressure indicator on the short tube of the MCO, as well as a flow indicator and timer in the process system, will isolate the MCO and initiate a safety-class helium purge upon detection of loss of pressure or detection of a loss of minimum flow for minimum time.	-	S3	F3	
Process bays 2-5 PBL-11f	75 °C pressure test	Flammable materials - hydrogen	Flammable atmosphere in MCO	Leaks in the normal helium system Loss of pressure due to the vacuum pump or ejector Water introduction during 75 °C pressure test Air ingress into the system of a condenser leak Improper 50 °C test performed	Air ingress mixing with hydrogen resulting in flammable mixtures	Hydrogen deflagration within the MCO and/or process system	Entering the 75 °C pressure test mode results in electrical isolation of valves from the demineralized water system and the condenser. An interlock on the process system will bring the system to an acceptable process condition if the process steps do not conform to the proper sequence parameters. Each bay contains temperature and pressure monitoring instrumentation.	50 °C pressure rebound test is performed to demonstrate that MCO conditions meet the pre- requisites necessary to continue with the 75 °C pressure test. Operators must perform the 50 °C pressure test, verifying that the temperature and pressure are stable for the test to be effective.	S3	F3	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 16 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bays 2-5 PB-L-11g	Shipment preparation	Flammable/ materials - hydrogen	Flammable atmosphere in or around MCO and cask during transport window	Failure to inert MCO Improper seating of valve plugs with resulting air ingress Failure to cool MCO sufficiently before shipment Inadequate 75 °C pressure test Incomplete draining of cask annulus Water introduction after 75 °C pressure test from the demineralized water system or condenser leak	Hydrogen generated within MCO at start of shipping window mixes with existing air environment	Hydrogen deflagration	An interlock on the process system will bring the system to an acceptable process condition if the process steps do not conform to the proper sequence parameters. Entering the 75 °C pressure test mode results in electrical isolation of valves from the demineralized water system and the condenser.	Operators are trained in the proper process steps for MCO preparation for shipment, including MCO cooldown, cask annulus draining, and MCO inerting. These steps are verified independently as part of the normal process. The MCO isolation valves are closed as part of the shipment preparation process.	NA ^a	F3	This consequence is a concern for the SARP ^b or the CSB FSAR.
Process bays 2-5 PB-N-01 PB-N-03	MCO draining	Ionizing radiation sources - radioactive material	Failure of MCO drain line downstream from MCO draining operations in an adjacent bay	Random failure	Release of water from the MCO onto the process bay floor Release of gaseous particulate from the MCO (due to purge flow)	Particulate release	Floor drains collect liquid spills to the process bay floor and route them to a catch tank. Bay and HEPA-filtered local exhaust ventilation provide confinement.	The catch tank is normally maintained with sufficient free space to hold the contents of the MCO drain volume.	S2	F2	
Process bays 2-5 PB-N-04a	MCO draining	Ionizing radiation sources - radioactive sources	Failure to correctly perform demineralized water rinse of PWC system drain lines	Human error Inadequate procedures	Increased radiation in drain lines Valve seals damaged or not resealing	Increased risk of exposure near the line Inability to close safety-class valves Air ingress after processing due to MCO plug valve leakage	—	Routine radiation surveys are conducted. Valve qualification is performed during design verification testing. Leak check procedure is followed during the pressure rebound test.	S1	F2	
Process bays 2-5 PB-N-04b	Processing modes involving the vacuum and purging system	Ionizing radiation sources - radioactive sources	Loss of filtration in the vacuum and purging system	Random failure	Increased radiation in process lines	Increased risk of exposure near the line	—	Routine radiation surveys are conducted.	S1	F1	
Process bays 2-5 PB-P-01	All modes	External events - explosion	External pressure on bay walls Missile impact on bay walls	Fuel truck accident Helium tank overpressure Forklift propane tank explosion	Impact on process or shutdown systems Impact on personnel	Personnel injury Spread of contamination Runaway reaction within MCO	Pressure vessels are built to industry standards. The bay walls are prestressed. The facility location is remote, reducing the likelihood of occurrence.	—	S3	F2	
Process bays 2-5 PB-P-02	All modes	External events - fire	Fire external to facility introduces heat and smoke	Human error Mechanical failure	Fire spread to a process bay that is processing an MCO	Structural damage of process bay Runaway reaction in MCO	The transportation cask acts as a heat shield to protect the MCO from fire damage. Fire protection system is present (sprinklers).	Combustibles in the process bay are limited to the FHA values. Fire department will respond.	S3	F2	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 17 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Conseq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bays 2-5 PB-P-03	All modes	External events - other sites	Accident at another facility (e.g., chlorine gas release from K Basins)	Various (identified in each facility-specific SAR)	Lack of operator control of the cold vacuum drying process	Runaway reaction in MCO	Safe shutdown features activate upon detection of unacceptable process upsets.	-	S3	F1	
Process bays 2-5 PB-Q-01	All modes	Vehicles in motion - airplane, helicopter									This hazard is evaluated for the heading of "outside" (OU-Q-XX).
Process bays 2-5 PB-Q-03	All modes	Vehicles in motion - train									This hazard is evaluated for the heading of "outside" (OU-Q-XX).
Process bays 2-5 PB-Q-04	All modes	Vehicles in motion - truck, bus, car									This hazard is evaluated for the heading of "outside" (OU-Q-XX).
Process bays 2-5 PB-R-01a	All modes	Natural phenomena - earthquake	Forces exerted upon the facility due to horizontal and lateral accelerations	Earthquake causes loss of power to crane with load to impact facility systems	Transporter, cat lid, striking walls, personnel, outer bay doors, electrical panels, demineralized water line, or chilled water line	Personnel injury Loss of power to the process bay Shear of demineralized water overflow the 300-gal drain tank into its concrete vault pit	Seismic monitoring trip will place the process bay in a safe shutdown condition. Bolts protect the process bay from seismic transport movement. High-level alarms are present in drain tank. Concrete vault pit has a large (approximately 5K gal) capacity.	Transporter placement will be controlled such that expected movement from seismic events will not impact key shutdown systems.	S1	F2	
Process bays 2-5 PB-R-01b	All modes	Natural phenomena - earthquake	Forces exerted upon the facility due to horizontal and lateral accelerations	Earthquake causes loss of power to crane with load to impact facility systems	Transporter, cat lid, striking process food, or crane striking tempered water line, instrument air lines, normal helium supply	Personal injury (high pressure air, noise, flying debris) Loss of tempered water, instrument air, or normal helium supply could impact the process reaction, hydrogen generation, and particulate releases due to increased MCO pressure	Seismic monitoring trip will place the process bay in a safe shutdown condition. A loss of instrument air will cause the supply and exhaust dampers to close, all COVs to go to a fail position, and lead the process to a safe shutdown condition.	Transporter placement will be controlled such that expected movement from seismic events will not impact key shutdown systems.	S3	F2	Asphyxiation would only be a possible problem if ventilation were off and the leak continued for several shifts.
Process bays 2-5 PB-R-01c	All modes	Natural phenomena - earthquake	Forces exerted upon the facility due to horizontal and lateral accelerations	Earthquake causes transporter or process crane with load to impact facility systems	Transporter, cat lid, striking the process skid or mezzanine supports	Damage to equipment on the process skid and subsequent runaway reaction Damage to equipment on the mezzanine and subsequent runaway reaction	Seismic monitoring trip will place the process bay in a safe shutdown condition.	Transporter placement will be controlled such that expected movement from seismic events will not impact key shutdown systems.	S3	F2	Unmitigated impacts have the potential to damage key systems that are credited for risk mitigation.

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 18 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Conseq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bays 2-5 PB-R-01d	All modes	Natural phenomena - earthquake	Forces exerted upon the facility due to horizontal and lateral accelerations	Earthquake causes transporter or process damage leading to impact facility systems	Transporter, cask lid, process hood, or crane lifting process (MCO drain) lines	Damage to process lines (e.g., drain lines from MCO) resulting in loss of helium from the facility bays from MCO draining operations path MCO bulk water will drain into the outdoor catch tank.	Seismic monitoring tip will place the process bay in a safe-shutdown condition. Process water conditioning system interlocks only allow one MCO drain line to be open at a time. Limiting the available fluid release volumes. (Only one isolation valve from the MCO drain line, condensate drain line, or tempered water drain line may be open at any time.) Floor drains in each bay will collect liquid and drain them to the outdoor catch tank.	The catch tank is normally maintained with sufficient free board to accommodate the MCO drain volumes. Transporter placement will be checked to ensure that movement from seismic events will not impact key shutdown systems.	S2	F2	
Process bays 2-5 PB-R-01e	All modes	Natural phenomena - earthquake	Forces exerted upon the facility due to horizontal and lateral accelerations	Earthquake causes damage to facility utility systems	Loss of utilities (e.g., power)	Hydrogen deflagration Particulate releases Runaway/fuel reactions	Seismic monitoring tip will place the process bay in a safe-shutdown condition. Loss of power results in valves positioning to a safe-shutdown condition.	The safety-class helium system can maintain its associated system pressure and temperature for 96 hr (the capacity of the safety- class helium bottles). After this, operators must monitor the status of the helium change out the helium bottles. Key parameters (e.g., annulus water level, helium pressure) are monitored continuously, which do not require power.	S3	F2	
Process bays 2-5 PB-R-01f	All modes	Natural phenomena - earthquake	Forces exerted upon the facility due to horizontal and lateral accelerations	Earthquake causes damage to local process control systems	Loss of control within the process bays	Hydrogen deflagration Particulate releases Runaway/fuel reactions	Seismic monitoring tip will place the process bay in a safe-shutdown condition. Interlocks in the process bays place systems in a safe-shutdown condition upon detection of unacceptable process upsets.	The safety-class helium system can maintain its associated system pressure and temperature for 96 hr (the capacity of the safety- class helium bottles). After this, operators must monitor the status of the helium change out the helium bottles.	S3	F2	
Process bays 2-5 PB-R-01g	All modes	Natural phenomena - earthquake	Forces exerted upon the facility due to horizontal and lateral accelerations	Earthquake causes damage to local and general exhaust ventilation systems	Loss of ventilation	Particulate releases	Seismic monitoring tip will place the process bay in a safe-shutdown condition.	-	S2	F2	
Process bays 2-5 PB-R-01h	All modes	Natural phenomena - earthquake	Forces exerted upon the facility due to horizontal and lateral accelerations	Earthquake causes damage to process lines	Break in process lines	Hydrogen deflagration Particulate releases Runaway/fuel reactions Release of contaminated water from the vault outside the facility (sources of water are MCO drain line contents, tempered water, and demineralized water)	Seismic monitoring tip will place the process bay in a safe-shutdown condition. Most lines run within the facility containment boundary, except for the condensate drain line which returns the liquid from the outside vault back into the facility process drain line.	-	S3	F2	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 19 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bays 2-5 PB-R-02 PB-R-03 PB-R-04 PB-R-05 PB-R-06 PB-R-07 PB-R-08 PB-R-09 PB-R-10	All modes	Natural phenomena - various									These hazards are evaluated for the facility as a whole under the heading of "outside" (OUT-003).
Process bay 1 (space bay) SB-F-01a SB-F-02a	Vehicle receipt	Linear kinetic - cars, trucks, buses, forklifts, dollies, carts	Vehicle impacts within the process bay	Human error Mechanical failure	Striking walls, personnel, outer bay doors, electrical panels, demineralized water line, or chilled water line	Personnel injury Loss of power to the process bay Shear of demineralized water and/or chilled water line may overflow the 300-gal drain tank into its concrete vault pit Wall damage could result in a confinement breach, or a process upset in an adjacent bay (e.g., activating a seismic switch)	It is unclear at this time whether utilities have stubbed entries into this bay or not. Bollards and other structural steel devices near the process bay doors protect the outer doors. High-level alarms are present in drain tank. Concrete vault pit has a large (approximately 5K gall capacity).	Vehicles are operated by qualified personnel and enter and exit the bays at a slow speed.	S1	F3	Breach of building confinement in other bays is not considered possible
Process bay 1 (space bay) SB-F-01b SB-F-02b	Vehicle receipt	Linear kinetic - cars, trucks, buses, forklifts, dollies, carts	Vehicle impacts within the process bay	Human error Mechanical failure	Striking instrument air line, normal helium supply, electrical panel	Personnel injury (high pressure air, noise, flying debris) Loss of instrument air, normal helium supply, or power could result in runaway fuel reactions and hydrogen generation	It is unclear at this time whether utilities have stubbed entries into this bay or not. A loss of instrument air will cause GOVs to go to a closed fail position and lead the process to a safe-shutdown condition. Loss of power results in valves positioning to a safe-shutdown condition.	Vehicles are operated by qualified personnel and enter and exit the bays at a slow speed.	S3	F3	Asphyxiation would only be a possible problem if ventilation were off and the leak continued for several shifts.
Process bay 1 (space bay) SB-F-01c SB-F-02c	Vehicle receipt	Linear kinetic - cars, trucks, buses, forklifts, dollies, carts	Vehicle impacts within the process 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 their drains	Process water conditioning system interlocks only allow one MCO draining operation to be in effect at a time, limiting the available liquid volume. The system is designed to allow one MCO draining operation valve from the MCO drain line, or tempered condensate drain line, or tempered water drain line may be open at any time.) Check valves on the drain lines provide protection from liquid releases from other bays. The common drain line is elevated and therefore protected from this hazard. Only the lines on the mezzanine are vulnerable. Floor drains in each bay will collect any liquid spills.	Vehicles are operated by qualified personnel and enter and exit the bays at a slow speed.	S2	F3	No differential pressure sensors are shown for this bay - ventilation control (other than manual) is not possible. It is possible that the floor drain in this bay may be intentionally plugged.

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 20 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features	Engineering features	Administrative features	Consq Freq	Remarks
SB-F-07 (space bay 1)	All modes	Linear kinetic - other (Gas bottles)	Stored gas bottles become missiles	Earthquake damage, forklift impact	Missile enters process bay, Runaway reaction in MCO	Runaway reaction spread if other accidents	Sturdy walls between the process bays reduce the likelihood of missile penetration.	Gas bottles are restrained in accordance with standard industrial practices.	Bay ventilation is isolated from door is open.	S3	F-1
SB-H-11 (space bay 1)	All modes	Pressure, volume - other (building zoned pressure boundaries)	hazardous pressures across boundaries	Failure to isolate bay ventilation bore (human error)	Loss of confinement zones Potential for a differential pressure inversion with adjacent confinement zones	Potential for a differential pressure inversion with adjacent confinement zones	Sturdy walls between the process bays reduce the likelihood of missile penetration.	Bay ventilation is isolated from door is open.	S0	F3	No differential pressure sensors are identified for this bay - (manual) is not possible. The floor drains communicate within the design.
Process bay 1				Bay door opens unintentionally, accidentally, isolation ventilation restricts not adequate (human error or mechanical failure) Failure to reestablish ventilation after closing bay door	Stagnant bay inversions	Potential for a differential pressure inversion with adjacent confinement zones					
SB-L-01 (space bay 1)		Flammable materials - packing materials, e.g., gasoline, lubricating oil, coolant oil, paint solvent, cleaning fluid, grease, etc.	Ignition of material within the process bay	Human error	Fire within this process bay into adjacent bays that are processing MCCs	Structural damage or failure of process bay			Combustible loading will be conducted to the fire hazard analyst's limits.	S1	F2
SB-L-02 SB-L-03 SB-L-04 SB-L-05 SB-L-06 SB-L-07 SB-L-08 SB-L-10 SB-L-13 SB-L-14 SB-L-16		Flammable materials - packing materials, e.g., gasoline, lubricating oil, coolant oil, paint solvent, cleaning fluid, grease, etc.	Ignition of material within the process bay	Human error	Fire within this process bay into adjacent bays that are processing MCCs	Structural damage or failure of process bay			Combustible loading will be conducted to the fire hazard analyst's limits.	S1	F2

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 21 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Conseq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bay 1 (spare bay) SB-N-05	All modes	Ionizing radiation sources - radioactive material	Contaminated MCO water leaking through PVC system drain line	Human error (vehicle impact, for example) Mechanical failure (vehicle impact, for example)	MCO drain line failure	Damage to process lines (e.g., drain lines from MCO), resulting in leakage of process liquids into bay from MCO draining operations in other bays through the open path between floor drains	Process water conditioning system inletpools only allow one MCO drain line to be open at a time, limiting the available liquid release volumes. (Only one isolation valve from the MCO drain line, which is closed and locked, and valve drain line may be open at any time.) Check valves on the drain lines provide protection from liquid releases from other bays. The common drain line is elevated above the floor level to prevent hazard. Only the lines on the mezzanine are vulnerable. Floor drains in each bay will collect any liquid spills.	Vehicles are operated by qualified personnel and enter and exit the bays at a slow speed.	S2	F3	No differential pressure sensors are shown for this bay. (see manual) is not possible. It is possible that the floor drain in this bay may be intentionally plugged.
Process bay 1 (spare bay) SB-P-01	All modes	External events - explosion	External pressure on facility walls Missile impact on facility walls	Fuel truck accident Helium tank over-pressure Forklift propane tank explosion	Impact on personnel	Personnel injury	Pressure vessels are built to industry standards. The bay walls are prestressed. The facility location is remote, reducing the likelihood of occurrence.	-	S1	F2	
Process bay 1 (spare bay) SB-P-02	All modes	External events - fire	Fire external to facility introduces heat and smoke	Human error Mechanical failure	Fire spread to the spare bay	Structural damage or failure of the spare bay	Fire protection system is present (sprinklers).	Fire department will respond.	S1	F2	
Process bay 1 (spare bay) SB-P-03	All modes	External events - other sites	Accident at another facility (e.g., chlorine gas release from K Basins)	Various (identified in each facility-specific SAR)	None	-	-	-	S0	F1	
Process bay 1 (spare bay) SB-Q-01	All modes	Vehicles in motion - airplane, helicopter									This hazard is evaluated for the facility as a whole under the heading of "outside" (OU-Q-XXX).
Process bay 1 (spare bay) SB-Q-02	All modes	Vehicles in motion - train									This hazard is evaluated for the facility as a whole under the heading of "outside" (OU-Q-XXX).
Process bay 1 (spare bay) SB-Q-03	All modes	Vehicles in motion - truck, bus, car									This hazard is evaluated for the facility as a whole under the heading of "outside" (OU-Q-XXX).
Process bay 1 (spare bay) SB-Q-04	All modes	Vehicles in motion - truck, bus, car									This hazard is evaluated for the facility as a whole under the heading of "outside" (OU-Q-XXX).

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 22 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process bay 1 (spare bay) SB-R-01	All modes	Natural phenomena - earthquake (equal to or less than the DSE)	Forces exerted upon the facility by horizontal and lateral accelerations	Earthquake causes stored equipment to strike MCO drain line.	Failure of MCO drain line	Liquid release if MCO draining, operating, or receiving	High MCO drain line placement reduces the likelihood of this event. Process water conditioning system interlocks only allow one MCO draining operation to be in effect at a time, limiting the available liquid release volumes. (Only one isolation valve from the MCO drain line, condensate drain line, or tempered water drain line may be open at any time.)	-	S2	F2	
Process bays 1 (spare bay) SB-R-02 SB-R-03 SB-R-04 SB-R-05 SB-R-06 SB-R-07 SB-R-08 SB-R-08 SB-R-09 SB-R-10	All modes	Natural phenomena - various									These hazards are evaluated for the facility as a whole under the heading of "outside" (OU-R-XX).
Process water room PW-G-03	-	Mass, gravity, height - lifts and cranes	IXM replacement requires a crane lift through a roof access panel	IXM dropped due to mechanical failure of the crane or human error	IXM breaches and releases radioactive particulate or other hazardous material	Personnel injury Damage to PWC room equipment Release of contaminated material	-	-	S2	F2	Confinement would be breached in this scenario, as the roof access panel is open. *This activity should be covered under shipping accidents for the IXM.
Process water room PW-J-06 PW-L-11	-	Flammable materials - hydrogen	Hydrogen generation in receiver tanks Inadequate ventilation Hydrogen introduced during MCO draining process	Loss of local exhaust ventilation Hydrogen introduced during MCO draining process	Hydrogen generated in receiver tanks mixes with air to create a flammable environment that then ignites	Hydrogen deflagration	Room provides confinement, including general exhaust ventilation with HEPA filtration. Ventilation provides dilution of the tank headspace with air.	-	S2	F3	
Process water room PW-J-10 PW-J-12	-	Explosives / pyrophorics - plutonium and uranium metal	Air ingress into the IXM (normal operations)	Mechanical failure	IXM explosion due to air- hydride or water-hydride reactions	Breach of IXM and release of radioactive particulate	Room provides confinement, including general exhaust ventilation with HEPA filtration.	-	S2	F3	This scenario needs to be further developed, including the assumed nature of the MCO water contents and hydride reactions.
Process water room PW-K-02 PW-K-04 PW-K-15	-	Nuclear criticality - temporary storage areas, filters, tanks	Criticality within an IXM or non- critically safe storage tank due to the accumulation of fissile material	-	-	-	The PWC receiver tanks, IXMs, and filters are passively designed for criticality protection.	-	S1	F1	* This hazard has the potential to cause serious harm to multiple workers or even cause a fatality.

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 23 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process water room PM-L-01 PM-L-02 PM-L-03 PM-L-04 PM-L-05 PM-L-06 PM-L-08 PM-L-10 PM-L-11 PM-L-14 PM-L-16	-	Flammable materials - resins, gasoline, lubricating oil, coolant oil, paint solvent, cuttings and other organic wastes, organics, propane, aerosol propellant	Ignition of flammable material within the process water room	Human error Mechanical failure	Fire within the process water room, spread of fire into adjacent facility	Structural damage or failure of process water room Smoke and heat in process water room Potential for a differential pressure invasion with adjacent confinement zones	Fire protection system is present (premixed).	Combustible loading will be analysed fire hazard analyses' limits. Fire department will respond	S2	F2	
Process water room PM-M-06	-	Hazardous materials - oxidizers	Exothermic reaction oxidation of resin	Mechanical failure	DM explosion due to air- water mixture explosion	Breach of DM and release of radioactive particulate	Room provides confinement, including general exhaust ventilation with HEPA filtration.	-	S2	F3	
Process water room PM-N-01 PM-N-03	-	Ionizing radiation sources - radioactive material	Radioactive liquid in process lines and tanks	Line break Faulty process connections Pump failure Plugged detector	MCO liquid release into process water room	Radioactive particulate release	Room provides confinement, including general exhaust ventilation with HEPA filtration. Metal lining on floor will contain spills and sprays. Leak detection is present to detect spills to the floor. CMAs are present in the room.	-	S2	F3	
Process water room PM-N-04	-	Ionizing radiation sources - radioactive sources	Direct radiation	Collection of radioactive liquid within the process tanks or lines	Normal operations	Increased risk of exposure near the line	CMAs are provided within the PMVC room.	A survey program to periodically survey the process lines will be in place.	S1	F3	The room is designed to handle beaten water with a source term of 6 g per MCO. A source term greater than several hundred grams could lead to a severe design problem. This is primarily an ALARA concern.
Process water room PM-P-01	-	External events - explosion	External pressure on facility walls Missile impact on facility walls	Fuel truck accident Helium tank overpressure Facility propane tank explosion	Impact on process systems Impact on personnel	Personnel injury Spread of contamination	Pressure vessels are built to industry standards. The bay walls are prestressed. The facility location is remote, reducing the likelihood of occurrence.	-	S2	F2	
Process water room PM-P-02	-	External events - fire	Fire external to facility introduces heat and smoke	Human error Mechanical failure	Fire spread to the PMVC room	Structural damage or failure of PMVC room	Fire protection system is present (premixed).	Fire department will respond	S2	F2	
Process water room PM-P-03	-	External events - other sites	Accident at adjacent facility and chlorine gas release (from K Basin)	Various identified in facility-specific SAG	None	-	-	-	S0	F1	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 24 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Process water room PW-Q-01 PW-Q-02	-	Vehicles in motion - airplane, helicopter									This hazard is evaluated for the facility as a whole under the heading of "outside" (OU-Q-XQ).
Process water room PW-Q-03	-	Vehicles in motion - train									This hazard is evaluated for the facility as a whole under the heading of "outside" (OU-Q-XQ).
Process water room PW-Q-04	-	Vehicles in motion - truck, bus, car									This hazard is evaluated for the facility as a whole under the heading of "outside" (OU-Q-XQ).
Process water room PW-R-01	-	Natural phenomena - earthquake	Forces exerted upon the facility due to horizontal and lateral accelerations	Earthquake causes damage to process lines or tanks	Break in process lines	Particulate releases Release of contaminated water to the PWC room	Room provides confinement including general exhaust ventilation with HEPA filtration. Metal lining on floor will contain spills and sprays. Leak detection is present to detect spills to the floor. CAMS are present in the room.	-	S2	F2	
Process water room PW-R-02 PW-R-03 PW-R-04 PW-R-05 PW-R-06 PW-R-07 PW-R-08 PW-R-09 PW-R-10	All modes	Natural phenomena - various									These hazards are evaluated for the facility as a whole under the heading of "outside" (OU-R-XQ).
Outside OU-B-12	-	Thermal - cryogenic	Cold weather freezes the water within a shipping cask containing a low heat MCO	Cold weather	Water in the cask and MCO freezes	Rupture of the MCO or cask	-	The shipping window ensures that the transported cask will not remain outdoors for long.	S3	F1	"This hazard should be covered under shipping accidents in the SNRP."
Outside OU-F-01	-	Linear kinetic - cars, trains (ballast delivery truck)	Impact with the facility	Human error Mechanical failure	Truck strikes facility	None	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 cruise vehicles.	S0	F3	
Outside OU-K-02 OU-K-15	-	Nuclear effluents - temporary storage areas; other (drain tank)									These hazards are addressed in the CVDF SNF, Chapter 8.0."

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 25 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Outside OU-L-01 OU-L-02 OU-L-03 OU-L-04 OU-L-05 OU-L-06 OU-L-07 OU-L-08 OU-L-10 OU-L-13 OU-L-14 OU-L-15 OU-L-16	—	Flammable materials - packing materials, rags, gasoline, lubricating oil, coolant oil, paint solvent, diesel fuel, buildings and contents, grease, organics, gases - other, liquids - other, other (aerosol propellant)									This hazard is bounded by the range fire discussion identified under OU-R-10.
Outside OU-L-11	—	Flammable materials - hydrogen	Hydrogen generation within drain tank LW-TK-4002	Drainage of MCO water from process bay	Hydrogen is generated within the drain tank and mixes with air	Hydrogen deflagration	—	The drain tank is drained of contaminated liquid, which is then pumped back into the facility's process drain line.	S1	F2	No more particulate in the drain line than is contained in the MCO drain line holdup (~5 gal) will drain to tank
Outside OU-N-01a OU-N-03a	—	Ionizing radiation sources - radioactive material	MCO drain line failure	Random failure	A break in the MCO drain line that pumps the drain tank to the MCO drain line within the facility causes a release outside the facility	Radioactive particulate or other hazardous material release	A high-level alarm in the drain tank indicates high levels of liquid, reducing the quantity of material available for release. A level alarm in the vault provides indication of water levels to prevent overflow of the vault.	—	S2	F3	
Outside OU-N-01b OU-N-03b	—	Ionizing radiation sources - radioactive material	Contaminated water on the vault floor	Human error (normal operations step when water is clean)	Radioactive particulate resuspended from liquid pool	Release of contaminated water outside of facility	A level alarm within the vault provides indication of high levels within the vault.	The drain tank is drained of contaminated liquid, which is then pumped back into the facility's process drain line.	S2	F2	
Outside OU-P-01	—	External events - explosion	External pressure Missile impacts	Fuel truck accident Helium tank overpressure Forklift propane tank explosion	Impact on outside support systems Impact on personnel	Loss of power Loss of normal helium supply Personnel injury	Pressure vessels are built to industry standards. The facility location is remote, reducing the likelihood of occurrence.	—	S1 ¹	F2	¹ For consequences within the facility refer to the appropriate location heading (XX-P-01).
Outside OU-P-02	—	External events - fire	Fire external to facility introduces heat and smoke	Human error Mechanical failure	Fire spread to CVDF	Loss of power Loss of normal helium supply Personnel injury	—	Fire department will respond.	S1 ¹	F2 ¹	¹ For consequences within the facility refer to the appropriate location heading (XX-P-02).
Outside OU-P-03	—	External events - other sites	Accident at another facility (e.g., chlorine gas release from K Basins)	Various (identified in each facility-specific SAR)	None	—	—	—	S0	F1	
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	Runaway reaction in MCOs	—	—	S3	F0	An assessment of aircraft impact frequency for the CVDF within Chapter 1.0 of the CVDF SAR concluded that such an event is beyond extremely unlikely.

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 26 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Outside OUQ-03	-	Vehicles in motion - train	Train impact	Human error Mechanical failure	Train impacts facility structure and/or key process systems	Runaway reaction in MCOs	-	-	S3	P0*	*Trucks run parallel to building, requiring a train of cars to impact train in order to impact facility the facility.
Outside OUQ-04	-	Vehicles in motion - truck, bus, car	Impact with the facility	Human error Mechanical failure	Vehicle strikes facility	Loss of power Loss of control room functions Runaway fuel reactions	Interior bay walls are 4- to 6-in.-thick concrete. Rear bay walls are 8-in.-thick concrete. Upon loss of power, valves go to their de-energized safe-shutdown positions. Interlocks in the process bays place systems in a safe-shutdown configuration upon detection of unacceptable process upsets.	Truck drivers are trained in the proper use of onsite vehicles.	S3	P3	
Outside OUR-01	-	Natural phenomena - earthquake	Excessive ground accelerations	Natural phenomena	High acceleration forces cause structural component outside the CVDF	Loss of power Loss of normal helium supply	-	-	S1*	P2	*For consequences within the facility refer to the appropriate location heading (XX-R-01).
Outside OUR-02 OUR-04	-	Natural phenomena - flood, rain	Water introduction into facility Water intrusion into process bays	Natural phenomena	Loss of power to key facility systems	Runaway reactions within MCOs	Upon loss of power, valves go to their de-energized safe-shutdown positions. Interlocks in the process bays place systems in a safe-shutdown configuration upon detection of unacceptable process upsets. Site drainage designed to handle maximum expected precipitation.	-	S3	P2	
Outside OUR-03	-	Natural phenomena - lightning	Electrical surge	Natural phenomena	Loss of power and/or control to key facility systems	Runaway reactions within MCOs	Facility designed to NFPA 780 for lightning protection.	-	S3	P2	
Outside OUR-05	-	Natural phenomena - freezing weather	Low temperatures	Extreme cold weather	Loss of power	Runaway reactions in MCOs	Interlocks in the process bays place systems in a safe-shutdown configuration upon detection of unacceptable process upsets.	-	S3	P3	
Outside OUR-05 OUR-09	-	Natural phenomena - snow, hailfall	Excessive roof loading	Natural phenomena	Roof collapse	Personnel injury Loss of ventilation Loss of power	Building designed to withstand design basis snow loads and hailfall loads.	-	S0	P3	
Outside OUR-06 OUR-07 OUR-08	-	Natural phenomena - straight winds, dust devils, tornadoes	Pressure differentials and missile strikes	Wind and loose debris	Wall or roof collapse Missile impacts upon the facility	Loss of control Loss of power Damage to process systems Runaway reactions in MCOs	Facility structure is designed to withstand design basis loads.	Process bays are closed prior to processing operations.	S3	P2	

Table A2-1. Cold Vacuum Drying Facility Hazard Analysis. (sheet 27 of 27)

Location/ checklist entry	Operating sequence mode/ block	Hazard energy source/ material	Hazardous condition	Cause	Potential accident	Consequence	Safety features		Consq categ	Freq categ	Remarks
							Engineering features	Administrative features			
Outside OU-R-10	-	Natural phenomena - range fire	Range fire spreading to facility	Natural phenomena	Fire in the CVDF	Loss of process control Loss of facility power Personnel injury A loss of process control or power may lead to runaway reactions within the MCOs	A loss of power results in valves positioning to a safe-shutdown condition. Interlocks in the process bays place systems in a safe-shutdown configuration upon detection of unacceptable process upsets. Fire protection system is present in bays (sprinklers). Outer bay walls are fire rated.	Fire department will respond.	S3	F3	

*Sadanaga, C. T., 1996, *Preliminary Fire Hazard Analysis for the Cold Vacuum Drying System Facility*, WHC-SD-SNF-FHA-003, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

*CBO, 1994, *Uniform Building Code*, International Conference of Building Officials, Whittier, California.

*Edwards, W. S., 1997, *Safety Analysis Report for Packaging (Onsite) Multicanister Overpack Cask*, HNF-SD-TP-SARP-017, Rev. 0, Fluor Daniel Hanford, Incorporated, Richland, Washington.

*Pili-Vincens, C., 1997, *Safety Analysis Report for the Cold Vacuum Drying Facility, Phase I, Supporting Civil/Structural Construction*, HNF-SD-SNF-SAR-002, Rev. 2, Fluor Daniel Hanford, Incorporated, Richland, Washington.

*NFPA, 1995, *Lightning Protection Systems*, NFPA 780, National Fire Protection Association, Quincy, Massachusetts.

CAM = continuous air monitor.

CSB = Canister Storage Building.

CVDF = Cold Vacuum Drying Facility.

DBE = design basis earthquake.

FHA = fire hazard analysis.

FSAR = final safety analysis report.

GOV = gas-operated valve.

HEPA = high-efficiency particulate air (filter).

HVAC = heating, ventilating, and air conditioning.

KMI = ion exchange module.

MCO = multicanister overpack.

MCS = monitoring and control system.

PWC = process water conditioning.

SAR = safety analysis report.

SARP = safety analysis report for packaging.

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ATTACHMENT 3

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

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Table A3-1. Three-by-Three Likelihood and Consequence Ranking Matrix.

F3	4	7	9*
F2	2	5	8*
F1	1	3	6*
	S1	S2	S3

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 10)

Checklist designators	Hazard energy source	Hazardous condition and initiator(s)	Bin	Consequence/ frequency categories	Risk ranking
AA-L-01 AA-L-02 AA-L-06 AA-L-08 AA-L-11 AA-L-16	Flammable materials	Runaway reactions in multiple MCOs due to loss of power and process control, initiated by the ignition of flammable materials in the administrative area	Runaway reactions in multiple MCOs	S3/F3	9
AA-P-01	External events - explosion	Runaway reactions in multiple MCOs due to loss of process control, initiated by an explosion external to the facility	Runaway reactions in multiple MCOs	S3/F2	8
AA-P-02	External events - fire	Runaway reactions in multiple MCOs due to loss of process control, initiated by a fire external to the facility	Runaway reactions in multiple MCOs	S3/F2	8
AA-P-03	External events - other sites	Runaway reactions in multiple MCOs due to a loss of process control, initiated by a facility evacuation or personnel loss due to an accident at another facility (e.g., chlorine gas release from K basins)	Runaway reactions in multiple MCOs	S3/F1	6
AA-R-01	Natural phenomena - earthquake (equal to or less than the DBE)	Runaway reactions in multiple MCOs due to a loss of power and process control, initiated by an earthquake	Runaway reactions in multiple MCOs	S3/F2	8
TC-F-07	Natural phenomena - earthquake (equal to or less than the DBE)	Runaway reaction in an MCO due to missile damage within the process bay caused by a gas bottle damaged in an earthquake	Runaway reaction in an MCO	F3/F1	6
TC-L-01 TC-L-02 TC-L-03 TC-L-04 TC-L-05 TC-L-06 TC-L-08 TC-L-09 TC-L-10 TC-L-11 TC-L-13 TC-L-14 TC-L-15 TC-L-16	Flammable materials	Runaway reactions in multiple MCOs due to a loss of power and support systems initiated by the ignition of flammable materials in the transfer/mechanical corridor	Runaway reactions in multiple MCOs	S3/F3	9
TC-P-01	External events - explosion	Runaway reactions in multiple MCOs due to loss of process support systems initiated by an explosion external to the facility	Runaway reactions in multiple MCOs	S3/F2	8
TC-P-02	External events - fire	Runaway reactions in multiple MCOs due to loss of process support systems initiated by a fire external to the facility	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 2 of 10)

Checklist designators	Hazard energy source	Hazardous condition and initiator(s)	Bin	Consequence/ frequency categories	Risk ranking
TC-R-01	Natural phenomena - earthquake (equal to or less than the DBE)	Runaway reactions within multiple MCOs due to loss of process support systems initiated by an earthquake	Runaway reactions in multiple MCOs	S3/F2	8
		Hydrogen deflagrations outside multiple MCOs due to loss of process support systems initiated by an earthquake	Hydrogen deflagrations outside multiple MCOs	S2/F2	5
		Particulate releases from HEPA filters on the local and general exhaust ventilation systems initiated by an earthquake	Gaseous releases	S2/F2	5
PB-B-02	Thermal - electrical equipment	Runaway reactions in multiple MCOs due to instrumentation errors initiated by room temperatures in excess of electrical equipment design limits	Runaway reactions in multiple MCOs	S3/F3	9
		Hydrogen deflagration within an MCO due to instrumentation errors initiated by room temperatures in excess of electrical equipment design limits	Hydrogen deflagration within an MCO	S3/F3	9
		Hydrogen deflagration outside an MCO due to instrumentation errors initiated by room temperatures in excess of electrical equipment design limits	Hydrogen deflagration outside an MCO	S2/F3	7
PB-B-03a	Thermal - heaters	Hydrogen release due to tempered water temperatures rising above 50 °C during initial MCO startup	Hydrogen deflagration outside an MCO	S2/F3	7
		Runaway reaction in an MCO due to tempered water temperatures rising above 50 °C for an extended period of time	Runaway reaction in an MCO	S3/F3	9
PB-B-03c	Thermal - heaters	Hydrogen release due to tempered water temperatures rising above 50 °C or loss of cask annulus water during MCO draining, helium recirculation, or vacuum drying	Hydrogen deflagration outside an MCO	S2/F3	7
		Runaway reaction in an MCO due to tempered water temperatures rising above 50 °C or loss of cask annulus water for an extended period of time	Runaway reaction in an MCO	S3/F3	9
PB-B-03d	Thermal - tempered water heater	Hydrogen release 75 °C pressure test due to tempered water temperatures dropping below 50 °C during 50 °C pressure test	Hydrogen deflagration outside an MCO	S2/F3	7
		Runaway reaction in an MCO during 75 °C pressure test due to tempered water temperatures dropping below 50 °C during 50 °C pressure test	Runaway reaction in an MCO	S3/F3	9
PB-B-13a	Thermal - MCO contents	Pressurized release of particulate during helium recirculation due to air ingress into the process system	Gaseous releases; hydrogen deflagration outside an MCO	S2/F3	7
		Hydrogen deflagration within an MCO during helium recirculation due to air ingress into the process system	Hydrogen deflagration within an MCO	S3/F3	9

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Table A3-1. Release Characteristics for Hazardous Conditions Associated with Offsite (Site Boundary) and Onsite (Collocated Worker) Receptors. (sheet 3 of 10)

Checklist designators	Hazard energy source	Hazardous condition and initiator(s)	Bin	Consequence/frequency categories	Risk ranking
PB-B-13b	Thermal - MCO contents	Hydrogen release during vacuum drying or the 50 °C pressure test due to excessive time at vacuum	Hydrogen deflagration outside an MCO	S2/F3	7
		Runaway reaction in an MCO during vacuum drying or the 50 °C pressure test due to excessive time at vacuum	Runaway reaction in an MCO	S3/F3	9
PB-B-13c	Thermal - MCO contents	Hydrogen release during processing due to loss of annulus water	Hydrogen deflagration outside an MCO	S2/F3	7
		Runaway reaction in an MCO during processing due to loss of annulus water	Runaway reaction in an MCO	S3/F3	9
PB-B-13d	Thermal - MCO contents	Hydrogen release due to excessive free water in the MCO during the 75 °C pressure test initiated by an inadequate 50 °C pressure test or water introduction from either the demineralized water system or a condenser leak	Hydrogen deflagration outside an MCO	S2/F3	7
		Runaway reaction in an MCO due to excessive free water in the MCO during the 75 °C pressure test, initiated by an inadequate 50 °C pressure test, air ingress, or water introduction from either the demineralized water system or a condenser leak	Runaway reaction in an MCO	S3/F3	9
		Hydrogen release during the 75 °C pressure test or cooldown due to air ingress into the process system	Hydrogen deflagration outside an MCO	S2/F3	7
PB-B-13e	Thermal - MCO contents	Hydrogen release due to a vacuum being drawn from an MCO above 50 °C (e.g., inadvertently returning to 50 °C mode instead of cooldown)	Hydrogen deflagration outside an MCO	S2/F3	7
		Runaway reaction due to a vacuum being drawn from an MCO above 50 °C (e.g., inadvertently returning to 50 °C mode instead of cooldown)	Runaway reaction in an MCO	S3/F3	9
PB-B-13f	Thermal - MCO contents	Excessive hydrogen generation in an MCO due to shipment from the CVDF at higher than expected temperatures	CSB-related accident	NA/F3	0
PB-B-13g	Thermal - MCO contents	Hydrogen release from an MCO due to loss of water covering the fuel initiated by improper loading at fuel retrieval or excessive shipping time	Hydrogen deflagration outside an MCO	S2/F3	7
		Excessive hydrogen generation in an MCO due to loss of water covering the fuel initiated by improper loading at fuel retrieval or excessive shipping time	Hydrogen deflagration inside an MCO	S3/F3	9
		Runaway fuel reaction in an MCO due to an extended period of time without water covering the fuel initiated by improper loading at fuel retrieval or excessive shipping time	Runaway fuel reaction in an MCO	S3/F3	9

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Table A3-1. Release Characteristics for Hazardous Conditions Associated with Offsite (Site Boundary) and Onsite (Collocated Worker) Receptors. (sheet 4 of 10)

Checklist designators	Hazard energy source	Hazardous condition and initiator(s)	Bin	Consequence/frequency categories	Risk ranking
PB-F-01c	Linear kinetic - transportation cask trailer	Release of contaminated liquid into a process bay due to a transporter impact with MCO drain lines	Liquid releases	S2/F3	7
PB-F-02b	Linear kinetic - forklifts, dollies, carts	Excessive hydrogen generation within multiple MCOs due to loss of instrument air or helium supply initiated by a forklift/dolly/cart impact Hydrogen deflagration outside multiple MCOs due to loss of instrument air or helium supply initiated by a forklift/dolly/cart impact	Hydrogen deflagration within multiple MCOs Hydrogen deflagration outside multiple MCOs	S3/F3 S2/F3	9 7
		Runaway reaction in multiple MCOs due to a loss of instrument air or helium supply initiated by a forklift/dolly/cart impact	Runaway reactions in multiple MCOs	S3/F3	9
PB-F-02d	Linear kinetic - forklifts, dollies, carts	Release of contaminated liquid into a process bay due to a forklift/dolly/cart impact with MCO drain lines	Liquid releases	S2/F3	7
PB-F-05b	Linear kinetic - crane loads	Excessive hydrogen generation within multiple MCOs due to loss of instrument air or helium supply initiated by a crane impact while loaded with a cask lid or process hood Hydrogen deflagration outside multiple MCOs due to loss of instrument air or helium supply initiated by a crane impact while loaded with a cask lid or process hood	Hydrogen deflagration within multiple MCOs Hydrogen deflagration outside multiple MCOs	S3/F2 S2/F3	8 7
		Runaway reaction in multiple MCOs due to a loss of instrument air or helium supply initiated by a crane impact while loaded with a cask lid or process hood	Runaway reactions in multiple MCOs	S3/F2	8
PB-F-05d	Linear kinetic - crane loads	Release of contaminated liquid into a process bay due to a crane impact with MCO drain lines while loaded with a cask lid or process hood	Liquid releases	S2/F2	5
PB-F-07a	Linear kinetic - other	Excessive hydrogen generation within an MCO due to process bay damage from a gas bottle missile Runaway reaction within an MCO due to process bay damage from a gas bottle missile	Hydrogen deflagration within an MCO Runaway reaction in an MCO	S3/F2 S3/F2	9 9
PB-H-06d	Pressure, volume - pressure vessels	Pressurized release of particulate from an MCO initiated by excessive pressure in the helium supply, inadvertent MCO isolation, or steaming forces on the process lines	Gaseous releases; hydrogen deflagration outside an MCO	S2/F3	7
PB-H-06a	Pressure, volume - pressure vessels	Hydrogen release from an MCO during draining due to excessive tempered water temperatures Runaway reaction in an MCO during draining due to excessive tempered water temperatures	Hydrogen deflagration outside an MCO Runaway reaction in an MCO	S2/F3 S3/F3	7 9

Table A3-1. Release Characteristics for Hazardous Conditions Associated with Offsite (Site Boundary) and Onsite (Collocated Worker) Receptors. (sheet 5 of 10)

Checklist designators	Hazard energy source	Hazardous condition and initiator(s)	Bin	Consequence/ frequency categories	Risk ranking
PB-H-06f	Pressure, volume - pressure vessels	Pressurized releases from an MCO during vacuum drying initiated by air or water ingress	Gaseous releases; hydrogen deflagration outside an MCO	S2/F3	7
		Excessive hydrogen generation within an MCO during vacuum drying initiated by air or water ingress	Hydrogen deflagration within an MCO	S3/F3	9
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 releases	S2/F3	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 releases	S2/F3	7
PB-H-06i	Pressure, volume - pressure vessels	Hydrogen generation within MCO due to excessive delays in shipping	Gaseous releases; hydrogen deflagration outside an MCO	S2/F3	7
PB-H-06j	Pressure, volume - pressure vessels	Excessive hydrogen generation within an MCO due to contaminants (e.g., oil, glycol) within the MCO	CSB-related accident	NA/F2	0
PB-H-06k	Pressurized MCO	Hydrogen release from an MCO due to inappropriate purge gas	Hydrogen deflagration outside an MCO	S2/F2	5
		Excessive hydrogen generation within an MCO due to inappropriate purge gas	Hydrogen deflagration within an MCO	S3/F2	8
		Runaway fuel reaction within an MCO due to inappropriate purge gas	Runaway reaction in an MCO	S3/F2	8
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	Gaseous releases	S2/F1	3
PB-H-11b	Pressure, volume - other (pressurized process lines)	Hydrogen release from an MCO initiated by a loss of process control due to contamination within the continuous air/instrument air supply	Hydrogen deflagration outside an MCO	S2/F1	3
		Excessive hydrogen generation within an MCO initiated by a loss of process control due to contamination within the continuous air/instrument air supply	Hydrogen deflagration within an MCO	S3/F1	6
		Runaway reaction within an MCO initiated by a loss of process control due to contamination within the continuous air/instrument air supply	Runaway reaction within an MCO	S3/F1	6
PB-J-12	Explosives / pyrophorics - other (uranium hydrides)	Uranium hydride reactions within an MCO during vacuum drying due to air ingress	Gaseous releases	S2/F2	5
			Hydrogen deflagration within an MCO	S3/F2	8

Table A3-1. Release Characteristics for Hazardous Conditions Associated with Offsite (Site Boundary) and Onsite (Collocated Worker) Receptors. (sheet 6 of 10)

Checklist designators	Hazard energy source	Hazardous condition and initiator(s)	Bin	Consequence/ frequency categories	Risk ranking
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	Hydrogen releases from multiple MCOs initiated by the ignition of flammable material within the process bays Excessive hydrogen generation within multiple MCOs initiated by the ignition of flammable material within the process bays Runaway reactions in multiple MCOs initiated by the ignition of flammable material within the process bays	Hydrogen deflagration outside multiple MCOs Hydrogen deflagrations within multiple MCOs Runaway reactions in multiple MCOs	S2/F2 S3/F2 S3/F2	5 8 8
PB-L-11a	Flammable materials - hydrogen	Flammable atmosphere developing in local exhaust ventilation system due to cask venting upon receipt	Hydrogen deflagration outside an MCO	S2/F3	7
PB-L-11b	Flammable materials - hydrogen	Flammable atmosphere developing within MCO during MCO draining due to air ingress into the process system from system leaks	Hydrogen deflagration outside an MCO Hydrogen deflagration within an MCO	S2/F3 S3/F3	7 9
PB-L-11c	Flammable materials - hydrogen	Flammable atmosphere developing within MCO during MCO draining due to air ingress from a loss of system pressure	Hydrogen deflagration outside an MCO Hydrogen deflagration within an MCO	S2/F3 S3/F3	7 9
PB-L-11d	Flammable materials - hydrogen	Flammable atmosphere developing within MCO during helium recirculation due to air ingress into the process system from system leaks or a loss of system pressure	Hydrogen deflagration outside an MCO Hydrogen deflagration within an MCO	S2/F3 S3/F3	7 9
PB-L-11e	Flammable materials - hydrogen	Flammable atmosphere developing within MCO during vacuum drying due to air ingress into the process system from system leaks or a loss of a purge path	Hydrogen deflagration outside an MCO Hydrogen deflagration within an MCO	S2/F3 S3/F3	7 9
PB-L-11f	Flammable materials - hydrogen	Flammable atmosphere developing within MCO during 75 °C pressure test due to air ingress, water ingress, or inadequate pretesting	Hydrogen deflagration outside an MCO Hydrogen deflagration within an MCO	S2/F3 S3/F3	7 9
PB-L-11g	Flammable materials - hydrogen	Flammable atmosphere developing within cask-MCO during transport window due to a failure to inert, improper valve plug seating, inadequate processing, or water introduction after the 75 °C pressure test	CSB-related accident	NA/F3	0
PB-N-01 PB-N-03	Ionizing radiation sources - fissile/radioactive material	Release of contaminated liquid into a process bay due to a crane/transporter/forklift impact with MCO drain lines	Liquid releases	S2/F2	5

Table A3-1. Release Characteristics for Hazardous Conditions Associated with Offsite (Site Boundary) and Onsite (Collocated Worker) Receptors. (sheet 7 of 10)

Checklist	Hazard energy source	Hazardous condition and initiator(s)	Bin	Consequence/frequency categories	Risk ranking
PB-P-01	External events - explosion	Failure of key process systems within the process bays initiated by an external explosion with resulting pressure forces and missile impacts	Hydrogen deflagration within multiple MCOs; runaway reactions within multiple MCOs	S3/F2	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	Multiple liquid releases; hydrogen deflagration outside multiple MCOs	S2/F2	5
PB-P-03	External events - other sites	Loss of local process control due to lack of operators results in multiple runaway reactions in MCOs initiated by an accident at another facility (e.g., chlorine gas release from K basins)	Runaway reactions in multiple MCOs	S3/F1	6
PB-R-01b	Natural phenomena - earthquake	Pressurized release of particulate from an MCO due to loss of instrument air, tempered water lines, or helium supply initiated by earthquake forces	Hydrogen deflagration within multiple MCOs	S3/F2	8
PB-R-01c	Natural phenomena - earthquake	Runaway reaction in multiple MCOs due to a loss of instrument air, tempered water lines, or helium supply initiated by earthquake forces	Runaway reactions in multiple MCOs	S3/F2	8
PB-R-01d	Natural phenomena - earthquake	Damage to process equipment results in runaway reactions within multiple MCOs initiated by earthquake forces	Liquid releases	S2/F2	5
PB-R-01e	Natural phenomena - earthquake	Loss of power within several process bays due to earthquake forces	Multiple gaseous releases; hydrogen deflagration outside multiple MCOs	S2/F2	5
PB-R-01f	Natural phenomena - earthquake	Loss of local process control within several process bays due to earthquake forces	Multiple gaseous releases; hydrogen deflagration outside multiple MCOs	S2/F2	5
PB-R-01f	Natural phenomena - earthquake	Loss of local process control within several process bays due to earthquake forces	Hydrogen deflagration within multiple MCOs; 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 10)

Checklist designators	Hazard energy source	Hazardous condition and initiator(s)	Bin	Consequence/ frequency categories	Risk ranking
PB-R-01g	Natural phenomena - earthquake	Loss of general and local exhaust ventilation due to earthquake forces	Gaseous releases	S2/F2	5
PB-R-01h	Natural phenomena - earthquake	Failure of process lines within process bays due to earthquake forces	Multiple liquid releases; multiple gaseous releases; hydrogen deflagration outside multiple MCOs Hydrogen deflagration within multiple MCOs; runaway reactions in multiple MCOs	S2/F2 S3/F2	5 8
SB-F-01b SB-F-02b	Linear kinetic - cars, trucks, buses, forklifts, dollies, carts	Hydrogen release from an MCO due to loss of instrument air, power, or helium supply initiated by a truck/forklift impact Excessive hydrogen generation within multiple MCOs due to loss of instrument air, power, or helium supply initiated by a truck/forklift impact Runaway reaction in multiple MCOs due to a loss of instrument air, power, or helium supply initiated by a truck/forklift impact	Hydrogen deflagration outside multiple MCOs Hydrogen deflagration within multiple MCOs Runaway reactions in multiple MCOs	S2/F3 S3/F3 S3/F3	7 9 9
SB-F-01c SB-F-02c	Linear kinetic - cars, trucks, buses, forklifts, dollies, carts	Release of contaminated liquid into a process bay due to a truck/forklift impact with MCO drain lines	Liquid releases	S2/F3	7
SB-F-07	Natural phenomena - earthquake (equal to or less than the DBE)	Runaway reaction in an MCO due to missile damage within the process bay caused by a gas bottle damaged in an earthquake	Runaway reaction in an MCO	S3/F1	6
SB-N-03	Ionizing radiation sources - radioactive material	Release of contaminated liquid into a process bay due to a truck/forklift impact with MCO drain lines	Liquid releases	S2/F3	7
SB-R-01	Natural phenomena - earthquake (equal to or less than the DBE)	Gas bottles in the spare process bay becoming missiles due to damage from earthquake forces damaging key equipment in an adjacent process bay	Runaway reaction in an MCO	S3/F2	8
PW-G-03	Mass, gravity, height - lifts and cranes	Breach of IXM and release of radioactive particulate due to a crane drop during replacement	Gaseous releases	S2/F2	5
PW-J-06 PW-L-11	Flammable materials - hydrogen	Excessive hydrogen generation in PWC room receiver tanks due to inadequate ventilation	Hydrogen deflagration outside an MCO	S2/F3	7
PW-J-10 PW-J-12	Explosives / Pyrophorics - plutonium and uranium metal	Breach of IXM and release of radioactive particulate due to air-hydride or water-hydride reactions	Gaseous releases	S2/F3	7

Table A3-1. Release Characteristics for Hazardous Conditions Associated with Offsite (Site Boundary) and Onsite (Collocated Worker) Receptors. (sheet 9 of 10)

Checklist designators	Hazard energy source	Hazardous condition and initiator(s)	Bin	Consequence/ frequency categories	Risk ranking
PW-L-01 PW-L-02 PW-L-03 PW-L-04 PW-L-05 PW-L-06 PW-L-08 PW-L-10 PW-L-13 PW-L-14 PW-L-16	Flammable materials	Failure of IXM, process lines, and tanks within the PWC room initiated by the ignition of flammable materials within the PWC room	Gaseous releases; liquid releases	S2/F2	5
PW-M-06	Hazardous materials - oxidizers	Breach of IXM and release of radioactive particulate due to air-hydride or water-hydride reactions initiated by the exothermic degradation of resin	Gaseous releases	S2/F3	7
PW-N-01 PW-N-03	Ionizing radiation sources - fissile/radioactive material	Failure of process lines and tanks within the PWC room initiated by faulty process connections, pump failures, etc.	Liquid releases	S2/F3	7
PW-P-01	External events - explosion	Failure of IXM, process lines, and tanks within the PWC room initiated by an external explosion with resulting pressure forces and missile impacts	Gaseous releases; liquid releases	S2/F2	5
PW-P-02	External events - fire	Failure of IXM, process lines, and tanks within the PWC room initiated by an external fire spreading to the facility	Gaseous releases; liquid releases	S2/F2	5
PW-R-01	Natural phenomena - earthquake	Failure of IXM, process lines, and tanks within the PWC room initiated by earthquake forces	Gaseous releases; liquid releases	S2/F2	5
OU-B-12	Thermal - cryogenic	Rupture of low heat cask-MCO due to freezing initiated by cold weather	Liquid releases	S3/F1	6
OU-L-01 OU-L-02 OU-L-03 OU-L-04 OU-L-05 OU-L-06 OU-L-07 OU-L-08 OU-L-10 OU-L-13 OU-L-14 OU-L-15 OU-L-16	Flammable materials	Runaway reactions in multiple MCOs due to a loss of facility power initiated by an external fire	Runaway reactions in multiple MCOs	S3/F3	9
OU-N-01a OU-N-03a	Ionizing radiation sources - radioactive material	Release of contaminated liquid outside of the facility due to failure of the MCO drain line feeding into the facility from the drain tank	Liquid releases	S2/F3	7

Table A3-1. Release Characteristics for Hazardous Conditions Associated with Offsite (Site Boundary) and Onsite (Collocated Worker) Receptors. (sheet 10 of 10)

Checklist designators	Hazard energy source	Hazardous condition and initiator(s)	Bin	Consequence/frequency categories	Risk ranking
OU-N-01b OU-N-03b	Ionizing radiation sources - radioactive material	Release of contaminated liquid outside of the facility due to inadvertent drainage of contaminated drain tank liquids to vault floor	Liquid releases	S2/F2	5
OU-Q-04	Vehicles in motion - truck/bus/car	Runaway reactions in multiple MCOs due to a loss of facility power or process control initiated by vehicle impacts with the facility	Runaway reactions in multiple MCOs	S3/F3	9
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
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.
 CVDF = Cold Vacuum Drying Facility.
 DBE = design basis earthquake.
 HEPA = high-efficiency particulate air (filter).
 IXM = ion exchange module.
 MCO = multicanister overpack.
 PWC = process water conditioning.

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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. (sheet 1 of 6)

Candidate accident	Consequence/ frequency categories	Risk ranking	Checklist designators	
MCO thermal runaway reactions				
Runaway reaction in MCO due to internal process upsets of key parameters (MCO pressure, helium flow, tempered water temperature, tempered water liquid level) ^a	S3/F3	9	AA-P-01 AA-P-03 TC-F-07 TC-P-01 PB-B-13c ^a PB-B-13d PB-F-07a PB-H-06e PB-P-01	PB-P-03 SB-F-07 OU-Q-04 OU-R-03 OU-R-06 OU-R-07 OU-R-08 OU-R-09 OU-R-10
Runaway reaction in MCO due to instrumentation failure	S3/F3	9	PB-B-02	PB-H-11b
Runaway reaction in MCO during heatup to 75 °C due to excessive water in MCO	S3/F3	9	PB-B-03a PB-B-03c	PB-B-03d PB-B-13d
Runaway reaction in heated MCO due to introduction of water	S3/F3	9	PB-B-13d	
Runaway reaction in MCO due to inadequate heat transfer within MCO	S3/F3	9	PB-B-13b	PB-B-13e

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Table A4-1. Binned Listing of Candidate Accidents Sorted by Risk Ranking. (sheet 2 of 6)

Candidate accident	Consequence/ frequency categories	Risk ranking	Checklist designators	
Runaway reaction in MCO due to facility fire	S3/F3	9	AA-L-01 PB-L-05 AA-L-02 PB-L-06 AA-L-06 PB-L-07 AA-L-08 PB-L-08 AA-L-11 PB-L-09 AA-L-16 PB-L-10 AA-P-02 PB-L-13 TC-L-01 PB-L-14 TC-L-02 PB-L-15 TC-L-03 PB-L-16 TC-L-04 PB-P-02 TC-L-05 OU-L-01 TC-L-06 OU-L-02 TC-L-08 OU-L-03 TC-L-10 OU-L-04 TC-L-11 OU-L-05 TC-L-13 OU-L-06 TC-L-14 OU-L-07 TC-L-15 OU-L-08 TC-L-16 OU-L-10 TC-P-02 OU-L-13 PB-L-01 OU-L-14 PB-L-02 OU-L-15 PB-L-03 OU-L-16 PB-L-04	
Runaway reaction in MCO due to delivery of an out-of-specification MCO to the CVDF	S3/F3	9	PB-B-13g	
Runaway reaction in MCO due to loss of support utilities	S3/F3	9	PB-F-02b OU-R-04 PB-F-05b OU-R-05 SB-F-01b OU-R-06 SB-F-02b OU-R-07 OU-Q-04 OU-R-08 OU-R-02 OU-R-09 OU-R-03 OU-R-10	
Runaway reaction in MCO due to contamination of helium supply	S3/F2	8	PB-H-06k	
Runaway reaction in MCO due to seismic event	S3/F2	8	AA-R-01 PB-R-01e TC-R-01 PB-R-01f PB-R01b PB-R-01h PB-R-01c SB-R-01	

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Table A4-1. Binned Listing of Candidate Accidents Sorted by Risk Ranking. (sheet 3 of 6)

Candidate accident	Consequence/ frequency categories	Risk ranking	Checklist designators	
MCO internal hydrogen explosions				
Hydrogen deflagration within an MCO due to process upsets of key parameters (MCO pressure, helium flow, tempered water temperature, tempered water liquid level) ^a	S3/F3	9	PB-B-13a PB-F-07a PB-H-06f ^a PB-L-11b PB-L-11c	PB-L-11d PB-L-11e PB-L-11f PB-P-01 PB-P-02
Hydrogen deflagration within an MCO due to instrumentation failure	S3/F3	9	PB-B-02	PB-H-11b
Hydrogen deflagration within an MCO during heatup to 75 °C due to excessive water in MCO	S3/F3	9	PB-L-11f	
Hydrogen deflagration within an MCO due to facility fire	S3/F3	9	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
Hydrogen deflagration within a heated MCO due to introduction of water	S3/F3	9	PB-H-06f	PB-L-11f
Hydrogen deflagration within an MCO due to delivery of an out-of-specification MCO to the CVDF	S3/F3	9	PB-B-13g	
Hydrogen deflagration within an MCO due to loss of support utilities	S3/F3	9	PB-F-02b PB-F-05b	SB-F-01b SB-F-02b
Hydrogen deflagration within an MCO due to hydride reactions	S3/F2	8	PB-J-12	
Hydrogen deflagration within an MCO due to contamination of helium supply	S3/F2	8	PB-H-06k	
Hydrogen deflagration within an MCO due to seismic events	S3/F2	8	TC-R-01 PB-R-01b PB-R-01e	PB-R-01f PB-R-01h
MCO external hydrogen explosions				
Hydrogen deflagration outside an MCO due to mixture of hydrogen and air in the local exhaust ventilation system ^a	S2/F3	7	PB-L-11a ^a	
Hydrogen deflagration outside an MCO due to delivery of an out-of-specification MCO to the CVDF	S2/F3	7	PB-B-13g	PB-H-06i

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Table A4-1. Binned Listing of Candidate Accidents Sorted by Risk Ranking. (sheet 4 of 6)

Candidate accident	Consequence/ frequency categories	Risk ranking	Checklist designators	
Hydrogen deflagration outside an MCO during heatup to 75 °C due to excessive water in MCO	S2/F3	7	PB-B-03d PB-B-13d	PB-L-11f
Hydrogen deflagration outside an MCO due to instrumentation failure	S2/F3	7	PB-B-02	PB-H-11b
Hydrogen deflagration outside an MCO due to internal process upsets of key parameters (MCO pressure, helium flow, tempered water temperature, tempered water liquid level)	S2/F3	7	PB-B-03a PB-B-03c PB-B-13a PB-B-13c PB-H-06d PB-H-06e PB-H-06f	PB-L-11b PB-L-11c PB-L-11d PB-L-11e PB-L-11f PB-P-01
Hydrogen deflagration outside a heated MCO due to introduction of water	S2/F3	7	PB-H-06f	PB-L-11f
Hydrogen deflagration in PWC room receiver tanks due to inadequate ventilation	S2/F3	7	PW-J-06	PW-L-11
Hydrogen deflagration outside an MCO due to inadequate heat transfer within the MCO	S2/F3	7	PB-B-13b	PB-B-13e
Hydrogen deflagration outside an MCO due to loss of support utilities	S2/F3	7	PB-F-02b PB-F-05b	SB-F-01b SB-F-02b
Hydrogen deflagration outside an MCO due to facility fire	S2/F2	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 PB-P-02
Hydrogen deflagration outside an MCO due to contamination of helium supply	S2/F2	5	PB-H-06k	
Hydrogen deflagration outside an MCO due to seismic events	S2/F2	5	TC-R-01 PB-R-01b PB-R-01e	PB-R-01f PB-R-01h
Gaseous releases				
Pressurized release of particulate due to internal process upsets of key parameters (MCO pressure, helium flow, tempered water temperature, tempered water liquid level)*	S2/F3	7	PB-B-13a PB-H-06d*	PB-H-06f

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Table A4-1. Binned Listing of Candidate Accidents Sorted by Risk Ranking. (sheet 5 of 6)

Candidate accident	Consequence/ frequency categories	Risk ranking	Checklist designators	
Pressurized release of particulate due to facility fire	S2/F3	7	PW-L-01 PW-L-02 PW-L-03 PW-L-04 PW-L-05 PW-L-06	PW-L-08 PW-L-10 PW-L-13 PW-L-14 PW-L-16 PW-P-02
Pressurized release of particulate due to introduction of water into heated MCO	S2/F3	7	PB-H-06f	
Pressurized release of particulate due to exhaust ventilation system failure	S2/F3	7	PB-H-06g	PB-H-06h
Pressurized release of particulate due to delivery of an out-of-specification MCO to the CVDF	S2/F3	7	PB-H-06i	
Pressurized release of particulate due to hydride reactions	S2/F3	7	PB-J-12 PW-J-10	PW-J-12 PW-M-06
Pressurized release of particulate due to seismic events	S2/F2	5	TC-R-01 PB-R-01b PB-R-01e PB-R-01f	PB-R-01g PB-R-01h PW-R-01
Breach of IXM and release of particulate due to impact	S2/F2	5	PW-G-03	PW-P-01
Pressurized release of particulate due to excessive helium supply pressure	S2/F1	3	PB-H-11a	
Liquid releases				
Sprays ^a	S2/F3	7	PW-L-01 PW-L-02 PW-L-03 PW-L-04 PW-L-05 PW-L-06 PW-L-08 PW-L-10	PW-L-13 PW-L-14 PW-L-16 PW-N-01 ^a PW-N-03 ^a PW-P-01 PW-P-02 PW-R-01
Spills inside the CVDF	S2/F3	7	PB-F-01c PB-F-02d PB-F-05d PB-N-01 PB-N-03 PB-P-01	PB-P-02 PB-R-01d PB-R-01h SB-F-01c SB-F-02c SB-N-03

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Table A4-1. Binned Listing of Candidate Accidents Sorted by Risk Ranking. (sheet 6 of 6)

Candidate accident	Consequence/ frequency categories	Risk ranking	Checklist designators
Spills outside the CVDF	S2/F3	7	OU-N-01a OU-N-03a OU-N-01b OU-N-03b
Rupture of low heat cask-MCO due to freezing weather	S3/F1	6	OU-B-12
CSB-related accidents ^b			
MCO shipped at excessive temperature	NA/F3	—	PB-B-13f
MCO shipped with excessive water content	NA/F2	—	PB-H-06j
MCO shipped with air contents	NA/F3	—	PB-L-11g

^aChosen as a representative and bounding accident for further accident analysis development.

^bAlthough there are no consequences for these accidents at the CVDF, these hazards will be evaluated for the FSAR as the CVDF process is better defined.

CSB = Canister Storage Building.
CVDF = Cold Vacuum Drying Facility.
FSAR = final safety analysis report.
IXM = ion exchange module.
MCO = multicanister overpack.
PWC = process water conditioning.

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