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ENGINEERING DATA TRANSMITTAL

Page 1 of 1

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17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)					
(G) Reason	(H) Disp	(J) Name	(K) Signature MSIN	(L) Date	(M) (G) Reason
1	1	Design Authority Carol C Pitkoff			
		Design Agent			
		Cog. Eng.			
1	1	Cog. Mgr. Andy McNeil			
		QA			
		Safety			
		Env.			
18. Signature of EDT Date Originator		19. Authorized Representative Date for Receiving Organization		20. Design Authority/ Date Cognizant Manager	
21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments					

Cold Vacuum Drying Facility: Phase I FMEA/FMECA Session Report

Carol Pitkoff

DE&S Hanford, Inc., Richland, WA 99352

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

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Abstract: Report of the Failure Modes, Effect, and Criticality Analysis performed for the Cold Vacuum Drying process equipment and facility. The report summerized potential problems with the designs, design requirments doument , and other baseline documentation.

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SPENT NUCLEAR FUEL COLD VACUUM DRYING FACILITY: PHASE I FMEA/FMECA SESSION

AUGUST 1997

Provided for:

**Carol C. Pitkoff
DE&S Hanford Inc.
Richland, Washington**

Facilitated By:

**Richard A. Harrington, CVS
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HNLF-2576
Rev D

TABLE OF CONTENTS

Section 1 - Executive Summary	1
Section 2 - Project Background and Introduction	3
Section 3 - Conduct of Session	4
Appendices	
A. Scope Statement Sheet	
B. Subsystem Final Pass, Actions, Potential Requirement and Design Changes	
C. Failure Modes, Effects and Criticality Analysis, Phase I Matrices	
D. Session Flipcharts	

SECTION 1

EXECUTIVE SUMMARY

The mission of the Spent Nuclear Fuel (SNF) Project is to remove the fuel currently located in the K-Basins 100 Area to provide safe handling and interim storage of the fuel. The spent nuclear fuel will be repackaged in multi-canister overpacks, partially dried in the Cold Vacuum Drying Facility (CVDF), and then transported to the Canister Storage Building (CSB) for further processing and interim storage.

The CVDF, a subproject to the SNF Project, will be constructed in the 100K area. The CVDF will remove free water and vacuum dry the spent nuclear fuel, making it safer to transport and store at the CSB. At present, the CVDF is approximately 90% complete with definitive design.

Part of the design process is to conduct Failure Modes, Effects, and Criticality Analysis (FMECA). A four-day FMECA session was conducted August 18 through 21, 1997. The purpose of the session was to analyze 16 subsystems and operating modes to determine consequences of normal, upset, emergency, and faulted conditions with respect to production and worker safety. During this process, acceptable and unacceptable risks, needed design or requirement changes, action items, issues/concerns, and enabling assumptions were identified and recorded. Additionally, a path forward consisting of recommended actions would be developed to resolve any unacceptable risks. The team consisted of project management, engineering, design authority, design agent, safety, operations, and startup personnel from DE&S Hanford Inc. (DESH), Numatec (NHC), Fluor Daniel Northwest (FDNW), Jason and Associates Co. (JAC), and Merrick Engineering. Technical facilitation was provided by Richard Harrington, CVS, Lockheed Martin Hanford Co. (LMHC), and Jeff Parker, CVS, ARES Corporation. The session successfully met the purpose as stated above.

Session Results

The session resulted in a Phase I FMECA Matrix, 37 Action Items, nine potential Design Requirement Document changes, and eight potential Design Changes. The most significant issues addressed, within the action items and potential design changes, were identified on the Heating Ventilation and Air Conditioning (HVAC), Process Water Conditioning (PWC), and the Helium (He) subsystems, as follows:

- A. HVAC current design and controls for each bay could result in an upset condition that pressurizes the bays. Two action items and one potential design requirement change were identified to resolve this issue.

**COLD VACUUM DRYING FACILITY:
PHASE I FMEA/FMECA SESSION REPORT**

- B. The PWC system requires a significant redesign due to a factor of 1000 increase in the source term. This redesign, addressed in four action items, will mitigate the increase of potential operator exposure.
- C. The He system requires a backup system for uninterrupted supply and in-field verification of He purity and miscellaneous gas constituents in the remaining 5%. Two action items and one potential design requirement change were identified to resolve this issue.

The process that developed the aforementioned results was an evaluation of 16 subsystems using a Phase I FMECA Matrix. In brief, the matrix was used to identify the likely failure modes (subsystem level), effects of those failures on production and worker safety, and actions required to minimize the likelihood of failure or effects of failures. The key to the worth of the matrix and the success of the session was the objective data known by the team members, or brought to light during the session, and the experience of the team members as they applied the matrix to each subsystem. After the Phase I FMECA Matrix was finished, it was reviewed and analyzed by subsystems to determine if a more detailed Phase II FMECA was needed by component and/or operating mode. As a result, it was recommended that five out of the sixteen subsystems should be subjected to a component level Phase II FMECA at a later date.

The five subsystems requiring a Phase II FMECA were: Vacuum & Purging System (VPS), PWC, HVAC-B, C, and D. While the entire PWC system was recommended for Phase II, only three operating modes on the VPS and one mode on the three HVAC systems were identified for component level analysis.

The balance of the action items, potential DRDs, and design changes, ranged from upgrading drawings to determining the need for additional instruments and/or components. Recommended design changes resulting from resolution of the action items, potential DRDs, and design changes, will need further evaluation to identify the impacts on capital, operations, and maintenance costs. Once cost is determined, the relative benefit to cost can be determined and a final decision made to make the change or not. That determination will be the subject of separate correspondence.

Due to time constraints the completion dates for actions, potential DRDs, and design changes, will be determined in subsequent meetings and tracked until closure in the on-going project status meetings.

SECTION 2

PROJECT BACKGROUND and INTRODUCTION

The mission of the Spent Nuclear Fuel (SNF) Project is to remove the fuel currently located in the K-Basins 100 Area to provide safe handling and interim storage of the fuel. The spent nuclear fuel will be repackaged in multi-canister overpacks, partially dried in the Cold Vacuum Drying Facility (CVDF), and then transported to the Canister Storage Building (CSB) for further processing and interim storage.

The CVDF, a subproject to the SNF Project, will be constructed in the 100K area. Once constructed and turned over to operations, the CVDF will remove free water and vacuum dry the spent nuclear fuel, making it safe to transport and store at the CSB. At present, the CVDF is approximately 90% complete with definitive design.

Part of the design process is to conduct Failure Modes, Effects, and Criticality Analysis (FMECA). The purpose of a FMECA is to evaluate the system design at the component level to determine possible failure modes and their effects on production and worker safety. Mike Wiemers, Project Manager for the CVDF Project, determined that a facilitated team session would be a good approach for completing a phased approach. This session was limited to a Phase I FMECA on subsystems and some component levels. In addition, the team in this phase would recommend any subsystems and operating modes that would require a Phase II approach, at the component level.

Prior to the session, a blank matrix was developed by the facilitators and several team members for use as a tool prompt and to record information during the session. In addition, 16 subsystems were identified as safety significant and within scope for this Phase I session.

SECTION 3

CONDUCT OF SESSION

Appendix A contains the Scope Statement Sheet and Agenda developed prior to and followed throughout the four day session. The scope statement sheet identifies the team members, and the session scope, objectives, and deliverables. The session began on Monday morning, August 18, 1997, with a review of the agenda, scope statement sheet, process guidelines and expectations, and opening remarks from the project and deputy project managers. During opening remarks both Mike Wiemers and Carol Pitkoff stressed the importance of building a system that works through the entire life cycle. Specifically, the team was encouraged to remember the system must produce the product needed, at an acceptable rate, and minimizing downtime and any upset conditions. In addition, process emphasis was placed on "recovery thinking" (i.e., what must be done to recover from something that breaks or fails). Following opening remarks the team overviewed the system process and operation.

The Phase I FMECA began with the team reviewing the blank matrix and developing common definitions for each section of the matrix. Following definitions, the team reviewed the list of 16 subsystems and analyzed each subsystem based on failure modes within the subsystem. In some subsystems component failure was considered, but most subsystems were kept at the subsystem level. Typically, the failures were that the system stopped supplying something, supplied too much of something, over pressurized or under pressurized. Once the failure modes were identified they were analyzed using the matrix contained in Appendix C. During this process any action items, potential Design Requirement Document (DRD) changes, design changes, enabling assumptions, and issues/concerns identified were recorded on corresponding flipcharts. Many of the action items identified will result in DRD or design changes. During this process the team was not certain whether an action was a potential DRD change, design change, or both. In the interest of time it was identified as an action item with impact to be determined later. Thus, a total of 37 actions were recorded. Potential impacts to capital, operation, and/or maintenance costs will be determined as actions are completed.

Once all 16 subsystems were analyzed with the FEMCA matrix, the team reviewed each subsystem matrix for consistency in approach relative to severity class (taking mitigation into account) and to determine if a Phase II FEMCA would be required. Minor corrections were identified and recorded to ensure that the team's analysis of severity class was consistent. In addition, any identified actions, DRDs, design changes, assumptions, and memory items were recorded. It was noted that a cost trade-off evaluation would be required at a later date based on the subsystem's failure rate, severity class and benefit of a change. Appendix B contains the typed copy of the Subsystem Final Pass/Review, Action Items, Potential DRDs, and Potential Design Changes.

**COLD VACUUM DRYING FACILITY:
PHASE I FMEA/FMECA SESSION REPORT**

Finally, a path forward was developed by reviewing and validating the recorded assumptions, issue/concerns, memories, potential DRD changes, potential design changes, and actions. Appendix D contains copies of the reduced Session Flipcharts developed during session and are backup reference to Appendix B and C..

The session ended with a round robin of each team member answering the questions of last minute items and meeting utility.

APPENDICES

- A. Scope Statement Sheet And Agenda
- B. Subsystem Final Pass/review, Actions Items, Potential Design Requirements And Design Changes
- C. Phase I FMECA Matrix
- D. Session Flipcharts

APPENDIX A

SCOPE STATEMENT SHEET AND AGENDA

HAIF-2576 Rev0

PROJECT SCOPE STATEMENT SHEET

Project Title: Cold Vacuum Drying Facility: Phase I FMEA/FMECA Session No. 001
 Location of Session: 345 Hills Street, Conference Room 124 Dates: 08/18-21/97
 Team Briefing Meeting: N/A Date: N/A

TEAM MEMBERS

<u>NAME</u>	<u>PHONE</u>	<u>MSIN</u>	<u>DISCIPLINE</u>	<u>CO.</u>
J.J. (John) Irwin (TL)	376-1639	R3-86	CVD Design Authority	NHC
C.C. (Carol) Pitkoff	376-5655	R3-86	Project Management	DESH
R.I. (Dick) Whitehurst	376-4663	R3-86	I&C Engineering	DESH
W.C. (Walt) Alaconis	376-9390	R3-85	Operations/Start-up	DESH
R.A. (Ray) Larson	373-1698	R3-85	Operations/Start-up	DESH
D.A. (Dan) Reny	373-7518	R3-15	Safety Engineering	JAC
C. (Carole) Pili-Vincens	373-1513	R3-86	Safety Engineering	NHC
K.J. (Kurt) McCracken	373-6653	S0-04	HVAC Engineering	FDNW
J. (Jim) Robinson	783-7404	-----	Design Agent	Merrick
D. (David) Munger	(505) 662-0606	-----	Design Agent	Merrick

Team Leader (TL)

FLOATERS

M.J. (Mike) Wiemers	376-9516	R3-85	Project Manager	DESH
C.A. (Chris) Thompson	372-0598	R3-85	Operations/Start-Up	DESH
G.P. (Gilles) Chevrier	373-3609	R3-86	Project Management	NHC
C.R. (Curtis) Miska	376-7103	R3-86	HCS Design Authority	NHC

FACILITATORS

<u>NAME</u>	<u>PHONE</u>	<u>MSIN</u>	<u>DISCIPLINE</u>	<u>CO.</u>
R.A. (Richard) Harrington	376-2331	H8-71	Value Engineering	LMHC
G.E. (Jeff) Parker	946-3300	-----	Value Engineering	ARES

HNF-2576 Rev 0

SCOPE

- Cold Vacuum Drying (CVD) Process and Facility Systems: Phase I FMEA/FMECA

- Focus of Phase I is on sub-systems (i.e., CVDF Systems List) and some specific components, as required
- Starting from the point a Multi-Canister Overpack is received with fuel, water, and sludge, and ending, after CVD processing, with the same MCO containing fuel and some water.

OBJECTIVES

- Overview normal operating process and facility systems sequence

- Describe and list subsystems and/or operating modes to be analyzed.

- Analyze subsystems and/or operating modes to determine consequences of normal, upset, emergency, and faulted conditions with respect to production and worker safety

- Identify acceptable and unacceptable risks, and their basis
- List needed design changes, spare parts, recovery procedures, and estimated recovery time.

- Develop the path forward recommendations and actions to resolve unacceptable risks

DELIVERABLES

- Draft Phase I FMECA Matrix

- Listings of needed design changes, spare parts, recovery procedures and estimated recovery times.

- Path Forward Recommendations and Actions

HNF-2576 Rev D

CVDF Phase I FMEA/FMECA Session

August 18 - 21, 1997

AGENDA

Day 1

- 7:30 - Welcome/Introductions/Review Agenda
 - Guidelines and Expectations
 - Review Scope Statement Sheet (Session Scope, Objectives, and Deliverables)
 - Opening Remarks
- 8:00 - Begin overview and sequencing of normal operating system
 - Identify/List subsystems and/or modes on process and facility systems to be analyzed
 - Utilize "parking-lot" sheets as required for running information
- 9:30 - BREAK
- 9:40 - Conduct Phase I FMECA and matrix on CA/IA and HE sub-systems
- 11:30 - LUNCH
- 12:30 - Conduct Phase I FMECA and matrix on FW, and DI sub-systems
- 2:30 - BREAK
- 2:40 - Continue FMECA on CHW and VPSCHW sub-systems
- 4:00 - Finish Day 1 with review of status and Day 2 agenda

Day 2

- 7:30 - Review agenda and scope statement sheet
- 8:00 - Continue FMECA on UPS and Crane/Hoist sub-systems
- 9:30 - BREAK
- 9:40 - Continue FMECA on HVACD sub-system
- 11:30 - LUNCH
- 12:30 - Continue FMECA on HVACC sub-system
- 2:30 - BREAK
- 2:40 - Continue FMECA on HVACB sub-system
- 4:00 - Finish Day 2 with review of status and Day 3 agenda

HNF-2576 Rev 0

CVDF Phase I FMEA/FMECA Session

August 18 - 21, 1997

AGENDA

Day 3

- 7:30 - Review agenda and scope statement sheet
- 8:00 - Continue FMECA on DCS sub-system
- 9:30 - BREAK
- 9:40 - Continue FMECA on PWC sub-system
- 11:30 - LUNCH
- 12:30 - Continue FMECA on TWC sub-system
- 2:30 - BREAK
- 2:40 - Continue FMECA on TW sub-system
- 4:00 - Finish Day 3 with review of status and Day 4 agenda

Day 4

- 7:30 - Review agenda and scope statement sheet
- 8:00 - Continue FMECA on VPS sub-system
- 9:30 - BREAK
- 9:40 - Continue FMECA on EPD sub-system
- 11:30 - LUNCH
- 12:30 - Conduct Subsystem Final Pass/Review
 - Identify Phase II Component FMECA Areas
- 2:30 - BREAK
- 2:40 - Develop path forward
 - Review/Validate running information on parking lot sheets
 - Identify actions needed resolve unacceptable risks and proceed forward
- 4:00 - Finish session with a Round Robin Close-out
 - Last minute items
 - Meeting utility

HNF 2576
Rev 0

APPENDIX B

- **Subsystem Final Pass/review**
- **Action Items**
- **Potential Design Requirement Document Changes**
- **Potential Design Changes**

Sub-System Final Pass/Review		
Sub-System	Actions, DRDs, D.C.s, etc.	Component FMECA Required?
EPD	See AI#31	No
VPS	AI #30, 29/DRD 9/Memories 14 & 15	Yes (Modes 1,4,10)
TW	AI #27, 28/Assumption #7	No
MCS	AI #21, 22/Assumption #4, 5	No
PWC	AI #23, 24, 25, 26/Memories 8, 9/Assumption 6	Yes (Significant re-design)
TWC	None	No
VPSCHW	AI #11	No
UPS	None	No
CRANES/HOISTS/S.R	AI #12/DRD #6	No
HVAC-B	AI #18, 19/DRD #8	Yes (Mode #2 Control & Balance)
HVAC-C	DRD #7/AI #15, 16	Yes (Mode #2 Control & Balance)
HVAC-D	AI #13, 14, 15, 17/DRD #7	Yes (Mode #2 Control & Balance)
CHW	Assumption #2	No
DI	D.C. #7	No
He	AI #8, 9/D.C. #6/DRD #5	No (Based on AIs, D.C., DRD)
CA/IA	AI #6, 7, 3, 4	No

Purpose of Phase 1: Screen systems and subsystems to determine which will be significant contributors to plant down time.

Voting for Phase 2 FMECA:

- Is system a significant contributor to plant downtime
 - Failure rate - frequency of occurrences
 - Restoration rate - mean time to restore
- The "yes" designation indicates that the follow-on reviewers will use the tabulated information to more precisely select the components to do a detailed FMECA.

NMF-2576
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ACTION ITEMS	
WHAT	WHO/WHEN
1. Determine what the 25 psig service supplies (instrument air to HVAC). See Note #1	WHO: Merrick - Dave Munger WHEN:
2. Finish thermo analysis to verify that shutdown system results in a safe plant condition and low corrosion environment (does design reflect results)	WHO: Project Team WHEN: Ongoing
3. Determine system failure compressor PM rate vs. demand and plant outage schedule (can facility last that long [partime] during compressor maintenance). See Note #1	WHO: Merrick - Dave Munger WHEN:
4. Develop an operator response to evacuate the bay on loss of HVAC (TSR consideration)	WHO: Operations - Walt Alaconis WHEN:
5. Verify the type of filters in compressed air dryer. See Note #1	WHO: Merrick - Jim Robinson WHEN:
6. Verify sight glasses exist for determination of liquid in the air lines (determine what is in dryer to help determine bad air). See Note #1	WHO: Merrick - Dave Munger WHEN:
7. Review potential impact of bad air on safety class valve operators; review to determine if an LCO is required (reevaluate severity class if LCO required)	WHO: Merrick on review; Dan Reny/Carol Pili-Vincens on LCO WHEN:
8. Determine minimum <u>He</u> purity requirement (Combine actions 8 and 9).	WHO: John Irwin WHEN:
9. Develop method to verify <u>He</u> purity at site receipt and/or MCO	WHO: John Irwin WHEN:
10. Switch to service water to supply DI water (design change)	WHO: John Irwin WHEN:
11. Determine impact of glycol on MCO and develop recovery plan, if required; and failure detection method, if required	WHO: John Irwin/Louie Goldman WHEN:
12. Develop recovery procedure(s) to accommodate delays that violate technical specifications	WHO: Walt Alaconis/George V. WHEN:
13. Verify function and need for Damper DMP-8060. See Note #1	WHO: Jim Robinson/Kurt McCracken WHEN:

ANF-2576 Rev 0

ACTION ITEMS	
WHAT	WHO/WHEN
14. Reevalue the approach to HVAC-D zone control (HVAC - all, not just D). See Note #1	WHO: Jim Robinson/Kurt McCracken WHEN:
15. Upgrade HVAC drawings to show condensate drain lines and seal pots	WHO: Jim Robinson/Kurt McCracken. WHEN:
16. Upgrade HVAC P&IDs to show: 1. correct connection of Tank 4001 to local exhaust system 2. correct connection of process skid vent to local exhaust system 3. Show the isolation damper in the process vent system at the bay walls	WHO: Jim Robinson/Kurt McCracken WHEN:
17. HVAC-D: delete fume hood callouts	WHO: Merrick - Jim Robinson WHEN:
18. Verify outside air damper interlock with general exhaust air flow. See Note #1	WHO: Dave Munger/Kurt McCracken WHEN:
19. Evaluate the need to provide a "vacuum" break in the event of loss of air to HVAC-B (design a change, if required) [safe exit through door]. See Note #1	WHO: Jim Robinson/Kurt McCracken WHEN:
20. Evaluate need for local bay repeater alarms (from problems in other bays). See Note #1	WHO: Operations - Walt Alaonis WHEN:
21. Determine needs of programming for MCS	WHO: Dick Whitehurst WHEN:
22. Conduct a Design Review on programs/reprogramming	WHO: Dick Whitehurst WHEN:
23. Do a dose study on the PWC; determine if design requires change; generate DRD or design change as required	WHO: Carol Pitkoff WHEN:
24. Develop procedures to use installed backup pumps to recover from PWC loss of pumping flow (or use pressure control); requires a DRD change for recognition of requirement. See Notes 1 & 2.	WHO: Walt Alaonis/John Irwin WHEN:

NAF-2576 Rev0

ACTION ITEMS	
WHAT	WHO/WHEN
25. Reevaluate source term for PWC and determine if DRD changes are required. (DRD to state different source term for design or develop a criteria that results in a design that provides an operable PWC AT ALL TIMES) (Include worker safety and ALARA) (Include sampling needs also) (Include IXM replacement). See Note #1	WHO: John Irwin WHEN:
26. Establish design requirements to mitigate leaks on the PWC system. See Note #1	WHO: John Irwin WHEN:
27. Develop a procedure for checking the inner seal of the MCO/cask annulus seal	WHO: John Irwin WHEN:
28. Determine severity class to the "cask low water level" for TW. See Note #1	WHO: John Irwin WHEN:
29. Ensure failure to drain recovery (unplugging) sequence is added to normal operations procedure In addition, add low level alarms on water and low level detection/correction methods	WHO: Merrick WHEN: WHO: Dick Whitehurst WHEN:
30. Evaluate need for RGA. See Note #1	WHO: John Irwin WHEN:
31. Review EPD for failure mode recovery procedures. See Note #1	WHO: John Irwin WHEN:
32. Status and complete DRD changes (eight total), & any others resulting from actions and design changes.	WHO: John Irwin WHEN:
33. Status and complete design changes 1-8, and any others resulting from actions and DRD changes.	WHO: Carol Pitkoff WHEN:
34. Develop method to keep IXM from going TRU. See Note #1	WHO: John Irwin WHEN:
35. Identify new strategy for combined HVAC design, procurement, and installation for single oversight. See DRD #8 and Note #1.	WHO: Carol Pitkoff WHEN:

HNF-2576 Rev 0

ACTION ITEMS	
WHAT	WHO/WHEN
36. Incorporate "plugging of flow meter" in PWC design. See Note #1	WHO: John Irwin/Dave Munger WHEN:
37. Define normal operating modes for the VPS in the re-cycle mode, and include in DRD. See Note #1	WHO: John Irwin WHEN:

Notes:

1. Using the resulting information, identify any design changes that would minimize the likelihood of failure and/or the effects of the failure. Identify the cost impact and benefit of any recommended design changes. Finally, recommend that change or no change be made. In either case, identify the resulting risk that management is accepting.
2. Consider remote replacement for PWC replacement pump.

HAUF-2576
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POTENTIAL DRD CHANGES	
WHAT	WHO/WHEN
1. Project philosophy on spare parts.	WHO: Walt Alaconis WHEN:
2. This item was deleted	N/A
3. Include capability to put the MCO in a cold shutdown condition (production consideration--not safety consideration).	WHO: John Irwin WHEN:
4. Investigate the dryness criteria on instrument to determine required dew point for the cask annulus area. Based on investigation develop requirement statement and revise DRD.	WHO: Kurt McCracken WHEN:
5. Add: "continuous supply of He" requirement. - Ensure overpressure or loss of He does not effect redundant supply trailer.	WHO: John Irwin WHEN:
6. Add: Requirements for crane & rigging (detect imbalance).	WHO: John Irwin WHEN:
7. Establish and add minimum DP requirements for zone control and alarm in HVAC systems.	WHO: Kurt McCracken WHEN:
8. <u>Potential change</u> - Require a stand alone HVAC control system with interfaces to MCS (HVAC-B). See Action Item #35.	WHO: Kurt McCracken/ Dick Whitehurst WHEN:
9. Identify requirement for <u>MCO block values</u> with respect to particulates in water streams	WHO: John Irwin WHEN:

NMF-2576

Rev 0

POTENTIAL DESIGN CHANGES	
WHAT	WHO/WHEN
1. Investigate maximum allowable connection pressure in cask (quick disconnects attached to cask). See Note #1	WHO: Andy Kee/John Irwin WHEN:
2. <u>Operating sequence</u> : close MCO block valve - when?? (<u>identify timing</u>)	WHO: Dick Whitehurst/Dan Reny WHEN:
3. <u>Potential Design Change</u> - Install check valve in air line to seal ring	WHO: Merrick/John Irwin WHEN:
4. On Drawing H-1-82222, add 100 psig service to rm 132; check if 25 psig service is needed a. Verify alarm type (PAL 5008) change as required (need high & low pressure). See Note #1	WHO: Merrick/John Irwin WHEN: WHO: Dick Whitehurst WHEN:
5. <u>Potential Design Change</u> - Allow the use of IA for formal purge of cask annulus. See Note #1	WHO: John Irwin WHEN:
6. Add PT or switch upstream of He pressure regulator to detect He supply pressure	WHO: Merrick/Dick Whitehurst WHEN:
7. <u>Global Change</u> - Review all P&IDs for change from PAL to PI	WHO: Merrick/Dick Whitehurst WHEN:
8. 82164 - Change EJR to EDR	WHO: Merrick/Dick Whitehurst WHEN:

Notes:

- Using the resulting information, identify any design changes that would minimize the likelihood of failure and/or the effects of the failure. Identify the cost impact and benefit of any recommended design changes. Finally, recommend that change or no change be made. In either case, identify the resulting risk that management is accepting.

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APPENDIX C

COLD VACUUM DRYING: FAILURE MODES, EFFECTS AND CRITICALITY PHASE I MATRICES

HNF-2576
Rev 0

SNF - Cold Vacuum Drying Project

Failure Modes, Effects and Criticality Analysis, Phase I

Date: 8/18-21/97

Sheet No: 1

Subcomponent/ Subsystem	Sub. Sys.. No./ Component ID	Sub. sys./ Comp/ Failure Rate	Failure Mode	Alpha Rank (TBD)	Failure Effects		Failure Detection Method	Mitigation of Cause	Reliability of Mitigation	Severity Class	Action(s) Required?		Remarks
					Local Effects	End Effects					Production	Worker Safety	
CA/IA	12	M	Slow loss (max. to 0)		None	@ 80 PSIG dampers close (supply & exhaust is isolated, recurc. still operable) * @ 50 PSIG all GOVs go to fail position @ 45 PSIG lose seal ring pressure Below 15 PSIG begin to lose HVAC cooling control - Loss of air balance - Loss of fresh air to bays * Process shutdown to safe conditions	PAL 5008 alarm	Compressor size Size of tank	H EL	B	Yes See AI #3	Yes See AI #4	
		EL	Fast loss (zero pressure)		Uncontrolled H.P. air, noise, & flying debris	@ 80 PSIG dampers close (supply & exhaust is isolated, recurc. still operable) * @ 50 PSIG all GOVs go to fail position @ 45 PSIG lose seal ring pressure Below 15 PSIG begin to lose HVAC cooling control - Loss of air balance - Loss of fresh air to bays * Process shutdown to safe conditions	PAL 5008 alarm	None	N/A	B	No	No	Acceptable risk
		L	Over pressure		H.P. air & noise	None	PT-5008 (MCS)	Relief valve SRV-5007 & compressor internal relief & PCV-5006	H H H	B	No	No	Acceptable risk
		L	Contaminated (bad) air		Inaccurate I & C & unreliable valves	Same as local effect	Manual surveillance	? See AI #6	? AI #6	? AI #7	Yes See AI #3, 6 & 7	Yes See AI #7	

HAIF 2576

SNF - Cold Vacuum Drying Project

Failure Modes, Effects and Criticality Analysis, Phase I

Date: 8/18-21/97

Sheet No: 2

Subcomponent/ Subsystem	Sub. sys. No./ Component ID	Sub. sys./ Comp. Failure Rate	Failure Mode	Alpha Rank (TBD)	Failure Effects		Failure Detection Method	Mitigation of Cause	Reliability of Mitigation	Severity Class	Action(s) Required?		Remarks
					Local Effects	End Effects					Production	Worker Safety	
He	13-1	H	Loss of He		None	Loss of production	PT-5030	None	N/A	B	See Remarks	None	DRD #5 Design Change #6
		EL	Over pressure		H.P. He & noise	Loss of H.E./loss of production	PT-5030	SRV-5027 SRV-5029	H	B	See remarks for #1	None	
		EL	Bad He		None	Contaminated gas system	None	Receipt inspection (paper) vendor certification	M	B	See AI # 8 & 9	See AI # 8 & 9	AI # 8 & 9
DI	25	L	Loss of Demin.		Potential flooding	potential interruption	PT-9005	None	N/A	B	None	N/A	Acceptable risk
		EL	Over pressure		H.P. (= 100 PSIG) water spray	None	PT-9005 (see design change #7)	SRV-9004	H	A	None	None	Acceptable risk
		EL	Bad demin.		None	None	CIT-9007	Change beds	H	A	None	None	Acceptable risk
CHW	47-3	EL	Loss of cooling capability for process		None	- Cannot achieve cold standby condition - Delay shipment (interruption)	TI-several 70xx	Redundant system	H	B	None	None	Assumption #2 Acceptable risk
		EL	Over pressure		Overflow to drain	None	PI-7031 & 7041	SRV-7050	H	A	None	None	Acceptable risk
		EL	Water leaks a. HVAC		Overflow to drain (contaminated water tank)	Overflow tank	LT-9035	Manual isolation	M	A	None	None	Acceptable risk
		EL	Water leaks b. Process		None	None	None	None	N/A	N/A	None	None	Acceptable risk
TWC	47-2	EL	Loss of cooling process		None	Cannot achieve cold standby & delay shipment	FI-7053 & TI-7054	Redundant pumps	H	B	None	None	Acceptable risk
		EL	Over pressure		Overflow to floor drain	None	Several PIs	SRV-7063	H	A	None	None	Acceptable risk
		EL	Water leaks, process		Overflow to floor drain	Cannot achieve cold standby & delays shipment	Several PIs	None	N/A	B	None	None	Acceptable risk

HAIF 2576

SNF - Cold Vacuum Drying Project

Failure Modes, Effects and Criticality Analysis, Phase I

Date: 8/18-21/97

Sheet No: 3

Subcomponent/ Subsystem	Sub. sys.. No./ Component ID	Sub. sys./ Comp. Failure Rate	Failure Mode	Alpha Rank (TBD)	Failure Effects		Failure Detection Method	Mitigation of Cause	Reliability of Mitigation	Severity Class	Action(s) Required?		Remarks
					Local Effects	End Effects					Production	Worker Safety	
VPSCHW	47-4	L	Loss of cooling		None	Increase process time	FI-7078 & TI-7077	Redundant pumps	H	B	None	None	Acceptable risk
		EL	Over pressure		Overflow to floor drain	None	PT-7079 & 7076	SRV-7081	H	A	None	None	Acceptable risk
		EL	Leaks - External		Overflow to floor drain	Loss of cooling	FI-7078 TI-7077	None	N/A	B	None	None	Acceptable risk
		EL	Leaks - Internal		None	Effluent to VPS & potential contamination of MCO fuel	Potentially RGA	None	N/A	C, See AI #11	Yes AI #11	No	See AI #11
UPS	93-3	EL	Loss of power with 480V AC unavailable (failure of batteries)		None	Total loss (MCS (process stops)	Plant goes dead	Periodic testing of battery	H	B	None	None	Acceptable risk
Cranes/hoists/seis mic restraints	14	L	Fail to operate		none	Delay in process	stops	periodic maintenance	H	B	See A #12	None	Acceptable risk
		EL	Drop load		- Equipment damage - Personnel injury	Delay in process	Visual audio	Procedures (O&M)	H	C	See DRD #6	No additional	Acceptable risk
		L	Seismic #1 failed to engage/disengage		None	Delay in process	Visual	None	N/A	B	See AI #12	None	Acceptable risk

WJF-2576

SNF - Cold Vacuum Drying Project

Date: 8/18-21/97

Failure Modes, Effects and Criticality Analysis, Phase I

Sheet No: 4

Subcomponent/ Subsystem	Sub. sys.. No./ Component ID	Sub. sys./ Comp. Failure Rate	Failure Mode	Alpha Rank (TBD)	Failure Effects		Failure Detection Method	Mitigation of Cause	Reliability of Mitigation	Severity Class	Action(s) Required?		Remarks
					Local Effects	End Effects					Production	Worker Safety	
HVAC-D	30-4	EL	Global loss of flow		None	- Loss of tank rm. confinement - Loss of ventilation to corridors & mech. rm.	AMS-8024	Redundant fans	H	A	None	None	See AI #13 & #17 Acceptable risk
		M	Loss of zone flow		None	Loss of confinement which may lead to process shutdown	DP & ref. air	O & M balancing	M	A	None	Yes, see AI #3 14	See DRD #7
		EL	Loss of filtration		None	None	DOS test	Two filters in series	H	A	None	None	See AI #15 Acceptable risk
HVAC-B	30-2	L	Loss of flow		Loss of heating & cooling	None	PDIS-05	None	N/A	A	None	None	Acceptable See AI # 18 See DRD #8
		L	Loss of outside air		Drop in pressure Increased DP	None	PDI-8*20	None	N/A	A	None	See A #19	AI #19
		EL	Over pressurization		Excess outside air Increase in pressure	Loss of confinement DP, process shutdown	PDI-8*20	Fixed manual controls	H	B	None	None	Acceptable risk
		EL	Loss of filtration		None	None	- PDIS 8*02 8*03 - DOS test	2 filters in services	H	A	None	None	Acceptable risk
HVAC-C	30-3	EL	Global loss of flow		Loss of flow through process hood	Potential work area contamination	AMS-8044	Redundant fans	H	B	None	None	See AI #16 Acceptable risk
		M	Loss of zone flow		None	Loss of confinement which may lead to process shutdown	See DRD #7	TBD via DRD #7	TBD	B	None	None	See DRD #7
		EL	Loss of filtration		None	None	DOS test	Two filters in series	H	A	None	None	See AI #15 Acceptable risk

SNF - Cold Vacuum Drying Project

Date: 8/18-21/97

Failure Modes, Effects and Criticality Analysis, Phase I

Sheet No: 5

Subcomponent/ Subsystem	Sub. sys.. No./ Component ID	Sub. sys../ Comp. Failure Rate	Failure Mode	Alpha Rank (TBD)	Failure Effects		Failure Detection Method	Mitigation of Cause	Reliability of Mitigation	Severity Class	Action(s) Required?		Remarks
					Local Effects	End Effects					Production	Worker Safety	
MCS	93-2	M	Partial loss of control at I/O		None	Component/subsystem shut down; possible process shutdown Component/subsystem continuing; possible process shutdown	PLC has self-diagnostics Component position detection System parameter detection I/O self-diagnostics	None	N/A	B	None	None	Acceptable risk (assumptions 4 and 5)
		L	I/O card fails		None	Same as above	Same as above	None	N/A	B	None	None	Acceptable risk
		L	Panel fails		None	Process shutdown in bay or PWC or mech. room	Same as above	None	N/A	B	None	None	Acceptable risk
		EL	Loss of communications between the PLC and computers		Alarms Communications errors	Program to go to safe condition of process after 60 second time out	Computer generated alarm PLC generated alarm	Redundant computers and cables	H	B	See AI #21	None	Acceptable risk
		EL	Total loss of MCS		System goes down, everything black	All processes are stopped in safe (failed) condition	Visual and audible (quiet)	UPS and redundant systems	H	B	None	None	Acceptable risk NOTE: this is an administrative nightmare
		M	Bad programming		False indication(s) or control	Process upset/shutdown	Direct and/or indirect alarms	Independent safety controls ; multiple alarms,; and a QA software program	H H M	B	Yes, see AI #'s 22 and 21	TBD; see AI #22	

SNF - Cold Vacuum Drying Project

Failure Modes, Effects and Criticality Analysis, Phase I

Date: 8/18-21/97

Sheet No: 6

Subcomponent/ Subsystem	Sub. sys.. No./ Component ID	Sub. sys./ Comp. Failure Rate	Failure Mode	Alpha Rank (TBD)	Failure Effects		Failure Detection Method	Mitigation of Cause	Reliability of Mitigation	Severity Class	Action(s) Required?		Remarks
					Local Effects	End Effects					Production	Worker Safety	
PWC	46-1	L	Loss of pumping flow		Increased radiation	MCO process delay, increased radiation & potential exposure	Pump status indication FT-4050 FT-4038 FT-4039 FT-4037 PT-4031	None	N/A	B	Yes See AI #23 & 24, and memories # 8 & #9	Yes See AI #23	
		H	Loss of IXM capability		Increased radiation	MCO process delay, increased radiation & potential exposure	PDISH-4044 or 4041 Sampler results FT-4039	Sampling	EL	B	Yes See AI #25	Yes See AI #25	Assumption #6
		M	IXMS GO TRU		None	Delay process	Sampling	Sampling & analysis frequency	EL	B	Yes See AI #25	Yes See AI #25	Assumption #6
		L	Loss of transfer capability		Potential for increased radiation	Production delays due to high/full tank	LI-4016 LI-4014	None	NA	B	Yes See AI #24	None	Accept the risk of no redundant pump for P-001
		M	Leaks		contamination spread (airborne)	Delay process Potential exposure	CAMs RAMs Visual LDE-4012	Proper maintenance	L	B	Yes See AI #26	Yes See AI #26	
		EL	Spray		contamination spread (airborne)	Delay process Potential exposure	CAMs RAMs Visual LDE-4012	Proper maintenance	H	C	Yes See AI #26	Yes See AI #26	

SNF - Cold Vacuum Drying Project

Failure Modes, Effects and Criticality Analysis, Phase I

Date: 8/18-21/97

Sheet No: 7

Subcomponent/ Subsystem	Sub. sys. No./ Component ID	Sub. sys./ Comp. Failure Rate	Failure Mode	Alpha Rank (TBD)	Failure Effects		Failure Detection Method	Mitigation of Cause	Reliability of Mitigation	Severity Class	Action(s) Required?		Remarks
					Local Effects	End Effects					Production	Worker Safety	
TW	47-1	L	1. Loss of flow		None	Processing delay and will not achieve cold standby	PT-3 * 08 FE-3 * 16	None	N/A	B	None	None	See Assumption #7, acceptable risk
		EL	2. Over pressure		Loss of seal; system drains through seal	System shutdown/failure; will not achieve cold standby	PT-3 * 08 FE-3 * 16	FCV-3 * 8 and various interlocks	H	B	None	None	Acceptable risk
		L	3. System water leaks		Potential contamination	Delay in process	Visual and LI-3 * 04	Testing before each operation	EL	B	Yes; AI #27	Yes; AI #27	
		EL	4. Cask low water level		None	Process shutdown	*S.C. indication	S.C. design prevention	H	*C	None	None	*See AI #28
		L	5. Bad water		Potential radiation	None	None	None	N/A	A	None	None	Acceptable risk
		EL	6. Loss of temperature control (high/low)		None	Process delays	TT-3 * 05 S.C. TSH	S.C. prevention and normal prevention	H	B	None	None	Acceptable risk
VPS	07	Valves L Plugging H	1. Loss of water drain path (valve lineup or plugging) (strainer screen)		Increased radiation	Fuel corrosion Production delay (More sludge & more hydrogen)	FI-4050, LI-4033, etc.	Valves-none Plugging-correct loading	N/A H	B	Yes See AI #29	None	
		M	1a. Excessive returned water		None	Process delay (long, long drying time)	See AI #29	Fully plugged-none Slow drain-multiple drain cycles	N/A EL	A	Yes; see AI #29	None	
		EL	2. Loss of purge path (HEPA plug sub. sys. or MCO)		None	Hydrogen buildup Process delay Potential S.C. shutdown	PDT-1 * 13 PDT-1 * 34 PT-1 * 08 FE-1 * 19 FE-2 * 12 S.C. flow switches	None	N/A	B	See remarks	See remarks	On-going effort to determine filter plugging likelihood and any actions
		EL	3. Loss of DI rinse (valves)		Increased radiation	Process delay MCO plug valve seal damaged or not reseating	Valve position alarms	None	N/A	B	Yes; see DRD #9 (and issue)	None	

*S.C. - safety class

HWF 2576-800

SNF - Cold Vacuum Drying Project

Failure Modes, Effects and Criticality Analysis, Phase I

Date: 8/18-21/97

Sheet No: 8

Subcomponent/ Subsystem	Sub. sys.. No./ Component ID	Sub. sys./ Comp. Failure Rate	Failure Mode	Alpha Rank (TBD)	Failure Effects		Failure Detection Method	Mitigation of Cause	Reliability of Mitigation	Severity Class	Action(s) Required?		Remarks
					Local Effects	End Effects					Production	Worker Safety	
VPS	07	L	4. Loss of vacuum (pump and path)		None	Process delay	PT-108, 110, 208, and 209	None	N/A	B	See memory item #14	None	
		EL	5. Loss of condenser		None	Process delay	TT-2 * 35 & 36	None	N/A	A	None	None	Acceptable risk
		EL	6. Loss of drain path		Potential overflow	None	LSH-2 * 25	None	N/A	A	None	None	Acceptable risk
		----	7. Loss of blower and path		None	None							See memory item #15
		H	8. Loss of RGA		None	None	AE-2 * 13	None	N/A	A	None	None	Acceptable risk - see AI #30
		EL	9. Loss of filtration		Increased radiation	Process delay	None	None	N/A	B	None	None	Acceptable risk
		M	10. Leaks (including condenser leaks) i.e., water, air, gas leaks out/leaks in		Potential contamination	Process shutdown	Visual and, in some cases, pressure indicators/ sensors, CAMs, and audible	None (other than initial start-up tests)	N/A H	B	None	None	Acceptable risk

SNF - Cold Vacuum Drying Project

Failure Modes, Effects and Criticality Analysis, Phase I

Date: 8/18-21/97

Sheet No: 9

Subcomponent/ Subsystem	Sub. sys.. No./ Component ID	Sub. sys../ Comp. Failure Rate	Failure Mode	Alpha Rank (TBD)	Failure Effects		Failure Detection Method	Mitigation of Cause	Reliability of Mitigation	Severity Class	Action(s) Required?		Remarks
					Local Effects	End Effects					Production	Worker Safety	
EPD	20	M	Loss of main power bus		Loss of everything except UPS, FPS, emergency lighting, communications, and S&S	Facility shutdown - production shutdown	Visual and Audible	None	N/A	B	None	None	Acceptable risk
		EL	Loss of bay bus		Loss of everything in bay except UPS, FPS, emergency lighting, communications, and S&S	Process shutdown Process delay	Alarms	None	N/A	B	None	None	Acceptable risk
		EL	Loss of equipment MCC		Loss of HVAC, chilled water, CA/IA	Process delays	Alarms	None	N/A	B	None	None	Acceptable risk

APPENDIX D

SESSION FLIPCHARTS

FACILITATED TEAM SESSION

SNF

CVDF
PHASE I
FMEA/FMECA
SESSION

AUGUST 18-21, 1997

345 HILL3, ROOM 124

ACTION ITEMS

①

WHAT

WHO/WHEN

1. - Determine what the
25 psig service supplies
(Instrument Air to HTA)

Merrick

2. - Finish Thermo analysis
to ~~verify~~ that shut-
down system ~~is~~ results in
a safe plant condition and low corrosion
environment.
[Does Design reflect
results]

On Going

3. - ~~Determine~~ Determine
system failure
Compressor ~~failure~~ PM rate
vs ~~plant~~ demand & Plant
Outage schedule [Can facility
last that long (PM Time) during
compressor maintenance]

Merrick
(D Munger)

4. - Develop an operator response
to evacuate the bay on
loss of ~~SAHVAC~~ HVAC [TSR consideration]

Operations
Walt A.

Action Items

(2)

What

type of

WHO / WHEN

5. - Varyfy 1 filters in compressed air dryer

Merrick
Jim R

6. - Varyfy sight glasses exist for determination of ~~liquid~~ in the air lines

Merrick

[Determine what is in dryer to help determine Bad air]

7. Review potential impact of bad air on safety class Valve operators. Review to determine if an LCO is required. [Reevaluate severity

Merrick
on Review

LCO - Dan R.
Carol

class if LCO required]

~~8. Determine how to~~

ACTION ITEMS

(3)

WHAT

WHO/WHEN

8. DETERMINE MINIMUM He PURITY REQNT. JOHN I.
-
9. DEVELOP METHOD TO VERIFY He PURITY @ SITE RECEIPT \$/OR MCO. JOHN I.
-
10. Switch to service water to supply ADC Water (Design Change) John I.
-
11. Determine impact of glycol on MCO & develop recovery plan if required; and failure detection method if required John Irwin
Louise Goldmann
-
12. DEVELOP RECOVERY PROCEDURE(S) TO ACCOMMODATE DELAYS THAT VIOLATE TECHNICAL SPECIFICATIONS. WALT A. GEORGE V.

ACTION ITEMS

(4)

WHAT

WHO/WHEN

013 - Verify function and need for Damper DMP-8060

Merrick
Jim R.
~~Kurt~~ Kurt

014 - Re evaluate ^{the approach} ~~needed for~~ to HVAC-D zone control [HVAC- All not just D]

Jim R.
Kurt M.

015 - Upgrade RHVAC Drawings to show a condensate drain lines and seal pots

Jim R.
Kurt M.

016 - Upgrade ~~HVAC P&IDs~~ ^{HVAC P&IDs} to Show: 1- correct connection of Tank 4001 to ~~the~~ Local exhaust sys
2. Correct connection of process skid vent to local exhaust system
3. Show the ~~the~~ isolation damper in the process vent system at the bay walls

Jim R.
Kurt

ACTION ITEMS

(5)

WHAT

WHO/WHEN

- 17 - HVAC-D - Delete
fume hood callouts

Merrick
Jim R.

- 18 - ~~Vacuum~~ ~~Interlock~~ ~~The~~ Varyfy
Outside air damper ^{interlock} with
general exhaust damper
air flow

Merrick
Kurt M.

- 19 - Evaluate the need to provide
a "vacuum" break in the
event of Loss of Air to HVAC-B
(Design a change if required) [Safe exit Thru Door]

Jim R.
~~Dan R.~~
Kurt M.

- 20 Evaluate need for local bay
repeater alarms (from problems
in other bays)

Walt A.

- 21 Determine needs of programming
for MCS

Dick W.

- 22 Conduct a Design Review for
~~FEMCA~~ on Programs/
reprogramming

Dick W.

ACTION ITEMS

⑥

WHAT

Who/WHEN

~~23/ Determine contaminant~~

- 23/ Do a dose study on the PWC. Determine if a design requires change. Generate DRD or Design change as required.

Carol P.

- 24/ Develop procedures to use installed backup pumps to recover from PWC loss of pumping flow. (or use pressure control) ~~[Based on redesign of PWC]~~

Walt A.
John I.

Requires a DRD
change for
recognition
of requirement

- 25/ Reevaluate Source Term for

John I.

PWC and determine if DRD [Include worker safety changes are required. [DRD to and ALARA] state different source term for [Include sampling design or develop a criteria needs, also] that results in a design that [Include IXM replacement] provides an operable PWC AT ALL TIMES]

Action Items

⑦

What

Who/When

26/ ESTABLISH DESIGN REQTS.
TO MITIGATE LEAKS ON
THE PWC SYSTEM. John I

27/ Develop a procedure for checking John I.
the inner seal ~~of~~ of the mco/
~~mechanical~~ cask annulus seal

28/ Determine severity class to ~~the~~ John I.
the 'cask low water level' for
Tw

29/ ENSURE FAILURE TO DRAIN DICK W.
RECOVERY (UNPLUGGING) SEQUENCE
IS ADDED TO NORMAL OPERATIONS
PROCEDURE.
- IN ADDITION ADD LOW LEVEL
ALARMS ON WATER & LOW LEVEL
DETECTION/CORRECTION METHODS.

Action Items

⑧

What

Who/When

'30/ Evaluate need for
RGA

John I.

31/ Review EPD for failure
mode recovery procedures

John I.

32. STATUS & COMPLETE
DRD CHANGES (EIGHT
TOTAL).

JOHN I.

33. STATUS & COMPLETE
DESIGN CHANGES 1-8

CAROL P.

34. DEVELOP METHOD TO KEEP
IXM FROM GOING TRY

JOHN I.

35. IDENTIFY NEW STRATEGY FOR
COMBINED HVAC DESIGN,
PROCUREMENT & INSTALLATION
FOR SINGLE OVERSIGHT.

CAROL P.

ACTION ITEMS

⑨

WHAT

WHO/WHEN

36. INCORPORATE "PLUGGING
OF FLOW METER" IN
PWC DESIGN

JOHN I.
JOHN M.
(MERRICK)

37. DEFINE NORMAL OPERATING
MODES FOR THE VPS IN
THE RE-CYCLE MODE, &
INCLUDE IN DRO.

JOHN I.

Purpose of Phase I

Screen systems, subsystems
to determine which will be
significant contributors to
plant down time.

Voting for Phase 2 FMECA

1. Is system a ^{significant} contributor
to plant downtime

- Failure Rate - Freq of Occur.

- Restoration Rate - Meantime
to restore

2. The "Yes" designation indicates
that the following ~~not~~ reviewers
will use the tabulated information
to more precisely select the components
to do a detailed FMECA.

SUB-SYSTEM FINAL PASS/REVIEW

SUB-SYS.	ACTIONS, DRDs, D.C.s, ETC.	COMPONENT FMEA REQ'D?
EPD	NO SEE AI #31	NO
VPS	AI #30, 29/DRD 9/MEMORIES 14 & 15	YES (MODES 1, 4, & 10)
TWI	AI #27 & 28/ASSUMPTION #7	NO
MCS	AI #21/ASSUMPTION 4 & 5 → #22	NO
PWC	AI 23, 24, 25/MEMORIES 8 & 9/ASSUMPTION #6 → & #26	YES (SIGNIFICANT RE-DESIGN)
TWC	NONE	NO
VPSCHW	AI #11	NO
UPS	NONE	NO
CRANES/HOIST/S.R.	AI #12/DRD #6	NO
HVAC-B	AI #18, 19/DRD #8	YES (MODE #2 CONTROL & BALANCE)
HVAC-C	DRD #7/AI #15 & 16	YES (MODE #2 CONTROL & BALANCE)
HVAC-D	AI #13, 14, 15, 17/DRD #7	" "
CHW	ASSUMPTION #2	NO
DI	NO D.C. #7	NO
He	AI #8 & 9/D.C. #6/DRD #5	NO, BASED ON,
CA/IA	AI #6, 7, 3 & 4	NO

MEMORIES

①

1. - Identify source of definitions for Severity Class - Give ^{to} John I
~~Production Remarks column~~
~~Action~~
2. - Remarks column is for clarification/Action items as related to on-site ~~and/or~~ off-site contamination
3. - ~~Compressed Air for final purge~~ (EA)
~~of cask annulus only~~ See Design Change #5
4. - Verify that thermo analysis is being done - Carol V. verify - Done
5. - Will Address recovery, recovery time, risk after completing entire review
• ~~One consideration is manual operation of valves to cool pipes & fluid maintain in a cold shutdown condition~~ See DRD change #3
→ To be accomplished in Phase 2

MEMORIES

(2)

- ✓ 6. Evaluate for Lessons Learned from WESF HVAC Design & Controls
[Concern is method of Design and Installation] Kurt Rife Mc. } Sel AI #35
- ✓ 7. MCS - Loss of communications to control room assumes that communications has exceeded the programmed time out
8. Consider remote replacement for PWC Recirc Pump - AI #24
- ✓ 9. Any process delay results in fuel corrosion & corrosion products
10. ~~CAROLE DOES NOT AGREE WITH DEFINITIONS.~~ Discussed and understood
- Don't check sheets for consistency of determination of ~~mitigation of cause~~ severity class [is it with mitigation or without?]
[With mitigation !!]

Memories

③

~~12. The purpose of this Phase I FMEA/FMECA was to focus on production~~

~~12. Consider change name of session to ~~#~~ Graded FMEA~~

✓ 13. ~~PLUG NEEDS TO ADDRESS PLUGGING OF FLOW METER.~~ - Merrick - AI# 36

✓ 14. - Vacuum pump and system being ~~D~~ evaluated (May result in changed component failure rate) - Phase 2

✓ 15. Operating without the blower (in the VPS) ~~#31~~ is not abnormal (Procedures will be developed to operate with or without blow)

✓ 16.

ASSUMPTIONS

1. Service water (not potable water)
Supplies DI system
2. LOSS OF HVAC COOLING DOES NOT
SHUT DOWN PROCESS
3. HVAC will be standalone with
interfaces to MCS - See DRD #8
4. We can program output signals for
failure positions (Assume correct
programming)
5. We will test for all normal sequences
& selected off normal events (key
is selection of off normal)
6. ~~WE ARE USING~~ Higher source Term (by 1000 Times)
than was given to Merrick for design

ASSUMPTIONS

(2)

and related instrumentation

7. ✓ Ion exchange loop ¹ deleted in the TWC system and replaced with by pass flow control for pump protection and pressure control. Duplex strainer deleted. Tank filter (PV-F-3*15) and related instrumentation removed. System now has safety class temperature shut down. Valve 3*15 deleted and TW⁵ disconnected from PWC (manually installed jumper available for interface as needed).
8. WILL NEVER USE THE RECYCLE WITHOUT THE CONDENSER.
9. ✓ ~~Filters on VPS~~ will be effective. Filter on MCO is not plugged when received at CVD.

DESIGN CHANGES

①

1. Investigate maximum allowable connection pressure in cask (Quick disconnects attached to cask) Andy Kee/John I.
2. Operating Sequence - Close MCO Block valve - when??
[Identify Timing] Dick W. Dan R.
3. Potential Design Change - Check valve in air line to seal ring Merrick/John I.
4. On Dwg H-1-82222 - Add 100psig service to Rm 132; check if 25psig service is needed Merrick/John I.
5. a. Verify alarm type (PAL 5008) change as required [Need high & Low Pressure] Dick W.
5. Potential Design Change - Allow the use of IA for final purge of cask annulus John I.

DESIGN CHANGES

- 6 ✓ ADD PT OR SWITCH UPSTREAM ②
OF He PRESSURE REGULATOR TO
DETECT He SUPPLY PRESSURE
Merrick/Dick W / QUANTITY
- 7 ✓ Global Change - review all P&IDs
for change from PAL to P I, Merrick
Dick W
- 8 / 82164 - Change ^{edr} to ^{edr}
(EJR) (EDR)
Merrick/Dick W

DRO CHANGES

- 1- Project philosophy on spare parts Walt A.
- 2- Identify the estimated pressure in the cask ~~at~~ when cask with MCO arrive at the CUDF
- 3- Include capability to put ^{the} MCO in a cold shutdown condition (Production consideration - not John I. safety consideration)
- 4- INVESTIGATE THE DRYNESS CRITERIA ON INSTRUMENT TO DETERMINE REQUIRED DEW POINT FOR THE CASK ANNULUS AREA. Kurt M.
- 5- ADD "CONTINUOUS SUPPLY OF He" REQUIREMENT.
 - ENSURE OVERPRESSURE OR LOSS OF He DOES NOT EFFECT REDUNDANT SUPPLY TRAILER. John I.
- 6- ADD: REQTS FOR CRANE & RIGGING ^{John I.}
- 7- Establish & Add minimum DP requirements ^{Kurt M. [Detect imbalance]} for Zone Control & Alarm in HVAC systems

DRD Changes

②

- 08 - Potential Change - Require a stand alone HVAC control system with interfaces to
✓ MCS [HVAC-B] ^{Kurt M} & Dick W.
- 9 - Identify requirement for MCO block values ~~that~~ with respect to particulate in water streams
John I

ISSUES/CONCERNS

①

Subsequent Phases of FEMA/~~F~~
FEMACA will ~~not~~ need to more
rigorously identify component failure
rate of Alpha. ~~2~~ -

- 8-4-4 - vacuum - purge - vacuum
sequence (8-4-4 in hours) -

USE OF POTABLE WATER TO SUPPLY
ALL WATER IN THE FACILITY - Assumption

✓ HVAC - 1. Multiple interactions/interfaces

2. A complex system

3. Recirc fan compressurize
room

4. What system controls HVAC
(MCS to date but!?)

See
AIs 14, 15, 16

AI #34

SAMPLING OF THE PWL WATER
MAY NOT PRECLUDE IXM GOING

✓ TRU OR LOSS OF IXM CAPABILITY.

DD9V

- DETERMINING THE AMOUNT OF SLUDGE

DEFINITION 3

①

- Component Failure Rate

EL: Extremely Low - not in life of facility

L: Low - maybe once during design life

M: Medium - 1 during life to 1 per year

H: High - > 1 per year

- Failure Mode - Subsystem

• Loss of _____ to _____

- Local Effects - What does it locally affect

- End Effects - end effect as result of failure

DEFINITIONS

(2)

- Mitigation of Cause -

• Prevention features (lessen severity of consequences)

~~Features to~~

~~Recovery~~

- Reliability of Mitigation

Same four definitions for failure rate in reverse

- Severity Class - (REF: DRD CALLOUT)

A - NORMAL: NEGLIGIBLE, NO EFFECT ON SYSTEM.

B - UPSET: FAILURE WILL DEGRADE SYSTEM TO SOME EXTENT BUT WILL NOT CAUSE MAJOR SYSTEM DAMAGE OR INJURY TO PERSONNEL

C - EMERGENCY: FAILURE WILL DEGRADE SYSTEM PERFORMANCE & MAY CAUSE PERSONNEL INJURY & IF IMMEDIATE

ACTION IS NOT TAKEN
STANDARD INSTRUCTIONS ON

DEFINITIONS

(3)

- SEVERITY CLASS (REF: DRD §)

A-NORMAL: NEGLIGIBLE, NO EFFECT
ON SYSTEM

B-UPSET: FAILURE WILL DEGRADE
SYSTEM TO SOME EXTENT BUT WILL
NOT CAUSE MAJOR SYSTEM DAMAGE
OR INJURY TO PERSONNEL.

C-EMERGENCY: FAILURE WILL DEGRADE
SYSTEM'S PERFORMANCE &/OR CAUSE
PERSONNEL INJURY, AND IF IMMEDIATE
ACTION IS NOT TAKEN SERIOUS INJURIES
OR DEATHS TO PERSONNEL &/OR LOSS
OF SYSTEM WILL OCCUR.

D-FAULTED: FAILURE WILL PRODUCE
SEVERE SYSTEM DEGRADATION
CAUSING LOSS OF SYSTEM &/OR
MULTIPLE DEATHS OR INJURIES

NOTE: LEVEL A, DOES NOT REQUIRE REPAIR
LEVEL B, IS MINOR REPAIR
LEVEL C, SIGNIFICANT REPAIR
LEVEL D, BEYOND REPAIR

SUB-SYSTEM BOUNDARIES

①

• CA/IA

- CA COMPRESSOR, TANK, & DRYER
100 PSIG FOR CA & 100/25 FOR IA
(25 TO HVAC, 100 TO PROCESS)
LOADS: HVAC DAMPERS, ~~SOLENOID~~
~~VALVES~~ & 40 V's
GAS OPERATED VALVES ON THE
PROCESS SIDE. CA TO SEAL RINGS
CASK PURGE.

• HE • 82222 SWT 1

Leased tube trailer to MCO (including
inside MCO, each bay)

Bottles - $\approx$ 1500 psig $\rightarrow$ 100 psig $\rightarrow$ 20 psig

Purge only

He Quality $> 99.9\%$ as delivered to
MCO

SUB-SYSTEM BOUNDARIES

• DI H-1-8222 SH1

STARTS @ CURTAIN UNIT & GOES
TO MAGA & PUQ. SUPPLY TO
DI IS POTABLE WATER. MAGA

FROM
~~PUQ & TWR~~

• CHW H-1-82201, -82208

Air cooled chillers, pumps,
overcoolers, heat exchangers,
Service - HVAC chillers, AHU,
TWS heat exchangers

- Temp of CHWS - 40-45°F

- Pressure of CHWS - 5.30 to 60 psig

- Refrigerant - R-

- Redundancy - ~~100%~~ 100% from Process
not 100% for Bldg coolant

- TWS - Designed to maintain MAGA at 260°F

(2)

SUB-SYSTEM BOUNDARIES ③

• VP3CHW H-1-82224

CLOSED LOOP, INTERFACE WITH
CONDENSER & HEAT EXCHANGERS

• TWC

CLOSED LOOP, INTERFACES CHW & TW
COOLED BY CHW, THEN COOLS TW.
REDUNDANT PUMPS

• HVAC-C - Process Bay Local

Exhaust - hoods and process vents
Thru the stack H-1-82206

Sub System Boundaries (4)

UPS - H-1-82247 SAT 3

- 8 hrs continuous ops

- ~~Lighting~~

- CAMS

- ~~Operator Station~~

- O₂ Monitors

- All of MCS

- Safety Class IFC

225 Amp

47.5 kva

120/208 volts 3 ϕ [no 208 loads]

HVAC-B - Bay Recirc - Separate
for each bay -

1-H-82204 - 6430.1A for energy
Conservation

Inter locks with exhaust system &
Fire protection

Subsystem Boundaries

(5)

* Cranes, Hoists, ~~and~~ seismic restraints

- 2 Ton Overhead in each process bay
- portable crane for Ixn movement
- One seismic restraint per MCO cart transporter/bay

• HVAC-D

H-1-82206

PROCESS GENERAL SUPPLY EXHAUST
~~STE1 FROM PROCESS BAYS THROUGH STE1~~
~~STE1 STACK FROM CORRIDORS, TRUNK RM,~~
~~& MECH. RM., THROUGH STACK~~

MCS - H-1-82291 Two Control ⑥

Computer systems - Desk Top - Big Screen
Windows NT, Graphic representation
of rooms & systems; Printing capability on
any page; Can develop any reports for
status & Tracking Control

3rd Engr Work station - Development &
on line changes to program

4th. read only in safety office

Alarms - Control Rm - computer acknowledge -
most of alarm

- Rod Rm - Rod alarms only
- Fire; Security

No Alarms in bays

Status light for work in bays

Control Rooms manned during any bay
operation

A person in one bay will not know of problems
in other bays unless notified by control ~~rm~~
Rm

PLCs in vicinity

MCS

②

PLC is networked to MCS

Programming occurs in PLCs

2 PLCs - normal & uninterrupted back up

7 I/O cabinets

Failures can happen on section of card,
a card, a cabinet, a room

Each rack has a single bus with 2 communication cards

X Dual communications with control room but all I/Os are single point

PLCs very reliable; Single point failure is L
EL failure rate (lot of faith in PLC)

Card Watch dog - exist but not sure if it causes fail position or maintain last position

SUB-SYSTEM BOUNDARIES (8)

• PWC

H-1-82223

H-1-82164

↓
FLOOR DRAIN
STORAGE TANK
4002

~~FROM MCC DRAIN PIPING TO THE
STORAGE TANKS & TRANSPORT
TANKER~~

FROM MCC DRAIN PIPING, FLOOR DRAIN
STORAGE TANK, VPS CONDENSOR &
TWS TO THE STORAGE TANK &
RECEIVER TANKS THEN

→ THEN TO TRANSPORT TANKER

• TW

H-1-82161 & 82163

TEMPERED

CIRCULATES CLEAN WATER TO THE
CLARK ANNULUS, WATER IS HOT OR
COLD. INTERFACES W/TWC, VENT, &
DI WATER SYSTEM. A CRITICAL
INTERFACE IS WITH S.C. I & C
SYSTEM. ADDITIONAL INTERFACES WITH
He & INST. AIR.

SUB-SYSTEM BOUNDARIES

• EPD H-1-82241 TO 82248

FROM 13.8 KV TO MAIN TRANSFORMER,
THEN TO VARIOUS MCCs, TO VARIOUS
PANELS & SWITCH GEAR, THEN OUT
TO VARIOUS COMPONENTS.

(eg: PUMPS, MOTORS, EGVs, HEATERS,
A/Hs, FANS, BLOWER, ~~FOR~~
STACK MONITOR, LIGHTING,
CHILLER, ALARMS, KITCHEN
APPLIANCES, COMPRESSORS, CRANES
& HOISTS, ETC.)

SUB-SYSTEM BOUNDARIES

⑨

VPS - H-1-82161, 82162

*MCO — Process Vent

3 sys/kms in one

① Vacuum Pumping

② Inert gas purge system

③ Gas Analysis System

* 10 normal operating modes

a. 50°C - water drain with purge

b. 50°C - Vacuum mode w/ condenser

c. " " " without "

d. 50°C - Purge mode with condenser

e. " " " without condenser

f. 50°C - Gas recycle with condenser

g. 75°C - Vacuum mode w/o condenser

h. " " Purge " " condenser

~~+15°C~~

VR3 SUBSYSTEM

MAJOR COMPONENTS

VACUUM PUMP
BLOWER
CONDENSER
VALVES - 1,
RGA SAMPLING SYSTEM
INSTRUMENTATION
RECYCLE HEATER
DRAIN TANK
FILTER (FI#11)
FLEX HOSES (MECH.)
MCO HEPA FILTER
MCO SEALS
MCO VALVES

Sub Sys Boulders

(10)

Op Modes (continued)

∴ 150°C - Vacuum mode with londs.
J " " " without londs.
K " - Purge mode with londs
L " - Purge mode without londs

Vacuum pump (1), (on) condenser, condenser
Tant (draw tank)

Opening Remarks ①

Must build something that works
Thru entire life cycle

"Think recovery time/process"

What if it breaks, fails, etc -

What must be done to recover

- Procedures
- Spare parts
- Design changes

Process Emphasis. ~~Design~~ Recovery Thinking
(This Process - This session) "What if?"

What recovery procedures do we have?
Have some but this process will
help identify needs

Opening Remarks

(2)

- Some components have a life time that exceeds the use life of the System
- As a team we need to be thinking probability
- Philosophy on spare parts - Site std.
- Using the Severity class identification with the project will finish procedures to address the 4 conditions of operations - normal, upset, emergency, faulted
- Budget attacks -
 - 1st Contingency
 - 2nd Spare Parts

Must engineer
in spare parts
to resist cuts
later

CVD Facility, Phase I FMEA/FMECA Session
2/18/97

<u>Name</u>	<u>Co</u>	<u>Phone</u>	<u>MSIN</u>
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Dave Mungen	McRAICK	505/662-0606	
Jim Robinson	Merrick	783-7404	
Carol Pittluff	DESH	376-5655	
Jalt Alauris	DESH	376-9390	
Ray Larson	DESH	373-1698	R3-85
Jim Cracken	FDNW	373-6653	
Deke Whitelaw	DESH (today)	376-4663	R3-86
Deke Vincens	NHC	373-1513	R3-85
Daniel A. Reny	Jason Assoc	373-7518	
John Irwin	DESH	376-3619	R3-86

CVD Phase 1 FMEA/FMECA

8/19/92

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CVD Phase 1 FMEA / FMECA

8/20/97

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HNF 2576 Rev 0

CVD Phase I FMEA/FMECA

8/21/97

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373 1513

373-7518

372-3743

376-2331

946-3300

R3-85

R3-85

R3-86

R3-86

R3-86

H8-17

Have 2576 Jan 0

GUIDELINES & EXPECTATIONS

- OPEN & HONEST COMMUNICATIONS
 - ACTIVE LISTENING
 - COURAGE & CONSIDERATION
- IDENTIFY FACTS VS. PERCEPTIONS
- HAZOP VS. FEMA VS. FEMCA
 - RECOGNIZE UNIQUENESS OF EACH
 - YET, ALL THREE ARE RELATIVE
- TYPICAL FEMA/FMCA IS DONE @ THE COMPONENT LEVEL, VS. SYSTEM
- OUR FOCUS (PHASE 1) IS AT THE SUB-SYSTEM LEVEL
 - ANALYZE FAILURE EFFECT OF A SUB-SYS. & ITS EFFECT ON THE OVERALL SYSTEM
 - MAY ANALYZE SOME COMPONENTS: TEAM TBD
- ROLES: FACILITATORS & YOU
- USE OF MATRIX & FLIPCHARTS
 - EXERCISE "PARKING-LOTS";
 - WILL VALIDATE/USE THURSDAY (PM)
 - FOR PATH FORWARD
- KEYS TO SUCCESS
 - FOCUS, TEAMWORK, & MAKING IT WORK FOR YOU.