ENGINEERING CHANGE NOTICE

Page 1 of 5

1. ECN 650982

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. T. A. Campbell, 32900, T4-56, 373-1800 6. Project Title/No./Work Order No. 242-A Evaporator Safety Analysis Report 9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HWHC-SD-WM-SAR-023, Rev. 3-A	4. USQ Required? ☒ Yes ☐ No 7. Bldg./Sys./Fac. No. 242-A 10. Related ECN No(s). NA	5. Date 3/15/99 8. Approval Designator SQ 11. Related PD No. NA
12a. Modification Work ☐ Yes (fill out Blk. 12b) ☒ No (NA Blks. 12b, 12c, 12d)	12b. Work Package No. NA	12c. Modification Work Complete NA Design Authority/Cog. Engineer Signature & Date	12d. Restored to Original Condition (Temp. or Standby ECN only) NA Design Authority/Cog. Engineer Signature & Date
13a. Description of Change This page change ECN includes updating of documents referenced in the SAR, clarification of system descriptions, and correction of typographical errors. 13b. Design Baseline Document? ☒ Yes ☐ No			
14a. Justification (mark one) Criteria Change ☒ Design Improvement ☐ Environmental ☐ Facility Deactivation ☐ As-Found ☐ Facilitate Const ☐ Const. Error/Omission ☐ Design Error/Omission ☐ 14b. Justification Details An annual update to the SAR is required by DOE Order 5480.23. This revision meets that requirement. Specific changes are discussed in USQ document LW-99-006.			
15. Distribution (include name, MSIN, and no. of copies) Per controlled distribution list maintained by UDC, A3-95.

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650982

A-7900-013-3 (05/96) GEF096

**UNREVIEWED SAFETY QUESTION (USQ)
SCREENING AND EVALUATION**

1. Identification Number: LW-99-006

USQ SCREENING

Page 1 of 3

2. Title: 242-A Evaporator Safety Analysis Report, 1999 Annual Update

Facility: 242-A Evaporator

ECN No. 650982

PCA No.

Work Pkg No.

Other (Specify)

TITLE: 242-A Evaporator Safety Analysis Report, 1999 Annual Update**Description of the proposed activity/reportable occurrence or PIAB:**

In compliance with DOE Orders, an update of the 242-A SAR has been prepared, as documented in the referenced ECN.

Introduction:

In order to define potential information for inclusion in this update, a thorough review of Calendar Year 1998 USQ documents was performed and interviews with facility personnel were conducted. Additionally, editorial and typographical corrections were identified through use of the document since the last update. Specific changes are described below.

Scope:

This USQ document evaluation was limited to the changes from revision 3-A to revision 3-B. Only the differences between the two revisions require analysis.

Changes previously evaluated through the USQ process in CY-1998 were included in this revision. As these changes were already reviewed and determined not to impact the Authorization Basis, they were included in this revision without additional analysis. Other changes included in this revision were strictly editorial. These included updating of supporting document references, correction of typographical errors, and clarification of system descriptions. No physical facility modification or procedural changes were included in this update other than those which had been previously evaluated through the USQ process.

Authorization basis:

The Authorization Basis for the 242-A Evaporator is the 242-A Evaporator Safety Analysis Report, WHC-SD-WM-SAR-023, Rev. 3-A. As the document being changed by the referenced ECN is the SAR itself, the new revision (Rev. 3-B) was evaluated against the old revision (Rev. 3-A).

UNREVIEWED SAFETY QUESTION (USQ) SCREENING AND EVALUATION

1. Identification Number: LW-99-006

USQ SCREENING

Page 2 of 3

2. Title: 242-A Evaporator Safety Analysis Report, 1999 Annual Update

Conclusion:

The changes in the SAR from revision 3-A to revision 3-B may be made at contractor discretion. DOE approval is not required.

References:

None outside of the Authorization Basis.

INSTRUCTIONS: Respond to each question and provide justification for each response. A restatement of the question does not constitute a satisfactory justification or basis. An adequate justification provides sufficient explanation such that an independent reviewer could reach the same conclusion based on the information provided (DOE 5480.21, 10.e.1).

QUESTIONS

1. Does the proposed change or occurrence represent a change to the facility or procedures as described in the Authorization Basis?

☐ N/A ☒ No ☐ Yes/Maybe

BASIS: As previously stated, only those physical modifications and procedural changes which had been previously evaluated and approved through the USQ process were included in this revision. Changes not previously evaluated were limited to supporting document updates, system clarification, and correction of typographical errors. None of these could represent a change to the facility or procedures as described in the Authorization Basis. Therefore, this revision does not represent a change to facility or procedures as described in the Authorization Basis.

2. Does the proposed change or occurrence represent conditions that have not been analyzed in the Authorization Basis?

☐ N/A ☒ No ☐ Yes/Maybe

BASIS: As previously stated, no changes to the facility or the manner in which it is operated are included in this annual update other than those which have already been reviewed and approved through the USQ process. Therefore, no new conditions are possible as a result of this revision.

3. Does the proposed change represent a test or experiment NOT described in the Authorization Basis that may affect the safe operation of the facility?

☒ N/A ☐ No ☐ Yes/Maybe

BASIS: No tests or experiments are included in this revision.

4. Does the proposed change or occurrence represent a change to the Technical Safety Requirements or a reduction in the margin of safety defined in the Technical Safety Requirements?

☐ N/A ☒ No ☐ Yes/Maybe

BASIS: The only revision to the Operation Safety Requirements proposed during CY-1998 was for the deletion of requirements for use of the 207-A steam condensate retention basins. This change was submitted to DOE, approved by DOE, and has been incorporated into the SAR as revision 3-A. Therefore, these changes have already been implemented and are not included in this revision. No other OSR

**UNREVIEWED SAFETY QUESTION (USQ)
SCREENING AND EVALUATION**

1. Identification Number: LW-99-006

USQ SCREENING

Page 3 of 3

2. Title: 242-A Evaporator Safety Analysis Report, 1999 Annual Update

changes were proposed for implementation in CY-98, and no OSR changes are included in this revision. Therefore, these changes do not represent a change to an OSR or it's margin of safety as described in the Authorization Basis.

USQE #1 Teresa A. Campbell

USQE #2 Thomas M. Galioto

(Print Name)

(Print Name)

Teresa A. Campbell
Signature

Date: 3/15/99

Thomas M. Galioto
Signature

Date: 3-15-99

If there is a YES/MAYBE response to questions 1, 2, 3, or 4, then a USQ Evaluation must be completed.

The following guidance should be considered when completing this screening. This guidance should not be considered all-inclusive; additional factors may need to be considered depending on the nature of the proposed change.

Does the proposed change:

- 1) Modify, add, or delete a safety class function of a structure, system or component stated in the authorization basis?
- 2) Alter the design of a structure, system or component as described in the authorization basis?
- 3) Modify, add, or delete the description of operation, operating environment, or analyses of any system or component described in the authorization basis?
- 4) Modify, add, delete or conflict with any of the design bases stated in the authorization basis?
- 5) Conflict with the principle or general design criteria stated in the authorization basis?
- 6) Modify, add, or delete any plant design features described in the authorization basis?
- 7) Modify, add, or delete a flow diagram or facility drawing provided in the authorization basis?
- 8) Create the potential for new system or component interactions (e.g., seismic, electrical breaker coordination)?

242-A Evaporator Safety Analysis Report

T. A. Campbell

Waste Management Federal Services Hanford, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

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Abstract: This ECN fulfills the requirement for an annual update of the Safety Analysis Report as required by DOE Order 5480.23.

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RECORD OF REVISION		(1) Document Number HNF-SD-WM-SAR-023	Page 1 of 2
(2) Title 242-A Evaporator Safety Analysis Report			
CHANGE CONTROL RECORD			
(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release	
		(5) Cog. Engr.	(6) Cog. Mgr. Date
1	(7) Replace entire document	JC Lavender (sign. copy on file)	LE Johnson (sign. copy on file 11/13/92)
1-A	Incorporate ECN 169368 Replace pages 2-24 - 2-36, 4-70 - 4-84, 5-101, 6-47 - 6-105, 6-167, 9-20	JC Lavender (sign. copy on file)	LE Johnson (sign. copy on file 07/23/93)
1-B	Incorporate ECN 189851 Replace pages: Table of Contents viii, ix, xxx, 2-24 - 2-26, 4-4, 4-12, 6-7, 9-iii, 9-v, 9-19, 9-20, 9-55 - 9-84	JC Lavender (sign. copy on file)	LE Johnson (sign. copy on file 1/6/94)
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2-B	Incorporate ECN 189868. Replace Chapters 1, 8, 10, & 12; Replace Appendices 1A, 4A; Delete Appendices 8A - 8F, 12A Replace pages: Main Table of Contents i - xxviii, 2-i - 2-iv, 2-1 - 2-4, 2-15 - 2-18, 2-23 - 2-26, 2-31 - 2-36, 3-i - 3-xiv, 3-1 - 3-2, 3-47 - 3-48, 3-145 - 3-148, 3-215 - 3-218, 3-259 - 3-266, 4-i - 4-viii, 4-1 - 4-4, 4-11 - 4-12, 4-37 - 4-38, 4-41 - 4-44, 4-49 - 4-50, 4-77 - 4-80, 5-i - 5-iv, 5-vii - 5-viii, 5-3 - 5-4, 5-12 - 5-13, 5-53 - 5-106, 6-i - 6-viii, 6-25 - 6-26, 6-35 - 6-36, 6-43 - 6-44, 6-49 - 6-50, 6-61 - 6-64, 6-67 - 6-68, 6-77 - 6-82, 6-85 - 6-86, 6-93 - 6-94, 6-107 - 6-134, 6-137 - 6-138, 6-143 - 6-146, 6-149 - 6-154, 6A-7 - 6A-8, 7-i - 7-vi, 7-1 - 7-2, 7-5 - 7-6, 7-11 - 7-12, 7-17 - 7-18, 7-27 - 7-38, 7-45 - 7-50, 8-i - 8-viii, 8-1 - 8-82, 8A-1 - 8A-28, 8B-1 - 8B-16, 8C-1 - 8C-12, 8D-1 - 8D-18, 8E-1 - 8E-8, 8F-1 - 8F-6, 9-i - 9-viii, 9-1 - 9-2, 9-9 - 9-32, 9-61 - 9-64, 9-75 - 9-76, 9-83 - 9-84, 10-i - 10-viii, 10-1 - 10-68, 10A-1 - 10A-6, 11-i - 11-iv, 11-23 - 11-24, 12-i - 12-vi, 12-1 - 12-42	H Aguirre (sign. copy on file)	GW Gault (sign. copy on file 3/21/97)

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(2) Title 242A Evaporator Safety Analysis Report			
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242-A EVAPORATOR SAFETY ANALYSIS REPORT

1.0 INTRODUCTION AND GENERAL DESCRIPTION OF THE 242-A EVAPORATOR

This report provides a revised safety analysis for the upgraded 242-A Evaporator (the Evaporator). This safety analysis report (SAR) supports the operation of the Evaporator following life extension upgrades and other facility and operations upgrades (e.g., Project B-534) that were undertaken to enhance the capabilities of the Evaporator. The Evaporator has been classified as a moderate-hazard facility (Johnson 1990).

The information contained in this SAR is based on information provided by 242-A Evaporator Operations, Westinghouse Hanford Company, site maintenance and operations contractor from June 1987 to October 1996, and the existing operating contractor, Waste Management Hanford (WMH) policies. Where appropriate, a discussion addressing the U.S. Department of Energy (DOE) Orders applicable to a topic is provided. Operation of the facility will be compared to the operating contractor procedures using appropriate audits and appraisals.

The following subsections provide introductory and background information, including a general description of the Evaporator facility and process, a description of the scope of this SAR revision, and a description of the basic changes made to the original SAR.

1.1 INTRODUCTION

The Evaporator began operations in 1977 and was designed with a useful life of 10 years. The Evaporator concentrates low-heat-generating liquid wastes, reducing the volume and the number of double-shell tanks (DST) required to store the liquid wastes. A simplified schematic of the Hanford Site waste management and treatment system is shown in Figure 1-1, which illustrates the role of the Evaporator in the overall waste management scheme.

Based on 1987 waste volume projections, Westinghouse Hanford determined that the Evaporator would be required through the year 2000. To extend the operating life of the Evaporator, engineering studies and design efforts (i.e., Project B-534) were initiated in fiscal year (FY) 1987 to upgrade the facility. These design changes, including a new monitoring control system and vessel ventilation system, were intended to extend the operating life of the Evaporator by 10 years. Additionally, a major construction outage to incorporate the B-534 design changes was scheduled for FY 1990 (November 1989 through October 1990).

The Evaporator was placed in temporary standby in April 1989 when Westinghouse Hanford determined that 'listed' dangerous waste may have been introduced into the DSTs and, consequently, into the Evaporator process condensate. The term "Dangerous Waste" is a Washington State Department of

Ecology (Ecology) term similar to "Hazardous Waste" defined by the U.S. Environmental Protection Agency (EPA). A waste is considered 'listed' if it contains spent organic solvents, such as acetone, which are listed in the EPA or Ecology regulations. The process condensate (PC) from the Evaporator was discharged into the 207-A South Retention Basins and then to the soil column via the 216-A-37-1 Crib. Regulations require that waste (such as Evaporator PC) derived from the treatment of listed dangerous waste must also be considered listed, unless a petition has been granted by the EPA delisting the waste. This requirement, along with the potential presence of listed waste in the DSTs (a source of feed to the Evaporator), resulted in concerns that the PC previously discharged to the 216-A-37-1 Crib may have been regulated as a dangerous waste. Section 3004(c) of the *Resource Conservation and Recovery Act of 1976* (RCRA 1976) prohibits discharge of liquid hazardous waste (listed and characterized) into landfill units such as cribs. As a precautionary measure, the Evaporator was temporarily removed from service pending resolution of the potential listed waste issue.

As a result of subsequent meetings with the Washington State Department of Ecology (Ecology), Westinghouse Hanford reevaluated the potential toxicity of the PC stream based on the presence of listed dangerous wastes, such as acetone. The Westinghouse Hanford evaluation indicated that the PC stream should be regulated as a toxic dangerous waste because of the presence of listed dangerous wastes and ammonia, and it was decided that immediate steps should be taken to ensure the PC was managed as a regulated dangerous waste stream, including prevention of any further discharges into the 216-A-37-1 Crib.

While the Evaporator was in standby, pending the resolution of the RCRA listed dangerous waste issues, Project B-534 upgrades were initiated. The B-534 upgrades and the RCRA shutdown are not directly related; however, because the B-534 project required an Evaporator outage, the RCRA shutdown was used as a window for the B-534 upgrades. After several schedule changes, the B-534 upgrade was completed in fiscal year 1993.

The operation of the Evaporator and the treatment and disposal of the Evaporator PC are key activities in supporting the goals and milestones defined in the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1994). Retention basins are constructed and in operation to support the Evaporator. Treatment facilities were constructed and in operation with the capability to reduce the concentration of ammonia, residual organics, and dissolved radionuclides in the Evaporator PC to levels that permit direct disposal of the treated liquid effluent to the soil column in the 200 Areas. The restart date for the 242-A Evaporator was April 1994.

1.2 GENERAL DESCRIPTION OF THE EVAPORATOR FACILITY

The Evaporator is located in the 200 East Area of the Hanford Site (Figures 1-2 and 1-3). Four principal structures make up the Evaporator facility:

- 242-A Building, the main process building
- 242-AB Building, the adjacent control room building
- 242-A-81 Building, the water services building

of eight times a year. High wind speeds have the potential to impact the Evaporator adversely. However, the normal wind load design is based on a 113 km/h (70 mi/h) wind speed (Section 4.2.1.1). Damage from high winds and duststorms is not expected to affect Evaporator operations. Additionally, in accordance with the Hanford *Standard Design Criteria* (SDC-4.1) (DOE-RL 1989), the effects of wind-generated missiles are to be accounted for in the design of Safety Class structures only. Because there are no Safety Class structures associated with the Evaporator, this criterion is not applicable.

2.1.1.1.2 Thunderstorms. The HMS reports the average year has 10 thunderstorm days. Thunderstorms are considered severe weather when accompanied by wind gusts >90 km/h (56 mi/h) or hail with a diameter ≥ 1.91 cm (0.75 in.). Although very rare, severe weather thunderstorms have occurred at the Hanford Site. However, damage from thunderstorms is not expected to hinder operation of the Evaporator.

2.1.1.1.3 Lightning Strikes. Of the lightning strikes reported at the Hanford Site, only 20% have been cloud-to-ground discharges. The only impact considered to affect the Evaporator is that of range fires from lightning strikes during the summer months. Range fires are discussed later in this section.

2.1.1.1.4 Tornadoes and Missiles. On the average, Washington State experiences just over one tornado a year. Since 1961, tornadoes and funnel clouds have been observed three times from the Hanford Site. According to SDC-4.1 (DOE-RL 1989), tornado loadings are only applicable for reactor facilities. Additionally, the effects of wind-generated missiles are only to be accounted for in the design of Safety Class structures. Because there are no Safety Class structures associated with the Evaporator, this criterion is not applicable.

2.1.1.1.5 Snow, Rain, and Volcanic Ash. The SDC-4.1 (DOE-RL 1989) requires snow loads to be determined in accordance with American National Standards Institute (ANSI) A58.1 (ANSI 1982a), which directs consideration of a 15-lb/ft² snow load. The SDC-4.1 (DOE-RL 1989) does not require any additional load for ashfall.

2.1.1.1.6 Floods. The sources of flood water considered were river flooding, intense precipitation flooding, and dam failure flooding. The Evaporator is not sited in wetlands, a coastal high-hazard area, or a 100-yr flood plain. The Evaporator lies at an elevation higher than any credible flood. Also, in accordance with SDC-4.1 (DOE-RL 1989) flood protection requirements do not apply.

2.1.1.1.7 Earthquakes. The primary seismic hazard is earthquake ground motion, which is a potential hazard to the Evaporator. Other earthquake hazards are fault displacement, liquefaction, seismic-induced slope instability, and ground settlement. As discussed in Chapter 3.0, these hazardous conditions are not present at the Evaporator site. U.S. Department of Energy (DOE) Order 6430.1A requires the use of basic seismic parameters derived from DOE site-specific hazard model studies that are documented in *Natural Phenomena Hazards Modeling Project: Seismic Hazard Models for Department of Energy Sites* (Coats and Murray 1984). In applying Coats and Murray (1984), specific guidance on relating frequency of occurrence to facility use category levels is to be in accordance with Kennedy et al.

2.0 SUMMARY SAFETY ANALYSIS

Inherent in the operation of the 242-A Evaporator (the Evaporator) are certain hazards, some of which are common to chemical plants and industrial facilities, and some of which are unique to the Evaporator given its specific design and operation. Associated with these hazards are risks to workers, the general public, or the environment.

The following sections summarize the safety aspects considered in this safety analysis report (SAR). Included is a description of how operation of the Evaporator will ensure the protection of operating personnel and the public. A summary of the Evaporator site analysis with regard to natural phenomena (such as earthquakes or severe weather), site characteristics affecting the safety analysis, and effects of nearby facilities on the safe operation of the Evaporator are contained in this chapter. The radiological impact to onsite and offsite receptors from abnormal and normal operations as well as postulated accidents is summarized. Because this chapter is a summary only of detailed analyses described in other chapters, the reader is referred to other areas of this SAR for more detailed information.

2.1 SITE ANALYSIS

Analysis of the Evaporator site is presented in detail in Chapter 3.0. This section summarizes the site analysis with regard to natural phenomena, characteristics affecting the safety analysis, and the effects of nearby facilities. Natural phenomena include such events as severe weather, floods, and earthquakes. Allowances have been made in the design and operation of the Evaporator to ensure that natural phenomena do not prevent safe operation of the Evaporator. The location of the Evaporator and its local meteorology play a role in the potential transport of accidental releases to onsite and offsite receptors. Finally, the Evaporator is not an isolated system, and the actions of nearby facilities may have an effect on the safe operation of the Evaporator. Because several other nuclear facilities are located in the 200 East Area, their safety analyses offer useful information about site characteristics and the hazards of nearby facilities. Some of this information is applicable to the Evaporator and is presented here.

2.1.1 Natural Phenomena

The natural phenomena that may adversely affect the safe operation of the Evaporator are summarized in this section. They are severe weather, including high winds and wind-generated missiles, tornadoes, floods, earthquakes, snow, rain, volcanic ash, and range fires.

2.1.1.1 Severe Weather. Severe weather phenomena include high winds (duststorms), thunderstorms, lightning strikes, and tornadoes.

2.1.1.1.1 High Winds (Duststorms). High winds and duststorms are the severe weather phenomena that most frequently occur at the Hanford Site and have the greatest impact. Duststorms occur when winds >29 km/h (18 mi/h) resuspend dust from various sources into the air. The Hanford Meteorological Station (HMS) reports that duststorms occur at the Hanford Site on the average

This accident results in a 50-yr committed dose equivalent of 3.6 rem to the maximum onsite individual and 8.5×10^{-2} rem to the maximum offsite individual.

2.4.2.4 Preliminary Hazards Analysis Hazard Category: Radiological Hazards. The following summarize the DBAs addressed in Chapter 9.0, Section 9.3.4 for radiological hazards.

2.4.2.4.1 Overflow into Tank TK-C-100 Through Foaming. This event occurs when the slurry boils rapidly causing foaming that overwhelms the demister pads and is carried over to the condenser. Rapid boiling can occur when a vacuum is applied to heated slurry in the Evaporator body. Increasing the vacuum lowers the boiling point of the slurry below the temperature of the slurry. In this scenario, the feed slurry is at a high temperature, either from the feed tank or from being recycled. The operators apply vacuum to the evaporator vessel. For some reason, the interlocks (14 and 20) on valve HV-EC1-1 have been overridden and the valve has been closed manually, which allows the vacuum to be established and leads to the rapid boiling with subsequent foaming and carryover of process slurries.

No material is released to the environment. The release source term referenced here is the material released to the tank that results in ionizing radiation exposure to personnel in proximity to the tank.

No impact to the environment or to onsite or offsite individuals occurs as a result of this event.

2.4.2.4.2 Overflow into Tank TK-C-100 Through Overfilling. In the event of Evaporator system upsets, the loss of power, equipment failures, or the improper control of the operating system, it is conceivable that process solutions could overflow the evaporator vessel and flow into the condensate collection tank, TK-C-100.

No release of material to the environment occurs as a result of this event. Exposure of an operator to ionizing radiation occurs as a result of material being collected in tank TK-C-100. Additional features reduce the likelihood of this event happening to a value that is considered highly unlikely.

No dose consequences to onsite or offsite individuals are anticipated from this accident.

2.4.2.5 Preliminary Hazards Analysis Hazard Category: Industrial Hazards. The following summarize the DBAs addressed in Chapter 9.0, Section 9.3.4 for industrial hazards.

2.4.2.5.1 Release of Ammonia to the Environs. An accident scenario is theorized in which an error in blending neutralized cladding removal waste (NCRW) with nonammonia-bearing wastes leads to a higher-than-expected ammonia concentration in tank TK-241-AW-102. The NCRW was selected for analysis over ammonia scrubber feed (ASF) because it typically has a higher ammonia content. A failure to detect or correct the blending error is assumed to occur such that the contents of tank TK-241-AW-102 are fed to the Evaporator, resulting in elevated ammonia releases. A failure of routine sampling to detect this error at an early stage allows the release to continue for several hours.

Given nominal feed and boiloff rates 300 and 150 L/min (80 and 40 gal/min), respectively, a 0.4-M feed concentration, and conservatively assuming that all of the ammonia in the feed is converted to ammonia gas in the Evaporator (as opposed to an expected 90%), the estimated ammonia concentration released out the vessel vent stack is 0.006 kg/s (0.013 lb/s).

Ammonia concentrations 100 m from the facility are calculated to be 8.3 ppm onsite and 0.11 ppm offsite. These concentrations are well below the TLV-TWA concentration of 25 ppm for ammonia. Therefore, no adverse consequences are anticipated for this accident.

2.5 SAFETY EQUIPMENT LIST FOR SYSTEMS AND STRUCTURES

Chapter 4.0, Section 4.4 identifies those hardware systems and structures or safety systems, structures, or components (SSCs), relied on to protect the public, onsite personnel, and the environment from postulated accidents associated with 242-A Evaporator operation. Potential safety SSCs are identified during the hazards and accident analysis process. The selection of a final list of safety SSCs is an iterative process involving the accident analysts and facilities personnel. That is, unmitigated accidents are analyzed and the potential consequences are reviewed to determine onsite and offsite impacts. If the impacts exceed consequence evaluation guidelines (see HNF-PRO-704, "Hazard and Accident Analysis Process") facilities personnel are consulted to identify potential SSCs to mitigate or prevent the accident. This process is repeated until the potential consequences meet or are below the consequence evaluation guidelines. The SSCs relied upon during this process, are called safety SSCs. The safety SSCs are designated Safety Class (SC), Safety Significant (SS), or General Services (GS) using the criteria shown in Table 4-25. Safety Class SSCs are SSCs required to prevent or mitigate radiological (airborne or liquid) releases to the public that would otherwise exceed the offsite radiological risk guidelines, or prevent an accidental nuclear criticality. Safety Significant SSCs are those SSCs required to prevent or mitigate releases of radiological materials to onsite workers and toxic chemicals to the offsite public and onsite workers, including SSCs that are judged to substantially contribute to defense-in-depth. General Service SSCs are those not designated as SC or SS. Only those SSCs designated as SC and SS are identified and compiled in a facility Safety Equipment List (SEL).

The original SEL for the Evaporator was based on the accident analysis contained in Chapter 9.0 of this SAR. However, since this SAR was prepared, the consequence evaluation guidelines and safety SSC designations and selection criteria have changed (see Table 4-25). In accordance with HNF-PRO-516, "Safety Systems, Structures, and Components," for facilities with existing safety analysis and safety equipment lists, the facility is required to update the existing SEL using the revised SSC selection criteria and new SSC designations.

As defined in HNF-PRO-516, SSCs originally classified as Safety Class 1 are comparable to SC, SSCs originally classified as Safety Class 2 are comparable to SS, SSCs originally classified as Safety Class 3 or 4 are comparable to GS. There were no Safety Class 1 SSCs identified in the original SEL. An updated SEL has been prepared for the Evaporator (Wahlquist 1997) using the new nomenclature and requirements discussed above. The

3.2.1.11 Waste Receiving and Processing Facility The WRAP Facility is located in the 200 West Area, about 11 km (7 mi) west of the 242-A Evaporator. The functions of the WRAP Facility are to receive, inspect, repackage, volume reduce, treat, and certify solid contact-handled low-level and low-level mixed wastes. The main mission of WRAP is to prepare contact-handled transuranic (TRU) wastes for shipment to disposal at the Waste Isolation Pilot Plant (WIPP) in New Mexico. The WRAP Facility has shipping and receiving capabilities, non-destructive assay and examination capabilities, as well as two glovebox lines for examination, sorting, and repackaging contact-handled TRU wastes. The facility also has a third glovebox line for treatment of certain wastes, including amalgamation, solidification, and absorption treatments. The WRAP Facility also includes a supercompactor for minimizing low-level waste volumes.

3.2.1.12 Central Waste Complex The Central Waste Complex (CWC) is located in the 200 West Area adjacent to the WRAP Facility and approximately 11 km (7 mi) west of the Evaporator. The CWC provides RCRA-compliant storage capabilities for solid wastes at the Hanford Site. The CWC consists of storage buildings specifically-designed for various types of solid wastes that will eventually be treated and/or disposed. The majority of the material stored at CWC is contact-handled TRU and mixed TRU wastes. The CWC includes structures to store a number of wastes, including Mixed Waste Storage Buildings, Low-Flashpoint Mixed Waste Storage Modules, Alkali Metal Waste Storage Modules, the 2727-W Product Sodium Storage Building, and a Special-Case Waste Storage Pad. WRAP also includes a Waste Receiving and Staging Area and limited repackaging capabilities.

3.2.1.13 Nonnuclear Industrial Facilities No commercial refineries, major oil, ammunition, or explosive storage facilities are located within 32 km (20 mi) of the Evaporator. The nearest natural gas transmission pipeline is ~48 km (~30 mi) away. The distance of these facilities from the Evaporator makes the hazard from explosions or fires at these installations almost nonexistent.

Other nonnuclear industrial facilities, located in the 200 East Area, with the potential to impact Evaporator operations are those facilities that provide steam and raw water. Raw water is supplied to the 200 East Area by the 282-E Building located ~1.450 m (0.9 mi) west-southwest of the Evaporator. The Evaporator facility provides equipment to regulate the pressure of the supplied water. No impacts have been identified for this facility that could adversely affect the safe operation of the Evaporator. A complete loss of water, however, may require a shutdown of the Evaporator.

Steam is provided by a diesel-fuel powered package boiler system located in the 242-BA Boiler Annex that is dedicated to 242-A Evaporator service (see Section 5.4.5). The package boiler and support facilities are sited such that the a severe overpressurization explosion of the boiler would have no impact on safe operation of the Evaporator (Huang 1997). No other nonnuclear industrial facilities have been identified that may impact Evaporator operations.

3.2.2 Potential Hazards to the 242-A Evaporator

Potential hazards to the Evaporator from nuclear and nonnuclear activities on the Hanford Site are examined under the following four classifications:

- Nonreactor nuclear facilities within a 8-km (5-mi) radius of the Evaporator, which includes all activities conducted at the 200 Areas.
- Nuclear reactors within a 80-km (50-mi) radius of the Evaporator.
- Transportation facilities within a 32 km (20 mi.) radius of the Evaporator.
- Military facilities within a 80 km (50 mi.) radius of the Evaporator.

3.2.2.1 Hazards to the 242-A Evaporator from Nonreactor Nuclear Facilities

Currently operating facilities at the 200 East and 200 West Areas were screened to select specific facilities that present the most risk to safe operation of the Evaporator. The SARs and accident analyses prepared for these facilities were reviewed to determine possible hazards, such as radiological doses to personnel resulting from direct radiation, release of airborne radioactivity, or exposure to toxic chemicals. Facilities that easily met risk acceptance criteria were eliminated from further discussion in this section. Considered, but not included, were the 200 East Area Burial Grounds, TEDF, and the 241-AP Tank Farm. In the 200 West Area, T Plant, Transuranic Waste Storage and Assay Facility (TRUSAF), REDOX, the 222-S Laboratory, U Plant, and the groundwater treatment system (GTS) were considered and eliminated. The location of 200 East and West Area facilities relative to the Evaporator are shown in Figures 3-7 and 3-23. The specific facilities investigated include the following: PUREX; Building 275-EA; GTF; PFP; WESF; DSTs; SSTs; the Aging Waste Facility; 244-AR Vault; 241-A-350 catch tank; 204-AR Unloading Station; B Plant; the Liquid Effluent Retention Facility (LERF); the 200 Area Effluent Treatment Facility (ETF); Waste Receiving and Processing Facility; and the Central Waste Complex.

3.2.2.1.1 Plutonium-Uranium Extraction Plant Classes of hazards that potentially can arise from PUREX Plant operation and that can have significant consequences are fires, loss of filtration capability with release of aerosols from stacks, and criticality in equipment, vessel sumps, and piping as identified in WHC-SD-HS-SAR-001 (WHC 1990b). The postulated PUREX Plant accidents having the most severe radiological consequences to a maximally exposed individual are associated with a cooling coil leaking into the 216-A-25 Pond and a fission product release from the PUREX pipe and operating gallery. The coil leak accident is estimated to result in a 50-yr whole-body dose commitment of ~2.2 rem to the maximum onsite individual. The pipe and operating gallery radiological release is estimated to result in 50-yr whole-body dose commitments of 0.76 rem. Even if the maximally exposed onsite individual were an Evaporator staff member, these doses are considerably lower than the annual committed effective dose equivalent (CEDE) limit of 5 rem that is allowed for radiological workers authorized unescorted access to radiological areas (*Hanford Site Radiological Control Manual*, HSRCM-1). Thus, no postulated PUREX Plant accident should impair Evaporator personnel in the performance of required safety actions.

observed that several potential accidents in SSTs could exceed DOE occupational exposure limits, including flammable gas deflagration and organic salt-nitrate reactions. SSTs vulnerable to flammable gas deflagrations include one or more tanks in the 241-A, -AX, -S, -SX, -T, and -U Farms. SSTs vulnerable to organic-nitrate reactions include one or more tanks in the 241-A, -AX, -B, -C, -S, -SX, -T, -TX, -TY, and -U Farms. Radiation doses to onsite personnel were calculated to be 990 rem for flammable gas deflagration in an SST that leads to tank dome collapse and 8800 rem for an organic-nitrate reaction. Since the 241-A and 241-AX farms are located close to the 242-A Evaporator, the potential exists for both accident scenarios to affect the safe operation of the Evaporator.

DST Farms Radioactive waste designated for storage in DSTs is segregated and concentrated by type to ensure safe and economical operational processing of their material. Liquid wastes are transferred among numerous storage tanks, processing facilities, and related operational structures such as the vaults and Evaporator facilities (see Figure 3-24).

Some DSTs are located as close as ~30 m (~100 ft) from the Evaporator. An accident involving a DST could impact the Evaporator given its relatively close proximity. The worst-case accidents involving DSTs that were examined in the *TWRS BIO* were flammable gas deflagrations and organic-nitrate fires. These events could result in failure to confine the wastes as well as significant aerosolization dispersion of released radioactive and hazardous chemical materials. Radiation doses to onsite personnel were calculated to be 820 rem for flammable gas deflagration in a DST leading to dome blowout and 8800 rem for an organic-nitrate reaction in a DST. Therefore, the potential exists for accidents at TWRS Facilities to affect the safe operation of the Evaporator.

Aging Waste Facility The Aging Waste Facility (AWF) is composed of four DSTs in the 241-AY and 241-AZ Tank Farms located in the 200 East Area. The tanks are situated ~200 m (~660 ft) north of the Evaporator. These four tanks, in conjunction with their supporting systems, allow for the safe storage of high-heat generating liquid radioactive waste. The aging waste tanks are currently among the least vulnerable tanks to flammable gas deflagration or organic-nitrate reaction accidents. They are addressed specifically here because they are located in close proximity to the Evaporator.

The worst-case credible accident that can be postulated for the Aging Waste Facility occurs as a result of a "bump." A "bump" is a pressurization above atmospheric pressure of an AWF tank dome vapor space due to the generation and rapid expansion of steam in the tank waste (radioactive solids and liquids stored in the tank). According to the *TWRS BIO*, this accident would result in a dose to the maximally exposed onsite individual of 250 rem. Since the Evaporator is located ~200 m (~660 ft) from the Aging Waste Tanks, doses to Evaporator personnel will be lower. However, the dose to Evaporator personnel would likely be greater than DOE's annual occupational exposure limit, thus creating the possibility that a tank bump in an AWF tank could adversely affect operations at the Evaporator.

244-AR Vault The 244-AR Vault is located north of the PUREX facility and ~150 m (~500 ft) west of the Evaporator in the 200 East Area (see Figure 3-5).

The 244-AR Vault provided for the safe and efficient transfer of PUREX-generated waste between the tank farms and the B Plant. The waste consisted of cladding removal waste (CRW), cesium, and strontium from the PUREX facility to be transferred to the B Plant and transuranic (TRU) waste enroute from B Plant and the WESF to the 200 East Area Tank Farms.

Although the 244-AR Vault is being cleaned and readied for decontamination and decommissioning, the TWRS BIO postulated and analyzed a maximum credible accident. The maximum credible accident postulated for the 244-AR Vault, as described in the *TWRS BIO*, involves a pressurized spray leak that could occur during a waste transfer. The spray leak accident scenario in the *TWRS BIO*, which was assumed to occur in a valve pit, was stated to bound or represent spray leaks that may occur in process pits, diversion boxes, vaults used in waste transfers (e.g., 244-AR and CR vaults), flush pits, cleanout boxes, and temporary overground waste transfer lines. With the *TWRS BIO* controls in place, the onsite radiation doses from a spray leak in the 244-AR Vault would be less than or equal to about 4.1 rem. The onsite consequences of this accident are close to the annual whole-body dose limits for radiological workers given in HSRCM-1 and may require immediate shutdown of the Evaporator.

241-A-350 Catch Tank The 241-A-350 catch tank and lift station is associated with the 241-A Tank Farm and is located southeast of the 241-A-106 waste storage tank, ~100 m (~330 ft) northwest of the Evaporator. The A-350 vault, receiver tank, and associated equipment receive drainage from 241-A Tank Farm valve pits, flush pits, clean-out boxes, and other such systems. The drainage is in turn transferred to the double-shell waste storage tank 241-AW-102.

Pressurized spray leaks are the maximum credible accidents postulated in the *TWRS BIO* that may occur at the A-350 Catch Tank. The onsite radiation dose calculated for a spray leak was 4.1 rem (see above discussion of accidents at 244-AR Vault). The onsite consequences of this accident are close to the annual whole-body dose limits for radiological workers given in HSRCM-1 and may require immediate shutdown of the Evaporator.

204-AR Waste Unloading Facility The 204-AR Waste Unloading Facility (204-AR facility) is located ~180 m (~600 ft) west of the Evaporator in the 200 East Area. The 204-AR facility receives liquid wastes generated by the Hanford contractors from railroad tank car transports for direct transfer to underground waste storage tanks and subsequent processing in the Evaporator. The 204-AR facility provides for agitation, neutralization, nitrite additions, and sampling of tank car wastes. Hydraulic sluicing of the tank cars for residual solids removal is also performed at the 204-AR facility.

The *TWRS BIO* analyzed specific accident scenarios for 204-AR that involve liquid releases from failed railcars or tank trailers. The leaks were assumed to occur both inside and outside the 204-AR Waste Unloading Facility. The resulting dose to the maximally-exposed onsite individual was calculated to be 0.85 rem. This value is less than allowable DOE annual occupational exposure limits, and this accident would have no impact upon Evaporator operations. The 204-AR facility would also be susceptible to pressurized

spray leaks. As described above, the onsite exposures calculated in the TWRS BIO for such events were 4.1 rem. Spray leaks in the 204-AR Waste Unloading Facility, similar to spray leaks in the 204-AR Vault and 241-A-350 Catch Tank, may require immediate shutdown of the Evaporator.

3.2.2.1.7 B Plant Facility The B Plant Facility in the 200 East Area is undergoing preparations for transition to a shutdown status. Currently, it is also providing essential support to WESF. The B Plant Facility is ~1.6 km (~1 mi) west of the Evaporator.

The most credible accident at B Plant, postulated in WHC-SD-WM-TI-385, Rev. 0, *B Plant Preliminary Accident Analysis*, (Marusich 1991) results from the simultaneous occurrence of (1) a solvent fire in which hot gases from a fire heat filters, driving off material on the filters, and (2) a blowback of process solution into the pipe gallery from tank pressurization. The probable dose from this worst-case scenario is a 5-rem whole body dose to the maximum onsite individual. Such an accident scenario may require the safe shutdown of the Evaporator.

3.2.2.1.8 Liquid Effluent Retention Facility The LERF is located 1.2 km (0.7 mi) north-northeast of the Evaporator. The LERF provides interim retention capability to store 88.5×10^6 L (23.4 Mgal) of effluent process condensate (PC) waste from the Evaporator.

All postulated offsite and onsite radiological and toxicological consequences from normal and abnormal operations, or accidental causes as described in HNF-SD-LEF-ASA-002, Rev. 1, *242AL Liquid Effluent Retention Facility Auditable Safety Analysis* (Galioto 1997), were found to be insignificant and acceptable. Therefore, the only impact the LERF facility would have upon Evaporator operations is non-safety related. That is, the Evaporator would be shutdown when capacity loading is reached at the retention basins.

3.2.2.1.9 200 Area Effluent Treatment Facility The ETF is located approximately 1.3 km (0.8 mi) north-northeast of the Evaporator. The ETF treats, and disposes of liquid effluent from various facilities, including, but not limited to, liquids generated at PUREX, contaminated N reactor fuel storage basin water, and water stored in LERF.

The maximum credible accident at ETF, as described in HNF-SD-ETF-ASA-001, Rev. 3, *200 Area Effluent Treatment Facility Auditable Safety Analysis Report*, (FLYCKT 1997) involved a spill from the hydrogen peroxide tank. The calculated consequence of this accident scenario was a hydrogen peroxide concentration at the maximum onsite individual location (i.e., 100 m from the ETF) of 8.9 parts per million (ppm), well below the risk evaluation guidelines for a release of this chemical. Therefore, accidents at the ETF would have no significant adverse effect on Evaporator operations.

3.2.2.1.10 Waste Receiving and Processing Facility The WRAP Facility is located in the 200 West Area about 11 km (7 mi) west of the Evaporator. The WRAP Facility functions include receipt, inspection, repackaging, volume reduction, treatment, and certification of solid wastes. The WRAP Facilities capabilities include shipping and receiving of over-the-road transportation packages, non-destructive assay and examination, and supercompaction. The

facility consists primarily of two glovebox lines for examination, sorting, and repackaging contact-handled TRU wastes and a third glovebox line for treatment of certain wastes, including amalgamation, solidification, and absorption treatments.

The maximum credible accidents postulated in the facility's authorization basis, HNF-SD-W026-ASA-001, Rev. 0, *Waste Receiving and Processing Facility Module 1 Auditable Safety Analysis* (Bottenus 1997), are drum handling accidents that lead to explosions and fires involving waste containers. Inadvertent mixing of incompatible chemicals and exposure of pyrophoric or combustible materials to an ignition source were the two potential accident scenarios that could result from events that involve damage to waste containers. The onsite radiological consequences of fires and explosions involving waste containers were 0.034 and 0.011 rem, respectively. Neither of these potential accidents could adversely affect the safe operation of the Evaporator.

3.2.2.1.11 Central Waste Complex The Central Waste Complex (CWC) is located in the 200 West Area adjacent to the WRAP Facility and approximately 11 km (7 mi) west of the Evaporator. The CWC provides RCRA-compliant storage capabilities for solid wastes at the Hanford Site in various storage buildings specifically-designed for various types of solid wastes that will eventually be treated and/or disposed.

The maximum credible accident postulated in HNF-SD-WM-ISB-007, Rev. 1, *Central Waste Complex Interim Safety Basis* (Ames and Bendixsen 1997), results from a truck collision with a storage building in the CWC. A truck driver was postulated to lose control of a truck causing it to collide with and penetrate the outer structure of the building. The truck continues on to strike the outer row of storage containers within the building. In addition, the fuel carried by the truck was assumed to spill and ignite, exposing the stored wastes to a pool fire. The consequences of this event were calculated to be 57 rem to the maximum onsite individual. Since the Evaporator is located further away from CWC than the onsite individual assumed in the HCF-SD-WM-ISB-007, Rev. 1, the doses at the Evaporator will be a small fraction of the 57 rem calculated for the CWC onsite individual. Therefore, the CWC is not anticipated to have significant impacts on the safe operation of the Evaporator or it's operations personnel.

3.2.2.2 Hazards to 242-A Evaporator from Nuclear Reactors There are two operating nuclear reactors and two nuclear reactors under deferred construction on the Hanford Site. The operating reactors (shown in Figure 3-3) are the FFTF and WNP-2 nuclear reactor facilities. The two nuclear reactors under deferred construction are the WNP-1 and WNP-4 plants. The Critical Mass Laboratories, located in the 209-E Building north of the PUREX Plant is presently being used as a Tank Farm office area. The N Reactor is in a shutdown mode (see Figure 3-20).

The FFTF, currently on standby status, is a 400 MW, sodium-cooled, mixed-oxide fueled breeder reactor that is used for fuel and material testing. It is located in the 400 Area, 7.2 km (4.5 mi) east of the nearest Hanford Site boundary. It is about 18.5 km (11.5 mi) southeast of the Evaporator.

plots the respective probabilities of given levels of ground acceleration being exceeded in any single year. It is noteworthy that structures, systems, and components at the Hanford Site must be able to withstand seismic events of varying intensities. The level of intensity that any given structure, system, or component must withstand is dependent upon its safety classification.

Kennedy et al. (1989) provide guidance, the object of which is to ensure compliance with DOE earthquake resistance requirements (see Section 4.2.5.2). Kennedy et al. also provide guidance relative to seismic design requirements for facility subsystems such as piping and equipment (see Section 4.2.5.3).

3.6.4.10 Static Analysis. Static analysis tests of such parameters as settlement performance, shrinkage performance, and soil compression are discussed in Sections 3.6.4.2 and 3.6.4.4.

3.6.4.11 Criteria and Design Methods. This section is not applicable to this FSAR. No criteria or design methods were developed to accommodate subsurface material stability. This is not a concern at this facility.

3.6.4.12 Techniques to Improve Subsurface Conditions. Techniques to improve subsurface conditions are not applicable at the 242-A Evaporator Site.

3.6.5 Slope Stability

The Evaporator is on level terrain and there is no evidence of landslides. The closest areas where large landslides have occurred are the northern flank of Rattlesnake Mountain at a distance of ≈ 10 km (≈ 6.2 mi), the northern flank of Yakima Ridge at ≈ 15 km (≈ 9.4 mi), the northern flank of Umtanum Ridge at ≈ 5 km (≈ 3 mi), and along the east bank of the Columbia River at White Bluffs at ≈ 16 km (≈ 10 mi) northeast of the Evaporator.

There are no nearby or adjacent unstable slopes that may fail and constitute a hazard. Moreover, the relatively dry soils at the Evaporator are typically granular and relatively resistant to failure from sliding.

3.6.6 Geochemical Characteristics

This information is provided in Section 3.6.1.2.2.2. Additional mineralogical analysis is provided in Tallman et al. (1979, App. E).

3.6.7 Natural Resources

3.6.7.1 Geologic Resources. See Section 3.1.4.5.

3.6.7.2 Water Resources. See Section 3.4.1.

3.7 SUMMARY OF CONDITIONS AFFECTING 242-A EVAPORATOR OPERATING REQUIREMENTS

The Evaporator is located near the center of the Hanford Site ≈ 11 km (≈ 7 mi) from the Columbia River. Activities on the Hanford Site are strictly controlled by the DOE. A hazards review of the Evaporator has shown that none of its systems designs will compromise the safety of individuals or undermine environmental protection standards (DOE-RL 1990).

There are a number of other reasons for selecting the present site for continued operation of the Evaporator. The information presented previously in this chapter indicates that the soils and sediments that underlie the Evaporator are ≈ 110 to 120 m (≈ 350 to 400 ft) thick and overlay a volcanic basalt volcanic sequence that is $\approx 3,200$ m ($\approx 10,500$ ft) thick. The sediments in question tend to be quite compact and, therefore, have a rather high loadbearing capacity. Moreover, the water table under the Evaporator is at a level ≈ 100 m (≈ 300 ft) below the facility. There is consequently no credible seismic event that would pose a liquefaction hazard for the facility.

3.7.1 National Environmental Policy Act Documentation

Efforts made toward restarting the 242-A Evaporator have proceeded on the assumption that existing National Environmental Policy Act documentation deals adequately with all relevant regulatory requirements. The 242-A Evaporator is included in the *Tank Waste Remediation System, Hanford, Site, Richland, Washington, Final Environmental Impact Statement*, (DOE/EIS -0189) (DOE 1997), which covers waste cleanup on the Hanford Site. Moreover, a memorandum to file was written for Project B-534 in order to document the ongoing upgrade, life extension, and future operation of the facility in question (Marchetti 1991).

Schedules for the 242-A Evaporator start-up are currently being prepared on the assumption that Start-up and Operations are presently covered within the purview of the existing Waste Operations Final Environmental Impact Statement delineated above.

3.8 REFERENCES

3.8.1 Documents

- ACGIH, 1987, *Threshold Limit Values and Biological Exposure Indices for 1987-1988*, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.
- Ames, R. R., and R. B. Bendixsen, 1997, *Central Waste Complex Interim Safety Basis*, HNF-SD-WM-15B-007, Rev. 1. Fluor Daniel Northwest, Inc. Richland, Washington.
- Baker, V. R., 1973, *Paleohydrology and Sedimentology of Lake Missoula Flooding in Eastern Washington*, Special Paper 144, Geologic Society of America, Boulder, Colorado.

The principal radionuclides present in the feed are ^{90}Sr and ^{137}Cs . Minor concentrations of ^{106}Ru -, ^{106}Rh -, ^{125}Sb -, and other fission products and trace quantities of ^{239}Pu are also present. Table 4-6 presents the concentrations of radionuclides in evaporator feed derived by the process flowsheet.

4.1.1.2 Feed Specifications. Feed specifications have been established to

- Maintain process operability and safety
- Ensure the process condensate meets Liquid Effluent Retention Facility (LERF) acceptance limits
- Limit volatile organic emissions to ensure the Hanford Site does not exceed 40 CFR 265, Subpart AA limits.

Feed specifications to maintain process operability and safety are shown in Table 4-7. The limits and the basis for these specifications associated with each specification is provided in *242-A Evaporator Data Quality Objectives*, HNF-SD-WM-DQO-014, Rev. 2 (Von Barga 1998).

Limits on the concentration of specific organics in the evaporator feed are established for two separate purposes: (1) compliance of the process condensate with LERF waste acceptance criteria, and (2) compliance of the vessel ventilation system exhaust with 40 CFR 265, Subpart AA limits. The most restrictive of these limits for a given organic constituent is limiting.

The feed concentration limits to ensure compliance with LERF waste acceptance criteria are described in HNF-SD-WM-DQO-014, Rev. 2 (Von Barga 1998). The organic feed concentration limits to ensure compliance with 40 CFR 265, Subpart AA limits are also present in (Von Barga 1998).

4.1.2 Plant Products and Byproducts

The Evaporator can produce three products: (1) double-shell slurry (DSS) and (2) DSSF or (3) DDSSF if the ending slurry concentration is limited to the dilute form. These products, collectively referred to as 'slurry', are defined by their relationship to the sodium-aluminate boundary (see Figure 4-1). When this boundary is crossed, aluminate solids (specifically sodium-aluminate crystals) precipitate out of solution and form DSS, the most concentrated product the Evaporator can produce. Although sodium-aluminate crystals represent only a small percentage of the solids in DSS, they greatly increase its viscosity (up to 100 cP) making it more difficult to pump from DSTs once transferred from the Evaporator.

Although it has been produced in the past, there currently are no plans to produce DSS. As mentioned in Section 4.1.1, processing of complexed wastes and phosphate wastes in the Evaporator requires more characterization to identify the end product density, temperature, and boiling point. Typically, these wastes enter the concentrator as dilute feeds and require multiple passes through the Evaporator to achieve the desired product concentration. Phosphate and complexed wastes cannot be concentrated to a DSS product because these wastes have very small or no dissolved aluminates.

The DSSF is defined as a slurry with a chemical composition that is below the sodium-aluminate boundary but that could be concentrated past the sodium-aluminate boundary, with a single additional pass through the Evaporator. In contrast to DSS, the viscosity of DSSF typically ranges from 20 to 40 cP. The DDSSF is more than one pass away from DSS.

The Evaporator produces one waste stream (i.e., process condensate) directly derived from the evaporator feed that requires further processing at a separate facility before discharge and thus can be considered a byproduct of the treatment. (Note: this should not be confused with other specialized applications of the term 'byproduct.') Process condensate consists primarily of the condensed vapors from the evaporator process. It is initially collected and filtered within the Evaporator then discharged to the LERF for storage. The process condensate is treated at the Effluent Treatment Facility (ETF) and disposed. Note that before the shutdown of the Evaporator in 1989 for Project B-534 upgrades, process condensate was treated, collected in retention basins, sampled, and discharged to an underground crib. The process condensate is designated as a mixed waste (DOE-RL 1997a), without further treatment at the ETF.

4.1.2.1 Physical, Chemical, and Radiological Characteristics. Like the evaporator feed, the physical, chemical, and radiological characteristics of the slurry vary from one evaporator campaign to the next. In general, the slurry is a highly alkaline liquid (pH 13) with a specific gravity ranging from 1.3 to 1.5. The temperature of the slurry as it is discharged from the process is $\approx 65.6^{\circ}\text{C}$ (150°F).

The slurry consists primarily of the inorganic waste constituents of the evaporator feed and most of the radionuclides. The major anions in the slurry are carbonate, chloride, fluoride, hydroxide, nitrate, nitrite, and sulfate. The major cations are aluminum, ammonium, barium, chromium, potassium, silicon, and sodium. Tables 4-4 and 4-5 present the inorganic and organic chemical constituent concentrations of slurry derived by the process flowsheet. Like the evaporator feed, the slurry has been designated as a mixed waste (DOE-RL 1997a).

Table 4-6 presents the concentrations of radionuclides in slurry derived by the process flowsheet. A second, more conservative estimate of slurry radionuclide concentrations has been developed specifically for application in accident analyses (Johnson 1991). These values, presented in Table 4-8, are judged to represent a worst-case condition, whereas the values derived by the process flowsheet represent normal operations.

The process condensate, consisting of condensed vapors from the evaporation process, is a liquid with a specific gravity of 1 and a pH ranging from 8 to 10 (depending primarily on the concentration of ammonia in the feed). Its temperature as collected in tank TK-C-100 is $\approx 28^{\circ}\text{C}$ (82°F). Tables 4-4 and 4-5 present the inorganic and organic chemical constituents of the process condensate derived by the process flowsheet. Based on its chemical composition, the process condensate has been designated a dangerous waste (DOE-RL 1991). Table 4-6 presents the concentrations of radionuclides present in process condensate.

the HFD and the estimated maximum possible fire loss, that the existing system is adequate, based on the cost to upgrade.

The DOE Order 6430.1A, Section 1530-4, "Automatic Sprinkler Protection," specifies that wet pipe systems are to be designed in accordance with National Fire Protection Association (NFPA) publication 13, *Standard for the Installation of Sprinkler Systems* (NFPA 1985). Since its construction, fire protection surveys of the Evaporator have been performed. Identified areas of nonconformance with NFPA 13 were corrected as part of Project B-534. Additional requirements for fire protection systems are stipulated in DOE Order 6430.1A, Section 1530-99.0, "Nonreactor Nuclear Facilities - General" and include the following.

- Total reliance shall not be placed on a single fire suppression system. Appropriate backup capability shall be provided.
- Fire protection systems shall be designed so that the failure of any active component shall not disable the system.
- The water supply for the permanent fire protection installation shall have a minimum of two reliable, independent sources each with sufficient capacity.

4.4 SAFETY CLASSIFICATION OF SYSTEMS AND STRUCTURES

The designation of safety Systems, Structures, and Components (SSCs) is typically performed as part of the safety analysis process. Safety SSCs are identified during the accident analysis process, and are primarily those SSCs relied upon to mitigate or prevent the occurrence of an unwanted event or accident with consequences in excess of approved guidelines. The required function of the system to mitigate the unwanted event or accident is defined as the systems safety function. For example, an exhaust ventilation system may be required to prevent an unfiltered release to the environment; therefore, the safety function of the system is "to prevent an unfiltered release to the environment". Additionally, using the same example, there may be discrete components that are relied upon to provide the safety function. That is, for a simple exhaust ventilation system, only one or two discrete components may be relied upon to provide the safety function, e.g., a filter and the ventilation system ductwork; however, for more complex systems, multiple discrete or interlocked components may be relied upon, e.g., filter(s), ductwork, interlocked exhaust fans and monitoring systems.

Potential safety SSCs are identified during the hazards and accident analysis process. The selection of a final list of safety SSCs is an iterative process involving the accident analysts and facilities personnel. That is, unmitigated accidents are analyzed and the potential consequences are reviewed to determine onsite and offsite impacts. If the impacts exceed consequence evaluation guidelines (see HNF-PRO-704, "Hazard and Accident Analysis Process") facilities personnel are consulted to identify potential SSCs to mitigate or prevent the accident. This process is repeated until the potential consequences meet or are below the consequence evaluation guidelines. The SSCs relied upon during this process, are called safety SSCs. The safety SSCs are designated Safety Class (SC), Safety Significant (SS), or

General Services (GS) using the criteria shown in Table 4-25. Safety Class SSCs are SSCs required to prevent or mitigate radiological (airborne or liquid) releases to the public that would otherwise exceed the offsite radiological risk guidelines, or prevent an accidental nuclear criticality. Safety Significant SSCs are those SSCs required to prevent or mitigate releases of radiological materials to onsite workers and toxic chemicals to the offsite public and onsite workers, including SSCs that are judged to substantially contribute to defense-in-depth. General Service SSCs are those not designated as SC or SS. Only those SSCs designated as SC and SS are identified and compiled in a facility Safety Equipment List (SEL).

The original SEL (WHC-SD-WM-SEL-028, Rev. 0) for the Evaporator was based on the accident analysis contained in Chapter 9.0 of this SAR. However, since this SAR was prepared, the consequence evaluation guidelines and safety SSC designations and selection criteria have changed (see Table 4-25). In accordance with HNF-PRO-516, "Safety Systems, Structures, and Components", for facilities with existing safety analysis and safety equipment lists, the facility is required to update the existing SEL using the revised SSC selection criteria and new SSC designations.

As defined in HNF-PRO-516, SSCs originally classified as Safety Class 1 are comparable to SC, SSCs originally classified as Safety Class 2 are comparable to SS, SSCs originally classified as Safety Class 3 or 4 are comparable to GS. There were no Safety Class 1 SSCs identified in the original SEL. An updated SEL has been prepared for the Evaporator (HNF-SD-WM-SEL-028, Rev.1) using the new nomenclature and requirements discussed above. The process followed to develop the updated SEL included, 1) reclassifying the safety classification of the systems currently designated Safety Class 2 to the new designations contained in HNF-PRO-516, 2) evaluating all systems contained in the Evaporator to the new requirements contained in HNF-PRO-516 to determine if there are other systems which meet the SC or SS classification, and 3) evaluating the existing SEL to determine if there are Safety Class 2 systems identified that do not meet the criteria shown in Table 4-25. Table 4-26, summarizes the revised SEL for the Evaporator (see HNF-SD-WM-SEL-028, Rev. 1 for the detailed SEL).

4.5 DECOMMISSIONING

As technology advances and missions change, facilities and equipment become obsolete. Because special handling is required for the disposal of radioactive plant components, the Decontamination and Decommissioning (D&D) program has been developed to ensure disposition in a manner that is safe to employees, the general public, and the environment. The D&D program must also address the decontamination hazardous plant components per the Part B Permit Application (DOE-RL 1997a).

The specific objective of D&D operations is to decontaminate and remove selected Evaporator components and dispose of them appropriately as transuranic or nontransuranic waste. Selected components could include the less contaminated process equipment and associated electrical piping systems, ventilation systems, vacuum systems, and drain systems.

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- Ybarra, R. M., 1990, *Engineering Study 242-A E/C Improvements*, SD-W085-ES-001, Westinghouse Hanford Company, Richland, Washington.

4.6.2 U.S. Department of Energy Orders

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- DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy, Washington, D.C.
- DOE Order 5480.1B, *Environment, Safety, and Health Program for Department of Energy Operations for Richland Operations*, U.S. Department of Energy-Richland Operations Office, Richland, Washington.
- DOE Order 5480.5, *Safety of Nuclear Facilities*, U.S. Department of Energy-Richland Operations Office, Richland, Washington.
- DOE Order 5480.7, *Fire Protection*, U.S. Department of Energy, Washington, D.C.
- DOE Order 5480.7A, *Fire Protection*, U.S. Department of Energy, Washington, D.C.
- DOE Order 5480.11, *Radiation Protection for Occupational Workers*, U.S. Department of Energy, Washington, D.C.
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- DOE Order 5480.23, *Nuclear Safety Analysis Reports*, U.S. Department of Energy, Washington, D.C.
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- DOE Order 5500.3A, *Reactor and Nonreactor Nuclear Facility Emergency Planning, Preparedness and Response Program for DOE Operations*, U.S. Department of Energy, Washington, D.C.
- DOE Order 5820.2A, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C.
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Table 4-6. Radionuclide Concentrations of Evaporator Feed, Double-Shell Slurry Feed, and Process Condensate.*

Radionuclide	Concentration ($\mu\text{Ci/mL}$)		
	Evaporator feed	Double-shell slurry feed	Process condensate
^3H	1.8 E-02	1.0 E-02	3.0 E-02
^{14}C	9.7 E-04	1.4 E-03	2.7 E-06
^{60}Co	2.3 E-02	3.3 E-02	6.4 E-05
^{79}Se	1.0 E-02	1.5 E-02	2.9 E-05
^{90}Sr	7.6 E+00	1.1 E+01	4.6 E-06
^{94}Nb	1.7 E-02	2.5 E-02	4.8 E-05
^{99}Tc	8.5 E-02	1.2 E-01	2.4 E-04
^{106}Ru	7.0 E+00	1.0 E+01	2.5 E-05
^{129}I	2.7 E-04	2.8 E-04	2.0 E-04
^{134}Cs	2.0 E+00	2.9 E+00	8.0 E-05
^{137}Cs	3.5 E+02	5.1 E+02	5.4 E-07
^{234}U	2.6 E-05	3.6 E-05	7.2 E-08
^{235}U	1.3 E-06	1.8 E-06	3.5 E-09
^{238}U	9.3 E-06	1.3 E-05	2.6 E-08
^{237}Np	4.4 E-05	6.3 E-05	1.2 E-07
^{238}Pu	5.1 E-04	7.3 E-04	3.9 E-10
^{239}Pu	1.1 E-03	1.5 E-03	8.0 E-10
^{241}Am	1.5 E-03	2.2 E-03	3.0 E-09
^{244}Cm	1.7 E-04	2.4 E-04	4.8 E-07

*Based on the Evaporator Process Flowsheet, see Chapter 6.0, Section 6.1.2.

Table 4-7. Evaporator Feed Specifications Controls Based on Operational Safety Considerations (from Von Barga 1998).

Process Control	Concentration Control	Safety Control
DST Corrosion Requirements	No significant exotherm at a temperature below 168 °C (335 °F) and the exotherm/ endotherm ratio <1	Criticality
Specific Gravity	Do not concentrate exceeding the $\text{NaNO}_3/\text{NaNO}_2$ precipitation boundary.	Source term of slurry
Mixing and Capability		Ammonia
PO_4 and Na		
Reynolds Number		
Percent solids predicted in slurry		
TRU in slurry		
BTUs in slurry		
Surface sample		

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LIST OF TERMS

ALARA	as low as reasonably achievable
AMU	aqueous makeup
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CAM	continuous air monitor
CCTV	closed-circuit television
CFR	Code of Federal Regulations
COB	clean-out box
CRT	cathode ray tube
DBE	Design Basis Earthquake
DOE	U.S. Department of Energy
dp	differential pressure
DSSF	double-shell slurry feed
DDSSF	dilute double-shell slurry feed
DST	double-shell tank
ETF	Effluent Treatment Facility
FEMP	Facility Effluent Monitoring Plan
FSAR	final safety analysis report
HAD	heat-activated devices
HEPA	high-efficiency particulate air (filter)
HVAC	heating, ventilation, and air conditioning
ID	inside diameter
LD	leak detector
LDE	leak detection element
LERF	Liquid Effluent Retention Facility
LMH	Lockheed Martin Hanford Company
MBH	thousands Btu/h
MCC	Motor Control Center
MCS	monitor and control system
NBS	National Bureau of Standards
NFPA	National Fire Protection Association
OD	outside diameter
PHA	Preliminary Hazards Analysis
PPE	personnel protective equipment
SAR	safety analysis report
SSE	Safe Shutdown Earthquake
TEDF	Treated Effluent Disposal Facility
the Evaporator	242-A Evaporator
UBC	Uniform Building Code
UPS	uninterruptible power supply
WAC	Washington State Administrative Code
WHC	Westinghouse Hanford Company
WF	weight factor
w.g.	water gauge

5.2.3.7.1 Function. The HVAC room contains equipment to supply conditioned air to the K1 and K2 ventilation systems.

5.2.3.7.2 Components. The following HVAC equipment is located in the HVAC room (items marked with asterisk are contained in a floor-to-ceiling equipment housing on the east wall):

- Preheat coils* (steam), K1-2-1 and K2-2-1
- 8% National Bureau of Standards (NBS) filters*, K1-7-1 and K2-7-1
- 95% NBS filter*, K1-11-1
- 50% NBS filter*, K2-1-1
- Reheat coils (steam), K1-4-1 and K2-4-1*
- Air washers, K1-3-1 and K2-3-1*
- Supply fans, K1-5-1 and K2-5-1
- HVAC instrument panel.

Section 5.4.1 describes both the K1 and K2 ventilation systems in detail.

5.2.3.7.3 Safety Features. With the exception of the ammonia gas bottle used for calibrating the ammonia monitor, there are no radioactive or hazardous materials processed or stored in the HVAC room. However, the HVAC equipment housing is posted as a surface contamination area as a result of incidents at nearby tank farm facilities (e.g., in 1978 wind blown contamination from an open valve pit contacted the louvered air supply vent).

5.2.3.8 Control Room. The control room is located in the 242-AB Building. The 242-AB Building shares a common wall with the 242-A Building and is 13.8 by 12.2 m (45 ft 4 in. by 40 ft). An interior wall divides the building into two areas: a 10.1 by 12.2 m (33-ft 4-in. by 40-ft) control room, and a 3.7-m by 12.2-m (12-ft by 40-ft) electrical room (Figure 5-14). Entry and egress from the control room are provided by two doors, one of which leads outside and is used for emergency exit. A third door provides entry to the electrical room.

5.2.3.8.1 Function. The control room houses the monitor and control system (MCS) for the Evaporator. In addition, the control room serves as the monitoring point for instrumentation located in the 241-AW, 241-AN, 241-AP, 241-A, and 241-AX tank farms.

5.2.3.8.2 Components. The MCS is an industrial-grade, microprocessor-based, distributive control system. The principal components include:

- Cathode ray tube (CRT)-based operator consoles
- CRT-based supervisory console
- Distributed multi-task controllers

There are four operator consoles each consisting of a CRT, operator interface keyboard, printer for report generation, disk drive for data storage, and an alarm logger for automatic logging of alarm conditions. Each console is capable of supporting the full monitoring and control function of the system.

The supervisory console is identical to the operator console but has an added configuration keyboard. The supervisory console can support the full monitoring and control function of the system and thus provides system redundancy. The supervisory console also is equipped with a configurations keyboard and is capable of configuring control algorithms, custom process graphics, safety limits and interlocks, and control strategies.

The distributed process controllers are located in the mux or electrical room. The controllers interface with the operator and supervisory consoles via data communication links. The controllers accept both discrete inputs (e.g., contact closures) and analog inputs (e.g. thermocouples). Outputs are converted to analog for control loop systems.

In addition to the process controllers, the mux room houses two air conditioning units and an uninterruptible power supply (UPS) system. The dedicated air conditioning units are designed to maintain a temperature of 18 °C (65 °F) in the control room. The UPS system (see Section 5.4.3, "Electrical") is designed to supply power to the MCS for a minimum of 22 min in a power outage.

5.2.3.8.3 Safety Assurances. There are no radioactive or hazardous materials processed or stored in the control room.

5.2.3.9 Miscellaneous Areas. Miscellaneous support areas within the 242-A Building are described below. A positive air pressure (relative to atmospheric) is maintained in each area by the K2 ventilation system.

5.2.3.9.1 Men's and Women's Change Rooms. The men's and women's change rooms contain sinks, toilets, showers, and lockers for personnel clothing. Note that 'change rooms' is a misnomer as personal protective equipment (PPE) (including clothing) is not permitted in these areas but instead is donned in the PPE dressing room and removed at control points. Water to the change rooms is supplied from the sanitary water system and drains to the sanitary sewer system.

Drainage from the change room showers is not monitored or sampled for radioactivity before discharge. Safety showers that drain to the evaporator feed tank, TK-241-AW-102, are located in the AMU and condenser rooms, and a personnel decontamination facility is located nearby in the 272-AW Building.

5.2.3.9.2 Protective Clothing Receiving and Shipping. Clean PPE is stored in bulk outside of the 242-A Building in shipping containers. Within the 242-A Building, PPE in an assortment of sizes is stored in the PPE dressing room. Used PPE is removed at control points, bagged, and stored in the soiled clothes storage room pending shipment to the 2724-W Laundry Facility located in the 200 West Area.

In addition to storing clothing, the soiled clothes storage room contains a small, shielded electric oven for the storage of process samples. These samples are shipped to the 222-S Analytical Laboratory located in the 200 West Area for analysis.

5.2.3.9.3 Survey Corridor. The survey corridor is located at the entry/exit points for the AMU and condenser rooms. This area serves as an operating

terminate at a valve/blind flange assembly. To detect liquid accumulation within the COB, a conductivity probe is mounted on the floor of the box. To drain such liquids, a valved (normally closed) 9-cm (3.5-in.) floor drain is provided. A 3.8-cm (1.5-in.) drain line with a 10-cm (4-in.) encasement connects the floor drain to the adjoining drain line, DR-301. Line DR-301, consisting of a 7.6-cm (3-in.) dia primary line and 15-cm (6-in.) encasement, terminates at the A-350 Catch Tank. For draining liquids generated by use of the water snake, a 2.5-cm (1-in.) drain line with a 5-cm (2-in.) encasement is provided that connects the valve/blind flange assembly to the COB drain line.

The above described COBs differ from those originally installed on lines SL-167 and SL-168; the principal differences being:

1. For connecting the COB to the slurry line, Project B-102 used encased pipes whereas Project B-120 used single pipes housed within a steel riser.
2. For draining liquid generated during use of the water snake, Project B-102 tied in to an adjacent drain line whereas Project B-120 tied in to an adjacent feed line.

Unlike the COBs on lines SL-167 and SL-168, the COBs on lines SL-113 and SL-114 never have been modified. As previously stated, lines SL-113 and SL-114 are currently out of service. Activation of these lines will require an engineering evaluation of the Project B-102 (Figure 5-18) COBs to determine their compliance with primary and secondary confinement requirements.

5.3.1.3 Evaporator Drains. Four drain lines, portions of which were constructed under both Projects B-102 and B-120, exit the 242-A Building:

- Sump drain line, DR-334
- Evaporator vessel C-A-1 drop-out line, DR-335
- Tank TK-C-100 drain line, DR-343
- Process condensate divert line, DR-338.

DR-338 drains to DR-334. The other three lines drain to tank TK-241-AW-102 via drain pit 241-AW-02D.

5.3.1.3.1 Drain Pit. Drain pit 241-AW-02D (Figure 5-19), mounted on the tank dome of TK-241-AW-102, measures 3.9 m (12 ft 8 in.) by 2.4 m (8 ft) and is ≈3 m (≈10 ft) deep. The floor and walls are constructed of 0.3-m (12-in.-) thick reinforced concrete. The pit is covered by three, 51-cm (20-in.-) thick concrete cover blocks. There are 8 wall nozzles (A through H). Two risers, one 91 cm (36 in.) and one 51 cm (20 in.), extend from the pit into the feed tank.

The three Evaporator drain lines pass through the drain pit wall and are piped directly into the 91-cm (36-in.) riser; no jumper connections are necessary. Two other lines, a 7.6-cm (3-in.) drain line from valve pits 241-AW-A and 241-AW-B and a 7.6-cm (3-in.) drain line from diversion box 241-A-151 terminate at wall nozzles F and A, respectively, and are routed via jumpers to the 51-cm (20-in.) riser. The other six wall nozzles currently are not used. A conductivity probe is mounted on the floor of the pit to detect leaks. Leakage, should it occur, is returned to the feed tank via a 7.6-cm (3-in.) drain line. Similar to the pump pit, a hose station provides raw water for spraying down the pit and risers.

5.3.1.3.2 Drain Line Piping. Drain lines DR-334 and DR-335, ~170 m (=560 ft) in length, consist of 25-cm (10-in.) primary piping and 30-cm (12-in.) encasement piping. The primary piping was designed for a maximum operating pressure of 138 kPa [20 lbf/in² (gauge)] and a maximum operating temperature of 93 °C (200 °F). Construction specifications for Projects B-102 and B-120 specified schedule 40 and schedule 20 carbon steel, respectively. The encasement piping was designed for a maximum operating pressure of 414 kPa [60 lbf/in² (gauge)] and maximum operating temperatures of 93 °C (200 °F) (Project B-102) and 171 °C (340 °F) (Project B-120).

Leak detector risers equipped with conductivity probes are installed on the encasement lines to detect primary piping failures in drain lines DR-334 and DR-335. The detectors, identical to those described above, are interlocked to shut down the slurry pump, P-B-2, upon alarm conditions. Leakage from the primary piping, should it occur, is drained by the encasement pipes to the drain pit.

There are three drain line COBs. The first, COB-A-30, has four 2.5-cm (1-in.) clean-out lines with 5-cm (2-in.) encasements. Two of the clean-out lines are connected to DR-334 and two are connected to DR-335. A 2.5-cm (1-in.) drain line drains to drain line DR-343. This COB is similar in design to those on slurry lines SL-113 and SL-114. The second (COB-AW-11) and third (COB-AW-12) COBs, installed on DR-334, are identical to those on slurry lines SL-167 and SL-168, and drain to drain line DR-335.

Drain line DR-343 consists of a 15-cm (6-in.) schedule 40 carbon steel pipe. It is designed for a maximum operating pressure and temperature of 138 kPa [20 lbf/in² (gauge)] and 93 °C (200 °F), respectively. It runs ~180 m (=600 ft) from the 242-A Building to drain pit 241-AW-02D.

5.3.2 Steam Condensate Retention Basins

Six 260-KL (70,000-gal) retention basins are located east of the 242-A Building. As originally designed and operated, these basins were used to retain process condensate and steam condensate until sample analyses verified acceptability for discharge to the 216-A-37-1 Crib and 216-B-3 Pond, respectively. Current waste management practices prohibit the soil column discharge of process condensate; consequently, process condensate now is piped to the LERF, and the three south basins were taken out of service in 1989. The three north basins are used for the temporary retention of steam condensate. Steam condensate is now discharged to the 200 Area TEF, which does not require the use of the retention basins. Therefore, an effort is underway to turnover these basins to a separate contractor for remediation and physically modify the steam condensate line to tie directly into the used raw water line, effectively bypassing the 207-A building and basins.

5.3.2.1 Building 207-A. Steam condensate drains by gravity from the 242-A Building to the 207-A Building (Figure 5-20). The building measures 3.8 m (12 ft 6 in.) by 4.6 m (15 ft). The walls, constructed of 0.3 m (1 ft) thick reinforced concrete, are 4.6 m (15 ft) high and extend from 3 m (10 ft) below grade to 1.5 m (5 ft) above grade. The floor contains a 0.6 m (2 ft) by 0.6 m (2 ft) by 0.6 m (2 ft) deep sump. The ceiling/roof of the building is comprised of metal decking. Access is via an entry hatch. A ladder extends

- Panel board C
 - Fire alarm panel
 - Emergency lights
 - Instrument panels
 - Control circuits
 - Alarm circuits
- Panel board E
 - Evacuation siren
 - Condenser room ammonia monitor
 - Vessel ventilation stack monitoring systems
 - Control room lighting
 - Computer shunt trip circuit
- Panel board F (control room UPS).

A one-line electrical diagram of the standby power supply is shown in Figure 5-31. Fuel for the generator is stored in an adjacent 2,100-L (550-gal), double-wall fiberglass-reinforced plastic tank equipped with leak and overflow detection.

The control room UPS provides power to the MCS to facilitate process monitoring upon loss of power. During normal operation, the electrical load is placed directly on a continuously recharged battery pack. On loss of power, the battery pack supplies power to the control system. The UPS provides sufficient time for standby power to be supplied [1 min (note above description of the diesel generator)] or, on complete loss of power, to monitor the dump of the Evaporator vessel into the feed tank (emergency dump is discussed in Chapter 6.0, Section 6.1.3.3.3).

5.4.4 Compressed Air

Components of the compressed air system include two identical air compressors (CP-E-1, CP-E-2) installed in parallel, an air receiver (R-E-1), an after-cooler (E-E-6), a separator, and two dryers (DR-E-1, DR-E-2). One compressor is used as the on-line unit; the other is used as a standby unit that is operated only if the on-line compressor fails or if the operating pressure drops below a preset limit. If regular power sources should fail, the compressors can be operated on standby power. The compressors are vertical, reciprocating, and nonlubricating, and are designed to deliver 2.8 kL/min (100 std ft³/min) at 690 kPa [100 lbf/in² (gauge)]. Each is cooled with a water jacket. Used cooling water is routed to the 200 Area TEF Pump Station 3 via the raw water drain line.

The after-cooler is a horizontal pipeline that includes a moisture separator, a sight-flow cooling water discharge separator drain valve, an automatic condensate trap, and a discharge air temperature indicator. The unit, sized to handle a minimum of 5.7 kL/min (200 std ft³/min) of air, is designed as a wet-shell unit with an air tube side. From the after-cooler, the process air is routed to the air receiver, which is an upright steel tank with a volume of 3.5 m³ (125 ft³). The 4.6 m- (15-ft-) high air receiver is equipped with an access hole, a safety relief valve set at 860 kPa [125 lbf/in² (gauge)], a pressure gauge, a moisture trap, and a drain valve.

Process air is routed from the air receiver to various locations within the facility (Table 5-3). Its principal use is to operate or control open/close piston-operated valves and to pressurize the reboiler (as required).

Air from the receiver also is routed through an electric-powered, twin-tower dryer system to produce instrument air. The system has two operational modes: (1) a timed mode in which 1 tower is online for 4 h while the other tower regenerates for 3 h and cools for 1, and (2) a dew-point controlled mode in which a sensor automatically switches towers when a dew-point is reached.

Instrument air is piped from the dryer system to various locations within the facility (Table 5-4). It is used primarily by process control instrumentation (e.g., specific gravity/weight factor tubes).

5.4.4.1 Safety Considerations and Controls. During normal and emergency operation, only one air compressor is required to operate. The process air system consists of two electric-powered compressors precluding the possibility that failure of a single component can cause a loss of compressed air.

The two electric-powered compressors receive power from the 400 A bus (MCC-2). Section 5.4.3 provides details on the electric power system. The 400 A bus has two sources of power: the normal power supply (line C8-L5) and the backup power supply from the 200 kW diesel generator. The diesel generator will start and transfer automatically on loss of normal power to the 400 A bus. An automatic transfer switch in the diesel generator enclosure supplies power to MCC-2 from the diesel generator. Electrical power is a General Services system which is not required to mitigate environmental releases.

If a compressor is out of service, a diesel-driven portable compressor can be brought to near the Evaporator and started to supplement the process air supply. However, this is not required to support the needs of the Evaporator. If both of the compressors are lost, the portable compressor can supply the priority needs of the Evaporator. Nonpriority needs of air will be curtailed. Air to the instruments and the control valves in the Evaporator has the highest priority. During shutdown, the HVAC controls have highest priority for safe operation of the Evaporator. Compressed air is not a Safety Class or Safety Significant system nor is it required to mitigate environmental releases.

Piston-operated valves at the Evaporator have inline oilers to maintain lubrication of the pistons. Therefore, using process air for piston-operated valves is acceptable.

5.4.5 Steam Supply and Distribution

Steam is supplied to the Evaporator from the 242A-BA boiler annex. The 242A-BA annex contains one 200 hp medium pressure (90 psig) boiler and two 700 hp low pressure (10 psig) boilers. Only one low pressure and one medium pressure boiler are required for facility operation. There is one dedicated backup 700 hp boiler for the low pressure system.

5.5 REFERENCES

5.5.1 Documents

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Yanochko, R. M., 1989, *Conceptual Design Report, Water System Upgrades, 200 East Area Laterals, Project L-005*, SD-L005-CDR-001, Kaiser Engineers Hanford, Richland, Washington.

Zaccone, 1994, *242-A Evaporator, Fire Hazard Analysis*, WHC-SD-WM-RPT-016, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

5.5.2 Code of Federal Regulations

10 CFR 20, "Standards for Protection Against Radiation," *Code of Federal Regulations*.

5.5.3 U.S. Department of Energy Orders

DOE Order 5400.5, 1990, *Radiation Protection of the Public and Environment*, U.S. Department of Energy, Washington, D.C.

DOE Order 5480.5, 1986, *Safety of Nuclear Facilities*, U.S. Department of Energy, Washington, D.C.

DOE Order 5480.7A, 1993, *Fire Protection*, U.S. Department of Energy, Washington, D.C.

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

5.5.4 Controlled Manuals

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

Table 5-4. Instrument Air Applications and Functions. (3 sheets)

Application	Pressure [kPa (lbf/in ²) gauge]	Function
FY-C100-5	138 (20)	Flow control of process condensate from condensate collection tank, TK-C-100 to ion exchange column, IX-D-1
PC-5000	138 (20) or 690 (100)	Dry LERF transfer line encasement

FSAR = final safety analysis report.

HVAC = heating, ventilation, and air conditioning.

Table 5-5. Raw Water Used in the 242-A Evaporator.

Function	L/min (gpm)
Condensers (EC-1,2,3) ^c	13,600 (3,600)
Air compressor cooling water ^c	38 (10)
HVAC equipment maintenance and housekeeping ⁱ	<0.003 (0.0008)
Water filter catch pan drainage ⁱ	<0.03 (0.008)
Evaporator startup and shutdown, deep flushes, etc. ⁱ	0.7 (0.2)
Deentrainment pad flushing ^c	.8 (2)
P-B-1 and P-B-2 seal water ^c	1 (0.3)
E-C-1 leakage ^c	0 ⁿ (0)
Maintain pump room sump level ⁱ	<0.03 (0.008)
Maintain seal pot level ⁱ	<0.03 (0.008)
Flush slurry lines, feed lines, dump lines ⁱ	0.05 (0.013)
Fire protection system ⁱ	0 (0)
Total	13,650 (3,600)

c = continuous during plant operation.

i = infrequent flow, averaged over a typical year.

n = E-C-1 is new and no leakage is expected.

HVAC = heating, ventilation, and air conditioning.

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LIST OF TERMS

AFPC	242-A filtered process condensate
ALARA	as low as reasonably achievable
AMU	aqueous makeup
AMW	ALARA management worksheet
APC	242-A process condensate
ASF	ammonia scrubber feed
ATP	acceptance test procedure
CAM	continuous air monitor
CEA	Criticality Engineering Analysis
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLU	Chemical Laboratory Unit
COB	clean-out box
CPS	criticality prevention specification
CRW	cladding removal waste
DCG	derived concentration guideline
DDSSF	dilute double-shell slurry feed
DOE	U.S. Department of Energy
DOP	dioctylphthalate
DP	differential pressure
DSS	double-shell slurry
DSSF	double-shell slurry feed
DST	double-shell tank
DTA	differential thermal analysis
EDTA	ethylenediaminetetraacetic acid
EPA	U.S. Environmental Protection Agency
FIC	flow indicating and control
FY	fiscal year
GEA	gamma energy analysis
GTF	Grout Treatment Facility
HEDTA	hydroxyethylenediaminetriacetic acid
HEPA	high-efficiency particulate air
HPT	health physics technician
HVAC	heating, ventilation, and air conditioning
HWVP	Hanford Waste Vitrification Plant
ICP	inductively coupled plasma
ID	inside diameter
II	amperage indicator
LERF	Liquid Effluent Retention Facility
LI	level indicator
MCS	monitoring control system
MOC	minimum oxygen for combustion
NCAW	neutralized current acid waste
NCRW	neutralized cladding removal waste
NRC	Nuclear Regulatory Commission
OCM	operator control module
OD	outside diameter
OSD	Operating Specification Document
OSR	operational safety requirements
OTP	operational test procedure

If a separable organic layer is observed, an operating specification limits the liquid level in TK-241-102-AW (Von Barga 1998). This limit is a control designed to prevent pumping of separable organics into the Evaporator facility.

6.4 CHEMICAL PROCESS SYSTEMS

The process systems discussed in this section are the Evaporator system and the vapor condensation and treatment system. These systems are shown on the facility flowsheet, Figure 6-1. Figure 6-1 also shows the location of the effluent sampling systems for the process. Not shown in the figure is the source of solid wastes generated within the Evaporator facility. Solid wastes are generated throughout the facility during normal operations and when the facility is in a shutdown mode. The solid wastes are failed equipment and failed equipment parts, special work permit clothing, contaminated tools, spent filters, etc. The appropriate portions of this section will be identified as sources of effluents and wastes for discussion in Chapters 7.0 and 8.0. References will be made to the physical layouts presented in Chapter 5.0, as appropriate. Each process system is discussed.

6.4.1 Evaporation System

6.4.1.1 Evaporation System Functional Description. The evaporation system includes the E-A-1 reboiler, the C-A-1 vessel, the P-B-1 recirculation pump, the P-B-2 slurry pump, and all associated equipment, instrumentation, utilities, and piping. The equipment and instrumentation in this system accept feed from the feed tank, concentrate the feed tank solution, pump the concentrate (slurry) to the slurry tank, and filter the C-A-1 offgas flow.

This part of the Evaporator facility is a conventional forced-circulation vacuum vessel designed to concentrate low-heat wastes containing relatively small quantities of fission products. The low-heat wastes are pumped from feed tank TK-241-AW-102 into the recirculation line of vessel C-A-1. The wastes mix with wastes being recirculated by the P-B-1 pump at a rate of 61,000 L/min. The wastes pass through the E-A-1 reboiler tubes and are heated slightly by low-pressure steam [21 to 69 kPa (gauge)] condensing in the shell side of the heat exchanger. The heated wastes are discharged under the surface of the C-A-1 liquid level with steam bubbles rising to the surface of the liquid and passing up through two deentrainer pads in the vessel. Counter current filtered raw water flows down through the deentrainer pads decontaminating the upward flowing vapors. The majority of the liquid in C-A-1 circulates downward through the vessel to be recirculated by the P-B-1 pump. A small fraction of the recirculated flow is withdrawn from the recirculation pipe line and pumped by the P-B-2 slurry pump to the underground slurry receiver storage tank.

6.4.1.2 Evaporation System Major Components. The following paragraphs describe the major components of the evaporation system, the interrelationship of the individual components, and the means by which these components are combined within the system. A physical description of each major component including dimensions, design and operating temperatures and pressures, materials of construction, special design features, and process limitations is described in Section 6.1.2.

6.4.1.2.1 Reboiler (E-A-1). Process slurry is heated in the reboiler before the slurry enters vessel C-A-1. A 0.71-m- (28-in.-) diameter stainless steel pipeline connects the reboiler with the P-B-1 discharge pump flange and with the C-A-1 vessel at a midpoint on the side of the vessel. Two pressure indicating probes, PE-EA1-2 and PE-EA1-12, monitor slurry differential pressure across the reboiler. These instruments assist the operators in determining plugging of the reboiler tubes. Temperature elements TE-EA1-7 and TE-EA1-1 provide temperature differential indication for the reboiler.

The steam required for the evaporation process is supplied to the 242-A Building via a 6-in. (15-cm) steam line from the 242A-BA boiler package. The 242A-BA annex contains one 200 hp medium pressure (90 psig) boiler and two 700 hp low pressure (10 psig) boilers. Only one low pressure and one medium pressure boiler are required for facility operation. There is one dedicated backup 700 hp boiler for the low pressure system. 69 kPa [10 lbf/in² (gauge)] steam is supplied to the facility from the 242A-BA boiler Annex and to the 41-cm- (16-in.-) diameter steam line to the reboiler. To reduce the steam temperature and ensure saturation before the steam is used in the reboiler, filtered raw water is added in a desuperheater. Steam at 620-kPa (gauge) [90 lbf/in² (gauge)] also is added to atomize the filtered water. The carbon steel desuperheater, designed to handle steam at 12,000 kg/h (27,000 lb/h), is an atomizing-type steam ejector.

Steam condensate from the reboiler discharges past an in-line radiation monitor (RE-EA1-1) at the flow measurement weir (TK-C-103). A portion of the steam condensate is pumped from upstream of the weir through a proportional sampler/radiation monitor (R-C-1) and returned to the steam condensate line downstream of the weir. If either radiation monitor detects radiation above normal background levels, the steam condensate is diverted to the feed tank (TK-241-AW-102). Normally, the steam condensate discharged from tank TK-C-103 is routed through 207-A Building to TEDF.

6.4.1.2.2 Evaporator Vessel (C-A-1). Process solution from the reboiler discharges to the C-A-1 Evaporator vessel via the upper recirculation line. The separator consists of two basic sections, the lower section containing the slurry being circulated, and the upper vapor-liquid separation section containing the deentrainer pads and deentrainer sprays. Vapor flows out of the separator through a 107-cm (42-in.) stainless steel vapor line at the top and concentrated slurry exits via the vessel's 71-cm (28-in.) stainless steel recirculation line at the bottom.

The top section of the vessel contains two deentrainer pads designed to remove liquids and solids that are carried into the vapor header. A total of 16 spray nozzles, 4 on the top and 4 on the bottom of each pad, are equally spaced and alternated for even distribution of water to the pads. Normally, the top sprays to the upper pad are controlled automatically for sequential operation for 15 s. Both sets of sprays to the bottom pad are on a distribution ring and are controlled manually. Separate manual controls and distribution header are provided for another set of sprays that permit the sides of the Evaporator below the lower deentrainment pad to be sprayed to prevent caking.

Temperature excursions and subsequent pressurization of the vessel is highly unlikely. The low-pressure steam supplied to the reboiler, 21- to 69-kPa (gauge) [3- to 10-lbf/in² (gauge)] does not supply sufficient heat to

6.4.1.3.2 Evaporation System Materials of Construction, Pressure and Temperature Limits, and Detailed Dimensions. Section 6.1.2 contains a summary table (see Table 6-2) of the materials of construction, pressure and temperature limits, and detailed dimensions for the major equipment items.

Table 6-4 is a list of the pipe codes used in the Evaporator facility and the intended service. A complete description of the materials of construction, pressure and temperature limits, and dimensions are found in the construction specifications (Vitro 1974). The materials listed are for historical purposes only. Modifications performed after the original construction were in accordance with applicable code requirements.

6.4.1.3.3 Evaporation System Corrosion Allowances. Corrosion allowances for equipment in the Evaporator system are $\leq 25 \mu\text{m/yr}$ (0.001 in./yr) unless otherwise specified on the individual equipment drawings.

6.4.1.3.4 Evaporation Material and Fabrication Specifications. Material and fabrication specifications for the major equipment items are shown in Table 6-5. The material specifications for piping are shown in Table 6-4 in the material column.

6.4.1.4 Evaporation System Safety Criteria and Assurance. The following safety features provide personnel and environmental protection from radiological contamination and exposure to radiation. These safety features also provide the means of ensuring a safe system as constructed, operated, and maintained.

The cell walls and removable cover blocks attenuate radiation during normal and abnormal operating conditions to a maximum surface dose rate of 0.5 mrem/h .

Exposure of maintenance personnel to radiological and chemical hazards is reduced to ALARA by flushing and chemical decontamination of the process equipment and piping, spray washdown and decontamination of the equipment exterior and cell walls, and disposal of flush and decontamination effluent to the feed tank.

Extensive radiation monitoring and process control instrumentation are provided for this system for protection of personnel and the environment and to indicate abnormal process conditions. Radiation detectors initiate local alarms and control system alarms at the radiation levels. Likewise, process alarms initiate local alarms and control system alarms. The limits set for each alarm identify a commitment to action by operations to respond to the alarm. These alarms provide operations enough time to respond and correct an out-of-control situation before an operational safety requirement is exceeded. Thus, the process alarms are beyond normal process operation and control and can be considered part of the engineered safety features.

Criticality control for the Evaporator facility is discussed in Section 6.1.3.1. The feed samples are scrutinized closely by operations, engineering, and safety for the sample analysis fissile concentrations. These values are then compared to the limit of 0.005-g Pu/L . Administrative controls prohibit processing any feed through the Evaporator facility that is above the limit. A criticality accident is not possible when the fissile

concentrations are below 2.6-g Pu/L of settled solids. This applies to all vessels in the Evaporator facility and includes overflowing C-A-1 into C-100.

6.4.1.5 Operating Limits. System operating limits and interlocks are discussed in Section 6.5.1.8.

6.4.2 Vapor Condensation and Treatment System

6.4.2.1 Vapor Condensation and Treatment System Functional Description. The vapor condensation and treatment system includes the E-C-1 primary condenser, the E-C-2 inter-condenser, the E-C-3 after condenser, the TK-C-100 condensate tank, the P-C-100 condensate pump, the F-C-1 condensate filter, the IX-D-1 ion exchange column, and all associated equipment, instrumentation, utilities, and piping. The equipment and instrumentation in this system accepts vapors from the C-A-1 vessel, condenses the vapors, maintains a vacuum in the C-A-1 vessel, filters and removes radioactive ions from the process condensate, and samples the process condensate effluent flow.

This system in the Evaporator facility contains standard industrial heat exchangers, a two-stage steam jet vacuum control process with the inter-condenser and after condenser, a condensate collection tank, a fiber-cartridge liquid filter, an ion exchange column, and a proportional sampling and monitoring system.

Vapors enter the primary condenser through an overhead 107-cm (42-in.) line. The vapors are drawn into the condenser by the two-stage steam vacuum system. The condensable vapors condense in E-C-1, E-C-2, or E-C-3 and drain into the condensate collection tank. The remaining noncondensed vapors exit from the E-C-3 condenser and are drawn into the offgas treatment system. The process condensate flow collected in TK-C-100 is pumped through the filter and, if used, ion exchange column to remove radioactive solids and ions. A proportional sampling and monitoring system provides data for this effluent stream of the radioisotopic and hazardous materials concentrations being discharged to the LERF. If the process condensate does not meet discharge specifications, it is diverted by the R-C-3 diverter valve back to the TK-C-100 collection tank or the feed tank.

6.4.2.2 Vapor Condensation and Treatment System Major Components. The following paragraphs describe the major components of the vapor condensation and treatment system, the interrelationship of the individual components, and the means by which these components are combined within the system. A physical description of each major component including dimensions, design and operating temperatures and pressures, materials of construction, special design features, and process limitations is described in Section 6.1.2.

6.4.2.2.1 Primary Condenser (E-C-1). The vapors removed from the C-A-1 vessel are condensed in the primary condenser. The condenser dimensions for this four-pass water-cooled carbon steel heat exchanger are detailed in Section 6.1.2. Raw cooling water flows through the tubes and process gas flows, including condensables, are on the outside of the tubes. Baffles are arranged in the gas flow section causing cross flow over the tubes. The cross flow pattern increases turbulence within the heat exchanger, the heat transfer rate, and the condensing efficiency. Vapors are cooled through surface heat exchange of vapors condensing on the outside of the cooler tubes. Baffles

strainer also is equipped with a filter bypass line, pressure gauges upstream and downstream from the filter, and a sight glass located upstream of the filter arrangement. This filtration is necessary to help prevent false high radiation readings at the RC-3 monitor as well as operational difficulties due to plugging.

6.4.2.3 Vapor Condensation and Treatment System, Design Description.

6.4.2.3.1 Vapor Condensation and Treatment System Design Basis. The design basis for the vapor condensation and treatment system is identical to the design basis for the Evaporator facility described in Section 6.4.1.3:

- Feed rate, 260 to 450 L/min (70 to 120 gal/min)
- Vessel C-A-1 operating pressure, 5.5 kPa (absolute) [0.8 lbf/in² (absolute)]
- Evaporation rate, 150 L/min (40 gal/min)
- Slurry rate, 130 to 260 L/min (35 to 70 gal/min)
- Slurry temperature, 52 to 77 °C (125 to 170 °F).

6.4.2.3.2 Vapor Condensation and Treatment System, Materials of Construction, Pressure and Temperature Limits, and Detailed Dimensions. Section 6.1.2 contains a summary table (see Table 6-2) of the materials of construction, pressure and temperature limits, and detailed dimensions for the major equipment items.

Table 6-4 is a list of the pipe codes used in the Evaporator facility and the intended service. A complete description of the materials of construction, pressure and temperature limits, and dimensions are found in the construction specifications (Automation Industries 1974).

6.4.2.3.3 Vapor Condensation and Treatment System, Corrosion Allowances. Corrosion allowances for equipment in the vapor condensation and treatment system are $\leq 25 \mu\text{m/yr}$ (0.001 in./yr) unless otherwise specified on the individual equipment drawings.

6.4.2.3.4 Vapor Condensation and Treatment System, Material and Fabrication Specifications. Material and fabrication specifications for the major equipment items are shown in Table 6-5. The material specifications for piping are shown in Table 6-4 in the material column. The piping specification for fabrication, assembly, welding, installation, and testing is ANSI B31.1 (ANSI 1989).

6.4.2.4 Vapor Condensation and Treatment System, Safety Criteria and Assurance. The following safety features provide personnel and environmental protection from radiological contamination and exposure to radiation. These safety features also provide the means of ensuring a safe system as constructed, operated, and maintained.

The equipment for the vapor condensation and treatment system is located in limited access areas of the Evaporator facility. These areas have

radiation alarms to alert operations when radiation limits are exceeded. When an area radiation alarm sounds, each person has been instructed to respond by leaving the area, contacting the RCTs, contacting the RCT manager and building manager, and waiting at the step-off pad just outside the affected area for a radiation survey to be performed by the RCT. This action assists in control and confinement of radioactivity.

Exposure of maintenance personnel to radiological and chemical hazards is reduced to ALARA by flushing and chemical decontamination of the process equipment and piping, spray washdown and decontamination of the equipment exterior and room walls, and disposal of flush and decontamination effluent to the feed tank.

Extensive radiation monitoring and process control instrumentation are provided for this system for protection of personnel and the environment and to indicate abnormal process conditions. Radiation detectors initiate local alarms and control system alarms. Likewise, process alarms initiate local alarms and control system alarms. The limits set for each alarm identify a commitment to action by operations to respond to the alarm. These alarms provide operations enough time to respond and correct an out-of-control situation before an operational safety requirement is exceeded. Thus, the process alarms are beyond normal process operation and control and can be considered part of the engineered safety features.

Criticality control for the Evaporator facility is discussed in Section 6.1.3.1. The vapor condensation and treatment system processes condensate having very tiny amounts of fissile material. Typical condensate concentrations are $<1 \times 10^{-5}$ g/L (1×10^{-7} lb/gal). This value is much less than the limit of 0.005 g Pu/L for feed to the facility. Therefore, criticality safety is not a safety issue for the vapor condensation and treatment system. Section 6.4.1.4 shows that even if the vessel overflows into the condensate collection tank, the fissile concentrations are too low to cause a nuclear criticality incident.

6.4.2.5 Vapor Condensation and Treatment System, Operating Limits. System operating limits are listed in this section, and the interlocks are discussed in more detail in Section 6.5.1.8.

6.4.2.5.1 Process Condensate High Radiation. The process condensate effluent flow is sampled and monitored continuously for radiation levels. The process condensate flow should be relatively free of radionuclides and contains only tiny amounts of hazardous wastes. Two radiation monitors are placed in the facility for monitoring process condensate. A radiation monitor on the condensate flow from the E-C-1 primary condenser will alarm, shut down the feed pump, turn off steam to the reboiler, remove C-A-1 vacuum and shut down condensate pump P-C-100. The other radiation monitor withdraws a continuous flow from the process condensate effluent flow downstream from the IX-D-1 column. When high radiation levels are detected, a diverter valve is activated by the radiation monitor diverting the process condensate to either TK-C-100 or feed tank TK-241-AW-102.

6.4.2.5.2 The TK-C-100 Liquid Level Alarm. The TK-C-100 liquid level is controlled to maintain vacuum control in the C-A-1 vessel, prevent overflow to the feed tank, and prevent damage to the TK-C-100 pump and agitator. Condensate drain lines from the three condensers have vacuum seal lines

6.5.1.8.49 **Interlock 45.** Reserved.

6.5.1.8.50 **Interlock 46.** Reserved.

6.5.1.8.51 **Interlock 47.** Reserved.

6.5.1.8.52 **Interlock 48.** This interlock is activated by:

- Leak detected in PC line to LERF.

The interlock then:

- Shuts off P-C-100 pump
- Diverts PC to either tank C-100 or tank 241-AW-102.

6.5.1.8.53 **Interlock 49.** This interlock is activated by:

- Basin SC-C-1, SC-2, or SC-3 drain valve open and level low.

The interlock then:

- Shuts down pump 207-A-P3.

6.5.1.8.54 **Interlock 50.** Reserved.

6.5.1.8.55 **Interlock 51.** This interlock is activated by:

- ETF Surge Tank HI or HI-HI, ETF modem failure, or ETF AOV closed.

The interlock then:

- Shuts off pump P-C100.
- Positions valve HV-RC3-3 to divert process condensate to TK-C-100.
- Generates permissive to allow P-C-100 to be manually restarted after receiving confirm from position switch ZS-RC3-3D.

6.5.1.8.56 **Interlock 52.** This interlock is activated by:

- Excessive differential pressure on filter F-C-5 or F-C-6.

The interlock then:

- Shuts down pump P-C106.
Activates Interlock 53.

6.5.1.8.57 **Interlock 53.** This interlock is activated by:

- Recycle pump P-C106 shutdown.

The interlock then:

- Positions valve HV-CA1-10 to the Filtered Raw Water supply.

6.5.1.8.58 Interlock 54. This interlock is activated by:

- Low recycle system discharge pressure.

The interlock then:

- Positions valve HV-CA1-10 to the Filtered Raw Water supply.

6.5.2 System and Component Spares

Spare or alternative instrumentation has been installed in the Evaporator facility to provide continuity of operation under normal and abnormal conditions. The instrumentation is installed in places where loss of an instrument is critical to continuous operation and where repair of the instrument would cause too much downtime to repair or replace the instrument. The spare and alternative instruments are listed in Table 6-8.

The instrument systems are provided with pressure taps and electrical contacts for checking operability of the instrument while the facility is operating. Coordinating the instrument technician's calibration checks with plant operation is done routinely through communications between the instrument technicians and plant operations. Safety and essential instruments are routinely calibrated and checked for operation. Nonessential instruments also are checked routinely for operation. Instrument technicians are available for checking the instruments during facility operations.

The instruments are designed for fail-safe operation (i.e., process control may be lost during an accident or equipment/instrument failure, but control of the Evaporator is maintained). Instruments were tested during OTPs and ATPs. Instruments are calibrated routinely per the Preventive Maintenance Recall System and are verified to be within calibration prior to start-up of a campaign. Retesting of the instruments also is done when maintenance is performed on the equipment/instruments or whenever operations/engineering determines that a retest of the instruments is needed.

6.6 CONTROL ROOM

The 242-AB Building constructed northeast of the Evaporator facility is the control room (Chapter 5.0, Figure 5-14) for the Evaporator facility. This building provides control and monitoring facilities for the Evaporator and a few monitoring and control functions for the 241-A, 241-AP, 241-AN, 241-AW, 241-AX, 241-AY, and 241-AZ Tank Farms.

The Evaporator alarms are annunciated in the control room. Some 200 East Area tank farm leak detectors and radiation alarms also are located here. Additionally, tank farm transfer pump ammeters and pump shutdown controls are located here.

6.6.1 Normal Operation

The control room (242-AB Building) is a centralized location for controlling and monitoring activity in the Evaporator facility and the pumps located in tank farms.

The controls and alarms are within the MCS. The control room contains all consoles, printers, process control functions, graphics displays, indicators, alarms, annunciators, controllers, and other instrumentation required to operate the facility.

6.6.1.1 Accident/Abnormal Operation. An earthquake is the worst-case DBA affecting habitability of the control room. Because the control room was designed to the 1988 UBC, a DBE may make the control room uninhabitable and unusable. Many interlocks automatically shut down the Evaporator, dump the evaporator vessel contents to the feed tank, and place the Evaporator facility in a safe shutdown condition. Because the concrete structures will survive a DBE, containment and confinement of radioactivity has a high probability. Therefore, the process will be shutdown safely for the time period required to restore use of the control room following a DBE. During loss of the control room and safe shutdown of the evaporator process, monitoring of the Evaporator building will be done by operators and HPTs based in nearby facilities. Because the highly radioactive process solution has been drained into the feed tank, monitoring of the Evaporator can be handled easily from another building, if necessary.

Another accident scenario that could conceivably influence habitability of the control room is inadvertent filling of a tank seal loop with subsequent release of contaminated effluent to the atmosphere. This accident is postulated as a credible worst-case accident for aging waste tanks. Wind data collected routinely at the Hanford Meteorology Station since 1945 show the prevailing wind directions are from the northwest in all months (Chapter 3.0, Figure 3-30). The 242-AB control room is located ~200 m south of the aging waste tanks, 241-AZ Tank Farms, in the path of the prevailing winds. Based on the calculated release level, facilities (including the Evaporator) will be controlled radiation zones for a few days until they can be decontaminated and returned to normal operation. All major Evaporator support buildings are located in the vicinity of the 242-AB control room building and likewise would become contaminated.

6.6.1.2 Redundancy. There is no backup control room for the 242-AB control room. Actual control is achieved only by manually adjusting the controls in the 242-AB control room. The control room has many interlocks that automatically will shut down the process if the process is left unattended for a lengthy time period. Also, the operators are trained to shut down the process in a short time period when an emergency situation occurs.

The probability that the control room will remain inhabitable during the time frame aging waste is stored in underground tanks is >0.98. Current plans for waste disposal will lead to converting all neutralized current acid waste

(NCAW) to glass in the Hanford Waste Vittrification Plant (HWVP) starting in December 1999 (Ecology, et al. 1990). A conservative estimate of one event per 20 yr of operation has been assigned for the probability of occurrence of the filled seal loop worst-case accident. Therefore, the annual probability of a seal loop accident is 0.05. Other factors that reduce this probability are the age of the waste and the magnitude of the event (e.g., amount of radioactive material released, wind direction, and plume aerodynamics). Therefore, a fully equipped backup control room to the 242-AB control room most likely is not required to ensure continued safe operation of the Evaporator facility.

6.7 SAMPLING--ANALYTICAL

Sampling of the candidate feed tanks, feed stream, and slurry stream is necessary to ensure that the system operates within applicable process and safety limits. Various sampling methods and systems are used, depending on the specific sampling requirements of each waste stream.

6.7.1 Sampling Requirements

Samples from the underground storage tanks scheduled for use in the Evaporator campaign are required to classify the waste as acceptable for feed into the Evaporator facility. These samples are taken and analyzed before the tanks contents are transferred to the feed tank. The sampling and analysis requirements for the Evaporator are described in *242A Evaporator Data Quality Objectives* (Von Bargaen 1998). The sampling procedures, the number of samples, and the sample locations also are applicable to the limits and controls established in Chapters 4.0 and 11.0.

The Data Quality Objectives identify the rationale and the analyses that will be performed on the samples taken from the underground storage tanks scheduled for processing or campaign tanks. The analyses that will be performed include the following:

- Ignitability/reactivity analysis
- Inorganic analyses
- Organic analyses
- Boildown
- Radionuclide analyses.

A survey of the contents of the DST has indicated that the DSTs may contain reactive and/or ignitable waste. Therefore, the Evaporator feed is analyzed using a differential scanning calorimeter to ensure that the limits in Chapter 4.0, Table 4-7 are met.

The inorganic constituents for each campaign tank are identified and consolidated to develop a feed stream. The feed stream is analyzed to verify

material compatibility within the Evaporator process equipment, to ensure that clogging of process piping does not occur during waste processing, and to ensure that the LERF acceptance criteria are not exceeded. The inorganics of concern are listed (Von Barga 1998).

The organic constituents of the campaign tanks are analyzed to assess vessel vent organic discharge and estimate LERF concentrations. An analysis for TOC is used to determine if the resultant slurry product will be designated as complexed. In addition to the Evaporator feed stream samples, a surface sample to detect separable organics, is performed on each of the campaign tanks (see discussion in Section 6.1.3.2).

A 'boildown' analysis of the Evaporator feed (or consolidated campaign tank wastes) is performed to determine the characteristics of the waste during processing. The 'boildown' analysis involves consolidating samples from each of the campaign tanks, concentrating the consolidated sample by boiling, and analyzing the concentrated solution. The laboratory boildown approximates the evaporation process at the Evaporator; therefore, the expected density of the slurry produced at the Evaporator for a specific WVR, can be accurately predicted based on the final density of the concentrated solution created during the laboratory boildown.

Each of the campaign tanks is analyzed for radionuclides and consolidated into a representative feed stream. The radionuclide feed concentrations will be evaluated using the process flowsheet developed in Appendix 6A. This evaluation will ensure that the Evaporator will not exceed the analyzed safety envelope and the subsequent OSR (see Chapter 11.0, Section 2.13) and will not exceed the LERF Inventory Control OSR (WMH 1997). The feed concentration evaluation will also be evaluated to ensure that the nuclear criticality control OSR at the Evaporator (see Chapter 11.0, Section 2.11) and the receiver tanks are not exceeded (see Chapter 11.0, Section 2.8.6).

The results of the inorganic chemical analyses are used in a process simulation tool called PREDICT. The PREDICT computer program simulates the evaporator process for a given feed composition. The computer program PREDICT uses the solubility relationships among OH^- , AlO_2^- , NO_3^- , NO_2^- , CO_3^{2-} , PO_4^{3-} , SO_4^{2-} , and F^- to estimate the solid formation in the evaporator vessel and in the slurry receiver tank. Also PREDICT uses the assumption that all organics remain in the slurry to calculate the TOC throughout the evaporator process. The program PREDICT is used to calculate waste volume reduction factor at which the limits on TOC, hydroxide, or solids formation is exceeded.

6.7.2 Sampling Systems

6.7.2.1 Storage Tank-Waste Solution Sampler. A supernatant sampler is used routinely in the tank farms for sampling liquids and to sample suspended solids and solids near the solid-liquid interface. The sampling method generally is referred to as 'bottle on a string.' The equipment is simple to operate but requires extensive preparation to prevent spread of contamination while sampling and to minimize operator exposure. To protect personnel and the environment from possible contamination, all sampling is done within the confines of a radiological containment.

A diagram of the typical sampling assembly is shown in Figure 6-16. To minimize potential contamination spread and high operator exposure, stainless steel wire is used for the sample suspension string, and localized shielding is placed around the tank riser. The sample suspension wire is measured for the length sufficient to submerge the bottle to the depth specified. A marker is affixed at the point that coincides with the tank riser flange when the sample bottle is at the desired depth. The sampler then is lowered into the riser up to the marker where the stopper is pulled with a quick jerk. The sample is retracted carefully to grade level where the sample bottle is capped, washed, and placed in the 'transfer pig.' During sample retrieval, the stainless steel wire is wiped clean with rags using tongs to reduce chances of contamination spread. If a high dose rate prohibits hand contact, tongs, dowel and tape, or other remote-handling apparatuses are used to handle the sample bottle. Tank samples are of 125 mL (0.33 gal) volume and are placed in casks for shipment.

Additional feed samples are taken throughout the campaign to verify that constituents are within the limits and that concentrations in the various streams are as expected.

6.7.2.2 Process Control Feed and Slurry Samples. Sampling of feed and slurry streams are performed regularly to check Evaporator boil-down performance. The sampling provides a means of determining the extent of concentration and measuring how close the solution is to DSSF concentration (the concentration just before forming precipitates). The analyses performed on each sample include testing for exotherms, plutonium content, specific gravity, percent solids, TOC, aluminum, nitrite, nitrate, hydroxide, GEA, ammonia, and many others. Many of these analyses are necessary for safe Evaporator operation. Exotherms are determined from a differential scanning calorimeter DSC on tank samples and provide an indication of thermal properties, that is, whether or not the solution is capable of generating more heat than it receives in the evaporation process. The solution's behavior under a DSC will simulate Evaporator heating and also will determine if temperature control will be a problem. Plutonium, cesium, strontium, and other fission product concentrations are determined as well.

Concentration of waste streams can potentially create radiation fields that exceed the parameters of shielding design criteria and could pose a hazard to workers in the personnel-occupied areas of the 242-A Building. The ¹³⁷Cs concentrations are monitored both in feed tank TK-241-AW-102 and the slurry product to maintain concentration levels in the 242-A Building below 1.5 Ci/L and this level has been established as a QSR Administration Control (see 11.2.13). However, for ALARA purposes, a limit of 0.8 Ci/L (3 Ci/gal) of ¹³⁷Cs has been set for Evaporator liquors. At process liquid concentrations at or below 1.5 Ci/L, the building design will provide <1 mR/h in the office rooms and minimum radiation levels in other personnel-occupied areas (Selle 1991).

The slurry and feed samples are available by remotely extracting a small portion of each stream via an Isolock sampling device. The samplers extract flow directly into 60-mL sample bottles that are loaded in lead shielding casks and transferred to the laboratory for analysis. Instrument air and hot or cold water is supplied to the sample enclosure for operation of the Isolock sampler and flushing, respectively.

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Figure 6-1. Simplified Schematic of the 242-A Evaporator.

RP99020184.1

Figure 6-2. Aluminate Solids Phase Curve as a Function of NaOH and NaAlO_2 Concentrations.

LIST OF TERMS

ACV	administrative control values
AEA	<i>Atomic Energy Act of 1954</i>
ALARA	as low as reasonably achievable
AMU	aqueous makeup
CAM	continuous air monitor
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act of 1980</i>
CFR	Code of Federal Regulations
COB	clean-out box
DAC	derived air concentration
DCG	derived concentration guide
DOE	U.S. Department of Energy
DP	differential pressure
Ecology	Washington (State) Department of Ecology
EDE	effective dose equivalent
EPA	U.S. Environmental Protection Agency
FEMP	Facility Effluent Monitoring Plan
FSAR	Final Safety Report
HEHF	Hanford Environmental Health Foundation
HEPA	high-efficiency particulate air
HPT	health physics technician
HVAC	heating, ventilation, and air conditioning
ICRP	International Commission on Radiological Protection
MCS	monitoring and control system
MSDS	material safety data sheet
ND	not detected
NESHAPS	National Emission Standards for Hazardous Air Pollutants
p/b	parts per billion
PCSP	process support calibration and maintenance procedure
PM/S	Preventive Maintenance/Surveillance System
PPE	personal protective equipment
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
RCT	radiological control technician
RQ	reportable quantity
RTR	real-time radiography
SAP	sampling and analysis plan
SWP	special work permit
the Evaporator	242-A Evaporator
TDS	total dissolved solids
TEDF	Treated Effluent Disposal Facility
TOC	total organic carbon
TSD	treatment, storage, or disposal
WAC	Washington (State) Administrative Code
Westinghouse Hanford	Westinghouse Hanford Company
WIPP	Waste Isolation Pilot Plant
WMH	Waste Management Hanford Company

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control room, lunchroom, corridors, clean- and soiled-clothes area, and office, is serviced by the K2 Ventilation System. The noncontaminated zone is pressurized by an intake fan, K2-5-1, which supplies 370 m³/min (13,000 ft³/min) of outside air and 23 m³/min (800 ft³/min) of recycled air to the zone. The air is drawn through a preheat coil, two filters, a reheat coil, and an air washer before entering the zone. The AMU room receives ~61% and the HVAC room ~7% of the intake air, while the remaining air is circulated throughout the other noncontaminated area rooms. Of the outside air intake, 62% is exhausted from the AMU room exhaust fan (K2-5-2) and 33% is exhausted from the roof exhaust fan (K2-5-3). The remaining air exits via leakage to the contaminated zone and to ambient air. Chapter 5.0, Figure 5-29, is a flow diagram of the K2 Ventilation System.

The two primary exhaust fans for the K2 system are controlled by pressure switches and are allowed to operate only when the supply air has increased zone air pressure to a set positive value. These exhaust fans are shut down automatically if air pressure drops to atmospheric pressure. (The restroom exhaust is not included in the automatic control system.) The intake fan is shut down automatically if supply system pressure drops below a set positive value [+0.1 in. H₂O (25 Pa)]. The uncontaminated zone will maintain a positive pressure while the intake fan is operating. If the supply air system fails, the uncontaminated zones of the facility will return to atmospheric pressure. The exhaust from the K2 system is not monitored because the possibility of radiological emissions from the noncontaminated zones is extremely low.

7.4.3.2 Contaminated Zone Building Ventilation. The contaminated zone, which includes the condenser room, evaporator room, pump room, load-out and hot-equipment storage room, loading dock, and ion exchange room, is serviced by the K1 Ventilation System. All contaminated areas are held at negative pressure to prevent leakage of contaminated air to noncontaminated zones and to ambient air.

The contaminated zone is supplied with 520 m³/min (18,500 ft³/min) of outside air from intake fan K1-5-1. Intake air is divided between the condenser room, which receives 52% of intake; the evaporator room, which receives 35% of intake; and the pump room, which receives 8% of intake. The loading dock receives the remaining 5% of intake and ~23 m³/min (~800 ft³/min) of ambient loading dock air in-leakage. The load-out and hot-equipment storage room is supplied with a 48-m³/min (1,700-ft³/min) airflow through the loading dock and exhausts that entire flow to the pump room. The ion exchange room is supplied with a 17-m³/min (600-ft³/min) airflow through the condenser room. The evaporator room supplies an additional 11-m³/min (400-ft³/min) airflow to the pump room. Only the condenser room, ion exchange room, evaporator room, and pump room exhaust directly to the stack system. Chapter 5.0, Figure 5-26, is a flow diagram of the K1 Ventilation System. Process flowsheets and more detailed information are found in Figure 5-21 and Sections 5.4.1 and 6.1.2.

Negative pressure in the contaminated zone normally is maintained through operation of the electric exhaust fan. After the exhaust fan has been started, the intake fan starts automatically when the pressure in the evaporator room approaches the required negative value [-0.15 in. H₂O (37 Pa)]. The contaminated zone will maintain a negative pressure while the

exhaust fan is in operation. If the exhaust air system fails, the contaminated zones of the facility will return to atmospheric pressure.

The exhaust air line splits for filtering before discharge to the atmosphere via the 296-A-21 Stack. The two parallel filter systems each consist of one dust (8% NBS) filter bank and two HEPA filter banks in series. Exhaust air exits at the rate of 283 KL/min (10,000 ft³/min) through a 620 m³/min (21,800 ft³/min)-capacity electric exhaust fan, K1-5-3. A backup electric fan, K1-5-2, of identical size is available as a backup. Failure of the electric exhaust fan to maintain a specific flow will initiate the shutdown of the electric fan and startup of the backup electric fan.

The differential pressures (DP) across both the first and second HEPA filters in the exhaust system are monitored. A low DP across either the first or second filters could indicate a failure resulting from loss of all or part of the filter media, whereas a high DP across the first filter would indicate a plugged filter with a potential for filter failure. Each condition is annunciated in the control room.

Air from the K1 system exhausts through stack 296-A-21. A portion of the exhaust air is drawn through an air sampler probe (see Section 7.4.2.1). This sample stream is monitored continuously for radiation and transferred via vacuum pump back into the exhaust stream for release through the stack. A high-radiation reading in the building ventilation exhaust stream initiates an interlock that will activate an exhaust stack high-radiation alarm annunciator in the control room. The building supply fan is shut down automatically by a pressure interlock. Hardwired Interlock 11 provides shutdown of the building exhaust fans (Section 6.5.1.8, Interlock 11).

Airflow measurements at the Evaporator are performed by the vent and balance group using an approved maintenance engineering services maintenance procedure 6-TF-155, Air Flow Tests for Tank Farm Stacks and Ducts. The maintenance engineering procedure uses a pitot tube as specified in 40 CFR 60, *Standards of Performance for New Stationary Sources*, Appendix A, Method 2.

Additionally, specific handling and custody requirements and EPA compliant "chain of custody" controls have been developed and are in place to ensure that samples for air monitoring stations are controlled and sampling locations are identified.

Monitoring instrumentation alarm set points are provided in Table 7-7. Bases for the alarm set points are taken from existing process support calibration and maintenance procedures (PSCP) and from operational and functional check procedures. Using the 8 derived air concentration-(DAC) h requirement in DOE Order 5480.11 as a lower level of detection, not an alarm level for CAMs, a 20 DAC-h alarm level has been established. This was established to reduce the incidence of false alarms due to radon daughter interference. Integrated samplers (record samplers) allow for retrospective air sampling analysis that ensures that the 8 DAC-h requirement is met.

7.4.3.3 Vessel Ventilation System. The vessel vent system filters and discharges noncondensed vapors from the vacuum condenser and process condensate systems to the atmosphere. The condensate collection tank also is vented to the atmosphere through this system. The system consists of a

7.5.3.5 Monitoring and Control System. Continuous monitoring of liquid waste retention and treatment systems is provided by the MCS located in the control room. The MCS performs continuous monitoring of the following used raw-water system instruments:

- Flow to 200 Area TEDF Pump Station 3, FI-RC2-1, not alarmed
- E-C-1 condenser flow controller, FIC-EC1-1, set at 1,200 gal/min (4,500 L/min) Low 2,800 gal/min (10,600 L/min) High
- Flow to 200 Area TEDF Pump Station 3 totalizer, FQI-RC2-1, not alarmed
- URW backpressure, PI-EC1-2, set at 20 lbf/in² (gauge) (138 kPa) Low, 30 lbf/in² (gauge) (210 kPa) High
- Radiation monitor/sampler, RI-RC2-1
- Valve E-C-1 condenser and 200 Area TEDF Pump Station 3, ZI-EC1-1 and -2, not alarmed.

Monitoring instrumentation alarm set points and bases for the used raw water system are provided in Table 7-9. Table 7-10 provides the monitoring instrumentation alarm set points and bases for the steam condensate system. The used raw water and steam condensate monitoring systems are designed to alarm before a total instantaneous gamma radiation limit of 1.5×10^{-2} $\mu\text{Ci/mL}$, as described in OSD-T-151-00012, *Operating Specifications for the Operation of the 242-A Evaporator/Crystallizer* (Wahlquist 1997).

The MCS also provides continuous monitoring of the following steam condensate system instrumentation:

- Reboiler steam condensate flow, FI-EA1-3, not alarmed
- Steam condensate flow, FI-RC1-1, not alarmed
- Diverted steam condensate flow totalizers FQI-EA1-D and FQI-RC1-D, not alarmed
- Reboiler steam condensate flow totalizer, FQI-EA1-NM, not alarmed
- Reboiler steam condensate radiation, RI-EA1-1
- Steam condensate sampler radiation, RI-RC1-1.

The control system balances automatic and operator-initiated control. Fixed sequences of operation, such as alignment of valves and sequencing of motors, are automated in the control system. The operator selects the sequences. Complete information on the process status is displayed, including the state of on/off devices and process parameter values such as flow, temperature, and pressure. Alarms are displayed on an alarm summary screen and logged on a printer. An alarm history file is maintained on disk.

The PM/S is used as a tool to manage plant calibrations. The PM/S provides a schedule for instrument calibration, evaluates the frequency of calibration, and increases the required frequency if the instrument is often out of calibration. To prevent hazards from operator or computer error, trained, independent quality assurance inspectors perform random calibration surveillances.

7.5.4 Operations

The Evaporator liquid waste treatment and retention systems are designed with safety interlocks that automatically provide for shutdown of system components in the event of unsatisfactory conditions within the process.

Monitoring instruments for the liquid waste systems are connected to audible alarms and to the MCS. The MCS performs continuous monitoring of system instruments as detailed in Section 7.5.3.5. When an alarm is activated, the process operator responds in accordance with the applicable plant operating procedure. An MCS alarm history file records all system events, operator responses, and the time of occurrence for future reference. A discrete console contains emergency controls to be used if the computer control system fails. These controls consist of selector switches and indicators that allow the operator to control those valves and motors essential to flushing process waste from the system and shutting the system down.

When the Evaporator is operating, composite and/or grab samples of used raw water stream are taken as required by the TEDF Interface Control Document (ICD) (WMH 1997). Composite samples are collected by periodic diversion of a portion of the used raw-water flow into a receiver tank, RC-2-1. Before collecting the sample, the tank is allowed to empty through a length of tygon tubing from the bottom of the tank to a floor drain for 10 s in order to flush any accumulated residue. After the sample has been collected from this composite, the remainder of the tank contents is also released to the floor drain. Grab samples are collected from valve 2-20. Before collecting the samples, the sample valve is opened, and the system is allowed to flow to a collection bucket for 10 s to flush any accumulated residue. After the sample has been collected, the contents of the collection bucket is discarded into the floor drain. The floor drain is piped into the primary drainage system, which routes material to the Evaporator feed tank, TK-241-AW-102. Collection of samples and analysis results are documented using the 242-A Evaporator Sample Log Sheet. The frequency of sampling and analysis performed is given in HNF-SD-WM-DQO-014, Rev. 2 (Von Bargen 1998).

Composite and/or grab samples are collected from the steam condensate effluent stream flow as required by the TEDF ICD (WMH 1997a). Composite stream samples are collected by periodic diversion of a portion of the steam condensate into a receiver tank, RC-1-1. Before the sample is collected, the tank is allowed to empty through a length of tygon tubing from the bottom of the tank to a floor drain for 10 s in order to flush any accumulated residue. After collecting the sample from this composite, the remainder of the tank contents also is released to the floor drain. Grab samples are collected from valve RC1-17. Before collecting the samples, the sample valve is opened, and

the system is allowed to flow to the floor drain for 10 s to flush any accumulated residue. The floor drain is piped into the primary drainage system, which routes material to the Evaporator feed tank, TK-241-AW-102. Collection of samples and analysis results are documented using the 242-A Evaporator Sample Log Sheet. The frequency of sampling and analysis performed is given in WHC-SD-WM-DQO-014, Rev. 2 (Von Bargaen 1998).

Maintenance is performed by contractor personnel specifically trained for the Evaporator. Equipment requiring maintenance is checked at least annually and may be checked more often depending on maintenance history and manufacturer recommendations. Preventive maintenance, which is not possible when the Evaporator is operating, is performed during scheduled outages.

Instruments are calibrated regularly to ensure operation within specification. All instruments are calibrated at least annually. Some systems are calibrated monthly, depending on previous calibration experience. The job control system is employed to direct, track, and evaluate the calibration frequency of each instrument and alarm.

7.5.5 Safety Criteria and Assurance

Chapter 8.0, "Radiation Protection," and Chapter 9.0, "Accident Safety Analysis," evaluate the facility liquid effluent management systems and the contribution these systems make to the release of radiological and hazardous constituents under all credible circumstances.

7.6 SOLID WASTES

7.6.1 Wastes

Solid waste produced at the facility consists primarily of used PPE and containment materials, spill cleanup materials, replaced HEPA filters or other process equipment, office wastes, and facility maintenance and janitorial wastes. Characterization of these streams is addressed in more detail in Sections 7.2 and 7.3. Solid waste generated at the Evaporator is segregated at the time of its generation. This segregation is performed at generation via process, maintenance, and job knowledge, which provides the initial controls for characterization of low-level waste. As described in WHC-EP-0063-4 (Willis 1993), categorization of the waste is performed and shipped to the appropriate Hanford Site solid waste facility.

7.6.2 Design, Equipment, and Systems

Waste management activities at the facility consist of waste identification, accumulation, and packaging for transportation. Design of the Evaporator does not include dedicated areas for storage of solid wastes.

Storage areas for low-level radioactive waste are provided at each stepoff pad in the facility. Waste is accumulated in 208-L (55-gal) drums provided by the Waste Control Group, and precoded for identification. Accumulation drums are lined with a 10-mil plastic bag and closed with a swing-lid cover while in use. Each storage area consists of two drums, plainly labeled "Compactible Waste Only" and "Noncompactible Waste Only." A temporary magnetic sign is attached to the drum to provide such labeling. Used PPE is collected in canvas bags at step-off pads. Packaged PPE is stored in the soiled-clothes storage room.

Nonradioactive hazardous and mixed wastes are not routinely generated at the facility. Satellite accumulation areas are established at the site of maintenance or upgrade activities that are performed on an as-needed basis. At the completion of the job, or on accumulation of 208 L (55 gal) of dangerous waste or 1 quart of acutely hazardous waste, accumulation containers are removed to less-than-90-d storage areas. Procedures for satellite accumulation areas for the Evaporator have been developed based on guidance provided in HNF-PRO-455.

7.6.3 Operations

Management of low-level radioactive solid wastes is conducted in accordance with the *Hanford Site Radioactive Solid Waste Acceptance Criteria*, WHC-EP-0063-4 (Willis 1993). Specific management methods are addressed by type of waste in the following sections.

7.6.3.1 Radioactive Solid Wastes. Waste accumulated at step-off pads is collected in plastic-lined rigid containers and segregated into the following categories:

- Special work permit (SWP) clothes
- SWP rubber
- Compactible waste
- Noncompactible waste.

Collected SWPs, consisting of used, undamaged PPE (coveralls, shoe covers, and respirators) are decontaminated at the onsite laundry facility for reuse. Used PPE is consolidated and bagged daily and is stored temporarily at the Evaporator for pickup by laundry personnel.

Compactible waste, consisting of nonreusable protective clothing or containment items such as rubber gloves, paper garments, and plastic sheeting, is bagged in the collection container, pigtailed and sealed with tape, removed from the rigid container, visually examined, surveyed by a RCT, and labeled with a completed Waste Identification Sticker. This sticker identifies the following:

- Waste type by percentage (e.g., plastic, paper, cloth, etc.)
- Package weight
- Location of generation by room and building
- Package dose rate
- RCT's signature and date of survey
- Signature of waste packager.

A Waste Disposal Analyses Request Form is completed for each container of hazardous waste generated. This form contains the following:

- The location and date of waste generation
- The number of waste containers and total weight of waste material
- The container contents, by weight percentage
- The chemical and physical characteristics of the waste
- The signature of the waste generator.

The completed form is forwarded to the Solid Waste Engineering Support Group for waste designation and instructions on transportation and disposition. Upon receipt of the waste designation, hazardous wastes are prepared for transportation in compliance with U.S. Department of Transportation requirements and transported to the onsite permitted Nonradioactive Dangerous Waste Storage Facility for storage. All nonradioactive hazardous wastes are transported offsite for disposal.

7.6.4 Safety Criteria and Assurance

Chapter 8.0, "Radiation Protection," and Chapter 9.0, "Accident Safety Analysis," evaluates the facility solid waste management systems and the contribution these systems make to the release of radiological and hazardous constituents under all credible circumstances.

7.7 REFERENCES

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Table 7-1. Building Exhaust Stack 296-A-21 Gaseous Radioactive Effluent.

Emission	1991 ^a	1992 ^b	1993 ^c	1994 ^d	1995 ^e	1996 ^f
Total volume (L)	2.90 E+11	2.90 E+11	2.80 E+11	3.7 E+08	1.2 E+08	2.5 E+08
	($\mu\text{Ci/mL}$)	($\mu\text{Ci/mL}$)	($\mu\text{Ci/mL}$)	($\mu\text{Ci/mL}$)	($\mu\text{Ci/mL}$)	($\mu\text{Ci/mL}$)
Alpha	3.5 E-15	ND	ND	ND	1.2 E-16	9.6 E-17
Beta	1.2 E-14	ND	ND	ND	8.2 E-16	1.6 E-15
²⁴¹ Am	2.06 E-15	ND	ND	ND	2.5 E-17	*
^{239,240} Pu	1.03 E-15	ND	ND	ND	3.4 E-17	*

ND - None detected, or average concentration less than background

* - Data not required

^a Data taken from WHC-EP-0527-1

^b Data taken from WHC-EP-0527-2

^c Data taken from WHC-EP-0527-3

^d Data taken from WHC-EP-0527-4

^e Data taken from WHC-EP-0527-5

^f Data taken from WHC-EP-0527-6

Table 7-2. Vessel Ventilation Stack 296-A-22 Gaseous Radioactive Effluent.

Emission	1991 ^a	1992 ^b	1993 ^c	1994 ^d	1995 ^e	1996 ^f
Total volume (L)	Stack not operated	1.10 E+10	2.40 E+09	7.5 E+07	9.6 E+06	7.7 E+06
	($\mu\text{Ci/mL}$)	($\mu\text{Ci/mL}$)	($\mu\text{Ci/mL}$)	($\mu\text{Ci/mL}$)	($\mu\text{Ci/mL}$)	($\mu\text{Ci/mL}$)
Alpha	*	3.6 E-16	7.7 E-16	ND	2.8 E-16	1.5 E-16
Beta	*	5.9 E-14	1.3 E-14	1.2 E-14	4.0 E-15	2.9 E-15
¹⁰⁶ Ru	*	*	*	ND	4.4 E-14	1.0 E-14
¹³⁷ Cs	*	*	*	ND	4.6 E-17	1.4 E-15
²⁴¹ Am	*	*	*	ND	3.3 E-17	8.6 E-17
^{239,240} Pu	*	*	*	ND	1.4 E-17	3.3 E-17

ND - None detected, or average concentration less than background

* - Data not required

^a Data taken from WHC-EP-0527-1; however, stack was not operated in 1991.

^b Data taken from WHC-EP-0527-2

^c Data taken from WHC-EP-0527-3

^d Data taken from WHC-EP-0527-4

^e Data taken from WHC-EP-0527-5

^f Data taken from WHC-EP-0527-6

Table 7-3. Radiological Assay of Compactible Wastes from Tank Farm Facilities.

Isotopes	Percentage of samples	Highest percentage of total activity
¹³⁷ Cs	100	100
¹³⁴ Cs	14.5	0.3
⁶⁰ Co	10.9	1.8
¹⁵⁴ Eu	9.1	2.4
¹⁵⁵ Eu	1.8	1.9
¹⁰⁶ Ru	9.1	11.8
¹²⁵ Sb	3.6	7.2
¹⁴⁴ Ce	7.2	16.3

Source: Olander (1991).

Table 7-4. Vessel Ventilation Stack 296-A-22 Ammonia and Estimated Organic Emissions^{(a)(b)}.

Campaign	Effluent	Regulatory Limit	Maximum Emission rate	Average Emission rate	Total Emission (lbs)
94-1	Ammonia	100 lbs/day	Not available	< 1	22
	Organic	3.0 lbs/hr	0.21	0.039	41
94-2	Ammonia	100 lbs/day	96	14	600
	Organic	3.0 lbs/hr	0.12	0.095	99
95-1	Ammonia	100 lbs/day	35	11	410
	Organic	3.0 lbs/hr	0.70	0.4	470
96-1	Ammonia	100 lbs/day	3.8	1.5	26
	Organic	3.0 lbs/hr	1.2	1.2	580
97-1	Ammonia	100 lbs/day	0.64	< 1	10
	Organic	3.0 lbs/hr	0.24	0.23	59

^a Ammonia emission data taken from 242-A Evaporator Post-Run Documents^b Organic emission data taken from WHC-SD-WM-ES-380.

Table 7-10. Monitoring Instrumentation for 242-A Steam Condensate System Waste Stream.

Instrument type	Set point (cps)	Bases
Steam Condensate Monitoring and Diversion System		
Steam condensate radiation monitor RE-RC1-1	Alarm: High radiation at 80 cps Diversion: Steam condensate diverted to feed tank 102-AW	<ul style="list-style-type: none"> ● 6-TF-045 (PSCP)^a ● 7-GN-38 (PSCP)^b ● PSCP-3-015^c ● RHO-SD-SQA-TI-003^d [80 cps = $9.5 \text{ E-}05 \text{ } \mu\text{Ci/mL}$ (^{137}Cs) on a secondary calibration] that is below the maximum instantaneous concentration limit of $1.5 \text{ E-}02 \text{ } \mu\text{Ci/mL}$. This set point activity provides an indication of process contamination in the steam condensate system. <p>Physical samples of steam condensate are taken for laboratory analysis to ensure the requirements specified in WHC-SD-W049H-ICD-001, Rev. 7 (WMH 1997a) are met.</p>

cpm = counts per minute.

cps = counts per second.

PSCP = process support calibration and maintenance procedure.

^aMeador 1992.

^bMickle 1990.

^cMeyers 1989.

^dMoss 1985.

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Radiological control personnel are required to monitor onsite activities as described in HSRM-1 and to be available to the facility line manager for radiological support to the work force. To ensure independence in making correct radiological decisions, the Radcon personnel are accountable to the radiological control manager. Radiological support personnel provide radiological engineering support to the RCO including, but not limited to, review and implementation of radiological safety in designs, procedures, the application of dosimetry (internal and external) and other aspects identified in HSRM-1. These personnel are competent (i.e., possess necessary training, education, and operations experience) and are capable of performing their assigned duties.

Radiological control personnel have the responsibility and authority to stop work or mitigate the effect of an activity if they suspect that the initiation or continued performance of a job, evolution, or test will result in the violation of radiological control standards or will result in imminent danger or unacceptable risk. In addition, radiological workers have stop work authority in accordance with Article 345.

Although many of the RCO activities are not specific to the hazards identified in Chapter 9.0, the organization is prepared to identify and respond to almost any incident that could potentially occur at the Evaporator. For example, routine radiological surveys and monitoring and the required data reviews allow for early detection of abnormal situations which, in turn, allow for hazard protection measures to be taken.

8.4 ALARA POLICY AND PROGRAMS

Maintaining personnel exposure ALARA is a guiding principle of radiological control programs at all U.S. Department of Energy (DOE) facilities. The legal requirement for establishing an ALARA program at a DOE facility is contained in 10 CFR 835.101, "Radiation Protection Programs." This statement specifically commits the contractor's organizations to limit radiation exposures to onsite and offsite individuals ALARA. The radiation protection program governing Evaporator operations has followed this policy by implementing ALARA into all facets of radiological work. The Evaporator ALARA program is described in HNF-IP-0931, *200 Area Liquid Waste Processing Facilities Administrative Policies*, Section 24, "ALARA Program."

The contractor's ALARA program establishes the lines of responsibility for ensuring that ALARA practices are properly administered. An ALARA program office and an ALARA council administer the company-wide program. A facility ALARA coordinator and facility ALARA-appointed committees are appointed to attend to facility-specific or project-level ALARA practices.

The administration of ALARA programs at the facility level for the 242-A Evaporator is described in HNF-IP-0931, Section 24, "ALARA Program." A facility ALARA coordinator and a facility ALARA Committee are appointed to deal with ALARA practices at the facility or project level. This manual also describes the responsibilities of individual employees, including hazardous material workers, radiological workers, and nonradiological workers.

The contractor's ALARA program reflects eleven primary elements of an ALARA program, as indicated in the *U.S. Department of Energy Implementation Guide G-10 CFR 835/B2*, "Occupational ALARA Program" (DOE 1994a), including policy and management commitment, assignment of responsibilities, establishing administrative control levels (ACLs), radiological and ALARA performance goals and indicators, ALARA training, plans and procedures, internal assessments and audits, optimization methodology, radiological design review, radiological work and experiment planning, and records. The contractor's ALARA program is documented in WMH-200, *Waste Management Hanford Procedures*, Section 3.2, "ALARA Programs".

8.4.1 Performance Goals and Indicators

The contractor has established a system for defining and tracking specific radiological performance goals and performance indicators using ALARA program assessment methods defined in HSRM-1, Articles 131, 132, and 133. When a performance goal is met, a defined task has been performed to specified criteria and has been completed to a specified endpoint. Performance indicators of the effectiveness of specified program elements are measured by comparing the element status from previous time periods. The HNF-IP-0931 administration manual describes how ALARA performance goals and indicators are set at the facility level. The contractor ALARA council and ALARA program office are responsible for recommending meaningful goals and performance indicators, and for reviewing and approving the goals. Specific goals and performance indicators are set primarily by individuals of each facility or organization. Therefore, facility ALARA Committees, facility management, and line management play major roles in setting these goals. The following are examples of performance indicators:

- Annual collective radiation dose of facility or organization staff
- Number of skin and clothing contaminations
- Number of contamination incidents outside of a contamination area
- Area of the facility that is controlled as a radiological area
- Volume and activity of generated radioactive waste
- Number of reportable radiological occurrences

Quarterly and annual ALARA reports, published by the ALARA program office, document program success with respect to performance goals and indicators.

8.4.2 ALARA Work Documentation

The contractor has a formal system to integrate ALARA reviews into the planning, conduct, and post-job reviews of all radiological work. Key features of this system are discussed in the following subsections. Radiological work is performed within radiological areas utilizing a radiological work permit (RWP) and procedures to implement ALARA.

8.4.2.1 Radiological Work Permits. The RWP is the administrative tool used to establish radiological controls for intended work activities. The RWP supplements a work package and is posted to inform workers of radiological conditions and entry requirements. At the Evaporator, the RWP is used for all radiological work, as specified in the HSRCM-1, to govern entries into radiological areas. A comprehensive description of the contractor's RWP process is presented in Section 8.6.2.1.

Radiological surveys and dosimetry records are routinely reviewed to evaluate adequacy of RWP requirements. The RWPs are updated if radiological conditions change to the extent that protective requirements need modification.

8.4.2.2 Radiological Work Planning. The planning of radiological work is a key element in the ALARA program. Radiological work at the Evaporator is planned in compliance with 10 CFR 835 and HSRCM-1 requirements.

Activities that are not conducted routinely, or are being planned for the first time, are subject to the following planning steps as described in HSRCM-1:

1. Formal radiological review, including design reviews
2. Senior management review directed toward anticipation of concerns and emphasis and specification of protective measures
3. Review and approval by the ALARA Committee
4. Pre-job briefing
5. Enhanced line and RCO management oversight during the initiation and conduct of the work
6. Post-job review.

8.4.2.3 ALARA Management Worksheet. The ALARA management worksheet documents pre-job ALARA considerations, ALARA practices, and the estimated collective dose.

8.4.2.4 Prejob ALARA Review. For tasks that exceed a trigger level (listed in HSRCM-1, Article 312), prejob review ensures that necessary ALARA considerations are included in the prejob planning. The ALARA management worksheet documents prejob ALARA considerations, ALARA practices, and the estimated collective dose.

8.4.2.5 Conduct of Work in Progress. Radiological work is periodically monitored to ensure proper implementation of controls identified in the ALARA management worksheet. Review of work in progress includes monitoring and comparing collective dose accumulation and contamination levels with pre-job estimates.

8.4.2.6 Postjob ALARA Review. A documented postjob ALARA review will occur whenever job-specific trigger levels (listed in HSRCM-1, Article 312) are reached. This review will compare actual doses to prejob estimates, evaluate

the effectiveness of ALARA controls, document lessons learned, and provide recommendations for similar activities.

At the Evaporator, the trigger levels for deciding on the use of an AMW, and thus a more detailed ALARA review, are structured to ensure that the necessary level of attention is given to each task, job, or project.

8.4.3 Internal ALARA Program Reviews and Work Practice Assessments

As mandated by 10 CFR 835.102, "Internal Audits," an internal audit of the ALARA program is conducted at least once every three years. During an internal audit, details of work processes such as work control preparation, pre-job briefings, application of ALARA techniques, pre-job briefings, and follow-up discussions or critiques are examined.

8.4.4 Records

All ALARA program documentation must be maintained according to 10 CFR 835 requirements. The following records are maintained at the 242-A Evaporator or at the operating contractor ALARA program office until final disposition:

- RWPs
- ALARA management worksheets
- Reviews of work in progress
- Pre-job ALARA reviews
- ALARA design reviews
- Cost and benefit analyses
- Pre-job briefings
- ALARA training
- Mock-up training
- Reviews of the ALARA program
- ALARA program documentation
- ALARA Committee meeting minutes.

8.5 RADIOLOGICAL CONTROL TRAINING

The radiological training program for the Evaporator complies with the requirements stated in 10 CFR 835 and Recommendations of *U.S. Department of Energy Implementation Guide G-10 CFR 835/J1*, "Radiation Safety Training," (DOE 1994b), DOE Order 5480.18B, and DOE Order 5480.20. The training program also meets the requirements of the DOE training program management manuals (DOE/EH-0258T-1, *General Employee Radiological Training and Radiological Worker Training, Program Management Manual*); and the DOE training accreditation program manual (DOE 1991, *Training and Accreditation Program Manuals*). The training program is structured so that every Evaporator employee receives the training necessary to safely perform their work but does not receive extraneous training. The quality of the radiological control training program is assured by the guidance of the RCO through their oversight function. Worker qualification records are maintained by the contractor's

8.7.1 Facility Monitoring or Surveying

The contractor has a formal program for conducting required radiological surveillances in facilities where radiological work is performed.

The surveillance program is designed to ensure that consistent scheduled radiation survey task descriptions are developed for all areas which require regular surveys. The program also specifies that the surveys are conducted on schedule; that the survey reports are appropriately completed, posted, and stored; and that the results of the survey are properly used for tracking and trending, and providing data that can be used to determine the effectiveness of the radiological control program.

A task description is completed for each radiological area at the 242-A Evaporator requiring regular surveys. This document describes the location and the type of survey needed, indicates the required frequency (which could range from once per shift to annually), lists required instrumentation (as described in Section 8.8), and lists any action levels that would require corrective action.

The radiological control manager for the Evaporator is required to ensure that the radiological survey reports are properly completed, compiled, and reviewed monthly. The reports are used to verify trends in radiological conditions, and to determine whether any conditions warrant corrective actions. The monitoring results are also made available to line management for use in support of pre-job planning and pre-job evaluations, for ALARA planning, for contamination control, and for management of radiological control operations. Data from the survey reports is provided to determine the total area (square footage) of contamination areas and high-contamination areas within and outside of buildings. This data is useful in controlling the spread of contamination in the Evaporator facility.

HNF-PRO-331, *Work Place Air Monitoring* describes the contractor program for air sampling, which is a key component of facility monitoring. Continuous air monitoring, using continuous air monitors (see Section 8.8), is primarily used in areas where an individual is likely to be exposed to airborne radioactivity exceeding 1 derived air concentration, or where there is a need to alert personnel to an unexpected increase in airborne radioactivity levels. Additional reasons for continuous air monitoring are given in HNF-PRO-337. The data derived from continuous air monitoring is used for tracking and trending, determining the effectiveness of contamination control and radiological control practices, identifying long-term variations in radioactivity levels, and identifying potentially improper radiological work practices.

Article 514 of HSRM-1 specifies that work locations adjacent to radiologically controlled areas must be monitored to ensure that radiological conditions are sufficiently low to justify maintaining them as nonradiological areas. The contractor has established an area dosimetry program to accomplish this monitoring (HNF-PRO-382, *Area Dosimetry Program*). The program uses area dosimeters strategically mounted in locations that will adequately characterize the work area, and requires a change-out frequency that will ensure that the monitoring is current.

8.7.2 Operational Monitoring of Workers

All workers who enter radiological buffer areas must wear personnel dosimetry (see Section 8.6.3.1) that provides the occupational doses of record for the worker and for the organization. The dosimeters of record cannot provide real-time indications of exposure, so a supplementary dosimeter is worn in situations where a real-time personnel dose is needed. This dosimeter is typically a self-reading gamma pencil dosimeter. Use of supplementary dosimetry is specified in an RWP; more information on the use of supplementary dosimetry is given in Section 8.6.3.1.

Other types of worker monitoring involve monitoring the radiological conditions of the work area, to ensure that general area dose rates, contamination levels, and airborne radioactivity levels are within reasonable levels.

The methods for establishing personnel dose rates in the Evaporator work areas are described in HNF-IP-0718, *Health Physics Technical Practices and Procedures*. The instruments used in the Evaporator to establish these dose rates are described in Section 8.8. Procedures for correct operation of the instruments are given in HNF-PRO-636, *Black Widow and Bumble Bee, CP*.

Contamination in the Evaporator is routinely monitored as described in Section 8.7.1. This routine monitoring provides a baseline understanding of the potential for contamination, which is useful for planning work in the facility. The RWP covering a job may require specific contamination monitoring that should be performed immediately before, during, or after radiological work to minimize the potential for the spread of contamination by the work activities. HNF-IP-0718 describes the proper release survey procedures to use when exiting a radiological area to ensure that contamination is not translocated out of the work area and to ensure that the workers do not themselves become contaminated. Evaporator workers use the instruments described in Section 8.8, including personal contamination monitors and friskers, to monitor themselves when leaving a radiological area.

Airborne radioactivity in the workplace is routinely monitored as described in Section 8.7.1. To support personnel entries into areas with suspected airborne radioactivity, grab air samples may be taken to characterize the possible radioactivity in a worker breathing zone. Grab air samples are taken as part of pre-job preparation, and they may be taken during performance of a job, or pre-job, if necessary. Procedures for grab air sampling are given in HNF-PRO-666, *Grab Air Sampling*.

8.7.3 Meteorological Data Sampling

The Hanford Meteorological Data Collection System is operated by staff from PNNL. The monitoring network and parameters monitored are discussed in PNL-6884, *The Data Collection Component of the Hanford Monitoring Program* (also see Chapter 3.0). The extensive network of meteorological towers scattered about the Hanford Site include a 125-meter tower between the 200 East and 200 West Areas. Smaller towers are also positioned in the 200 East and 200 West Areas. These towers contain instruments to record atmospheric conditions at several elevations above the ground, thus providing

used while out of calibration, immediate notification of the out-of-calibration condition is made to the appropriate RCO office. The RCO office reviews any measurements performed with the instrument while it was suspected of being out-of-calibration.

A program for preventive and corrective maintenance of radiological instruments is described in PNL-MA-563. The components and procedural recommendations used for preventive and corrective maintenance are at least as stringent as those specified by the manufacturer. After any preventive or corrective maintenance or any adjustment that voids the previous calibration, radiological instruments undergo calibration before use.

8.9 RADIOLOGICAL PROTECTION RECORDKEEPING

The records that relate to radiation doses received by radiological workers at the Hanford Site are maintained by the Hanford Radiological Records Project, which is administered by PNNL. This project is documented in PNL-MA-553, *Hanford Radiological Records Project Manual*.

Radiological control records that relate to the operation of the radiological control program such as RWPs, ALARA reviews, radiological surveys, and radiological problem reports are maintained by the 242-A Evaporator RCO according to the contractor's document control and quality assurance manuals, and approved as discussed in previous sections (i.e., safety, quality assurance, RCO, and facility management).

8.10 OCCUPATIONAL RADIATION EXPOSURES

Occupational radiation doses that would result from continued operation of the Evaporator can be estimated based on recent historical data. Data for the last five years of tank farm operations including the Evaporator are presented in this section. Collective dose levels have been low, increasing only with increases in levels of activity. The number of contamination incidents has also been low; no internal depositions have been recorded; and no exposures exceeding regulatory limits have been recorded. Historical data indicates that the radiation protection program has been successful (i.e., no adverse radiological impacts to workers) and that future operations performed within the requirements and guidelines of the radiation protection program will maintain exposures below guidelines.

8.10.1 Collective External Radiation Doses

The collective external radiation doses received at the tank farms including the Evaporator for 1990 through 1995 are shown in Table 8-5. As of October 1996, the operation of the Evaporator was transferred to the liquid waste processing contractor; therefore, as expected, due to the number of employees at the Evaporator versus the number of tank farm employees, the collective dose for 1997 is significantly less than the previous years shown in Table 8-5.

The data for the years before 1992 describe only the external dose equivalent due to external sources of radiation and do not include the dose contribution from internal depositions. Beginning in 1993, the dose received from internal depositions was added to the annual totals. The influence of internal depositions on the collective dose equivalent received by tank farm workers is relatively small because these workers have not experienced significant intakes (see Section 8.10.3).

8.10.2 Skin and Clothing Contamination Incidents

The reportable skin and clothing contamination incidents that occurred at the tank farms including the Evaporator are shown in Table 8-6. Because of changes in reporting requirements, clothing contamination data is available for part of 1993, and all of 1994, and 1995. Because there have been no changes in the reporting requirements for skin contamination events, data is available from 1988 through 1997.

As of October 1996, the operation of the Evaporator was transferred to the liquid waste processing contractor; therefore, as expected, due to the number of employees at the Evaporator versus the number of tank farm employees, the number of contamination incidents in 1997 is significantly less (there were no contamination incidents at the Evaporator in 1997) than the previous years shown in Table 8-6.

8.10.3 Intakes of Radioactive Materials

The contractor began facility-specific tracking of significant intakes of radioactive material (i.e., intakes with cumulative effective dose equivalent exceeding 500 mrem) in 1993. The Evaporator has had no incidents of this nature since 1993.

8.11 RESPONSE TO ABNORMAL EVENTS

Abnormal events may vary considerably in magnitude. Some events may be obvious, whereas other events may be detected only by sensitive radiation detection instruments. The response of the RCO to an abnormal event is dependent on the nature and extent of the event (see HNF-IP-0718, Part 2, Section ER-02, "General Emergency Response Guidelines and Checklists").

8.11.1 Recognition of the Event

Early detection of an abnormal event may help to reduce the ultimate magnitude of the event. Early detection is made possible through the use of radiological control hold points (see Section 8.6.2.1) that allow workers to determine whether radiological (and other) conditions are within predetermined limits, and the use of routine monitoring and surveys (see Section 8.7) that are used to track the radiological conditions in a work area. Timely detection of personnel exposures is afforded by the use of supplemental dosimeters (see Section 8.6.3.1) that can be read often, and by personnel contamination surveys performed with hand-held instrumentation or portal

8.12.2 DOE Orders

- DOE Order 5400.1, *General Environmental Protection Program*, U.S. Department of Energy, Washington, D.C.
- DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy, Washington, D.C.
- DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards*, U.S. Department of Energy, Washington, D.C.
- DOE Order 5480.11, *Radiation Protection for Occupational Workers*, U.S. Department of Energy, Washington, D.C.
- DOE Order 5480.18B, *Nuclear Facility Training Accreditation Program*, U.S. Department of Energy, Washington, D.C.
- DOE Order 5480.20A, *Personnel Selection, Qualification, Training, and Staffing Requirements for DOE Nuclear Facilities*, U.S. Department of Energy, Washington, D.C.

8.12.3 Manuals and Procedures

- HNF-IP-0718, 1993, *Health Physics Procedures*, Rev. 0, Fluor Daniel Hanford Company, Richland, Washington.
- HNF-IP-0931, *200 Area Liquid Waste Processing Facilities Administrative Policies*, Waste Management Hanford Company, Richland, Washington.
- HNF-PRO-060, *Reporting Occurrences and Processing Information*
- HNF-PRO-077, *Reporting and Investigating Accidents*
- HNF-PRO-079, *Pre-Job Safety Planning*
- HNF-PRO-210, *Records Management Program*
- HNF-PRO-329, *Radiological Training*
- HNF-PRO-331, *Work Place Air Monitoring*
- HNF-PRO-382, *Area Dosimetry Program*
- HNF-PRO-436, *Radiation Protection Instrument Program*
- HNF-PRO-636, *Black Widow and Bumble Bee, CP*
- HNF-PRO-666, *Grab Air Sampling*
- HNF-SP-1145, *Fluor Daniel Hanford Radiation Protection Program Implementation of Title 10 Code of Federal Regulations Part 835*

WMH-200, *Waste Management Hanford Procedures*

8.12.4 Public Law

- 10 CFR 835. 1993, "Occupational Radiation Protection," *Code of Federal Regulations*.
- 10 CFR 835.101, 1993, "Radiation Protection Programs," *Code of Federal Regulations*.
- 10 CFR 835.102, 1993, "Internal Audits," *Code of Federal Regulations*.
- 29 CFR 1910. 1993 "Occupational Safety and Health Standards," *Code of Federal Regulations*.
- 29 CFR 1910.134, 1993 "Respiratory Protection," *Code of Federal Regulations*.
- 40 CFR 61. 1996, "National Emission Standards for Hazardous Air Pollutants," *Code of Federal Regulations*.

on-line immediately after the power loss. The emergency power and main power were restored later, and the incident resulted in insignificant consequences.

7. ONCE-86-39 (09/11/1986)--Presence of organics in tank TK-C-100 and ion exchange column (242-A).

A sample taken from the ion exchange column eluate appeared to contain a separable organic layer equal to ~50% of the sample volume. The organics had reached the ion exchange column from the TK-C-100 condensate tank. The source of the organics was believed to be an undetermined waste stream from the PUREX facility. A similar incident occurred later in 1988.

8. ONCE-86-26 (5/20/86)--Evaporator vessel vent fan failure (242-A).

On loss of the vessel vent system, the interlocks automatically shut down the Evaporator as designed. Worn-out vent fan motor bearings caused the vent failure. The only significant impact was a relatively short downtime.

9. ONCE-83-25 (12/20/83)--Inadvertent partial dump (242-A).

An instrument technician installed a jumper wire for system calibrations. The jumper shorted the count-rate meter to the panel boards, tripping power from A, B, C, and D panels. The Evaporator pot immediately began dumping to tank 241-AW-102. Approximately half of the pot was dumped before power was restored to stop the dump. A similar event (ONCE-86-09) occurred on January 16, 1986, because of human errors and equipment malfunction.

Of these 16 UOs/ROs and significant ONCEs, 5 (ROR-80-2788, UOR-89-0059, ONCE-85-31, ONCE-86-26, and ONCE-86-46) were caused by equipment failures; the others either occurred at the sister facility, 242-S, which has some significant differences, or belonged to a general accident category--human factors complicated by abnormal operating conditions and/or inadequate training. During the last 10 yr, about one unusual event per 5 facility-years (5 out of 25) was caused by equipment failure, and one unusual event every 2 facility-years (12 out of 25) was caused by human error because of abnormal operating conditions and/or inadequate training. Project B-534 has addressed the problems exposed by these occurrences and has installed a new, state-of-the-art, control system. In addition, numerous hardware changes have been implemented. These changes have been backed up with new operating procedures (see Chapter 10.6) and training written and implemented using the knowledge gained from these old occurrences. These abnormal events resulted in insignificant environmental and/or personnel consequences (except for the spill at 242-S that occurred with a single encased pipe versus a double encased pipe at the evaporator).

9.2 PRELIMINARY HAZARDS ASSESSMENT

Potential hazards at the Evaporator have been identified through a facility and procedures review; a review of applicable supporting documents; and discussions with cognizant process engineers, safety engineers, and

operations personnel. Those hazards to be encountered within the bounds of the facility (see Figure 1-6), with the exception of those accepted routinely by private industry or the public, are evaluated in PHA tables (Tables 9-4 through 9-8). The PHA tables include qualitative estimates of consequence and frequency for each potential hazard (see HNF-PRO-704, Rev. 0, Hazard and Accident Analysis). For convenience, descriptions of the qualitative frequency and consequence categories are provided below.

Frequency Category Definitions

Anticipated (F3)	An event that has occurred or is likely to occur during the lifetime of the facility. Event frequency is in the nominal range of 10^{-2} to 1 per yr.
Unlikely (F2)	An event that is foreseeable but unlikely to occur during the lifetime of the facility. Event frequency is in the nominal range of 10^{-4} to 10^{-2} per yr.
Extremely unlikely (F1)	An event that is perhaps possible but extremely unlikely to occur during the lifetime of the facility. Event frequency is in the nominal range of 10^{-6} to 10^{-4} per yr.
Beyond Extremely Unlikely (F0)	An event that is considered to be too improbable to warrant further consideration. Event frequency is less than 10^{-6} per yr.
Note:	The PHA tables contain the words, "Anticipated", "Unlikely", etc. The nomenclature in parentheses indicate the corresponding frequency classifications in HNF-PRO-704, Rev. 0.

Qualitative Accident Severity Levels

Category I (S3)	There is sufficient material and energy available to cause a high or moderate impact to the maximum offsite individual .
Category II (S2)	There is sufficient material and energy available to cause a high or moderate impact to the maximum onsite individual .
Category III (S1)	There is sufficient material and energy available to cause an industrial injury, radiological dose, or chemical exposure to one or more facility workers .
Category IV (S0)	There is insufficient material and energy available to adversely impact facility workers .
Note:	The PHA tables contain the words, "Category I", "Category II", etc. The nomenclature in parentheses indicate the corresponding consequence classifications in HNF-PRO-704, Rev. 0.

The possibility does exist, however, of excess ammonia concentration in the Evaporator feed. It might be possible, under worst-case conditions, for feed solution to be as high as 0.41 M in ammonia (see Section 9.3.5). Transient conditions might then occur in which a small amount of vapor has undergone the equivalent of one stage of distillation and would be higher in ammonia than the feed solution. At near ambient temperatures this gives vapor concentrations of <1% and ~1.6% at a temperature of 45 °C (113 °F). This is far below the 16% minimum required for combustion. Above 45 °C (113 °F) in a system with water and air there is enough water vapor to suppress the ammonia combustion regardless of the ammonia concentration. Therefore, combustion of ammonia vapors from a strong feed solution is not considered credible. Some of these vapors subsequently would be exhausted from the facility via the vessel vent system. Vapors which were not exhausted would be redissolved into the condensate.

9.3.2.2 Second-Phase Organics. The primary organic solvent used at the PUREX Plant was a 30 vol% solution of TBP in a normal paraffin hydrocarbon (NPH) diluent. Exposure to ionizing radiation, the presence of reactive chemicals (e.g., nitric acid), and heat degrade this solvent; in particular, the TBP component. Degraded solvent was recovered by alkaline-permanganate and acid washes that removed degradation products and acidified the solvent for reuse in the PUREX process.

Periodically, the alkaline-permanganate wash solution used in the solvent recovery process was replaced because its efficiency was lowered by either a reduced pH; an accumulation of fission products, plutonium, or uranium; or the buildup of organic impurities. The resultant aqueous waste solution, referred to as solvent treatment waste, was stored in two 18,927-L (5,000-gal) tanks (TK-G8 and TK-R8) and batch transferred to the 241-AW Tank Farm.

The equilibrium concentration of TBP and NPH in the PUREX solvent treatment waste is low: ~0.3 g/L (156 oz/gal) and 0.005 g/L (2.6 oz/gal), respectively (Bendixsen 1983). A separable organic phase was normally present in tanks TK-G8 and TK-R8 because of entrainment of TBP-NPH during waste solution transfers. There is the potential for small quantities of oxidizing agents to be present in the Double Shell Tanks, as discussed in Section 6.1.3.2, but not in quantities that could contribute to a reaction. Because operating specifications for the Evaporator require the feed to be free of separable organics, all candidate feed tanks are sampled as specified in Section 6.1.3. To further reduce the probability of transferring organics, tanks TK-G8 and TK-R8 were equipped with interlocks that automatically terminated transfers to the AW Tank Farm if a ≥0.9 sp. gr. was detected by tank monitoring equipment. As operations at PUREX have been discontinued, only residual amounts of organics in wastes generated from decontamination efforts could be transferred to the Tank Farms. Large volumes of organics in wastes transferred from PUREX are no longer a possibility.

Operations maintains a minimum liquid level (HNF-SD-WM-DQO-014, Rev. 2, Von Bargen 1998) above the pickup pump if a separable organic layer is suspected or detected in the feed tank TK-AW-102. Organics are detected from samples taken before an evaporator campaign. By maintaining this level, separable organics are expected to remain isolated well above the pump suction point.

These controls are relatively effective. There are only two known cases of organics being processed through the Evaporator and accumulating in the condensate collection tank TK-C-100 (RHO 1986). These occurrences were discovered by routine surveillance of the ion exchange column. However, such surveillance could not show the volume of organics involved or the residence time in tank TK-C-100. Laboratory analysis identified the organic material in the sample as being essentially 100% NPH. In one of these instances, 167 L (44 gal) of NPH were removed from C-100. Note that this is much less likely today. The feed transferred to tank 102-AW is now characterized before being sent to the Evaporator. There are no undetermined waste streams from PUREX as identified in the ONCE that mentions this instance. The organic layer was pumped as the C-100 tank volume was diminished and the organic layer dropped to the pickup point. There are also level controls on C-100 to ensure that any organic layer collected there remains in C-100 where it can be routed back to AW-102.

The NPH is a flammable, kerosene-like mixture of five different saturated, straight-chain hydrocarbons that range from 10 to 14 carbon atoms per molecule. It has a flashpoint that ranges from -71°C (160°F) (Johnson 1993) to 80°C (176°F) and a lower flammability limit (LFL) of 0.6 vol% or 46 mg/L (Stordeur 1983, Van Tuyl 1983a, 1983b).

Another measure of flammability is the autoignition temperature (spontaneous ignition). This is different from the flashpoint temperature, which is the point at which a material will form an ignitable mixture. The spontaneous ignition temperature is the temperature at which a material (solid, liquid, or gas) will self-ignite and sustain combustion in the absence of a spark or flame. For NPH, the autoignition temperature is 220°C (428°F).

Ignition of combustible organic vapors in the Evaporator vessel itself has been shown to be incredible in the present operating environment because of the thermodynamics of the system. Calculations using NPH (Van Tuyl 1983a, 1983b, Wilson 1991), as well as calculations using miscible organic material with a relatively high vapor pressure and low LFL (e.g., acetone) (Johnson 1993), have shown that at system temperatures necessary to produce an organic vapor concentration at the LFL, the presence of water vapor effectively precludes the possibility of ignition. This is true both during startup as well as the subsequent operation of the Evaporator.

The same thermodynamics apply in the condensate system for miscible organics as apply in the Evaporator vessel. Thus it is not possible for flammable mixtures of these materials to exist in this system either. In the situation where a layer of immiscible organic (i.e., NPH) is floating on top of the liquid surface of Tank C-100, the evolution of water vapor would be reduced to the point at which it could no longer be relied on to prevent formation of flammable mixtures of NPH and air. However, calculations have shown that the operating temperatures of the condensate system are well below the minimum temperatures needed to form concentrations of NPH at its LFL (Johnson 1993). Also, for NPH, the temperature of the steam supplied to the facility (at 167°C) (Meyer 1967) is substantially lower than the autoignition temperature of NPH (220°C). This is true even for the unlikely condition of a closed tank that is allowed to come to equilibrium. Therefore, at presently designed operating temperatures, organic vapor explosions in the condensate system are considered extremely unlikely.

- Von Bargen, B. H., 1998, *242-A Evaporator Data Quality Objectives*, HNF-SD-WM-DQO-014, Rev. 2, Waste Management Federal Services of Hanford, Richland, Washington.
- Wang, O. S., 1991, *Risk Assessment of Red Oil Explosion and Organic Flammability for 242-A Evaporator/Crystallizer Operations*, WHC-SD-WM-RA-003, Westinghouse Hanford Company, Richland, Washington.
- Wenzel, D. R., 1990, *Interim User's Manual for RSAC-4 Radiological Safety Analysis Computer Program Version 4.03*, Vendor Information No. 19175, Westinghouse Idaho Nuclear Company, Idaho Falls, Idaho.
- WHC, 1991, *Users Guide and RSAC-4 Verification and Validation Document*, EDT 154747, Westinghouse Hanford Company, Richland, Washington.
- Wilson, P. F., 1991, *Compliance of Basic Letters and Communications Referenced in the 242-A Evaporator/Crystallizer Final Safety Analysis Report*, WHC-SD-WM-TI-490, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
- Winkler, C. M., 1987, *242-A Evaporator/Crystallizer FY 1987 Campaign Run 87-3 Post Run Document*, SD-WM-PE-033, Westinghouse Hanford Company, Richland, Washington.

9.6.2 Project Hanford Policies and Procedures

The following Hanford Policies and Procedures are available on the Internet at the following URL: <http://docs.rl.gov/php/index.html>.

Hazard and Accident Analysis, HNF-PRO-704, Rev. 0. (1997)

Workplace Air Monitoring, HNF-PRO-331, Rev. 0 (1997)

Engineering Design and Evaluation, HNF-PRO-97, Rev. 0 (1997)

9.6.3 U.S. Department of Energy Orders

DOE Order 5400.5, 1990, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy, Washington, D.C.

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Table 9-4. Loss of Confinement. (13 sheets)

Systems subsystem	Hazard/energy source	Potential accident and sequence	Target/potential consequences	Mitigating features		Category level	
				Engineered	Administrative	Cons*	Freq*
1.2.1 K1 HVAC system	Radio-active material	Moisture from a pipe jumper is carried into filters causing weakening and rupture (both filters). Filters elements impact fan and break up into small fragments.	Onsite personnel Onsite environment	<p>1) Radiation detection devices exist in the discharge stack. These alarm in the control room: RSH-K1-11 (p/y) and RSH-K1-12 (a). Hi B/y alarm activates interlock to shutdown fans differential pressure across the individual HEPA filter banks is continuously monitored. A high dp alarm would occur and prior to failure of the filters, PDSH-K161 (hi dp) and PDSH-K162 (hi dp). Low dp alarms also are monitored: PDSL-K161, PDSL-K163, PDSL-K162 and PDSL-K164.</p>	<p>1) For high radiation, verify both fans are shut-down and notify management and the HPT.</p> <p>2) For high dp, notify management and HPT. If the alarm is real, replace the real, appropriate filter bank.</p> <p>3) The filters are periodically checked for degradation by annual aerosol testing.</p>	IV	Anticipated

Table 9-4. Loss of Confinement. (13 sheets)

Systems subsystem	Hazard/energy source	Potential accident and sequence	Target/potential consequences	Mitigating features		Category level	
				Engineered	Administrative	Cons*	Freq*
1.2.2 Ion exchange column IDX-D-1	Radio-active material	Clinoptilolite fully loaded so that ion-exchange column no longer removes radionuclides from process condensate.	Discharge to the LERF in excess of allowable limits	1) Interlock 5 activates when high-radiation is detected on the process condensate radiation monitor, RC-3 pig. As a result, process condensate divert valve HV-RC3-3 diverts process condensate flow to RW-102 on tank T-100 depending on valve alignment. Condensate pump P-C-100 shuts down. 2) RC3 continuous monitor	1) RC-3 (AFPC) sample analyses to ensure discharge limits are met. 2) Respond to alarms to verify interlock sequence.	IV	Anticipated
1.3.1 Raw water services	Loss of raw water supply and pressure	<ul style="list-style-type: none"> Loss of desuperheater Loss of P-B-1 and P-B-2 pumps (Loss of seals) 	<ul style="list-style-type: none"> Overheating of evaporator contents results in a flashover to the condenser. Loss of P-B-2 could cause evaporator to overflow. 	1) Interlocks 38 and 45 monitor and respond to desuperheater probs. 2) Interlocks 2, 13, 21, 22, and 23 respond to seal water problems.	Respond to alarms.	IV	Unlikely

Table 9-5. Uncontrolled Chemical Reaction. (5 sheets)

Systems subsystem	Hazard/energy source	Potential accident and sequence	Target/potential consequences	Mitigating features		Category level	
				Engineered	Administrative	Cons	Frequency
2.2.2 Vessel Vent System	Organic material present in evaporator feed is processed through evaporator and passes on to the vessel vent system and is ignited by the heater.	Potential damage to vessel vent system HEPA filters and rupture of the housing resulting in corresponding exposures to onsite and offsite personnel.	1) System temperatures are normally too low. 2) Dilution by air from bleed and tank C-103.	1) Evaporator feed routinely sampled for separable organic. 2) Minimum level in TK-241-AW-102 below which feed not pumped. 3) Contamination levels in HEPA are low (e.g., mCi) because filter is contact maintained.	III	Extremely unlikely	
2.2.3 Ion exchange	Resin explosion	Nitration of organic resin results in a runaway reaction and explosion.	Potential structural damage to column contamination of ion-exchange enclosure and condenser room.	1) Clinoptilolite is a nonorganic ion-exchange media. Organic IX media is not used. 2) Process condensate is caustic in nature.	1) Procedures that require use of inorganic resins. 2) Process condensate is caustic in nature. 3) Regeneration of IX col. does not use nitric acid.	II	Incredible

Table 9-5. Uncontrolled Chemical Reaction. (5 sheets)

Systems subsystem	Hazard/energy source	Potential accident and sequence	Target/potential consequences	Mitigating features		Category Level	
				Engineered	Administrative	Cons	Frequency
2.3.1 Control room-- Monitor Control System	Combustible material & contamination spread	Ignition of accumulated combustible material (or a power surge) in control room results in loss of evaporator I & C systems. Uncontrolled operations leads to process upset and carryover to condenser room via vapor line.	<ul style="list-style-type: none"> Contamination of process condensate system. Exposure of facility personnel. Potential Release to the environment in excess of allowable limits Loss of process controls Loss of surveillance of tank farm operations (controls pass thru evaporator facility) 	<ol style="list-style-type: none"> Fused link/met pipe fire detection and extinguishing system. Interlock system designed to shutdown system, not correct deviation. Equipment is designed to fail to safe shutdown. This means that pumps will stop, emergency valves (1" steam) will close and the two dump valves off of the evaporator (HV-CA1-7 and HV-CA1-9) will open (fail open) to dump evaporator contents to TK-241-AW-102. Much of system is fed off the UPS (in oper 95% of time) which eliminates power surges. Emergency computer power shutdown button. 	<ol style="list-style-type: none"> Portable fire extinguishers located in facility. Response of Hanford Fire Department. The Operators can shut the system down from their consoles. Vaporover Emergency Plan, HNF-IP-0265 Rev. 3 (LMHS 1997). 	III	Unlikely
2.3.2 Evaporator (9.3.3.1)	Red oil in slurry	Red oil is formed and being unstable explodes.	Radioactive materials are freed from their containers with sufficient energy to contaminate extensive areas and recipients.	<ol style="list-style-type: none"> Temp in evaporator is limited by pressure through interlock #8 (PSH-CA111 and PI-CA1-1). 	<ol style="list-style-type: none"> Temperature controlled by pressure. pit always maintained at > 7 and >12 when process is running. Waste feed is maintained caustic. 	II	Incredible

Table 9-7. Radiological Hazards. (7 sheets)

Systems subsystem	Hazard/energy source	Potential accident and sequence	Target/potential consequences	Mitigating features		Category level	
				Engineered	Administrative	Cons	Frequency
4.1.1 Evaporator (9.3.4.1)	Radioactive material	Excessive foaming in evaporator vessel results in carryover to E-C-1 condenser via vapor line.	Exposure of facility personnel.	<ol style="list-style-type: none"> 1) Upper and lower deentrainment pads and spray system. 2) High differential pressure across deentrainment pads PDIH-CA1, PDI-CA1-1, and PDI-CA1-2 annunciate in control room and interlocked #4 to break vacuum, close feed valve, and shut off feed pump. 3) (RE-CA1-1) downstream of primary condenser interlocked (#3) to shutdown steam to reboiler, pump from C-100 tank, and feed to evaporator. 4) In line radiation monitor downstream of ion-exch. col. interlock #5 to shut off pump from tank TK-C-100 and divert process condensate back to tank C-100 or to TK-24-W-102. 5) Area radiation monitors in condenser room. 	<ol style="list-style-type: none"> 1) Monitor differential pressure across pads and notify supervisor of gradual increase. 2) Respond to high PDI-CA1-1 or PDI-CA1-2 alarm by notifying supervisor and flushing pads. 3) Respond to high PDI-CA1-1 or PDI-CA1-2 alarm by notifying management, HPI, and LPE and verifying interlock sequences. 	iii	Unlikely

Table 9-7. Radiological Hazards. (7 sheets)

Systems subsystem	Hazard/energy source	Potential accident and sequence	Target/potential consequences	Mitigating features		Category level	
				Engineered	Administrative	Cons	Frequency
4.2.1 Evaporator	Radioactive material	The deentrainer pads become plugged with deposits from the raw water spray used for cleaning the pads (a calcium buildup for instance).	This could lead to heating the evaporator contents above boiling with resultant flashing and carry over to the condenser.	<ol style="list-style-type: none"> Upper and lower deentrainment pads and raw water cleansing sprays. High differential pressure across deentrainment pads, PODH-CA1, PDI-CA1-1, and PDI-CA1-2 annunciate in control room and activates interlock #14 to break vacuum, close feed valve and shut off feed pump. Evaporator temperature and pressure recorded in control room. Low evaporator vacuum (high pressure) interlocked #8 to close steam valve FV-EA1-1 and open air valve HV-EA1-3 (to pressurize reboiler chest). Inline radiation monitor (RE-CA1-1) downstream of primary condenser interlocked #5 to shutdown steam to reboiler, pump from C-100 tank, feed pump to evaporator, and close feed block valve. Inline radiation monitor downstream of reboiler chest interlocked #5 to shut off pump from C-100 tank and divert process condensate back to tank C-100 or TK-241-AW-102. Area radiation monitors in condenser room. Condenser room and Dr343 are secondary confinement and liquid ret to TK-241-AW-102. 	<ol style="list-style-type: none"> Monitor differential pressure across pads and notify supervisor of gradual increase. Respond to high PDI-CA1-1 or PDI-CA1-2 alarm by notifying supervisor and flushing pads. Respond to high PDI-CA1-1 or PDI-CA1-2 alarm by notifying management, HR, and engineering and verifying interlock sequences. 	III	Extremely unlikely

LIST OF TERMS

A/E	architect/engineer
ALARA	as low as reasonably achievable
ARP	alarm response procedures
ATP	acceptance test procedure
BED	Building Emergency Director
CBT	computer-based training
CFA	current files area
CPE	Certified Process Engineer
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
EAL	Emergency Action Level
EMT	Emergency Management Team
ECC	Emergency Control Center
ECM	Engineering Configuration Management
Ecology	Washington State Department of Ecology
EMC	Emergency Management Center
EMT	emergency medical technicians
EPA	U.S. Environmental Protection Agency
EP/APC	emergency procedures and abnormal plant
ERG	emergency response guides
ERPG	emergency response planning guideline
ETF	Effluent Treatment Facility
Evaporator	242-A Evaporator
FDC	functional design criteria
FDH	Fluor Daniel Hanford
FSAR	final safety analysis report
GRCO	general radiochemical operations
HAMTC	Hanford Atomic Metal Trades Council
HEHF	Hanford Environmental Health Foundation
HP	health physics
JCS	job control system
LERF	Liquid Effluent Retention Facility
LWPF	Liquid Waste Processing Facilities
MCS	monitor control system
MOU	memorandum of understanding
NPO	Nuclear Process Operator
ONC	Occurrence Notification Center
ORR	operational readiness review
OSR	operating safety requirements
OTP	operational test procedure
PCA	procedure change authorization
POP	plant operating procedure
PNNL	Pacific Northwest National Laboratory
QA	quality assurance
QAPP	Quality Assurance Program Plan
QI	quality instruction
RCRA	Resource Conservation and Recovery Act of 1976
RCT	radiological control technician
SAD	safety analysis document

LIST OF TERMS (Continued)

SAR	safety analysis report
SALDS	state-approved land disposal structure
SAT	Systematic Approach to Training
SME	Subject Matter Expert
the Supply System	Washington Public Power Supply System
TEDF	Treated Effluent Disposal Facility
TPAP	Training Program Accreditation Plan
TRI	Training Records Information
TWRS	Tank Waste Remediation System
UDAC	Unified Dose Assessment Center
UO	unusual occurrence
WAC	Washington Administrative Code
WCPE	Waste Concentration Process Engineering
WMH	Waste Management Federal Services of Hanford

The process for the development of ERGs is uniform throughout the Hanford Site. The subject facility is assessed for each ERG that is developed. The assessment includes the following:

- The purpose and operation of facility systems, equipment, instrumentation, and alarms
- Operating limits
- Engineering, environmental, and safety requirements
- Emergency events that can occur due to a loss or upset condition of systems or equipment
- Safety systems and equipment used to terminate or control emergency events
- Personnel assignments and job tasks for the facility during normal and emergency conditions.

Applicable ERGs are developed and implemented based on the findings of the assessment. The ERGs are structured in the following manner:

- Indications. The indications that alert the operator that an emergency event is occurring, or is likely to occur, are listed. This can include audible alarms, gauges, and/or observation by both visual and audible means.
- Immediate personnel protective actions. Step-by-step instructions that ensure the safety of personnel within the immediate and/or surrounding area are provided, as necessary. These instructions include evacuation or take-cover actions, barricades to restrict access, first aid/medical assistance, and protective equipment (respirators) and clothing.
- Subsequent corrective or control actions. Step-by-step instructions are provided to perform corrective actions to terminate or control the emergency condition. This may include facility shutdowns and/or isolation of systems and equipment, isolating the affected area (securing ventilation, closing doors, etc.), activating safety systems, or requesting assistance from onsite/offsite organizations (Section 10.7).

10.5.4 Industrial Health and Safety Program

The industrial health and safety program for the Evaporator is documented in HNF-IP-0931, Section 20, "200A LWPF Health and Safety Plan". The health and safety plan (HASP) addresses routine facility operations and recovery actions. The purpose of the HASP is to provide an overview of expected hazards, and management controls used to maintain all exposures to environmental and occupational health and safety hazards As Low As Reasonably Achievable (ALARA).

The hazards addressed in the HASP include chemical and radiological material hazards, and physical hazards (e.g., moving equipment, confined spaces). The routine radiological hazards have been addressed in Chapter 8.0 and accident response and recovery actions (e.g., emergency response, notification) are addressed in Sections 10.6 and 10.7. Therefore, the following sections discuss those portions of the HASP addressing chemical and physical hazards.

10.5.4.1 Hazards Evaluation and Control. The HASP identifies potential hazards as well as control measures used by LWPF personnel to minimize, control, or eliminate employee exposures. Potential hazards present under worst case emergency conditions are evaluated in the *242-A Evaporator/Crystallizer Hazard Assessment*. The response actions for each of the identified hazards are provided in HNF-IP-1053 *242-A Evaporator Event Response Plan* and HNF-IP-0263-242A, *Building Emergency Plan for the 242A Evaporator*.

The following is a list of potential Evaporator worker chemical and physical hazards. These hazards have been evaluated in Chapter 9 or are evaluated during facility inspections or walkdowns, safety and health reviews of operating and maintenance procedures, or during job hazards analyses (JHA).

- Chemicals, Contact and Inhalation Exposures
- Mechanical and Equipment Hazards
- Confined Space Hazards
- Non-Ionizing Radiation
- Heat and Temperature Hazards
- High Noise Areas
- Special Working Surfaces
- High Temperature and Pressure Hazards
- Electrical Hazards
- Fire Hazards
- Material Handling and Storage Hazards
- Biological Hazards
- Compressed gases

Each of these hazards and hazard control measures are discussed in the following sections. Detailed descriptions of the control measures are provided in HNF-IP-0931, Section 20, "200A LWPF Health and Safety Plan".

10.5.4.1.1 Chemicals, Contact and Inhalation Exposures. The majority of chemical hazards at the Evaporator are associated with the chemicals contained in the tank waste or slurry. The primary chemicals of concern, due to the significant quantities present in the slurry, are ammonia and sodium hydroxide; however, as discussed in Appendix 9A, these chemicals are contained within process piping and cells. Small quantities of residual mercury, at levels below the limits requiring respiratory protection, have been found in the condenser room. In addition, small quantities of asbestos may also be present in gaskets, electrical components and building materials. Other chemicals that may be found in the Evaporator include maintenance products and decontamination solutions.

Control measures have been implemented at the Evaporator to minimize employee exposures to the chemical hazards. To minimize employee exposure to the chemicals contained in the slurry, all process piping and vessels are flushed and decontaminated, prior to performing hands on maintenance. In addition to the engineered barriers, administrative policies or programs compliant with 29 CFR 1910 have been established for LWPF personnel, including Evaporator personnel. These policies or programs include a hazard communication program, personnel protective equipment (PPE) program, a lock-out/tag-out program, personnel training, medical surveillance, and procedures writer and development guides.

10.5.4.1.2 Electrical, Mechanical and Equipment Hazards. Potential mechanical and equipment hazard exposure to Evaporator personnel includes rotating pump shafts, chains, sprockets and gears on conveyor drives, maintenance tools (saws, grinders and drills) and fans and blowers.

In addition to the controls discussed in Section 10.5.4.1.1, assessments performed by industrial safety personnel identify and recommend machine guarding and control requirements.

10.5.4.1.3 Confined Space Hazards. The Evaporator has a variety of confined spaces including tanks, sumps, manholes, and utility vaults. Although, the majority of the confined spaces are within radiological areas, the potential hazards include oxygen deficient, flammable or toxic atmospheres, mechanical equipment, electrical hazards and engulfment hazards.

In addition to the control measures discussed in Section 10.5.4.1.1, a formal confined space program has been developed for LWPFs, including the Evaporator. The program includes methods for performing confined space evaluations, confined space labeling, atmospheric testing, entry permits, rescue teams, special equipment and training. A confined space log which identifies all known confined spaces and entry requirements, is maintained in the Evaporator control room.

10.5.4.1.4 Non-Ionizing Radiation. The primary exposure to non-ionizing radiation at the LWPF is associated with welding operations during maintenance and/or repair projects.

Welders and Evaporator personnel exposures to non-ionizing radiation are controlled through the use of PPE's and by maximizing the use of shop areas with welding curtains and shields.

10.5.4.1.5 Heat, Temperature, and Pressure Hazards. The potential exists for thermal burns during routine and maintenance activities at the Evaporator. The potential hazards at the Evaporator include steam which is supplied to the facility in an insulated piping system and other industrial type source (e.g., space heaters). All other potential sources for thermal burns are within evaporator and pump rooms. The potential for heat related illness is aggravated by the use of non-porous PPE such as acid suits or tyvek coveralls used for spill clean up and/or in potential radiological areas.

In addition to the control measures discussed in Section 10.5.4.1.1, control measures have been implemented at the Evaporator to minimize high pressure hazards, thermal burns, and heat related illnesses. All steam piping systems and hot surfaces are insulated or posted to prevent thermal burns.

Additionally, pressurized vessels are provided with pressure relief valves or pressure reducing devices. To minimize the potential for heat related illnesses, job planning and heat stress monitoring is performed in accordance with HNF-PRO-121, *Job Planning and Heat Stress Monitoring*.

10.5.4.1.6 High Noise Areas. The air compressor buildings, AMU room, HVAC room, and condenser room are posted high noise areas (i.e., noise level is greater than 85 dBA) in the Evaporator.

The programs implemented at the Evaporator to protect the worker include, industrial hygiene surveys and postings as required in HNF-PRO-115, *Industrial Hygiene Surveys and Posting of High Noise Areas*, and hearing protection as required in 29 CFR 1910.95, *Occupational Noise Exposure Standard*. Additionally, personnel exposed to high noise areas receive annual audiometric testing and training, as required in HNF-PRO-115, *Hearing Conservation Program*.

10.5.4.1.7 Special Working Surfaces. Evaporator personnel, during maintenance activities, may be required to work on the roof or other elevated surfaces at the Evaporator. This may require the use of ladders or mobile personnel lifts.

To protect personnel, ladder cages, toe boards, guardrails, and fall protection systems (e.g., harnesses, lanyards, lifelines) are provided. Personnel are also trained in the use of fall protection and mobile lift systems.

10.5.4.1.8 Fire Hazards. The fire hazards associated with the Evaporator have been addressed in the FHA and this SAR (see Chapter 9.0). There are very limited quantities of combustible materials stored at the Evaporator. The facility has been designed to meet the applicable NFPA construction requirements, including fire barriers two- and four- hour rated fire walls, and automatic and manual fire suppression systems (see Chapter 5.0).

In addition to the engineered barriers and minimal combustible loading, personnel are protected through the use of hot work permits.

10.5.4.1.9 Material Handling and Storage Areas. Material handling and storage policies/procedures are contained in HNF-PRO-96. Evaporator personnel are exposed to potential compressed gas, material handling, and storage hazards. The compressed gas hazards at the Evaporator are small based on the quantity of compressed gasses contained in the facility when compared to the number of material handling and waste storage activities performed at the Evaporator. The potential handling and storage hazards include the storage and handling of bulk chemicals for decontamination activities, waste drum handling, hoists, overhead cranes and forklifts as well as the storage of small quantities of corrosive and flammable maintenance chemicals.

A variety of administrative, personal protective equipment and engineering controls are in place for the control of these potential hazards. In addition to the controls identified in 10.5.4.1.1 (e.g., training, PPEs) the additional controls implemented at the Evaporator include implementation of DOE-RL-92-36, *Hanford Site Hoisting and Rigging Manual*, cranes, hoists and rigging equipment inspections and maintenance, and the use of NFPA/UL approved flammable liquid storage cabinets. Additionally, corrosive chemicals such as

OPERABLE/OPERABILITY

A system, subsystem, train, component or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified function(s), and:
a) Actuation points are within limits; and b) All necessary attendant instrumentation, controls, electrical power sources, cooling or seal water, lubrication or other auxiliary equipment that are required for the system, subsystem, train, component or device to perform its function(s) are also capable of performing their related support function(s).

Example: A system such as leak detection or radiation monitoring/diversion is OPERABLE when performing its specified detection or monitoring function. It is OPERABLE and operating when performing an action such as activating an interlock to stop a pump, and/or diversion of a stream.

OPERATIONAL SAFETY
REQUIREMENTS (OSR)

Those requirements that define the conditions, safe boundaries, and BASES thereof and the management or ADMINISTRATIVE CONTROLS required to ensure the safe operation of a nuclear facility.

OR

See Section 1.7, Logical Connectors.

SAFETY LIMIT (SL)

See Section 1.4, Safety Limits.

SLURRY

As applied to the evaporator vessel, C-A-1, it is the WASTE liquid contained in the vessel and/or the WASTE liquid that is transferred from the vessel through the slurry pump, PB-2, or an evaporator drain line to a DST. As used in the OSRs, SLURRY does not include the residuals allowed for in the definition of EMPTY. Normally, the SLURRY is more concentrated than the FEED as a result of the evaporation process. The term also applies to FEED in the vessel when it has not been concentrated by evaporation.

SURVEILLANCE
REQUIREMENT

Requirements relating to test, calibration, or inspection to ensure that the necessary OPERABILITY and quality of OSR systems, components, and support systems are maintained within operating limits.

(continued)

VERIFY/VERIFIED/
VERIFICATION

A qualitative assessment to confirm or substantiate, per established procedures, specific plant conditions exist, and if not in this condition, ensure that action is taken to satisfy the requirements. This includes to read and record on a log or data sheet and to evaluate the subject information in accordance with procedures.

Verification activities can include: parameters (e.g., temperature, pressure, flow rate, liquid level) are within limits; power supply is on; counts are recording on a meter; interlocks are in their required state; breakers are aligned properly; valves are aligned properly; waste meets facility inventory limits (waste receipt by the facility).

VIOLATION

See Section 2.4.1. Operational Safety Requirement Violations.

WASTE

Radioactive solids and liquids transferred to, stored in, or transferred from DSTs.

WMH

Waste Management Federal Services, Hanford Inc.

1.2 MODES

The three MODES for the Evaporator are OPERATION, SHUTDOWN and REPAIR.

OPERATION MODE

The evaporator vessel, C-A-1, is allowed to contain solution (e.g., WASTE, decontamination solutions, flush water) and is capable of the evaporative liquid concentration process. The systems required by OSR applicability for this MODE are OPERABLE.

SHUTDOWN MODE

The Evaporator is capable of OPERATION MODE but the evaporator vessel, C-A-1, is EMPTY and FEED or other solution is not being transferred into the vessel. The systems required by OSR applicability for this MODE are OPERABLE.

REPAIR

The OSR systems needed to meet the MODE requirements for

MODE

OPERATION MODE or SHUTDOWN MODE are not OPERABLE, as a result of testing, calibrations, equipment failures, maintenance activities or during planned outages. The evaporator vessel, C-A-1, may or may not be allowed to contain solution dependent upon the OSR. The systems required by OSR applicability for this MODE are OPERABLE.

procedure shall be provided that defines the auditable records necessary to show compliance with each Operating Limit, Surveillance Requirement, and Administrative Control, and defines and identifies the Instrument of Record and alternates. The DOE will be notified when the Instrument of Record or alternates have been changed.

2.10.2 RECORDS RETENTION

The retention periods vary according to the type of record and shall be established by Evaporator Operations in accordance with DOE Order 1324.5B, *Records Management Program*.

2.11

NUCLEAR CRITICALITY CONTROL

A program implementing DOE Order 5480.24, *Nuclear Criticality Safety*, is provided for criticality safety analyses, controlled criticality prevention specifications, procedures, and controls to prevent an accidental criticality in the Evaporator. The program shall include a requirement for the limits, shown in Table 11-2, on the amount of fissile material allowed in the FEED solution to the Evaporator. The analyses, specifications, and procedures shall be maintained current (see Section 2.8.4).

If the limit specified in Table 11-2 is discovered to be exceeded, proceed as follows:

- a. Notify the Criticality Safety Representative and prepare a written recovery plan
- b. The operating contractor's management shall notify DOE of the occurrence in accordance with DOE O 232.1, *Occurrence Reporting and Processing of Information*.

Based on the discussion of criticality safety in the Evaporator SAR, Chapter 6.0, Process Systems, section "Identification of Items For Safety Analysis Concern," it is considered to be not possible for the system to go critical when the fissile content in the FEED processed in the Evaporator is limited to 0.005 grams per liter. Plutonium concentrations that could result from evaluated normal and abnormal operations of the Evaporator do not present a criticality safety problem. Any accumulation of plutonium in the Evaporator would be well below the concentration of concern regarding criticality. Hence, the Evaporator is classified as a Limited Control Facility.

These administrative controls are necessary because there is no real time instrumentation installed at the Evaporator to measure fissile material concentration.

2.12

RADIATION PROTECTION

A radiation protection program shall be provided that implements 10 CFR 835, *Occupational Radiation Protection*, and DOE Order 5480.11 *Radiation Protection for Occupational Workers*.

2.13

BOUNDING SOURCE STRENGTH CONTROL

A program shall be implemented to ensure that the total dose consequences of any waste in the Evaporator facility do not exceed the total dose consequences of bounding radiological source strength waste shown in Table 11-3 through the use of approved and controlled procedures. The operating specifications and procedures shall be maintained current (see Chapter 11, Section 2.8.4).

If the dose consequences of the bounding radiological source strength waste are discovered to be exceeded, an Occurrence Report shall be written as required by DOE O 232.1 *Occurrence Reporting and Processing of Information*.

These administrative controls are necessary because there is no real time instrumentation installed at the Evaporator to measure the FEED or SLURRY concentrations of radionuclides.

This program has been implemented through HNF-SD-WM-OCD-016, Rev 1A, (Campbell 1998).

2.14

EFFLUENT MONITORING AND SAMPLING

An effluent monitoring and sampling program shall be provided that implements DOE Orders 5400.1, *General Environmental Protection Program*, and 5400.5, *Radiation Protection of the Public and the Environment*.

2.15

UNREVIEWED SAFETY QUESTION (USQ)

An Unreviewed Safety Question is determined in accordance with DOE Order 5480.21, *Unreviewed Safety Questions*. A proposed change or discovery shall involve a USQ under the following conditions:

- a. If the probability of occurrence or the consequence of an accident or malfunction of equipment important to safety previously evaluated by safety analyses may be increased, or

BASES

REFERENCES

1. WMH 1998, *242-A Evaporator Safety Analysis Report*, HNF-SD-WM-SAR-023, Rev. 3, Chapter 9.0 Accident Safety Analysis, section "Loss of Confinement.", Waste Management Federal Services, Hanford Inc., Richland, Washington.
 2. WMH 1998, *242-A Evaporator Safety Analysis Report*, HNF-SD-WM-SAR-023, Rev. 3, Chapter 9.0 Accident Safety Analysis, section "External Occurrences.", Waste Management Federal Services, Hanford Inc., Richland, Washington.
 3. WMH 1998, *242-A Evaporator Safety Analysis Report*, HNF-SD-WM-SAR-023, Rev. 3, Chapter 4.0 Principal Design Criteria, section "Safety Classification of Systems and Structures.", Waste Management Federal Services, Hanford Inc., Richland, Washington.
 4. U.S. DOE Order O 232.1, *Occurrence Reporting and Processing of Operations Information*, U.S. Department of Energy, Washington, D.C.
 5. ASME, *Testing of Nuclear Air Cleaning Systems*, N 510, American National Standards Institute and American Society of Mechanical Engineers, New York, New York.
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B 3.5 BUILDING VENTILATION SYSTEMS

B 3.5.2 K1 Stack Radiation Monitoring SystemBASESBACKGROUND
SUMMARY

The K1 ventilation system airflow is discharged at a nominal rate of 19,300 ft³/min from exhaust stack 296-A-21 to the environment. Stack 296-A-21 is equipped with a stack monitoring system. This system withdraws a sample of the exhaust air from the stack and splits it. One portion is sent to a record sampler, which is not subject to this LCO. The second portion of the air sample is sent to the K1 stack radiation monitoring system where the sample is split again. One portion passes through an alpha detector and the other portion passes through a beta-gamma detector.

The K1 stack radiation monitoring system is interlocked to shut down exhaust fans K1-5-3 (electric) and K1-5-2 (electric backup). On detecting high beta-gamma, interlocks remove power to fans K1-5-3 and K1-5-2.

APPLICATION TO
SAFETY ANALYSIS

The OPERABILITY of the K1 stack radiation monitoring system is a part of the Evaporator confinement integrity assumed in the accident safety analysis section "Loss of Confinement" (Ref. 1). The DBAs requiring the K1 stack radiation monitoring system are those involving the generation of aerosols in the pump room via the FEED and SLURRY pumps. K1 stack radiation monitoring integrity is not assumed for DBAs discussed in the Accident Safety Analysis section "External Occurrences" (Ref. 2) involving DBEs.

In the DBA analysis it is assumed that the K1 stack radiation monitoring system integrity is intact at event initiation and throughout the entire event. The release of radioactivity to the environment from a pump room aerosol DBA is mitigated by the K1 ventilation filtration system. In the event the mitigation provided by the K1 ventilation filtration system is not adequate, the K1 stack radiation monitoring system will alarm and shut down the K1 exhaust fans upon detection of high radiation levels in the stack exhaust air, allowing for corrective action to be taken.

The K1 stack radiation monitoring system has been identified in the SAR (Ref. 3) as Safety Significant based on maintaining exposures to onsite workers and the environment within limits during DBAs involving aerosols generated in the pump room.

- **Quality Assurance Engineers** — Quality assurance engineers provide support services to include interpretation of quality requirements, review of quality affecting documents, e.g., procedures, design documents, requisitions, and work control packages.

The QAP is integral to the many processes used by the Evaporator in accomplishing its mission. The QA organization is integral to the development and implementation of the processes used to ensure safe operations and safe working conditions. Evaporator personnel are responsible for ensuring that the QA requirements are met.

12.3.3 242-A Evaporator Quality Assurance Organization

Organization of the Evaporator is described in Chapter 10.0. The Evaporator QA is a separate, independent support organization. Safe operations and safe working conditions are built into mission implementation programs when the Evaporator QA organization is involved from planning through execution.

12.3.4 Personnel Training and Qualification

The contractor Personnel Training and Qualification Program ensures that personnel are trained and qualified to perform their assigned tasks. This program provides for the development of personnel proficiency commensurate with the scope, complexity, and nature of assigned activities. Management is responsible for developing generic staff position requirements based on these proficiency requirements.

Facility managers and suppliers who provide personnel to support facility operations are responsible for ensuring that staff members are trained. Specifically, staff must be trained to perform assigned tasks in a manner that minimizes (1) risk to onsite workers and the public, (2) negative environmental impact, and (3) risk of damage to the facility and facility equipment. Retraining of Evaporator operations personnel is accomplished as described in Chapter 10.0.

12.4 QUALITY IMPROVEMENT

The Evaporator QAP provides for quality improvement through the control of conditions adverse to quality. Conformance identification is the responsibility of everyone, not only the quality organization. Adverse conditions are characterized as nonconformances or noncompliances. Nonconformances relate to items that do not meet established requirements, and noncompliances relate to failures to follow procedures or failures to perform activities as required. Procedures documented in the Evaporator quality assurance document identify the processes used to control and correct both nonconformances and noncompliances. By following the processes, adverse conditions are detected, characterized, documented, dispositioned, and resolved. Data is collected and analyzed for potential quality improvements. The quality improvements are implemented through preventive actions and process control improvements.

There are significant differences in the role of the QAP for activities when the SSCs are operational (i.e., performing active or passive functions) compared to the role of the program when the SSCs are not operational. The program role differences concerning handling nonconformances and noncompliances are particularly significant. For nonoperational situations, the emphasis is to prevent inadvertent use of nonconforming items. For operational situations, the emphasis is to avoid noncompliances with operating requirements that could impact safety. Operational noncompliances are evaluated for reportability within the occurrence reporting system, which takes precedence over a QAP reporting system. The QAP reporting system becomes a complementary activity when the occurrence reporting system has precedence.

Operating items can become nonconforming to the original design and are typically maintenance activities performed within the job control system (see Section 12.6.1). See Chapter 10.0 for occurrence reporting, and conduct of operations information. Sections 12.4.1, 12.4.2, and 12.4.3 describe the nonoperational activities.

12.4.1 Nonconformances

Items that do not conform to established design requirements are documented as nonconforming. Upon detection as nonconforming, the item is segregated to preclude it from being inadvertently installed or used.

A nonconformance is documented after the nonconforming item is placed in the holding area. The documentation (1) uniquely identifies the nonconforming item, (2) accurately cites the violated requirement and its source, and (3) identifies the unique tracking number associated with the nonconformance. The nonconformance is then dispositioned. A nonconformance report is complete when Evaporator QA personnel mark that the disposition has been implemented.

12.4.2 Noncompliances

A failure to comply with procedures or to perform as required is documented as a noncompliance. A noncompliance differs from a nonconformance in that items installed in the plant or used in plant operations are not involved. Most elements of the process to document and resolve a noncompliance are the same as for the nonconformance process. Because there is no item involved, the noncompliance process is reduced to (1) initial documentation of the violated requirement and description of the noncomplying event; (2) determination, documentation, and approval of the course of action to resolve the noncompliance; (3) implementation of the action; and (4) verification of the completion of the remedy.

12.4.3 Preventive Actions

Nonconformances and noncompliances are tracked to ensure resolution by appropriate personnel and to develop trends in the quality of operations and output. When a specific condition adverse to quality is determined to require preventive action, a root cause analysis is performed to determine the direct

Assessment results are formally documented and reported to applicable management for information and action. This formal report becomes the official basis for triggering any corrective actions to address negative findings. When the nature of the finding requires corrective action to be taken, responsible personnel implement corrective action and notify the Evaporator QA assessment team of its completion. The Evaporator QA assessment team then verifies corrective action implementation depending on the significance of the finding.

Other evaporator management assessments are conducted in accordance with the requirements of a system that has the same basic features as the herein described assessment system. Whenever it is beneficial, assessments are integrated to minimize the disruptive impact on the organization being assessed.

12.7 REFERENCES

10 CFR 830.120, 1994, "Quality Assurance," *Code of Federal Regulations*.

DOE Order 5700.6C, 1991, *Quality Assurance*, U.S. Department of Energy, Washington, D.C.

HNF-IP-0931, *200 Area Liquid Waste Processing Facilities Administrative Policies*, Waste Management Hanford Company, Richland, Washington.

HNF-MP-599, *Project Hanford Quality Assurance Program Plan*

HNF-PRO-261, *Quality Assurance Program Plans*

HNF-PRO-706, *PHMC Acquisition System Requirements*

HNF-SD-WM-QAPP-036, *Quality Assurance Program Plan*, Waste Management Hanford Company, Richland, Washington.

WMH-200, *Waste Management Hanford Procedures*, Waste Management Hanford Company, Richland, Washington.

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