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By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

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RPP-PLAN-60780	00	242-A Evaporator Inspection Plan
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242-A Evaporator Integrity Assessment Plan

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Abstract: The purpose of this plan is to familiarize the Independent Qualified Registered Professional Engineer performing the 242-A Evaporator System integrity assessment with the facility and ancillary equipment. The plan defines the boundaries of the integrity assessment, and describes the activities, analyses and reviews typically required in order to certify, in accordance with requirements in the Washington State Administrative Code 173-303-640(2) for existing tank systems, that the 242-A Evaporator System will not collapse, rupture or fail, and is not leaking.

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242-A Evaporator Integrity Assessment Plan

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EXECUTIVE SUMMARY

Integrity assessments must determine that existing Treatment, Storage and Disposal (TSD) unit/components are adequately designed and have sufficient structural strength and compatibility with the waste to be stored or treated, to ensure that it will not collapse, rupture, or fail. For each existing TSD unit, such as the 242-A Evaporator System, it must be determined that the system is not leaking or is unfit for use (WAC 173-303-640(2)(a)). A written assessment, reviewed and certified by the IQRPE, must be obtained and maintained as a record. The assessment report should include a review of the elements in WAC 173-303-640(2)(c).

Additionally, a schedule must be developed for conducting future integrity assessments once the component is placed into service to ensure that the tank system retains its structural integrity. The schedule must be based on the results of past integrity assessments, age, materials of construction, characteristics of the waste, and any other relevant factors (WAC 173-303-640(2)(e)).

This plan provides guidance for the 2017 integrity assessment necessary for continued operation of the 242-A Evaporator System under the State of Washington, Department of Ecology Permit WA 7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit*, *Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Part III, *Operating Units*, *242-A Evaporator Operating Unit Group 4*. The assessment will be completed by an Independent Qualified Registered Professional Engineer (IQRPE) in accordance with an IQRPE plan that explicitly addresses all elements of the integrity assessment necessary to fulfill the requirements of the Washington Administrative Code WAC 173-303-640(2). The integrity assessment is being completed on behalf of the 242-Evaporator System operator, Washington River Protection Solutions, LLC, for the owner, U.S. Department of Energy. The 2017 assessment will use the results of past integrity assessments as a fixed, reference baseline for purposes of assessing the 242-A Evaporator System, and will take into consideration (*i.e.*, take credit for) IQRPE integrity assessments performed after December, 2007.

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LIST OF TERMS

Abbreviations and Acronyms

ACI	American Concrete Institute
ALARA	as low as reasonably achievable
AOR	analysis of record
API	American Petroleum Institute
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASME BPVC	ASME Boiler and Pressure Vessel Code
BTU	British thermal unit = 1.05 kilojoule = 1.05E+10 erg
CY	calendar year (January through December)
DOE	U.S. Department of Energy
DST	double-shell tank
Ecology	State of Washington, Department of Ecology
ESPC	Hanford Energy Savings Performance Contract
FY	fiscal year (October through the following September)
HEIS	Hanford Environmental Information System
HFFACO	Hanford Federal Facility Agreement and Consent Order
HPS	Hanford Plant Standard
IQRPE	Independent Qualified Registered Professional Engineer
NDE	non-destructive examination
NPH	natural phenomena hazards
ORP	U.S. Department of Energy, Office of River Protection
RCRA	Resource Conservation and Recovery Act of 1976, as amended
RTRP	Glass-Fiber Reinforced Thermosetting-Resin Pipe
SSC	systems, structures and components
TPA	Tri-Party Agreement
TSD	treatment storage and disposal
UT	ultrasonic testing
WAC	Washington [State] Administrative Code
WRPS	Washington River Protection Solutions, LLC
WTS	waste transfer system

Units

d/p	differential pressure
^{o}F	degrees Fahrenheit
ft	feet
ft^2	square feet
ft^3	cubic feet
gal	gallons (liquid)
gpm	gallons per minute
hp	horsepower
hr	hour
in.	inch
mil	one thousandth of an inch
min	minute
psia	pounds per square inch absolute
psig	pounds per square inch gauge
rad	radiation absorbed dose = 100 ergs/gram

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1.0 INTRODUCTION AND BACKGROUND

The 242-A Evaporator System is located in the 200-East Area of the Hanford Site. Project B-100 construction occurred from 1974 to 1977. Process piping was terminated at the building wall by the original project and continued later to the 241-A and 241-AW tank farms by Projects B-102 and B-120. Operation began in 1977. The design life as originally constructed was ten years. Service life extension upgrades have been made throughout its operating life.

The mission of the 242-A Evaporator is to maintain the volume of liquid radioactive waste stored in the double-shell tanks (DSTs) within their capacity, currently ~32.5 million gallons, by concentrating dilute waste received into the DST system. Operation will be required until at least the mid-21st century.

The 242-A Evaporator System is classified by the *Resource Conservation and Recovery Act of 1976* (RCRA) regulations, and the State of Washington, Department of Ecology Dangerous Waste Regulations in Washington Administrative Code (WAC) 173-303-640, *Tank Systems*, as a final status, permitted treatment, storage, and disposal (TSD) existing tank system, operating in accordance with Dangerous Waste Permit WA 7890008967.

- A "Tank system" is a dangerous waste storage or treatment tank and its associated ancillary equipment and containment system.
- "Ancillary equipment" is any device including, such devices as piping, fittings, flanges, valves, and pumps, that is used to distribute, meter, or control the flow of dangerous waste from its point of generation to a storage or treatment tank(s) (refer to WAC 173-303-040, *Definitions*).
- "Secondary containment systems" must be designed, installed, and operated to prevent any migration of wastes or accumulated liquid out of the system to the soil, ground water, or surface water at any time during the use of the tank system; and be capable of detecting and collecting releases and accumulated liquids until the collected material is removed (refer to Subpart J *Tank Systems* §264.193, *Containment and Detection of Releases*).

As an existing tank system (*i.e.,* a system used for storage or treatment of dangerous waste in operation before February 3, 1989) the 242-A Evaporator must comply with the requirements of WAC 173-303-640(2). The WAC 173-303-640(2) requires periodic integrity assessments of tank systems that store dangerous waste and requires a determination by an Independent Qualified Registered Professional Engineer (IQRPE) that the tank system is not leaking or is unfit for use.

Table 1-1 lists the 242-A Evaporator System integrity assessments that have been performed to date and certified by an IQRPE. The inspections, tests, and analyses performed provide assurance that the 242-A Evaporator tank system has adequate design, sufficient structural strength, and sufficient compatibility with the waste to not collapse, rupture, or fail during operation. The last integrity

assessment was completed in December, 2007 (RPP-RPT-33306, *IQRPE Integrity Assessment Report for the 242-A Evaporator Tank System*, and RPP-RPT-33307, *IQRPE Integrity Assessment Report for the 242-A PC-5000 Transfer Pipeline*). No evidence of degradation was noted during the visual test, ultrasonic test, or leak test. The tank TK-C-100 condensate collection tank and the C-A-1 vapor-liquid separator, E-A-1 reboiler, and the recirculation loop passed leak tests. The frequency of subsequent integrity assessments has been established at every 10 years in the WA7890008967, Rev. 8c, *Hanford Dangerous Waste Permit* (refer to Part III, *Operating Units – 242-A Evaporator*). The next 242-A Evaporator integrity assessment is due in 2017.

Table 1-1. 242-A Evaporator System Integrity Assessments through 2007

Document/ Rev No.[a]	Date of Publication[b]	Document Title	Description
RPP-RPT-33306, Rev. 0	12/28/2007	*IQRPE Integrity Assessment Report for the 242-A Evaporator Tank System*	Provides integrity assessment for the 242-A system at Hanford
RPP-RPT-33307, Rev. 0	12/26/2007	*IQRPE Integrity Assessment Report for the 242-A PC-5000 Transfer Pipeline*	Part of 2007 Integrity Assessment; for process condensate line PC-5000 extending from 242-A to the Liquid Effluent Treatment Facility
HNF-2905, Rev. 0	07/02/1998	*1998 242-A Interim Evaporator Tank System Integrity Assessment Report*	Five year interim integrity assessment based on recommendations in initial integrity assessment
WHC-SD-WM-ER-124, Rev. 1	04/27/1994	*The 242-A Evaporator-Crystallizer Tank System Integrity Assessment Report*	Initial integrity assessment performed on 242-A Evaporator System

The 242-A Evaporator System 2017 Integrity Assessment Plan (IAP) is organized as follows:

- Section 1: Introduction and Background: Description of the project, integrity assessment requirement, past assessment activities, and organization of the integrity assessment plan.
- Section 2: Integrity Assessment Scope: Description of the project scope, including the objectives of the 2017 integrity assessment, and the boundaries of the assessment.
- Section 3. Integrity Assessment Exclusions: Description of components and systems excluded from the 2017 integrity assessment.
- Section 4. Integrity Assessment Report Development: Integrity assessment report development.
- Section 5. Integrity Assessment Report Certification: IQRPE requirements for certification of the integrity assessment report per Washington State Administrative Code WAC 173-303-810(13)(a), *Certification*.

- Section 6: Facility Description: Design information, including the design codes and standards for the system; the original basis of design; structural analysis of the system; waste compatibility information; primary and secondary containment features; ancillary equipment; corrosion protection measures; and ongoing inspection activities.
- Section 7. Process Description: Operating information.
- Section 8. Integrity Assessment Activities: Integrity assessment activities necessary to certify the system.
- Section 9: References.

2.0 INTEGRITY ASSESSMENT SCOPE

The purpose of this plan is to define the activities, reviews, analyses, and evaluations necessary to support the IQRPE preparation of the 242-A Evaporator System 2017 integrity assessment report (IAR) to be issued on or before December 31, 2017.

The 2017 IAR scope includes the tank system, ancillary equipment and secondary containment system components in use at the time that the 2007 IAR was completed, and designs, calculations, modifications and new installations assessed and certified by other IQRPEs during the 2008 - 2017 time period after the 2007 integrity assessment was completed. Re-evaluations of pre-2008 work will be performed only as necessary to understand previous assessment approaches used and the assessments' conclusions. The 2017 assessment will rely on existing baseline requirements for design, installation, testing, and monitoring that govern 242-A Evaporator System operation rather than creating new requirements. The requirements of the IAR include the following for the tank system, ancillary equipment, and secondary containment system (excerpts from WAC 173-303-640(2), *Assessment of Existing Tank System's Integrity*):

- Determine that the tank system is not leaking or is unfit for use.
- Determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated to ensure that it will not collapse, rupture, or fail. At a minimum, this assessment must consider the following:
  - Design standards, if available, according to which the tank system was constructed.
  - Dangerous characteristics of the waste(s) that have been and will be handled.
  - Existing corrosion protection measures.
  - Documented age of the tank system, if available (otherwise, an estimate of the age).
  - An estimate of remaining useful life of the system, if practical.

- Results of leak test, internal inspection, or other tank integrity examination.
- For nonenterable tanks the assessment must include a leak test that is capable of taking into account the effects of temperature variations, tank end deflection, vapor pockets, and high water table effects.
- For ancillary equipment, this assessment must include either a leak test, as described above, or other integrity examination, that is certified by an independent, qualified, registered professional engineer.

This plan supports the integrity assessment necessary for the continued operation of the 242-A Evaporator System under the State of Washington, Department of Ecology Permit WA 7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit*, *Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Part III, *Operating Units*, *242-A Evaporator Operating Unit Group 4*. The assessment is being completed by the 242-Evaporator System operator, Washington River Protection Solutions, LLC, for the owner, U.S. Department of Energy.

The assessment provides review of analyses performed from December 26, 2007, through September 30, 2017 (the time period since completion of the 2007 integrity assessment). It may recommend additional analysis, but the scope does not primarily require new analysis of components or reevaluation of prior IQRPE work. The scope of the assessment includes the 242-A Evaporator tanks, piping and ancillary equipment comprising the liquid dangerous waste primary containment boundary, the PC-5000 process condensate handling system, and the liquid dangerous waste secondary waste containment boundary, up to the last valved or flanged connection at the 242-A Evaporator interior wall, and up to the vessel ventilation exhaust air exit from the E-C-3 after-condenser (refer to Section 3.0 for exclusions).

The compliance matrix included in Appendix C is used to ensure that the regulations identified in Section 1.0 are met. The matrix will be revised during preparation of the IAR to reference applicable documents used by the IQRPE. The matrix will ultimately provide a summary assessment of compliance, including cross-reference to the document or documents that demonstrate meeting the requirements. The matrix will be included as an appendix to the 2017 IAR. Table B-1 through Table B-7 of RPP-RPT-58441 provide examples of one form of compliance matrices.

The IQRPE will determine the topics, checks and extent of analyses necessary to independently demonstrate that the 242-A Evaporator System complies with the State of Washington dangerous waste regulations contained in WAC 173-303-640(2) for existing tank systems.

In addition to the requirements of WAC 173-303-640(2), the IAR must include the following elements[1]:

- A site map of the facility showing the location of the tank system.
- A sketch of the tank system including connected piping and fittings. The individual tanks should be clearly labeled. Locations of specific items inspected should be clearly indicated and cross-referenced in the results of the integrity assessment.
- Results of the structural integrity assessment, including leak testing or other methods used. The results should clearly state whether the tank system has sufficient structural strength and compatibility with the waste being stored or treated.
- An assessment of the wastes to be treated and their compatibility with the tank system.
- An assessment of ancillary equipment, including results of leak testing or other methods used for this assessment.
- Results of the secondary containment assessment.
- Results of the tank system corrosion assessment.
- Results of evaluation of the tank anchoring mechanism.
- Description of the bonding and grounding system in place and an evaluation of its adequacy.
- Description of the spill prevention and overfill prevention controls and an evaluation of whether the equipment is in proper working order.
- Results of the review of the tank venting system.
- Review of the disposition of the forty-five deficiencies identified in the 2007 Integrity Assessment Report (RPP-33306).[2]
- An estimate of remaining useful life of the system, if practical.
- A recommended schedule of future tank system integrity assessments, "to ensure that the tank retains its structural integrity and will not collapse, rupture, or fail."
- A statement by an independent, qualified, registered professional engineer certifying the results of the integrity assessment. This certification must be according to WAC 173-303-810(13)(a), *Certification*. The engineer's signature and stamp must be placed below the certification statement.

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[1] Refer to State of Washington Department of Ecology Publication 94-114, *Guidance for Assessing and Certifying Tank Systems*, for additional integrity assessment guidance for existing tank systems.

[2] Minor deficiencies identified in the 2007 Integrity Assessment Report were determined by the IQRPE as not impacting the safe operation of the facility. These were to be addressed as part of scheduled, routine maintenance and were not required to be addressed prior to 242-A Evaporator operation (refer to Appendix B for list of deficiencies and their disposition).

The State of Washington, Department of Ecology has issued integrity assessment supplemental guidance documents for use by Washington State dangerous waste regulation permittees. These documents contain examples of integrity assessment content and conduct:

- Publication 94-114, *Guidance for Assessing and Certifying Tank Systems*.
- Publication 95-420, *Guidance for Assessing Dangerous Waste Secondary Containment Systems*

The State of Washington Permit WA7890008967, Rev. 8c, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Part III, *242-A Evaporator Operating Unit Group 4,* Chapter 4, *Process Information*, especially Sections 4.1.1, *Design Requirements*; 4.1.5, *Integrity Assessments*; 4.1.6, *Additional Requirements for Existing Tanks*; 4.1.7.1, [Secondary Containment] *Requirements for All Tanks*; 4.1.7.2, *242-A Building Secondary Containment*; 4.1.7.3.3, *PC-5000*; and 4.1.8, *Variances from Secondary containment Requirements*; discusses information associated with design requirements, integrity assessments, and any additional requirements for tanks used to treat and store dangerous waste in the 242-A Evaporator.

3.0 INTEGRITY ASSESSMENT EXCLUSIONS

The following facilities and equipment are excluded from the 2017 integrity assessment because they are not within the dangerous waste primary containment boundary, or they are not a credited secondary containment feature:

- Structural features not related to dangerous waste secondary containment.
- Architectural features not related to dangerous waste secondary containment.
- Lighting systems.
- System design features related to protection of the system due to vehicular traffic.
- Functional hardware/software logic for operation and control of the 242-A Evaporator system.
- Tank Farm Waste Transfer System supernatant lines (SN) upstream, slurry lines (SL), and drain lines downstream of the 242-A Evaporator facility, including first valved or flanged connection inside facility structure. These lines were included in the 2016 DST integrity assessment, RPP-RPT-58441, Rev. 0, *Double-Shell Tank System Integrity Assessment Report (DSTAR)*.
- Air handling systems used to ventilate the 242-Evaporator system. The vessel ventilation system, including condensers E-C-1, E-C-2, and E-C-3, and the process condensate handling systems, including the seal pot and associated drain lines and collection features of the vessel ventilation system upstream of the E-C-3 after-condenser air discharge, are included in the assessment.

- Plant utilities and services, including chemical supply storage and piping systems, instrument and plant air supply lines, steam supply and condensate handling, raw water handling and disposal and electrical power beyond the first upstream device or uninterruptible power supply systems that do not directly affect the ability of the system to prevent the collapse, rupture, or failure of components handling dangerous wastes.
- Instrumentation or signal lines beyond the first upstream field termination box (FTB), motor control center (MCC), or instrument control panel (JCS). Electrical feed, including wiring, local hand switches, terminations, breakers, and other equipment or instruments located in motor control centers will be reviewed to the extent they affect the ability of the system to prevent the collapse, rupture, or failure of components handling dangerous wastes. Instrument cabling and termination assessments will be limited to locally mounted devices and field termination boxes and/or local instrumentation and control panels to the extent they affect the ability of the system to prevent the collapse, rupture, or failure of components handling dangerous wastes.
- Radionuclide and radiation control subsystems as they are outside the scope of the WAC dangerous waste regulations. These include:
  - Radiation monitoring or detection components that may be mounted at various locations throughout the system.
  - Requirements regarding waste feed radionuclide properties, including radioactive and radionuclide property considerations.
  - Requirements developed to ensure exposure of plant operating personnel to radioactive process streams (radiation) is as low as reasonably achievable (ALARA).
- System safety features related to Personnel Safety, Fire Protection and Nuclear Criticality Safety.
- 242-A Evaporator system dangerous waste treatment modifications for which design, construction or construction acceptance have not been completed.

4.0 INTEGRITY ASSESSMENT REPORT DEVELOPMENT

The IQRPE integrity assessment will be performed by addressing each task identified within this plan and then generating a final 2017 IAR for release to the U.S. Department of Energy (DOE). The reference media used to prepare or cited in this plan and listed in Section 9.0, *References* (*e.g.*, drawings, design calculations, technical reports and technical evaluations, and work orders) will be provided to the IQRPE to support the integrity assessment.

IQRPE analyses of various 242-A Evaporator system components have continued to be performed since the 2007 IQRPE assessment. Table A-2 lists post-2007 IARs. Any additional reports prepared subsequent to issuance of this plan will be provided to the IQRPE during the assessment. Additionally by the time the 2017 integrity assessment is underway, a number of

CY 2016 242-A Evaporator system primary and secondary containment boundary inspection reports and leak evaluations will have been issued covering leak integrity status of the primary and secondary containment boundaries. Each of these inspection reports will need to be evaluated and activities identified, if necessary, which will enable those reports to support the conclusions of the final IAR. The scope is described in RPP-PLAN-60780, Rev. 0, *242-A Evaporator Inspection Plan*.

5.0 INTEGRITY ASSESSMENT REPORT CERTIFICATION

At the conclusion of the 2017 integrity assessment, the IQRPE may choose to certify the integrity of the 242-A Evaporator system in part or in its entirety. The IQRPE will be required to maintain a direct supervisory role over the development of the IAR or any other document the IQRPE is required to certify with the professional engineer's stamp/seal. In addition, the IAR bears the stamp of the IQRPE, since it was prepared using qualitative engineering judgment and specifies engineering related criteria in accordance with the prevailing laws related to registered professional engineers in Washington State.

The following certification language from WAC 173-303-810(13)(a) must be used:

> *I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.*

6.0 FACILITY DESCRIPTION

The following four principal structures make up the 242-A Evaporator system:

- 242-A Building, main process building.
- 242-AB Building, adjacent control room building.
- 242-A-81 Building, water services building.
- K1 Ventilation HEPA filter banks and stack structure.

Figure 6-1 through Figure 6-3 show the facility and floor plans.

Figure 6-1. 242-A Evaporator System Facilities

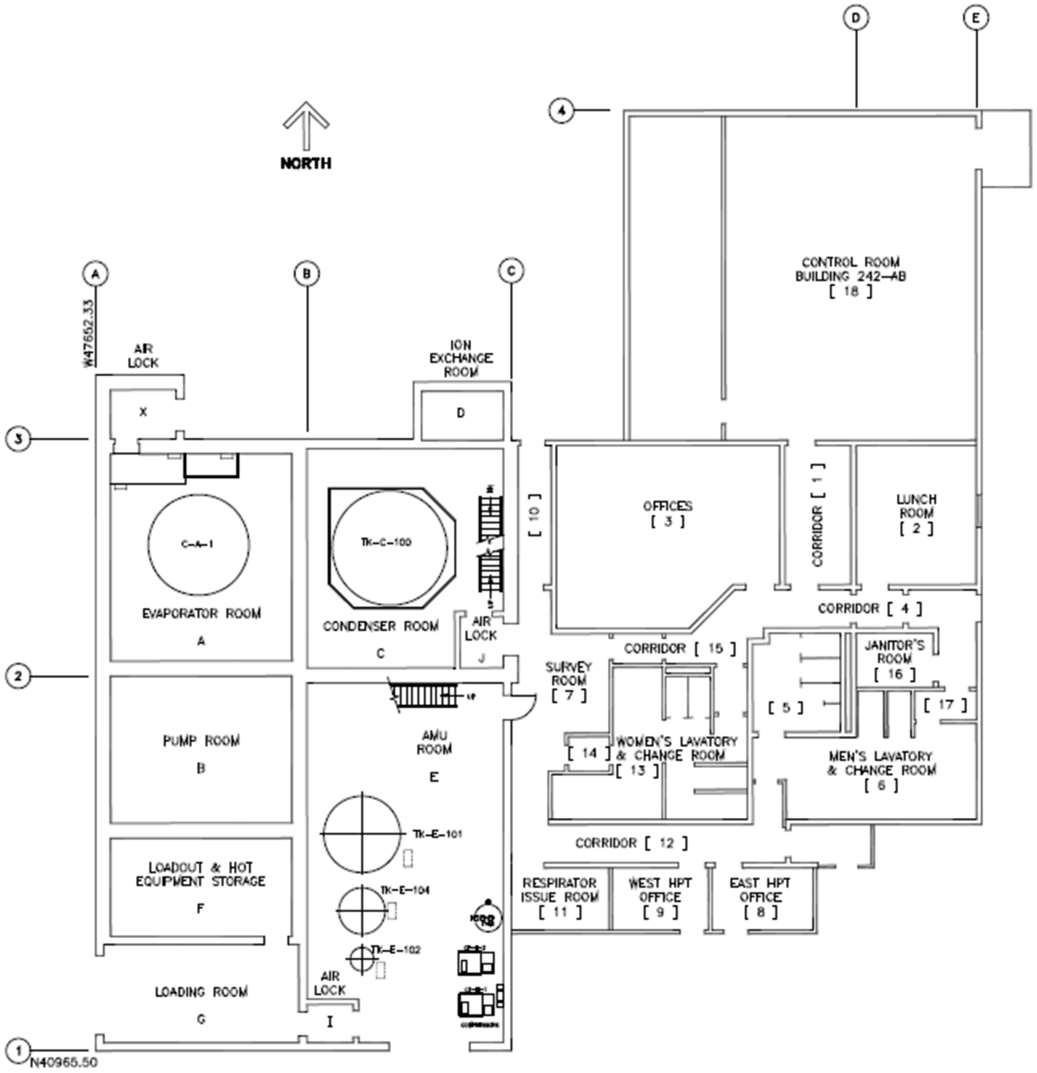

Figure 6-2. 242-A Evaporator Building First Floor Plan

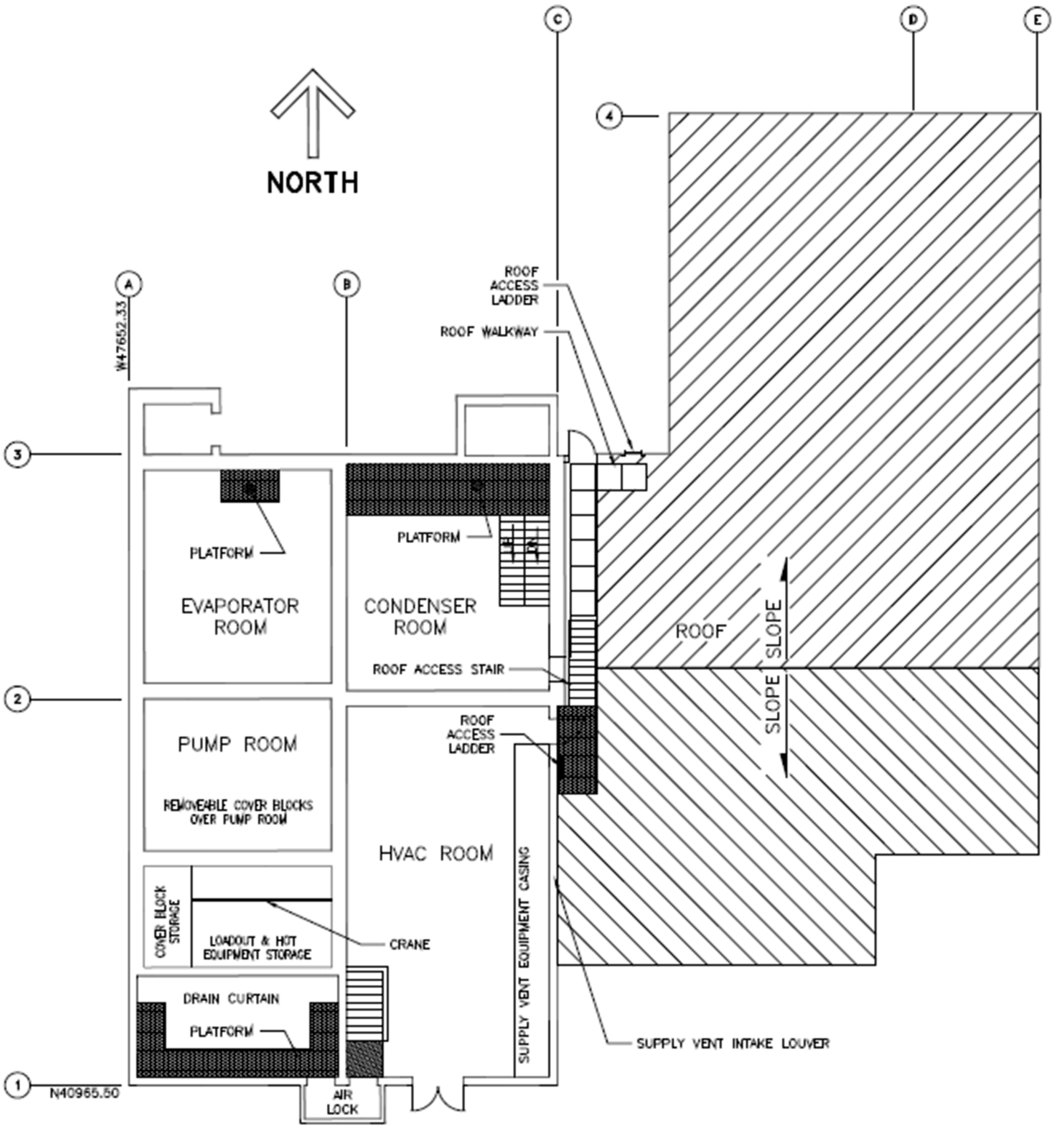

Figure 6-3. 242-A Evaporator Building Second Floor Plan

6.1 242-A BUILDING SECONDARY CONTAINMENT BUILDING

The 242-A Building serves as a secondary containment barrier for the process and ancillary equipment used for dangerous waste treatment in the 242-A Evaporator system. The concrete for the operating area was poured to form a monolithic structure. Where needed, joints in the concrete were fabricated with preformed filler conforming to the standards of the American Society of Testing and Materials. Joints were sealed with a polysulfide sealant per the requirements of the construction specifications.

Four rooms contain equipment used to treat or store dangerous waste:

- Pump room.
- Evaporator room.
- Condenser room.
- Load-out and Hot Equipment Storage room.

6.1.1 Pump Room

The pump room secondary containment walls are 1.25-ft – 1.84-ft thick reinforced concrete. The secondary containment floor is 1.67-ft thick reinforced concrete. The pump room floor is lined with ¼-in. stainless steel and the concrete walls and ceiling cover blocks are painted with a special protective coating. The pump room contains pipe jumpers used to transport feed and slurry solutions between the C-A-1 vapor-liquid separator and the DSTs, the recirculation loop, the P-B-1 recirculation pump, and P-B-2 slurry pump.

Leaks in the pump room collect in the pump room sump, a 5-ft x 5-ft x 6-ft deep floor cavity lined with ¼-in. stainless steel. The pump room sump collects spills from various sources for transfer to tank AW-102.

Drainage to the sump includes:

- Loadout and Hot Equipment Storage room floor drains.
- Leaks to the pump room floor from equipment in the pump room.
- Evaporator room floor drain.
- Raw water backflow preventer drain.

Solution in the pump room sump is transferred to tank AW-102 using a steam jet eductor. A 10-in. secondary containment overflow line is provided for draining large volumes of solution should a failure of the C-A-1 vapor-liquid separator or E-A-1 reboiler occur. Because the overflow line provides a direct path between the headspace of tank AW-102 and the pump room, a minimum level of water must be maintained in the sump to seal the overflow and prevent air reversals. A leak into the pump room sump would be detected by a rise in the sump level. Instrumentation provides alarms on high sump level.

The P-B-1 recirculation and P-B-2 slurry pumps in the pump room are equipped with mechanical seals. Pressurized water is introduced between the seals. The seal water is maintained at a pressure that exceeds the process pressure at the seal to ensure water leaks into the waste solution, but waste solution does not leak out. Water from seal leakage is collected in funnels in the pump room and routed to tank AW-102 via the 10-in. overflow line described previously.

6.1.2 Evaporator Room

The evaporator room secondary containment walls are 1.84-ft thick reinforced concrete. The secondary containment floor is 1.67-ft thick reinforced concrete. The evaporator room contains the C-A-1 vapor-liquid separator, part of the recirculation loop, the E-A-1 reboiler, the 42-in. diameter vapor line, and the line used to empty the C-A-1 vapor-liquid separator to tank AW-102.

Leaks in the evaporator room flow to a floor drain that routes through a 3-in. line to the pump room sump. A leak in the evaporator room would be detected by a rise in the sump level. The floor of the evaporator room and a portion of the pump room floor are 9.84-ft below grade to contain the entire contents of the C-A-1 vapor-liquid separator, the E-A-1 reboiler, and the recirculation loop. The floor and walls of the evaporator room up to an elevation of 6-ft are covered with a special protective coating.

6.1.3 Condenser Room

The condenser room secondary containment walls are 1.18-ft – 1.84-ft thick reinforced concrete. The secondary containment floor is 1.67-ft thick reinforced concrete. The floor and walls of the condenser room up to an elevation of 4-ft are covered with a special protective coating. The condenser room contains the components of the process condensate system, including tank TK-C-100.

Leaks in the condenser room flow to two floor drains that join and route through a 6-in. line to tank AW-102. Leaks in the condenser room are detected by the following:

- Unexpected changes in liquid level in tank TK-C-100. Instrumentation is provided to monitor liquid level in the tank, including high- and low-level alarms.
- Daily visual inspections of process condensate system components and piping.

6.1.4 Load-out and Hot Equipment Storage Room

The load-out and hot equipment storage room's secondary containment walls are 1-ft – 1.84-ft thick reinforced concrete. The secondary containment floors are 6-in. thick reinforced concrete. The room contains two recirculation lines and samplers once used to sample the feed and slurry streams. The feed sampler has been bypassed and removed from service; the slurry sampler is in use. The lines and samplers are located in a shielded enclosure adjacent to the pump room wall.

The load-out and hot equipment storage room contain two sumps: the drain sump and the decontamination sump. The sumps are 3-ft in diameter, about 4-ft deep, and lined with stainless steel. Both sumps drain via a 3-in. drain line to the pump room sump. The sumps, floor and walls of the load out and hot equipment storage room up to an elevation of 12-ft 6-in. are covered with a special protective coating.

Leaks in the sampler piping flow into two drains in the sample enclosure, which drain via a 2-in. line to the decontamination sump, which drains to the pump room sump. Leaks in the sampler piping are detected by leak detectors in the sampler enclosures or a rise in the pump room sump level.

6.2 242-A BULDING DRAIN LINES

The 242-A Evaporator system operating unit boundary includes the drain lines up to the last valved or flanged connection at the 242-A Evaporator interior wall. Beyond this point, the lines are identified as DST system components. Four lines serve to drain the 242-A building and equipment to tank AW-102:

- Pump room sump drain line DR-334, a 10-in. carbon steel line that transfers process condensate overflow/diverted liquids and contents of the pump room sump to tank AW-102.
- C-A-1 vapor-liquid separator vessel drain line DR-335, a 10-in carbon steel line that allows gravity drain of the C-A-1 vapor-liquid separator to tank AW-102.
- Condenser room drain line DR-343, a 6-in. carbon steel line that drains leakage from the condenser room to tank AW-102.
- Diverted process condensate drain line DR-338, that drains to tank AW-102 via a connection to the DR-334 sump drain line.

The four lines are sloped to drain about 560-ft to tank AW-102 via the 241-AW-02D pit. Although WAC 173-303-640(1)(c) exempts systems that serve as secondary containment from requiring secondary containment, drain lines DR-334, DR-335, and DR-338 have outer encasement piping. The drain lines are connected to an impressed current cathodic protection system to prevent soil-contact encasement corrosion. The proper operation of the cathodic protection system is checked annually; sources of impressed current must be inspected and/or tested as appropriate at least every two months. The performance of the cathodic protection was evaluated during the 2016 DST Integrity Assessment [RPP-RPT-58441, *Double-Shell Tank System Integrity Assessment Report (DSTAR)*].

During construction the pump room, evaporator room, load-out and hot equipment storage room, and the ion exchange room (no longer used – equipment bypassed) concrete and exposed carbon steel piping, equipment, and supports were sealed with three coats of radiation- and chemical spill-resistant special protective coating paint conforming to ANSI N5.9-1967, *Protective Coatings (Paints) for the Nuclear Industry*, suitable for dry temperatures $\leq$ 170°F, spills of 3 percent sulfuric acid, 3 percent nitric acid, or 25 percent sodium hydroxide, occasional decontamination with those solutions, and frequent detergent-water solutions and water rinses.

Radiation resistance was specified as 1E+08 rad total integrated dose without discoloration and 5E+09 rad with no damage more severe than surface chalking. Carboline Co. Phenoline 305, or equal was the specified coating (Construction Specification B-100-C1, *Construction Specification for 242-A Evaporator-Crystallizer Facilities Project B-100*, Division XIV, *Painting and Special Protective Coating*; Drawing H-2-69274, Rev. 1, *Architectural Schedules & Details*)

Before 242-A Evaporator restart in 1994, a new acrylic special protective coating was applied to the concrete in the pump, evaporator, and condenser rooms. The new coating met original construction specifications detailed above. The 2007 integrity assessment (RPP-RPT-33306) identified numerous areas of chipped or missing special protective coating; these areas were subsequently repaired (refer to Appendix B).

In August, 2007, a new special protective coating, Amerlock® 2 was tested for its adhesion to the existing Carboline Phenoline 305 coating. Nine test patches were applied to areas in the condenser room, allowed to cure, and tested per ASTM D5064, *Standard Practice for Conducting a Patch Test to Assess Coating Compatibility* and ASTM D3359, *Standard Test Methods for Measuring Adhesion by Tape Test*. The Amerlock 2 test patch adhesion was rated 5A – "no peeling or removal," or 4A – "trace peeling or removal along incisions or at their intersection" (incision depth to Carboline coating substrate). Amerlock 2 is a two component high solids epoxy coating rated for 250ºF continuous temperature exposure, and 350ºF intermittent exposure, with good dampness and chemical resistance to splashes and spills (refer to work order WFO-WO-07-1956, *242A Test Amerlock 2 Paint*). Engineering Change Notice ECN-725049, Rev. 1, was prepared to revise Drawing H-2-69274, Sheet 1, Rev. 1, *Architectural Schedules & Details*, to allow use of either Amerlock 2 or Amerlock 400 over the existing coating per the painters' request due to Amerlock 400's slower cure time.[3] The ECN states that the Amerlock 2 and Amerlock 400 are essentially the same coating (refer to ECN-725049, Rev. 1, *242-A Change Paint Requirements for Room A and C*).

During the CY 2007 integrity assessment inspections, minor surface defects were observed in the special protective coating on the condenser room and evaporator room floors and walls. These were repaired July 27, – August 3, 2008, in the evaporator room, and February 14 – 21, 2009, in the condenser room (refer to work order WFO-WO-07-1602, *242A Evaporator/Condenser Room Painting*).

[3] ECN-725049, Rev. 1, was signed off as "Modifications Complete" following coating repairs in the Evaporator Room and Condenser Room per work order WFO-WO-07-1602. The drawing H-2-69274 was last revised in December, 1976; the note allowing use of Amerlock 2 or Amerlock 400, has not been incorporated.

7.0 PROCESS DESCRIPTION

The 242-A Evaporator treatment process uses a conventional forced-circulation, reduced pressure vacuum evaporation system to concentrate mixed waste solutions from the DSTs. The feed stream is separated by evaporation into two liquid streams: a concentrated slurry product that is returned to the DSTs and a process condensate stream discharged to the Liquid Effluent Retention Facility (LERF) for further treatment at the 200-East Area Effluent Treatment Facility (ETF) and eventual disposal at the Treated Effluent Disposal Facility (TEDF). Water vapor from the evaporation process, consisting primarily of water with trace amounts of organic material and a small fraction of the radionuclides, is condensed. Vacuum for the 242-A Evaporator is provided by two steam jet ejectors, producing a gaseous vessel vent exhaust. The vessel vent stream is filtered and discharged through an exhaust stack. A simplified process flow diagram for the 242-A Evaporator process is provided in Figure 7-1.

Before a 242-A Evaporator campaign, a dilute radioactive waste feed batch is staged in the feed tank, tank AW-102. Once the feed batch is made up and mixed using the two internal airlift circulators in the tank, samples are taken to the 222-S Laboratory for analysis and a simulated boildown. The boildown establishes the pressure-temperature boiling curve and operating parameters unique to the feed batch, the terminal slurry product concentration and the slurry solids concentration.

The 242-A Evaporator campaign is terminated when the desired endpoint concentration of the slurry product is met. If the necessary concentration cannot be achieved in a single pass through the evaporator, the partially-concentrated product is returned to the feed tank, and a second pass made. At the end of each campaign, the 242-A Evaporator process equipment is shut down, emptied, flushed with raw water, and placed in standby mode.

The 242-A Evaporator system is comprised of four subsystems. These are described in more detail below.

7.1 VAPOR-LIQUID SEPARATOR SUBSYSTEM

The 242-A Evaporator process employs a conventional forced circulation, vacuum evaporation system to concentrate the waste stored in the DSTs. The major components of this system include the E-A-1 reboiler, C-A-1 vapor-liquid separator, P-B-1 recirculation pump, recirculation loop, and slurry system.

E-A-1 Reboiler: Dilute waste is concentrated to slurry in the E-A-1 reboiler before entering the C-A-1 vapor-liquid separator. A 28-in. diameter stainless steel line connects the reboiler with the P-B-1 recirculation pump discharge 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 are used to monitor reboiler

operation and to assist in detecting reboiler tube plugging. Temperature elements TE-EA1-1 and TE-EA1-7 provide differential temperature indication for the reboiler.

Steam condensate from the reboiler flows to the condenser room via a 4-in. diameter drain line and discharges past an in-line radiation monitor, RE-EA1-1, just before condensate enters the steam condensate weir box TK-C-103. A portion of the steam condensate is pumped from the weir through a proportional sampler/radiation monitor, R-C-1, and returned to the weir. If the radiation monitor detects radiation above the instrument alarm setpoint, the steam condensate is automatically diverted to tank AW-102. Normally, the steam condensate discharged from steam condensate weir box TK-C-103 is routed to the TEDF disposal ponds.

The 2.5 x 10^7 BTU/hr duty reboiler is a single-pass shell and tube heat exchanger with 2000 ft^2 of conductive surface area. The unit has steam on the shell side and dilute waste slurry solution on the tube side. The reboiler shell is fabricated from ⅜-in. ASME SA-240 Grade 304L stainless steel. The shell is 40-½-in. outside diameter (OD) and 15-ft long. It contains 364 tubes, fabricated from 14 gauge (0.083-in.) ASME SA-213 Grade 304L stainless steel seamless tubing, each having a 14-ft-⅛-in. length and a 1-½-in. OD, arranged with a 1-⅞-in. triangular pitch. The tube sheets are fabricated from 1-¼-in. thick ASME SA-240 Grade 304L stainless steel. The reboiler has three equally spaced baffles, as well as an impingement baffle at the steam inlet to distribute steam vapor evenly. Standard operating parameters of the waste (tube side) are 40 - 80 torr (40 – 80 mm Hg) absolute pressure and 115°F - 140°F temperature. The reboiler was designed and fabricated to ASME Boiler & Pressure Vessel (ASME BPVC) Code Section VIII, Division 1, *Rules for Construction of Pressure Vessels*, standards and code-stamped after fabrication.[4]

Steam at a pressure of 10 psig is supplied to the reboiler shell side by a 16-in. diameter feed line. When steam is isolated from the reboiler, solenoid valve HV-EA1-3 is open and 39 psig air is provided to the reboiler shell. When process activities are underway, and steam is supplied to the reboiler, solenoid valve HV-EA1-3 closes to isolate the air to the reboiler. Two vacuum breakers, PSV-1 and PSV-2, connected to the steam feed line prevent a vacuum from forming in the event of a steam column collapse.

The E-A-1 reboiler has been in service since facility startup in 1977. Prior to being placed in service, the reboiler was pressure tested to 1.5X the design pressure (refer to Certified Vendor File CVI-20253, Rev. 0, *Surface Condenser;* RPP-TE-54842, Rev. 2, *242-A Evaporator E-A-1 Reboiler Upgrade to Safety Significant QL-2*; and RPP-RPT-52352, Rev. 2, *242-A Evaporator E-A-1 Reboiler – Functions and Requirements Evaluation Document*, for additional information).

[4] The ASME BPVC Code Section VIII Division 1 does not apply to pressure vessels having an internal or external pressure not exceeding 15 psig (refer to ASME BPVC Section VIII-2015, Division I *Introduction*, U-1 *Scope*, Part *(c)(2)(h)(1)*. However, any pressure vessel which meets all of the applicable requirements of Division 1 may be ASME-stamped (refer to ASME BPVC Section VIII-2015, Division 1 *Introduction*, U-1 *Scope*, Part (*c*)*(2)*. This appears to be the case for the installed E-A-1 reboiler.

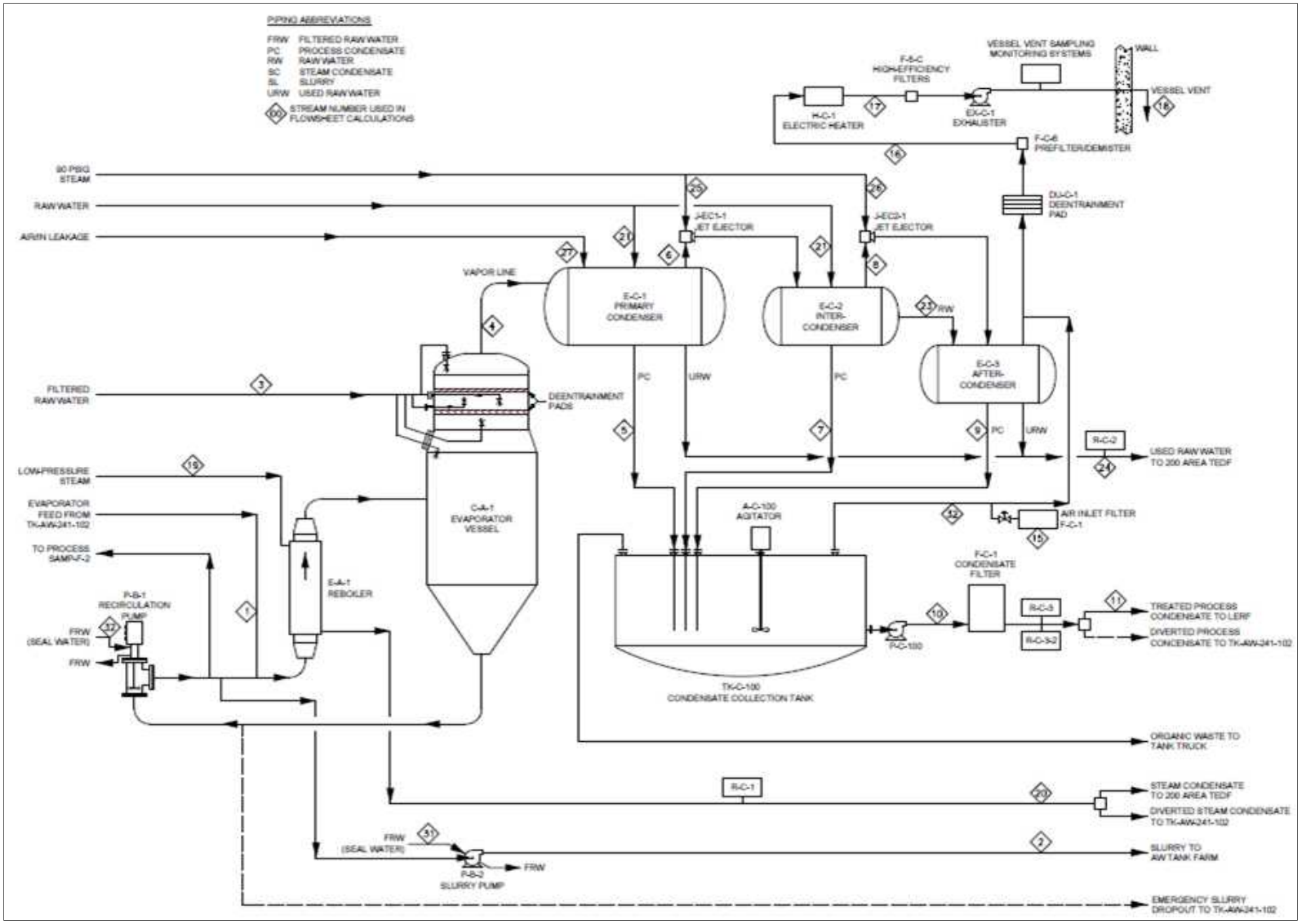

Figure 7-1. 242-A Evaporator Process Flowsheet
(Source: HNF-14755, Rev. 5, Figure 2-6)

Between March 7, and March 12, 2014, a leak integrity test was performed on the E-A-1 reboiler, injecting fluorescein dye into the process (tube) side, and monitoring the steam condensate flow from the steam side for evidence of leakage. Four of five post-test samples indicated fluorescein had entered the steam condensate. The calculated leak rate was below the established leak tightness performance standard, and E-A-1 was declared leak-tight (refer to RPP-RPT-52352, Rev. 2, *242-A Evaporator E-A-1 Reboiler – Functions and Requirements Evaluation Document* for derivation of performance standard; RPP-RPT-57257, *Test Report for Leak-Tightness of Reboiler Vessel E-A-1 at 242-A Evaporator Facility*, for leak rate determination). Amended Consent Decree No. 2:08-CV-5085-RMP *Amended Consent Decree Between Department of Energy and State of Washington*, mandated that a spare E-A-1 reboiler be purchased by December 31, 2016.

An available spare reboiler was fabricated for the 242-S Evaporator, a nearly identical twin to the 242-A Evaporator that began operation in 1973, four years earlier than the 242-A Evaporator. However, it was not ASME BPVC Division VIII Section 1 code-stamped after completion. It was judged that design, fabrication, and certification of a new reboiler would be quicker and less expensive than attempting to qualify the existing spare.

C-A-1 Vapor-Liquid Separator ("Evaporator Vessel"): Dilute waste slurry from the reboiler enters the C-A-1 vapor-liquid separator via the upper recirculation line. Some of the solution flashes into water vapor, which exits through a vapor line at the top of the separator. The concentrated waste slurry solution exits through the recirculation line at the bottom.

The C-A-1 vapor-liquid separator consists of a lower and upper section. The total volume of the separator, if filled to the top of the vapor section, is 35,600 gal. Both sections of the separator are constructed of 0.374-inch ASTM SA 240 304L stainless steel. The lower (liquid) section is 14-ft in diameter having a 22,500 gal – 25,000 gallon nominal operating capacity, including the recirculation loop and E-A-1 reboiler. The upper (vapor) section is 11-ft 7-in. in diameter and contains two deentrainment pads spaced ~3-ft 4½-in. apart. The pads remove liquids and solids to prevent carryover into the vapor header. The lower pad is 4-in. thick, and the upper pad is 6-in. thick; both are Type-304 stainless steel 0.011-in. wire mesh packed to a density of 12 lb/ft^3.

Sixteen spray nozzles, four on the top and four on the bottom of each pad, are spaced equally and operated alternately to distribute water to the deentrainment pads. The top sprays to the upper pad are controlled automatically for sequential operation for 15 seconds. Both sets of sprays to the bottom pad are on a distribution ring and are controlled manually. Four other nozzles located below the lower deentrainment pad serve to spray down the side of the vessel with water at the end of the campaign. These nozzles are shared with the vessel purge air system. Spray nozzles can use either recycled process condensate or filtered raw water.

The C-A-1 vapor-liquid separator is equipped with a 6-in. diameter drop-out drain line that runs from the 28-in. recirculation loop along the evaporator room floor through a penetration in the north wall and out to feed tank AW-102. This line drains the C-A-1 vessel contents back to feed tank via encased drain line DR-335 under six conditions:

- At the end of a campaign when slurry can no longer be pumped by the P-B-2 slurry pump.
- Upon loss of P-B-1 recirculation pump (which initiates an automatic shutdown of the 242-A Evaporator process).
- An emergency shutdown of the 242-A Evaporator process.
- A seismic event in which the facility emergency stop button is activated.
- Flammable gas conditions of high temperature or loss of vacuum without purge air are detected.
- High liquid level or waste boil-over conditions are detected.

The drop-out line ties into the 28-in. recirculation line at dump valve HV-CA1-7 and contains an inline dump valve, HV-CA1-9. A 2-in. raw water flush line ties in to the drop-out line between these two valves.

Instruments monitor the following C-A-1 operating parameters:

- Temperature.
- Pressure.
- Weight factor (WF) (*i.e.*, liquid level and density).
- Flow indication (via coriolis flowmeter).
- Density (via coriolis flowmeter).
- Differential pressure across the upper and lower deentrainment pads.

Both the E-A-1 reboiler and C-A-1 vapor-liquid separator, as well as the recirculation loop, are insulated. The insulation is comprised of a 2-in. thick fiberglass blanket encapsulated in a silicon-coated, woven fiberglass fabric jacket with a silicone foam backing. The insulation reduces the quantity of steam the process requires and ensures a more uniform operating temperature in the vapor-liquid separator subsystem.

Temperature excursions and pressurization of the vessel are highly unlikely. The low-pressure 10 psig steam supplied to the E-A-1 reboiler does not supply sufficient heat to cause a rapid temperature increase in the liquid. However moderate temperature excursions of approximately 10°F – 20°F in 20 minutes are still possible. Any increase in pressure caused by a temperature increase is relieved through the 42-in. vapor line.

The feed line from feed tank AW-102 and the slurry line to the DSTs are connected to the 28-in. recirculation line. Slurry can be discharged from the C-A-1 vapor-liquid separator through DR-335 to tank AW-102 in case of an emergency. In addition, if the valves on the drain line should fail to operate or if the drain line to the tank is plugged, an emergency method of discharging the slurry is provided by a 4-in. nozzle (Nozzle E) on the bottom of the recirculation

line. A connector head can be removed from it remotely, discharging the contents of the system to the pump room floor. The pump room sump overflows to tank AW-102.

The C-A-1 vapor-liquid separator and the recirculation loop have provisions for flushing residual solids from the system and for reducing radiation levels. The most common flush solution is water, but dilute nitric or citric acid solutions can also be used. All acidic flush solutions are chemically adjusted to meet DST waste acceptance criteria before transfer to the DST System.

Water can be added from the raw water supply via the slurry product line flush system, the deentrainer spray and vessel spray systems, and the dump line. The drain line to tank AW-102, the slurry line to the slurry receiver DST, and the dump line to tank AW-102 can be flushed with hot water during the deep flush at the end of a campaign. The deep flush involves heating water to boiling temperature in the C-A-1 vessel after the waste solution is emptied, and draining the hot water down the feed line, the slurry line, and the dump line. During campaigns antifoam solution is added at a variable rate of 0.01 – 0.1 gal/min to the vessel to prevent foaming. The antifoam solution is a silicone-based solution that is stated to be compatible with the evaporator components.

P-B-1 Recirculation Pump: The stainless steel recirculation pump discharges slurry back to the reboiler via the upper recirculation line. The 28-in. axial flow pump is driven by an electric vertical induction motor and has a 13,000 gal/min output with a 10.85-ft total dynamic head. It is designed to handle slurry containing up to 30 volume percent solids and a slurry specific gravity of 1.8. The recirculation pump moves waste at high velocities through the reboiler to improve heat transfer, keep solids in suspension, and reduce fouling of the heat transfer surfaces.

The P-B-1 recirculation pump is equipped with shaft seals with high-pressure recycled process condensate (or raw water) introduced between the seals to prevent the waste solution from leaking out of the system. Seal water pressure and flow are monitored and controlled to shut down the recirculation pump if conditions are not adequate to prevent waste liquid from migrating into the seal water. The used seal water is routed to tank AW-102.

On Friday, November 9, 2007, the P-B-1 pump was discovered running undetected without seal lubrication, monitoring or interlocks. At the time of the event, the 242-A Evaporator facility was shutdown with no waste or other liquid in the C-A-1 vapor-liquid separator and the monitoring and control system (MCS) out-of-service for upgrades (refer to Appendix D, Occurrence Report EM-RP--CHG-TANKFARM-2007-0014, *242-A Evaporator Recirculation Pump P-B-1 Inadvertently Started And Operated Without Seal Water*).

The P-B-1 pump was removed to the Loadout and Hot Equipment Storage Room, and replaced August 14, 2008, with a refurbished spare, S/N 88371. Pump 88371 had been previously removed from service and refurbished in *ca*. 1996, however preservation maintenance had not been performed, nor was complete documentation of the refurbishment available. Prior to installation, the spare was disassembled and inspected, new upper and lower bearings and seals replaced, and the pump reassembled.

The installation was confirmed leak tight during the 242-A cold run in September, 2008 (Work orders WFO-WO-07-3094, *242A Refurbish and Prep Spare PB-1*; WFO-WO-07-3095, *242A Replace PB-1 with Spare*; TFC-WO-08-0925, *242-A, PB-1 Post Maint Testing*; and TFC-WO-08-1307, *242A Perform Leak Checks During Cold/Hot Run 2008*).

During the PB-1 pump installation, solids were observed in the 28-in recirculation line just downstream of the pump during the August 6, 2008 camera inspection. The flow through this line at 13,000 gal/min is almost seven feet per second flow velocity average for the line. The remainder of the horizontal run of visible pipe interior was completely clean. It was thought that the solids we not scoured because of uneven flow conditions right at the outlet of the pump (refer to RPP-RPT-41939, *242-A Evaporator Campaign 09-01/09-02 Post-Run Report*, including recirculation line inspection photographs).

Recirculation Loop: The recirculation loop consists of a 28-in. diameter stainless steel line that connects the C-A-1 vapor-liquid separator to the P-B-1 recirculation pump and E-A-1 reboiler. The lower loop runs from the bottom of the separator to the pump inlet. The upper loop connects the pump discharge to the reboiler and from the reboiler back into the C-A-1 vapor-liquid separator. The feed line from tank AW-102 and the slurry line to other DSTs are connected to the upper recirculation line.

7.2 SLURRY SUBSYSTEM

The slurry system withdraws a portion of the concentrated waste from the upper recirculation loop and transfers it to the slurry receiver DST. The major components of the slurry system are the P-B-2 slurry pump and the slurry transfer pipelines.

P-B-2 Slurry Pump: The P-B-2 slurry pump is used to transfer slurry from the recirculation loop to the DSTs. The pump has a total dynamic head of 500-ft and is constructed of 304 L stainless steel. It is a single stage, horizontal, centrifugal pump driven by a variable speed motor with a normal flow of 32 – 110 gal/min. The slurry pump is designed to generate high pressures and high slurry transfer line velocities to minimize the possibility of transfer line plugging. The installed pump is a replacement installed in 1990 as part of Project B-534.

Interlocks control the operation of the slurry pump. The slurry pump is interlocked to shut down automatically if any of the following occur:

- Excessive pressure is detected in the slurry line to 241-AW Tank Farm.
- A leak is detected in the slurry transfer route secondary containment.

The P-B-2 slurry pump uses a shaft seal with recycled process condensate (or raw water) and pressure and flow controls similar to the system described for the P-B-1 recirculation pump.

The flow rate of the slurry transfer through the slurry line is monitored and a decrease in flow below a specified value automatically shuts down the slurry pump and initiates a line flush with water.

7.3 CONDENSATE COLLECTION AND TREATMENT SUBSYSTEM

Process vapor enters the E-C-1 primary condenser through an overhead 42-in. line. The vapor is drawn into the condenser by vacuum and condenses in the E-C-1 primary condenser, E-C-2 inter-condenser, and E-C-3 after-condenser. Two steam jet eductors, located between E-C-1 and E-C-2 and between E-C-2 and E-C-3, create the vacuum that draws process vapor from the C-A-l vapor-liquid separator into the condenser system. Condensate from E-C-1 primary condenser drains to a 20-in. hot well and from there to the process condensate collection tank TK-C-100 via a 4-in. line. Condensate from E-C-2 and E-C-3 drain directly to tank TK-C-100 through separate ¾-in. lines. The remaining uncondensed vapors exit from the E-C-3 condenser via a 3-in. line and are discharged into the vessel vent treatment system. The process condensate collected in tank TK-C-100 is pumped through filters. Under normal operation, process condensate is pumped to the LERF Basin 43 via the PC-5000 line. The process condensate is diverted back to tank TK-C-100 or tank AW-102 by valve HV-RC3-3 if the R-C-3 radiation monitor setpoint is exceeded.

The vacuum condenser system has the following components:

- E-C-1 Primary condenser.
- E-C-2 Inter-condenser.
- E-C-3 After-condenser.
- J-EC1-1 and J-EC2-1 Steam jet eductors.

E-C-1 Primary Condenser: The E-C-1 primary condenser is a four-pass, tube-in-shell, raw water-cooled condenser with a design heat duty of 2.2E+07 BTU/hr. The shell is 17-ft 6-in. long and has an 85-in ID. It contains 2,950 tubes through which raw water passes at a maximum rate of 3,500 gal/min. The tubes are 11-ft long with a ¾-in. OD. A 4-ft 6-in. impingement plate is located at the vapor inlet; five baffles are evenly spaced through the length of the condenser, and two baffles act as a shroud over the vapor outlets. The existing condenser is a spare fabricated in 1976 and installed in 1990 as part of Project B-534.

The used raw water flow from the primary condenser is joined by the E-C-3 used raw water flow and becomes one of three liquid effluent streams from the 242-A Evaporator. A small portion of the used raw cooling water is routed through the R-C-2 radiation monitor, pH and conductivity meters, and proportional sampler as the stream exits to the TEDF Pump Station 3.

Steam jet eductor J-EC1-1 maintains a vacuum on the primary condenser that in turn creates a vacuum in the C-A-l vapor-liquid separator. The ejector consists of a steam nozzle that discharges a high-velocity jet across a suction chamber. Uncondensed vapors from the primary

condenser are entrained by the steam and carried into a venturi-shaped diffuser that converts the velocity energy of steam into pressure energy. Steam is supplied via a 3-in. 90 psig steam line, reduced to 1½-in. before entering the jet, and discharged to the inter-condenser via a 10-in. line.

E-C-2 Inter-Condenser: The inter-condenser is a four-pass, tube-in-shell, raw water-cooled condenser with a design heat duty of 1E+06 BTU/hr. The shell is 7-ft 3-in. long and has a 15.4-in. ID. It contains 144 tubes through which raw water passes at a rate of 150 gal/min. The tubes are 66 in. long with a ¾-in. OD.

Uncondensed vapors from the primary condenser enter the E-C-2 inter-condenser via a 10-in.discharge line from steam jet eductor J-EC1-1. A ¾-in. line drains condensed vapors and condensed steam from the steam jet to tank TK-C-100. Uncondensed vapors exit via a 2½-in. vacuum line to steam jet eductor J-EC2-1. Cooling water enters the inter-condenser through a 3-in. raw water line and exits via a 3-in. line to the after-condenser.

Steam pressure is controlled by a pressure control valve, and the desired vacuum is controlled by bleeding ambient air into the system through air intake filter F-C-2. The air bleed valve is controlled by a pressure-indicator controller that receives its signal from the weight factor reference pressure tap in the C-A-l vapor-liquid separator.

The inter-condenser was replaced in April, 2004 after tube leakage was noticed following the FY 2000 – 2001 campaign (Work Order EE-03-00085/W, *242-A East Evaporator, Replace E-C-2 and E-C-3 Condensers and Associated Steam Jets (J-EC1-1 & J-EC2-1)*; USQ No. EV-03-4060-D, *Work Instruction EE-03-00085/W, 242-A East Evaporator, Replace E-C-2 and E-C-3 Condensers and Associated Steam Jets (J-EC1-1 & J-EC2-1), (No revision Number), and Engineering Change Notice ECN-721299, Fabricate/Install New Gauge Rack for PI-EC1-1, PI-EC2-1 and PI-EC3-1, Revision 0*.)

E-C-3 After-Condenser: The E-C-3 after-condenser is a two-pass, tube-in-shell, raw water-cooled condenser with a design heat duty of 7E+05 BTU/hr. The shell is ~7-ft 5-in. long with an 8-in. ID. It contains 45 tubes through which raw water passes at a rate of 150 gal/min. The tubes are 72-in. long with a ¾-in. OD.

Vapor discharged from the inter-condenser enters the second stage of the vacuum system. This stage consists of a second steam jet eductor and the after-condenser. Steam pressure is again controlled and the discharged vapor contacts cooling tubes in the after-condenser. Condensate is routed to tank TK-C-100 while the uncondensed vapors are filtered and discharged to the atmosphere through the vessel vent system. Cooling water for this condenser comes from the inter-condenser. The used water exiting from E-C-3 after-condenser combines with the used raw water from the E-C-1 primary condenser and drains to the 200 Area TEDF Pump Station 3. A small amount of the combined used cooling water is routed through the R-C-2 sampler and monitor before draining to the pump station.

The after-condenser was replaced in October, 2004 (RPP-21574, Rev. 0, *Specification for Replacement Intercondenser E-C-3 for 242-A Evaporator*; Work Order EE-03-00085/W; USQ No. EV-03-4060-D).

7.4 PROCESS CONDENSATE SUBSYSTEM

The process condensate system is comprised of the following principal components:

- In-line radiation monitoring system, RI-CA1-1.
- Process condensate tank, TK-C-100.
- Process condensate pump, P-C-100.
- Process condensate recycle pump, P-C-106.
- Process condensate filter, F-C-l.
- Process condensate filter, F-C-3.
- Condensate recycle filters, F-C-4 and F-C-5.
- Radiation monitoring, sampling, and diversion system, RC-3.

RI-CA1-1 In-line Radiation Monitoring System: The RI-CA1-1 radiation monitoring system consists of a radiation detector mounted on the process condensate line between the E-C-1 primary condenser and tank TK-C-100. The detector is interlocked to shut off the process condensate pump and prevent the contamination of downstream equipment when a solution radiation level above the alarm setpoint is detected.

TK-C-100 Process Condensate Collection Tank. Process condensate from the primary, inter- and after-condensers drain by gravity to tank TK-C-100. The tank also receives potentially contaminated drainage from the vessel vent system via a 27 gal seal pot. The process condensate tank was fabricated in 1951, and repurposed from another Hanford facility. It is constructed of stainless steel, 14-ft in diameter and 19-ft high, with a capacity of 17,800 gal. The tank is equipped with an agitator, weight factor instrumentation, temperature instruments, and has overflow and drain lines to tank AW-102. A spray nozzle from the facility decontamination tank is provided for flushing the tank. A 4-in. line vents the tank to the vessel vent system and 2-in. steam vent line V-1209 connects to flow measurement tank TK-C-103. Since no valves are installed on the steam vent line, barometric breathing is always assured in the condensate tank and excessive buildup of flammable gases is prevented in both the TK-C-100 and TK-C-103 tanks.

P-C-100 Process Condensate Pump: Process condensate is pumped from tank TK-C-100 directly to the F-C-1 filter by the P-C-100 process condensate pump. The pump has a normal operating capacity of 60 gal/min. The original Ingersoll Rand/Dresser pump was replaced with a new Flowserve pump, Model Number: CG1.5X1-82 M3GD-FPD-D4, in January, 2013 (Work order TFC-WO-11-5323, *242-A Replace P-C-100*).

P-C-l06 Process Condensate Recycle Pump: The process condensate recycle pump supplies process condensate for the C-A-1 vapor-liquid separator lower and upper deentrainer sprays and seal water for the P-B-1 recirculation pump and P-B-2 slurry pump.

F-C-1 Condensate Filter: Condensate filter F-C-1 removes particulate matter from the process condensate. It is an in-line filter located downstream of the P-C-100 process condensate pump. Pressure indicators are located upstream and downstream of condensate filter F-C-1 to measure the differential pressure and determine when the filter elements need to be replaced. Process condensate bypasses the filter during filter element replacement.

F-C-3 Process Condensate Filter: Process condensate filter F-C-3 is a duplex strainer unit. It provides additional filtering of the process condensate stream prior to leaving the facility. The duplex design supports continuous operation by permitting one strainer to be online while the other is cleaned.

F-C-4 and F-C-5 Condensate Recycle Filters: The condensate recycle filters prevent particulate material from reaching the C-A-1 vapor-liquid separator upper deentrainment spray pads and seals for P-B-1 recirculation pump and P-B-2 slurry pump. The system is monitored for differential pressure across the filters.

RC-3 Radiation Monitoring, Sampling, and Diversion System: The RC-3 radiation monitoring, sampling and diversion system consists of a sampler, sample receiver and radiation monitor. If the process condensate exceeds the radiation setpoint for allowable radioactive discharge from the facility, it is diverted by the R-C-3 diverter valve back to tank TK-C-100 or tank AW-102.

7.5 PC-5000 PROCESS CONDENSATE TRANSFER LINE

The PC-5000 transfer line is a ~4,900-ft underground transfer line consisting of a 3-in. primary line inside a 6-in secondary encasement. Electronic leak detection elements are provided at 1000-ft intervals along the transfer line and swab risers are provided every 100-ft between the leak detection elements. In the event of a primary line failure, the encasement provides secondary containment of the liquid, preventing the process condensate from leaking to the surrounding soil.

Both the 3-in. primary line and 6-in. encasement are ASTM D2997-1989, *Standard Specification for Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe,* centrifugally cast, fiberglass-reinforced epoxy thermoset resin pressure pipe. The primary pipe is centered and supported within the encasement. Pipe supports are fabricated of the same material as the pipe, and meet the strength requirements of ASME B31.3-1987 for dead weight and seismic loads.

The maximum operating pressure for the primary line is 100 psig, and for the encasement, 60 psig. The pipeline was designed for fluid characteristics having a temperature range of 40°F - 120°F. The design flow rate is 75 gal/min. The pipeline system was designed to ensure that no overpressure transients would take place during operation.

The WA7890008967 Permit identifies approved leak detection methods as being electronic continuous monitoring or visual inspection at the identified periodicity while the PC-5000 transfer line is in use. Single-point electronic leak detection elements were installed along the transfer line at the time of construction. The leak detection elements were located in the bottom of specially designed test risers. Each sensor element employed a conductivity sensor, which was connected to a cable leading back to the 242-A Evaporator control room.

A low-volume, continuous air purge of the annular space between the primary pipe and the encasement prevents condensation buildup and false alarms by the leak detection elements. If a leak developed in the primary line during a transfer, the leak would trip a leak detection element, sound an alarm in the 242-A Evaporator and/or the ETF control room and indicate the leak zone on a digital display. In the event that the purge air pressure approaches the 60 psig encasement maximum operating pressure, a rupture disc provides pressure relief.

The original leak detection design provided an interlock that automatically shut down the P-C-100 process condensate pump in the 242-A Evaporator in the event of a leak detector trip. However, the system had not been used during evaporator campaigns after 2003 because of numerous false alarms (refer to ECN-721677, Rev. 0 – 7, *Disable 242-A Evaporator Trace Tek Leak Detectors to LERF and Associated Interlocs*[5] [*sic*]). The WA7890008967 permit allows an alternate means of leak detection using visual observation of the encasement termination at the LERF end of the line for evidence of leakage. Project E-528, *Trace-Tek Leak Detection System Upgrade*, replaced the continuous leak detection cable with six single-point leak detectors and a 30 gal stainless steel catch tank equipped with a seventh leak detector to collect any encasement drainage at the LERF termination of the line. Construction was completed in March, 2010 (refer to RPP-RPT-40663, Rev. 0, *Functions and Requirements for 242-A PC-5000 Condensate Drain Line Leak Detection System*, and PC5000-PTD-001, Rev. 0, *PC-5000 Leak Detection Upgrades Project Turnover Document*).

7.6 PRIMARY CONTAINMENT BOUNDARY MATERIALS, AND DESIGN AND OPERATING PARAMETERS

Table 7-1 summarizes the primary containment boundary component, materials and characteristics for the 242-A Evaporator system. Table 7-2 summarizes the piping materials used for the 242-A Evaporator system.

[5] Although ECN-721677 revisions include various titles; all provide identical instructions for placing the leak detection system "off-scan" during evaporator campaigns. A new ECN revision was issued for each evaporator campaign, beginning with Rev. 0 for Campaign 04-01 and continuing through Rev. 7 for Campaign 10-01, before the PC-5000 leak detector modifications were completed.

Table 7-1. Primary Containment Barrier Component Materials and Parameters (4 pages)

	Nominal Operating Range		Design			
Component	**Pressure / Flow**	**Temperature**	**Design Criteria**	**Design Limits**	**Material of Construction**	**Reference**
C-A-1 Vapor-Liquid Separator						
Vapor Section	< 0.8 psia	95°F	• ASME Section VIII Div. 1 • HPS-220-W[a,b] • HPS-230-W[a,c]	200°F Full Vacuum	ASME SA-240 304L SS	• B-100-P1[d] • B-534-P11[e] • CVI-14739[l] • FDM-T-600-0001[f] • H-2-69320, Rev. 1[g] • RPP-PLAN-32530, Rev. 1, Table 4.1[h] • SD-WM-TI-003, Rev. 1[i]
Recirculation Loop	14,000 gpm	70°F			AISI 304L SS	
E-A-1 Reboiler						
Tube Side (Waste Feed)	14,000 gpm	170°F	• ASME Section VIII Div. 1 • HPS-230-W & HPS-220-W •	250°F Full Vacuum	ASME SA-213 304L SS	• CVI-14739[l] • FDM-T-600-0001 • H-2-69322, Rev. 8[j]
Shell Side (Steam)	24.7 psia	240°F		350°F 100 psig	ASME SA-240 304L SS	
P-B-1 Recirculation Pump	• 5.7 psig Total Dynamic Head • 14,000 gpm			200°F	ASTM A296 Gr. CF-8 & GF-8	• B-534-P4[k] • FMD-T-600-00001, Page 18
P-B-2 Slurry Pump	32 – 110 gpm		500 psig Total Dynamic Head	155°F		• B-534-P11 • FMD-T-600-00001, Page 18
E-C-1 Primary Condenser						
Tube Side (Raw Cooling Water)	3,500 gpm	72°F	• ASME Section VIII Div. 1 • HPS-220-W	150°F 100 psig	• ASME SA 515 Gr. 70 CS (Tubes, Tube Sheets)	CVI-14739-000-VI-001

Table 7-1. Primary Containment Barrier Component Materials and Parameters (4 pages)

	Nominal Operating Range		Design			
Component	**Pressure / Flow**	**Temperature**	**Design Criteria**	**Design Limits**	**Material of Construction**	**Reference**
Shell Side (Waste Vapor)	0.8 psia	78°F		150°F Full Vacuum	• ASME SA285 Gr. C CS (Shell, Heads, Internal Supports)	
E-C-2 Inter-Condenser						
Tube Side (Raw Cooling Water)	80 gpm	72°F	ASME Section VIII Div. 1	• 350°F • 100 psig		• H-2-69320, Rev. 1 • Schutte & Koerting Spec. Sheet 72-T-018-J-1[m] • WHC-SD-WM-ER-124, Rev. 1
Shell Side (Waste Vapor)	2.6 psia	100°F		• 350°F • 100 psig – Full Vacuum	• ASTM SA53 Gr B CS (Shell) • ASTM SA515 Gr. 300 CS (Head)	
E-C-3 After-Condenser						
Tube Side (Raw Cooling Water)	80 gpm	95°F	ASME Section VIII Div. 1	• 350°F • 100 psig		• H-2-69320 • Schutte & Koerting Spec. Sheet 72-T-018-J-1[m]
Shell Side (Non-Condensable Waste Vapor)	15.7 psia			• 350°F • 100 psig – Full Vacuum	• ASTM SA53 Gr B CS (Shell) • ASME SA515 Gr. 300 CS (Head)	
TK-C-100 Condensate Catch Tank	19.6 psia	151°F	• ASME Section VIII, Div. 1 • HWS 4311, Rev. 2	5 psig	ASTM A167, Type 347 SS	• H-2-40704, Rev. 4[n] • H-2-69320 • H-2-69357[o] • WHC-SD-WM-124, Rev. 1 • WHC-SD-WM-DP-019[p], Rev. 0, Section 7.1
TK-C-103 Condensate Measurement Tank	Atmospheric pressure		ASME Section VIII, Div. 1	Atmospheric pressure	• ASTM A36 CS	H-2-69370[q], Sheet 1, Rev. 1[aa]

Table 7-1. Primary Containment Barrier Component Materials and Parameters (4 pages)

	Nominal Operating Range		Design			
Component	**Pressure / Flow**	**Temperature**	**Design Criteria**	**Design Limits**	**Material of Construction**	**Reference**
					• ASTM A240 304L SS (Weir Plate)	
Seal Pot			ASME Section VIII Div. 1		ASTM A36 CS	H-2-69368, Sheet 1, Rev. 1[r]
PC-5000 Process Condensate Line						
Primary Line	20 – 60 gpm	80ºF – 110ºF	• ANSI/ASME B31.3-1987 • ANSI/AWWA C950-88	• 40ºF – 120ºF • 100 psig • 75 gpm	ASTM D 2997 RTRP Type II Grade 1, Class C	• H-2-98990, Sheet 1, Rev. 19[s] • H-2-88766, Sheet 1, Rev. 14 and Sheet 3, Rev. 19[t,u] • RPP-RPT-33307, Rev. 0[v] • W-105-P, Rev. 0[w] • WHC-SD-WM-DP-019, Rev. 0[x,y] • WHC-SD-WM-ER-112[z] Rev. 0
Encasement (Secondary Line)	N/A			• 40ºF – 120ºF • 60 psig		

Table Notes and References:

a. Hanford Plant Standards (HPS) were withdrawn from use September 20, 1994, because they did not meet the requirements of DOE 6430.1A, *General Design Criteria*, leaving only Standard Design Criteria (SDC) for mandatory compliance (refer to Letter, 94-PMDB-106, W. S. Chin, Acting Director, Project Management Division, U.S. Department of Energy, Richland Operations Office, to President, Westinghouse Hanford Company, *Hanford Plant Standards (HPS), Elimination of Standard Details and Standard Specifications*, dated September 20, 1994).

b. HPS-220-W *Standard Specification for Welding Carbon Steels*

c. HPS-230-W *Standard Specification for Welding Austenitic Stainless Steels*

d. B-100-P1, Rev. 1, *Specification for Fabrication of Evaporator-Crystallizer System Additional Waste Concentrate and Saltcake Storage Facility*

e. B-534-P11

f. FDM-T-600-0001, Rev. A-0, *Facility Description Manual, 242-A Evaporator-Crystallizer*

g. H-2-69320, Sheet 1, Rev. 1, *Process Flow Diagram Vacuum Evaporator Crystallizer System*. The PFD was voided in 2004 by ECN-721822, Rev. 0, and not updated or superseded.

Table 7-1. Primary Containment Barrier Component Materials and Parameters (4 pages)

	Nominal Operating Range		Design			
Component	Pressure / Flow	Temperature	Design Criteria	Design Limits	Material of Construction	Reference

[h] RPP-PLAN-32530, Rev. 1, *IQRPE Integrity Assessment Plan for the 242-A Evaporator System and PC-5000 Process Condensate Transfer Line*, Table 4.1, *Equipment Design Criter*ia

[i] SD-WM-TI-003, Rev. 1, *Technical Bases for OSD-T-151-00012*

[j] H-2-69322, Sheet 1, Rev.8, *Engineering Flow Diagram Pump & Evaporator Rooms*

[k] WHC-SD-WM-ER 124, Rev. 1, The *242-A Evaporator/Crystallizer Tank System Integrity Assessment Report*, Table 4, *Facility Piping and Component Materials*B-534-P4

[l] CVI-14739, *Vacuum Evaporator Crystallizer*

[m] Schutte & Koerting Spec. Sheet 72-T-018-J-1 [refer to RPP-21574, Rev. 0, *Specification for Replacement Intercondenser E-C-3 for 242-A Evaporator*, Attachment 2, for E-C-2 inter-condenser and E-C-3 after-condenser data sheet.]

[n] H-2-40704, Sheet 1, Rev. 4, *Class II Vessel – 14'- 0" x 14' - 0" Tank TK-386*

[o] H-2-69357, Sheet 1, Rev. 2, *Condensate Tank TK-C-100 Assembly & Details*

[p] WHC-SD-WM-DP-019, Rev. 0, *Data Package for 242-A Evaporator/Crystallizer Tank System Integrity Report* Section 7.1, *Operating Parameter Calculations and References*

[q] H-2-69370, Sheet 1, Rev. 1, *Flow Measurement Tank TK-C-103 Assembly & Details*

[r] H-2-69368, Sheet 1, Rev. 1, *Seal Pot Assembly & Details*

[s] H-2-98990, Sheet 1, Rev. 19, *P & ID Process Condensate System*

[t] H-2-88766, Sheet 1, Rev. 14, *P & ID LERF Basin & ETF Influent Evaporator*

[u] H-2-88766, Sheet 3, Rev. 19, *P & ID LERF Basin & ETF Influent Evaporator*

[v] RPP-RPT-33307, Rev. 0, *IQRPE Integrity Assessment Report for the 242-A PC-5000 Transfer Pipeline*, Section 1.4.4, *Operating Parameters*

[w] C-018H-P2, Rev. 1, *Procurement Specification for Fiberglass Epoxy Resin Double Containment Piping System and Associated Engineering Services for 242-A Evaporator and PUREX Condensate Effluent Treatment Facility*

[x] WHC-SD-WM-DP-019, Rev. 0, *Data Package for 242-A Evaporator/Crystallizer Tank System Integrity Report* Section 6, *Analysis*

[y] WHC-SD-WM-DP-019, Rev. 0, *Data Package for 242-A Evaporator/Crystallizer Tank System Integrity Report* Section 7.1, *Operating Parameter Calculations and References*

[z] WHC-SD-WM-ER-112, Rev. 0, *Integrity Assessment Report for 242-A Evaporator/LERF Waste Transfer Piping*

Table 7-2. Pipe Material Applications (2 pages)
(Source: RPP-PLAN-32530, Rev. 1, Table 4.2)

242-A Pipe Code Designator	Material	Drawing Reference	System Application	Maximum Operating Press	Maximum Operating Temp	Notes
M-1	ASTM A53 Type E or S, Gr. B, or ASTM A106, Gr. B	H-2-830281, Sheet 1, Rev. 0	• Steam • High pressure steam condensate	• 225 psig • 420 psig	• 450ºF • 420ºF	Refer to H-2-830281 Sheets 60 – 63 for valve specifications.
M-2	ASTM A53 Type E or S, Gr. B, or ASTM A106, Gr. B	H-2-830281, Sheet 2, Rev. 0	• Steam • Steam condensate	• 125 psig • 125 psig	• 353ºF • 353ºF	
M-5	ASTM A53 Type E or S, or ASTM A106, Gr. B galvanized or plain	H-2-830281, Sheet 5, Rev. 0	• Equipment drains • Filtered Raw Water • Raw Water	• 150 psig • 150 psig • 150 psig	• 120ºF • 120ºF • 120ºF	
M-9	ASTM A312 – TP304L	H-2-830281, Sheet 9, Rev. 0	• Non-process waste and/or non-radioactive general service • Chemical sewer	• 100 psig • Ambient	• 160ºF • 160ºF	
M-21	ASTM A312 – TP304L	H-2-830281, Sheet 21, Rev. 0	• Process waste and/or radioactive general service	• 150 psig	• 370ºF	
M-24	ASTM 53 Type E or S Gr. B, or ASTM A106 Gr. B	H-2-830281, Sheet 24, Rev. 0	• Open funnel and floor drains	• 20 psig	• 200ºF	
M-25	ASTM A53 Type E or S, Gr. B, or ASTM A106, Gr. B	H-2-830281, Sheet 25, Rev. 0	• Insulated drains	• 120 psig	• 340ºF	
M-27	ASTM A312 – TP304L seamless	H-2-830281, Sheet 27, Rev. 0	• Open funnel and floor drains • Process drain (Drop-out)	• 20 psig • 120 psig	• 200ºF • 330ºF	

Table 7-2. Pipe Material Applications (2 pages)
(Source: RPP-PLAN-32530, Rev. 1, Table 4.2)

242-A Pipe Code Designator	Material	Drawing Reference	System Application	Maximum Operating Press	Maximum Operating Temp	Notes
M-31	ASTM A269 – TP304L	H-2-830281, Sheet 27, Rev. 0	• General process steam / condensate / cooling water • Sampling, vacuum, vent sump/drain	• 90 psig • Ambient	• 275ºF • 275ºF	
M-42	ASTM A53 Type E or S, or ASTM A106, Gr. B galvanized or plain	H-2-830281, Sheet 42, Rev. 0	• Equipment Drains • Filtered Raw Water • Raw Water • Process Condensate	• 150 psig • 150 psig • 150 psig • 150 psig	• 120ºF • 120ºF • 120ºF • 120ºF	

8.0 INTEGRITY ASSESSMENT ACTIVITIES

The IQRPE will assess the 242-A Evaporator system integrity by evaluating the information gathered to meet the requirements identified in Section 2.0. The compliance matrix in Appendix C is used to confirm that the requirements in Section 2.0 have been met. The matrix will be revised as the integrity assessment proceeds to reference applicable documents and then be included as an appendix to the 2017 IAR. The matrix will ultimately provide a summary assessment of compliance, including cross-reference to the integrity assessment evaluations, analyses and reviews that demonstrate the requirements have been met.

Additional information supporting key elements of the integrity assessment is provided in this section.

8.1 STRUCTURAL EVALUATIONS AND LOADING CONDITIONS

The integrity assessment will review the processes used for structural evaluations, including determination of credible loading conditions. A thorough description of the materials used in construction, construction methods employed, quality control, and testing performed on materials and the final structure prior to being placed in service will be provided. The evaluation will also review the engineering codes referenced for construction and in design to the extent that these have not been completed during previous integrity assessments, in order to determine the existing design margin and fitness-for-use of each structure. Where archived codes are not available, current equivalent codes can be used.

Applicable portions of these codes and standards are the primary means of evaluating continuing fitness-for-use as applied to each case. Comparison of these present day standards with the standards in effect at the time of construction will be evaluated by the IQRPE for any impacts to structural integrity.

In addition to documenting codes and standards used in the original design, the following regulations, codes, and standards will be considered in evaluating the adequacy of the 242-A Evaporator system for treatment of dangerous waste:

Washington State Regulations

- WAC 173-303-040, *Definitions*.
- WAC 173-303-400, *Interim Status Facility Standards.*
- WAC 173-303-640, *Dangerous Waste Regulations, Tank Systems.*
- WAC 173-303-810, *Dangerous Waste Regulations, General Permit Conditions*.

Hanford/DOE Orders

- DOE O 435.1, Radioactive Waste Management.

National Codes and Standards

- ACI 318, Building Code Requirements for Structural Concrete.
- ACI 349, Code Requirements for Nuclear Safety-Related Concrete Structures.
- API 579-1/ASME FFS-1, Fitness for Service.
- ASCE 7, Minimum Design Loads for Buildings and Other Structures.
- ASME, Boiler and Pressure Vessel Code, Section III, Rules for Construction of Nuclear Power Plant Components.
- ASME B31.1, Power Piping.
- ASME B31.3, Process Piping.

DOE-STD-1020, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, identifies requirements applicable to systems, structures and components (SSCs) based on life-safety or safety classification established by safety analysis. The 242-A Evaporator facility is a safety significant Performance Category-2 (PC-2) facility. The Natural Phenomena Hazards (NPH) requirements of DOE-STD-1020 are implemented through TFC-ENG-STD-06, *Design Loads for Tank Farm Facilities*. The integrity assessment will review prior analyses of the effects of wind, seismic, snow, and ashfall loading on the 242-A structural integrity.

The 242-A Evaporator building is a reinforced concrete structure that contains Areas 1 and 2 (refer to drawings H-2-69269 and H-2-69272). Area 1 contains the evaporator and condenser rooms. Area 1 measures approximately 50-ft 10-in. by 29-ft 0-in. and is approximately 61-ft 6-in high. Area 2 contains the pump room and loadout and hot equipment storage rooms.[6] Area 2 measures approximately 50-ft 10-in. by 45-ft 10-in. and is approximately 36-ft 6-in. high. The floor of the evaporator and condenser rooms and a portion of the pump room extend to ~10-ft 0-in. below grade. An administration building which contained the original control room shares the east wall of the main Evaporator building, but is structurally isolated from it.

The 242-A Evaporator building is identical to the 242-S Evaporator building located in 200-West Area of the Hanford site. In 1972, John A. Blume and Associates performed seismic analysis of the 242-S Evaporator Building. The analysis is documented in JABE-VITRO-03, *Earthquake Analysis of the Evaporator Facilities Building 242-S Hanford Atomic Energy Reservation*. A follow-up review was performed by Blume to confirm that the 242-S analysis was applicable to the 242-A Evaporator system. This was documented in ARH-R-171, *Evaporator Building 242-A at Hanford, Washington, Phase I Review*. An seismic evaluation of the 242-A Evaporator building was performed in 1992 by Westinghouse Hanford Company, WHC-SD-WM-ER-102, *242-A Evaporator Seismic Design Basis Evaluation*. The assessment compared the design basis

[6] Areas 1 and 2 are illustrated in Sketches A1 – A9, RHO-R-24 / JABE-VITRO-03, *Earthquake Analysis of the Evaporator Facilities Building 242-S Hanford Atomic Energy Reservation*, 1972, John A. Blume Associates, and Engineers, San Francisco, California.

earthquake (DBE) [which in this case was the safe-shutdown earthquake (SSE), used in the ARH-R-171 analysis] to the then current DBE for Safety Class 2 Moderate Hazard Facility Use Category structures. The current direction for PC-2 SSCs is documented in DOE-STD-1020 and flowed down through TFC-ENG-STD-06. The State of Washington has adopted IBC 2009, *International Building Code*, also reflected in TFC-ENG-STD-06. In accordance with the IBC 2009, ASCE 7-05, *Minimum Design Loads for Buildings and Other Structures*, is used to determine applicable loading associated with snow, wind, and seismic NPH.

A summary of the classification and associated wind and seismic NPH are provided in Table 8-1. The 242-A Evaporator System was re-evaluated for applicable NPH associated with a PC-2 classification in RPP-RPT-52517, *242-A Evaporator Facility Assessment for Performance Category 2 Natural Phenomena Hazards* in 2013. The assessment concluded:

> "It has been shown that the current PC-2 loads resulting from applied NPH are generally lower than loads considered in the original design or analyzed in a previous integrity assessment. The roof structures for the 242-A and 242-AB buildings were further analyzed for applicability of snow drift. The roofing systems of the reinforced concrete 242-A Evaporator building were found to be adequately designed to withstand additional loading associated with snow drift. The C-A-1 Evaporator Vessel is adequate for PC-2 seismic loading and is adequately supported by the upper and lower support framing. It is also determined that the emergency dump line (SN-269) and normal drain line (DR-335) will not be damaged to prevent flow during a PC-2 seismic event."

Table 8-1. 242-A Evaporator Building NPH History
(Source: RPP-RPT-52517, Rev. 0, Table 2)

Timeframe	Classification	Design Load Standard	Seismic		Wind	
			Operating Basis Earthquake	Design Basis Earthquake	Wind Speed	Tornado Missile
Original – At the time of construction	Quality Assurance Level 1 Structure per ARH-2929	SDC 4.1, Rev. 6	0.125g response spectrum (2% damping)	0.25g response spectrum (5% damping)	Unknown	Unknown
1992 – Update to Safety Analysis Report	Category 1 Structure – Nonreactor Facility	SDC 4.1, Rev. 9	N/A	N/A	Total Horizontal Tornado Wind Velocity of 120 mph[a]	Yes
	Safety Class 2 Moderate Hazard	SDC 4.1, Rev. 11	N/A	0.12g response spectrum (5% damping)[b]	Fastest Wind speed of 80 mph. Importance Factor, I = 1.0. Exposure Category C	N/A
2012 – Update to Documented Safety Analysis	Performance Category 2 (PC-2)	TFC-ENG-STD-06 Rev. C-6	N/A	IBC Response Spectrum (5% damping) with: Horizontal SDS = 0.588g SD1 = 0.192 Vertical SDS = 0.346 SD1 = 0.098 Importance Factor = 1.5	3-second Gust Wind Velocity, V = 91 mph. Importance Factor, I = 1.0 Exposure Category C	N/A

Table Notes and References:
The 1992 integrity assessment evaluated the building for a total horizontal tornado wind velocity of 120 mph from SDC 4.1, Rev. 9
The 1992 integrity assessment compared a 5% damped spectra for Safety Class 2 Moderate Hazard to the 5% damped spectra for the original DBE

Additional structural analyses have been performed to support 242-A Evaporator modifications since the 2007 integrity assessment. Most are not associated with the primary or secondary containment boundaries, but do have implications for Two over One system interaction effects [DOE-STD-1021-93, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*, Section 2.5, *System Interaction Effects ("Two Over One Protection")*].

If a seismic event occurs, the C-A-1 Vessel Seismic Dump System is used to drain waste from the C-A-1 vapor-liquid separator back to tank AW-102 by opening 3-in. valve HV-CA1-1 in the 242-A Evaporator pump room and stopping feed pump 241-AW-P-102-1 in the 241-AW-02E pit. The seismic dump system can drain C-A-1 to a ~2,700 gallon heel in several hours. It also stops steam to the E-A-1 reboiler by closing steam valve HV-EA1-5 and stops recirculation pump P-B-1. The C-A-1 Vessel Seismic Dump System is actuated manually using a seismically-qualified emergency stop button HS-CA1-1.

Draining the C-A-1 vapor-liquid separator after a seismic event prevents a flammable gas accident in the vapor-liquid separator if the temperature of the C-A-1 contents cannot be stabilized by stopping steam to the E-A-1 reboiler and stopping recirculation pump P-B-1. Preventing waste from overfilling the C-A-1 vapor-liquid separator by stopping feed pump 241-AW-P-102-1 and opening feed valve HV-CA1-1 also prevents the waste from overflowing into the process condensate system preventing a flammable gas accident and creating a direct radiation hazard in process condensate tank TK-C-100.

The [D to 13A] jumper is part of the C-A-1 Vessel Seismic Dump System return route needed to empty the vessel to tank AW-102 after a seismic event. Seismically-qualified valve HV-CA1-1 is mounted on the jumper. However, the valve operator had not been seismically-qualified, and was replaced with a seismically-qualified one. At the same time two airflow controllers were added to the actuator port in order to increase the valve actuation times before the jumper was installed in the pump room (refer to ECN-12-001281, Rev. 0, *HV-CA1-1 Valve Assembly Seismic Qualification Modification*; ECN-13-001070, Rev. 0, *Jumper D to 13A; As-Built and FCN Incorporation*). The change was evaluated for overpressure transients, and the closure time found to be acceptable (RPP-CALC-48695, Rev. 3, *Jumper Assembly D-13A Calculation Package*). However the jumper could not be installed into position because of a physical interference between the controllers and adjacent equipment. The operator was re-oriented 180° and remounted. Information from the vendor indicated that the reorientation would not affect the operator's seismic qualification or operation (refer to Work Order TFC-WO-13-4964, *242A Rotate Valve Actuator on D-13A*).

Table 8-2. 242-A Equipment Post-2007 Structural Analysis (2 pages)

Doc. No.	Title	Release Date
RPP-CALC-32229, Rev. 1	*242-A HVAC Upgrades – Control Rack Supports*	2008
RPP-CALC-32230, Rev. 0	*242-A HVAC Upgrades – Cooling Coil and Ductwork Supports*	2007
RPP-CALC-32231, Rev. 0	*242-HVAC Upgrades – Chiller Anchorage, Tank Anchorage and Exterior Pipe Supports*	2007
RPP-CALC-32232, Rev. 0	*242-A HVAC Upgrades – Interior Pipe Supports*	2007
RPP-CALC-36792, Rev. 1	*242-A K1 Duct and Support Structural Analysis*	2011
RPP-CALC-38196, Rev. 0	*242-A Exterior Electrical Conduit Support Adequacy Analysis*	2008
RPP-CALC-38309, Rev. 0	*Pipe Support Design of 2" U-852 Raw Water Line at 242-A Evaporator Facility*	2008
RPP-CALC-41989, Rev. 0	*Evaluation of Foot Bridge Anchor System, 242-A Evaporator*	2012
RPP-CALC-44877, Rev. 0	*Evaluation of 242-A Ductwork Replacement and Asbestos Abatement Design*	2010
RPP-CALC-44879, Rev. 1	*242-A K-1 HVAC Concrete Pad Analysis*	2011
RPP-CALC-45658, Rev. 1	*242-A K-1 Evaporator Exhaust System Support Structure and Anchorage Analysis*	2010
RPP-CALC-45659, Rev. 1	*242-A Stack Platform Structure Analysis*	2010
RPP-CALC-45782, Rev. 1	*242-A Evaporator K-1 Anchorage Analysis*	2011
RPP-CALC-45783, Rev. 2	*242-A Evaporator K-1 Embedded Plate and Headed Anchor Analysis*	2011
RPP-CALC-46539, Rev. 0	*242-A K1 Exhauster Power Distribution Racks Structural Analysis*	2011
RPP-CALC-49324, Rev. 0	*242-A Evaporator Flush Manifold Pipe Support Analysis*	2011
RPP-CALC-51243, Rev. 0A	*242-A Reboiler Condensate System B31.1 Piping Analysis*	2012
RPP-CALC-54143, Rev. 1	*242-A Steam Isolation Valve Replacement Stress Analysis*	2015
RPP-CALC-54399, Rev. 0	*Structural Analysis for Fall Protection Anchorage in the 242-A Condenser Room*	2013
RPP-CALC-54774, Rev. 0	*242-A Drain Line Pipe and Support Analysis*	2013
RPP-CALC-56651, Rev. 1	*P-B-2 Pump Skid Piping Calculation*	2015
RPP-CALC-56791, Rev. 0	*P-B-2 Pump Skid Structural Analysis*	2014
RPP-CALC-57330, Rev. 0	*Structural Analysis for VFD and Load Reactor Enclosures in 242-A*	2015

Table 8-2. 242-A Equipment Post-2007 Structural Analysis (2 pages)

Doc. No.	Title	Release Date
RPP-CALC-57727, Rev. 0	*Analysis of the Pipe Support Concrete Footings for the 242-A Steam Line*	2014
RPP-CALC-60374, Rev. 0	*242-A Auxiliary Hoist Bracket Design*	2012
RPP-RPT-52517, Rev. 0	*242-A Evaporator Facility Assessment for Performance Category 2 Natural Phenomena Hazards*	2013
RPP-RPT-53035, Rev. 0	*242-A Evaporator C-A-1 Vessel Seismic Dump System – Functions and Requirements Evaluation*	2015

8.2 CORROSION PREVENTION AND AGING EVALUATIONS

The 242-A Evaporator corrosion prevention operating envelope is defined by a combination of several State of Washington permits, as well as the technical bases for operation. The characteristics of the dangerous waste treated at the 242-A Evaporator receive most emphasis with respect to corrosion protection of the primary and secondary containment boundaries. Process steam, raw water, and process condensate are also in contact with the boundaries and therefore can contribute to corrosion. In some cases the corrosion prevention envelopes of the utility streams used by the facility are defined by acceptance criteria at downstream facilities accepting the discharged effluents from the 242-A Evaporator. Thus, several permits, as well as multiple facilities' acceptance limits jointly establish the 242-A Evaporator's corrosion prevention operating envelope. This complex interaction is illustrated by Figure 8-1.

The IQRPE will assess the 242-A Evaporator System for leak integrity and the viability of existing corrosion prevention measures by examining the liquid dangerous waste characteristics of the wastes that have been and will be handled (WAC 173-303-640(2)(c)(ii), *Dangerous characteristics of the waste(s) that have been and will be handled*), the existing corrosion prevention measures of the primary and secondary liquid containment barriers (WAC 173-303-640(2)(c)(iii), *Existing corrosion protection measures*); and the steam and raw water in contact with the primary containment and secondary containment boundaries. Assessment of the corrosion prevention measures will be supplemented by examining a sufficient number of operating records to confirm that the activities necessary to ensure conformance with the corrosion prevention requirements are routinely and effectively being performed. Figure 8-1 graphically illustrates the requirements and activities.

The 242-A Evaporator corrosion prevention envelope is defined by the intersection of requirements stated in the following State of Washington operating permits:

- WA7890008967, Rev. 9, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Part III, *Double Shell Tank System & 204-AR Operating Unit Group 12*, Addendum B, *Waste Analysis Plan*.
- WA7890008967, Rev. 9, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Part III, *242-A Evaporator Operating Unit Group 4,* Addendum B, *Waste Analysis Plan*.
- WA7890008967, Rev. 9, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Part III, *LERF and ETF Operating Unit Group 3*, Chapter 3.0, *Waste Analysis Plan*, Section III.3.C, *Waste Analysis*, Part III.3.C.1 and Addendum B, *Waste Analysis Plan*.
- State of Washington Waste Water Discharge Permit No. ST0004502 [Steam condensate and Raw Water discharged to the Treated Effluent Disposal Facility].
- State of Washington Waste Water Discharge Permit No. ST 4500 [ETF treated 242-A Evaporator process condensate discharge to the State-Approved Land Disposal Site, Section S1]

Additionally, the 242-A Evaporator corrosion prevention envelope must meet technical requirements of the following:

- OSD-T-151-00007, *Operating Specifications for the Double-Shell Storage Tanks*.

  The 242-A Evaporator System dangerous waste dilute aqueous feed and the concentrated slurry product are stored in the DSTs. The 242-A Evaporator feed and slurry envelopes are subject to the DST waste storage composition limits for hydroxide (OH^-), nitrate (NO_3^-) and nitrite (NO_2^-) of Operating Specification OSD-T-151-00007. In the event that the DST waste composition limits are not met, the nitrite, nitrate, or hydroxide concentrations must be re-established within the limits within 30 days and verified by sample analysis that the waste chemistry is within the established limits within 90 days; alternatively Engineering must complete an recovery action plan to restore the nitrite, nitrate, or hydroxide concentrations within established limits in accordance with the approved plan.

  The DSTs are constructed of A515, A516, and A537 carbon steel, the interconnecting pipelines of ASTM A53 Type S Grade B or ASTM A-106 carbon steel and since 1986, ASTM A312 Type 304L stainless steel, and most jumpers of ASTM A312 Type 304L stainless steel. Integrity assessment report RPP-RPT-58441, examined the DST waste envelope and concluded that, “Waste and the acceptance criteria for adding waste in the DSTs and the ancillary equipment are compatible with the

materials of construction of the DSTs and ancillary equipment" (RPP-RPT-58411, page 141). Wall thinning evaluations performed on tank farm carbon steel pipelines and stainless steel jumpers demonstrated a very low rate estimated at -0.2 mils/year (RPP-RPT-52791, *Tank Farm Waste Transfer System Fitness-for-Service Erosion and Corrosion Basis*). Similar wall thinning evaluations completed on DST carbon steel primary tanks in contact with the waste show that no detectable wall thinning has occurred during the eight to ten year interval between consecutive ultrasonic wall thickness evaluations on any of the tanks.

- OSD T-151-000012, *Operating Specifications for the 242-A Evaporator*.

  The equipment and piping materials used for the 242-A Evaporator System primary containment boundary are listed in Tables 7-1 and 7-2. They are carbon steel and stainless steel alloys identical with or similar to the DST System alloys. Ultrasonic wall thickness inspections of primary containment boundary components completed in 1993, 1996, and 2007 generally confirm similar corrosion resistance to the waste, with corrosion rates of -$\leq$1 mil/year. The 2007 integrity assessment stated, "The materials of construction, system design, and protective coatings for the 242-A Evaporator unit provide adequate corrosion protection and compatibility with the wastes processed and generated by the unit." (RPP-RPT-33306, pages 98, and 101). OSD-T-151-00012 requires a waste nitrate to chloride ratio (NO_3^-:Cl^-) of $\geq$ 2, and slurry pH $\geq$ 13. The 2016 inspection results, which are expected to be similar to past results, were not available at the time this plan was prepared.

- HNF-3172, *Liquid Waste Processing Facilities Waste Acceptance Criteria*.

  HNF-3172, *Liquid Waste Processing Facilities Waste Acceptance Criteria*, requires the sum of the fractions for individual organic chemistry compounds within organic chemical families be $\leq$ 1 in the process condensate accepted at LERF (Table E-1). Process condensate with a separable organic layer is not acceptable (page 11)

In the 242-A Evaporator system dilute waste feed, concentrated slurry product, process steam condensate, process condensate, and used raw water are continuously in contact with the primary containment boundary during operation. In addition to the corrosion prevention envelopes described above, minimum sampling frequencies are identified in RPP-16922, Rev. 30, *Environmental Specification Requirement*.

Table 8-3. Sampling and Analysis Requirements for 242-A Evaporator System Operation

Stream	Sampling Frequency	Acceptance Envelope
Dilute Waste Feed	• Candidate waste feed • Each campaign batch per	Accepted as 242-A Evaporator System feed per HNF-SD-WM-DQO-014[a]
Concentrated Slurry Product	Not required for return to DST per RPP-29002[b], Section 3.8	RPP-RPT-58179[c], potential E-A-1 cracking
Used Raw Water	• 1/campaign (maximum 2/year) • Stream monitored for pH, conductivity and flow by RC-2 monitoring and diversion system per HNF-SD-W049H-ICD-001[d], Table 2 and RPP-16922[e]	Accepted at 200 Area TEDF per HNF-SD-W-049H-ICD-001, Table 2, Table 3 and Table 4, Expanded analysis
Process Steam Condensate	• 1/campaign (maximum 2/year) • Stream monitored for pH, conductivity and flow by RC-1 monitoring and diversion system per HNF-SD-W049H-ICD-001, Table 2.	Accepted at 200 Area TEDF disposal per HNF-SD-W049H-ICD-001, Table 3 and Table 4, Expanded analysis
Process Condensate	N+1 samples required where N = number of source DSTs in feed batch make up per 242-A Waste Analysis Plan, WA7890008967[f]	Accepted at LERF per HNF-3172[g], HNF-3395[h], and HNF-SD-WM-DQO-014 for subsequent treatment at ETF and disposal at SALDS

Table Notes and References:

[a] HNF-SD-WM-DQO-014, Rev. 7, *242-A Evaporator Data Quality Objectives*

[b] RPP-29002, Rev. 1, *Double Shell Tank Waste Analysis Plan*, Section 3.8, *Sampling Process for Dangerous Waste Generated from Treatment*

[c] RPP-RPT-58179, Rev. 0, *Evaluation of Halide Stress Corrosion Cracking and Pitting in the 242-A E-A-1 Reboiler as It Relates to Operating Parameters and Tank Waste Chemistry*

[d] HNF-SD-W049H-ICD-001, Rev. 11, *200 Area Treated Effluent Disposal Facility Interface Control Document*, Table 2, *Generating Facilities Continuous Online Monitoring Requirements;* Table 3, *200 Area Treated Effluent Facility Generating Facilities Sampling and Analytical Requirements*; Table 4, *Minimum Generating Facilities Sampling Requirements*

[e] RPP-16922, Rev. 30, *Environmental Specification Requirements*

[f] WA 7890008967 , Rev. 8c, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Part III, *242-A Evaporator Operating Unit Group 4*, Chapter 3.0, *Waste Analysis Plan*

[g] HNF-3172, Rev. 8, *Liquid Waste Processing Facilities Waste Acceptance Criteria*

[h] HNF-3395, Rev. 6, *Interface Control Document between the 242-A Evaporator Facility and the Liquid Effluent Retention Facility*

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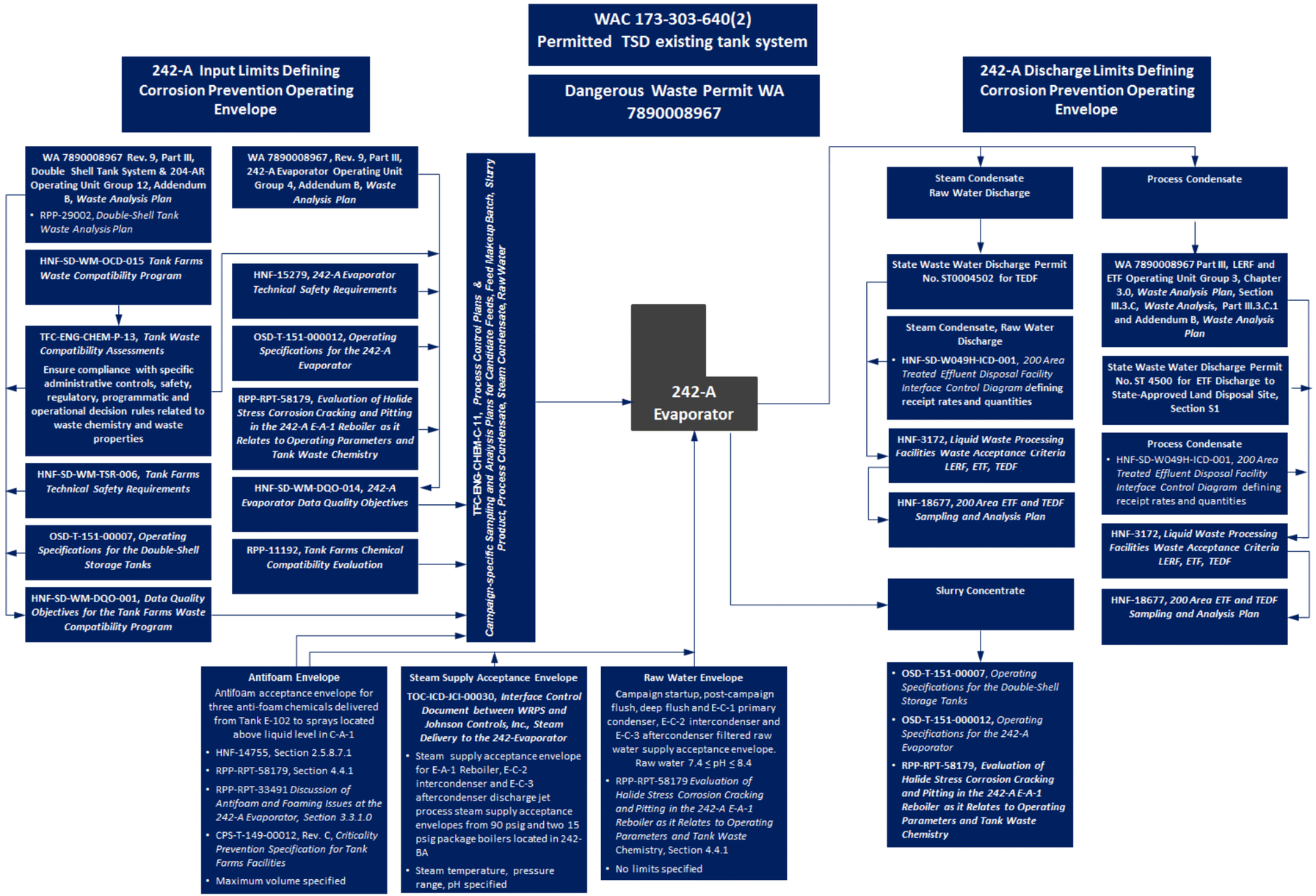

Figure 8-1. 242-A Evaporator Corrosion Prevention Operating Envelope

Dilute feed, slurry concentrate, process condensate, steam condensate, and used raw water sample data for each 242-A Evaporator campaign are issued in feed and product sample reports and campaign post-run reports. During evaporator campaigns these streams are in contact with the 242-A Evaporator system's primary containment boundary, and in the event of primary containment leakage or purposeful drainage, in contact with the secondary containment boundary as well. Analytes with known stainless steel and/or carbon steel corrosion propensities are present in these streams, including chloride (Cl^-), nitrite (NO_2^-), nitrate (NO_3^-), hydroxyl (OH^-), and sulfate (SO_4^{2-}) anions and pH, and corrosion-sensitive analyte ratios, $[NO_3^-]/[Cl^-]$, $[NO3^-]/[OH^-+NO_2^-]$, and in the process condensate, steam condensate and raw water effluent streams with low NO_3^- concentrations the additional analyte ratios, $[Cl^-]/[NO_2^-]$ and $[SO_4^{2-}]/[NO_2^-]$.

At sufficiently low NO_3^- ion concentrations, it has been previously observed that other aggressive anions besides NO_3^- (*e.g.*, Cl^- and SO_4^{2-}) control the corrosion reaction and therefore the minimum level of NO_2^- ion needed to inhibit corrosion was greater than predicted solely by the NO_3^- concentration. The minimum NO_2^- ion concentration was set above the amount that would be required to inhibit the other aggressive ions and the nitrate ion.

Pitting corrosion studies have determined that the chloride ion (Cl^-) becomes the controlling corrosive ion if its concentration is greater than 3 percent of the nitrate ion concentration, while sulfate (SO_4^{2-}) becomes controlling if its concentration is greater than 30 percent of the nitrate concentration (WSRC-TR-94-0250, *Recommended Nitrite Limits for Chloride and Sulfate in ESP Slurries*).

Equation 8.2-1 and Equation 8.2-2 were developed for these situations.

If the chloride ratio is exceeded, the following equation is used to determine the minimum nitrite concentration $[NO_2^-]$ needed at 40°C and pH 10 to be protective.

$$\log [NO_2^-] = 2.25 + 1.34 * \log [Cl^-] \qquad \text{Equation 8.2-1}$$

If the sulfate ratio is exceeded, the following equation is used to determine the minimum nitrite concentration needed at 40°C and pH 10 to be protective.

$$\log [NO_2^-] = 0.0675 + 0.835 * \log [SO_4^{2-}] \qquad \text{Equation 8.2-2}$$

Preemptive corrosion protection measures ensure their concentrations are within corrosion prevention envelopes, thereby sustaining leak integrity of the containment boundaries. Table 8-4 through **Error! Reference source not found.**Table 8-7 identify the sample and campaign post-run reports for evaporator campaigns completed after the 2007 IAR, and the availability of corrosive species' sample data in the reports. The integrity assessment will review the sample data from each of these streams and determine the likely corrosion influence each is having on the materials in contact with them, with reference to structural and leak integrity, and service life. The effects of factors such as flushing and layup practices, frequency and duration of evaporator campaigns, addition of corrosion-inhibiting steam additives, and ambient layup conditions between evaporator campaigns will be considered.

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Table 8-4. Post-2007 IAR Campaigns Slurry Concentrate Sample Data (2 pages)

Doc. No.	Title	Presence of Sample Analytes with Corrosion Envelope Limits					
		Cl^- (µg/mL)	SO_4^{2-} (µg/mL)	NO_2^- (µg/mL)	NO_3^- (µg/mL)	OH^- (µg/mL)	pH
Campaign EC-05 (Report to be issued)	*242-A Evaporator Campaign EC-05 Post-Run Report*						
	[Single Pass AW-102 Heel + Second Transfer from AP-104 {241-C Retrieved Waste} – Slurry to AP-104]						
Campaign EC-04 (Report to be issued)	*242-A Evaporator Campaign EC-04 Post-Run Report*						
	[Single Pass AW-102 Heel + First Transfer from AP-104 {241-C Retrieved Waste} – Slurry to AP-103]						
Campaign EC-03 (Report to be issued)	*242-A Evaporator Campaign EC-03 Post-Run Report* [Single Pass AW-102 – AY-101 + AP-103 Blend via AZ-102]						
RPP-RPT-59017, Rev. 0	*Final Report for 242-A Evaporator Slurry Samples in Support of Campaign EC-03*						
	Sample SLY-EC03-01	3.98E+0	6.28E+03	7.40E+04	1.57E+05	1.93E+04	>13
	Sample SLY-EC03-02	4.12E+03	6.51E+03	7.60E+04	1.61E+05	1.84E+04	>13
Campaign EC-02 (Report to be issued)	*242-A Evaporator Campaign EC-02 Post-Run Report* [Single Pass AW-102 – AZ-102 Blend]						
RPP-RPT-58875, Rev. 0	*Final Report for 242-A Evaporator Slurry Samples in Support of Campaign EC-02*						
	Sample SLY-EC02-1	3.25E+03	1.20E+04	8.07E+04	1.72E+05	1.92E+04	>13
	Sample SLY-EC02-2	2.93E+03	1.08E+04	7.15E+04	1.55E+05	1.94E+04	>13

Table 8-4. Post-2007 IAR Campaigns Slurry Concentrate Sample Data (2 pages)

Doc. No.	Title	Presence of Sample Analytes with Corrosion Envelope Limits					
		Cl^- (µg/mL)	SO_4^{2-} (µg/mL)	NO_2^- (µg/mL)	NO_3^- (µg/mL)	OH^- (µg/mL)	pH
Campaign EC-01 (Report to be issued)	*242-A Evaporator Campaign EC-01 Post-Run Report* [Single Pass AW-102]						
RPP-RPT-58762, Rev. 0	*Final Analytical Report for 242-A Evaporator Slurry Samples in Support of Campaign EC-01*						
	Sample SLY-EC01-1 [Single Pass AW-102]	4.00E+03	4.74E+03	8.24E+04	1.92E+05	2.19E+04	12.8
	Sample SLY-EC01-2 [Same date as SLY-EC01-1]	3.98E+04	5.59E+03	8.31E+04	1.93E+05	2.18E+04	13.0
Campaign 13-01 RPP-RPT-58561, Rev. 0	*242-A Evaporator Campaign 13-01 Post-Run Report* [Two Pass AW-102]						
RPP-RPT-58385, Rev. 0	*Final Report for 242-A Evaporator Slurry Samples in Support of Campaign 13-01*						
	Sample SLY-1301-1 [Second Pass AW-102]	3.14E+03	1.50E+04	7.18E+04	2.48E+05	1.73E+04	13.0
	Sample SLY-1301-2 [Same date as SLY-1301-1]	3.33E+03	1.60E+04	7.70E+04	2.67E+05	1.75E+04	12.9
Campaign 10/01/10-02 RPP-RPT-48755, Rev. 0	*242-A Evaporator Campaign 10-01/10-02 Post-Run Report* [10-01/10-02 – Two Pass AW-102]						
RPP-RPT-47980, Rev. 0	*Final Report for Evaporator Process Grab Samples in Support of Evaporator Campaign 10-01/10-02*						
	Sample SLY-1001-2	3.87E+03	1.21E+04	6.67E+04	2.35E+05	1.6E+04	>13
	Sample SLY-1001-3	3.30E+03	1.15E+04	5.75E+04	2.09E+05	1.6E+04	>13
Campaign 09-01/09-02 RPP-RPT-41939, Rev. 0	*242-A Evaporator Campaign 09-01/09-02 Post-Run Report* [Single Pass AW-102 + AW-102 – AP-101 Blend]						
RPP-RPT-42077, Rev. 0	*Final Report for Evaporator Process Grab Samples in Support of Evaporator Campaign 09-01/09-02*						
	Sample SLY-0901-1 [AW-102]	2.55E+03	5.12E+03	4.01E+04	2.66E+05	2.89E+04	>13
	Sample SLY-0901-5 [Second AW-102 – AP-101 Blend]	2.96E+03	5.45E+03	4.64E+04	2.69E+05	3.09E+04	>13

Table 8-4. Post-2007 IAR Campaigns Slurry Concentrate Sample Data (2 pages)

Doc. No.	Title	Presence of Sample Analytes with Corrosion Envelope Limits					
		Cl^- (µg/mL)	SO_4^{2-} (µg/mL)	NO_2^- (µg/mL)	NO_3^- (µg/mL)	OH^- (µg/mL)	pH
Campaign 07-01/07-02 RPP-RPT-37727, Rev. 0	*242-A Evaporator Campaign 07-01/07-02 Post-Run Report* [06-01 {07-01/07-02} – Single Pass as AW-102 feed and slurry receiver, then AW-102 – AP-104 Blend]						
20070744/751	*Final Report for Evaporator Process Grab Samples in Support of Evaporator Campaign 07-01/07-02*						
	Sample SLY-0701-4 [First AW-102 – AP-104 Blend]	§	§	9.35E+04	1.36E+05	2.67E+04	13.4
	Sample SLY-0701-6 [Second AW-102 – AP-104 Blend]	§	§	9.75E+04	1.49E+05	3.23E+04	13.4

Table Notes and References:

§ Analyte not analyzed for.

Table 8-5. Post-2007 IAR Campaigns Process Condensate Sample Data (3 pages)

Doc. No.	Title / Sample[1]	Sample Analytes with Corrosion Envelope Limits[2]					
		Cl^- (µg/mL)	SO_4^{2-} (µg/mL)	NO_2^- (µg/mL)	NO_3^- (µg/mL)	OH^- (µg/mL)	pH
Campaign EC-06 RPP-PLAN-57535, Rev. 3	*Sampling and Analysis Plan for 242-A Evaporator Process Condensate* [EC-06 – Single Pass AW-102 – AP-104 Blend]						
HEIS data	Sample PCEC06-01 – AW-102						
HEIS data	Sample PCEC06-02 – AW-102						
Campaign EC-05 RPP-PLAN-57535, Rev. 3	*Sampling and Analysis Plan for 242-A Evaporator Process Condensate* [EC-05 – Single Pass AW-102 Heel + Second Transfer from AP-104 {241-C Retrieved Waste} – Slurry to AP-104]	No Campaign EC-05 process condensate samples taken					
Campaign EC-04 RPP-PLAN-57535, Rev. 3	*Sampling and Analysis Plan for 242-A Evaporator Process Condensate* [EC-04 – Single Pass AW-102 Heel + First Transfer from AP-104 {241-C Retrieved Waste} – Slurry to AP-103]						
HEIS data	Sample PCEC04-01 – [AW-102 Heel – AP-104 First Transfer]						
HEIS data	Sample PCEC04-02 – AW-102						
Campaign EC-03 RPP-PLAN-57535, Rev. 2	*Sampling and Analysis Plan for 242-A Evaporator Process Condensate* [EC-03 – Single Pass AY-101 + AP-103 Blend via AZ-102]						
HEIS data	Sample PCEC03-01 – AW-102	8.2E-02	§§	§§	§§	§	10.2
HEIS data	Sample PCEC03-02 – AW-102	7.81E-02	§§	§§	§§	§	10.2
HEIS data	Sample PCEC03-03 – AW-102	9.01E-02	§§	§§	§§	§	10.4
Campaign EC-02 RPP-PLAN-57535, Rev. 1	*Sampling and Analysis Plan for 242-A Evaporator Process Condensate* [EC-02 – Single Pass AW-102 – AZ-102 Blend]						

Table 8-5. Post-2007 IAR Campaigns Process Condensate Sample Data (3 pages)

Doc. No.	Title / Sample[1]	Sample Analytes with Corrosion Envelope Limits[2]					
		Cl^- (µg/mL)	SO_4^{2-} (µg/mL)	NO_2^- (µg/mL)	NO_3^- (µg/mL)	OH^- (µg/mL)	pH
HEIS data	Sample PCEC02-01 – AW-102	Process Memo # PM-15-09, *242-A Campaign EC-02 Sampling*, requires two process condensate samples. HEIS database does not have sample results.					
HEIS data	Sample PCEC02-02 – AW-102						
Campaign EC-01 RPP-PLAN-57535, Rev. 1	*Sampling and Analysis Plan for 242-A Evaporator Process Condensate* [EC-01 – Single Pass AW-102]						
HEIS data	Sample PCEC01-01 – AW-102	§§	§§	§§	2.5E+00	§	10
HEIS data	Sample PCEC01-02 – AW-102	8.430E+00	1.26E+01	§§	§§	§	10.4
Campaign 13-01 RPP-PLAN-57535, Rev. 0	*Sampling and Analysis Plan for 242-A Evaporator Process Condensate* [13-01 – Two Pass AW-102]						
HEIS data	Sample PC1301-01 – First Pass AW-102	§§	§§	§§	§§	§	10.2
HEIS data	Sample PC1301-02 – Second Pass AW-102	1.02E-01	1.92E-01	§§	2.08E-01	§	9.7
Campaign 10/01/10-02 RPP-RPT-48755, Rev. 0	*242-A Evaporator Campaign 10-01/10-02 Post-Run Report* [10-01/10-02 – Two Pass AW-102]						
HEIS data	Samples B23N20 – First Pass AW-102 [Campaign 10-01]	§§	§§	§§	4.29E-02	§	9.87
HEIS data	Sample B23N31 – Second Pass AW-102 [Campaign 10-02]	§§	§§	§§	6.15E-02	§	9.54
Campaign 09-01/09-02 RPP-RPT-41939, Rev. 0	*242-A Evaporator Campaign 09-01/09-02 Post-Run Report* [09-01/09-02 – Single Pass AW-102 + AW-102 – AP-101 Blend]						
HEIS data	Sample B1YMN5 – AW-102	§§	§§	§§	§§	§	9.88
HEIS data	Sample B1YMN7 – AW-102 + AP-101 First Transfer	§§	§§	§§	§§	§	10.4
HEIS data	Sample B1YMN9 – AW-102 Heel + AP-101 Second Transfer	§§	§§	§§	§§	§	10.4

Table 8-5. Post-2007 IAR Campaigns Process Condensate Sample Data (3 pages)

Doc. No.	Title / Sample[1]	Sample Analytes with Corrosion Envelope Limits[2]					
		Cl^- (µg/mL)	SO_4^{2-} (µg/mL)	NO_2^- (µg/mL)	NO_3^- (µg/mL)	OH^- (µg/mL)	pH
Campaign 07-01/07-02 RPP-RPT-37727, Rev. 0	*242-A Evaporator Campaign 07-01/07-02 Post-Run Report* [06-01 {07-01/07-02} – Single Pass as AW-102 feed and slurry receiver, then AW-102 – AP-104 Blend]						
HEIS data	Sample B1NP69 – AW-102 Feed and Slurry Receiver	§§	§§	§§	6.2E-02	§	9.77
HEIS data	Sample B1NP71 – AW-102 + AP-104 First Transfer	§§	§§	§§	§§	§	10.3
HEIS data	Sample B1NP73 – AW-102 + AP-104 Second Transfer	§§	§§	§§	§§	§	10.3

Table Notes and References:

[1] Individual samples separated by at least 24 hrs.

[2] Analyte data from Hanford Environmental Information System (HEIS) polled April 26, 2016 and May 5, 2016.

§	Analyte not analyzed for.
§§	Analyte analyzed for and reported as 'below detection threshold," *i.e.*, analyzed for but not detected above limiting criteria.

Table 8-6. Post-2007 IAR Campaigns Steam Condensate Sample Data (3 pages)

Doc. No.	Title		Presence of Sample Analytes with Corrosion Envelope Limits				
		Cl^- (µg/mL)	SO_4^{2-} (µg/mL)	NO_2^- (µg/mL)	NO_3^- (µg/mL)	OH^- (µg/mL)	pH
Campaign EC-06 RPP-PLAN-58022, Rev. 2	*Sampling and Analysis Plan for 242-A Evaporator Cooling Water and Steam Condensate* [EC-06 – Single Pass AW-102 – AP-104 Blend]						
HEIS data	Sample SCEC06-01						
Campaign EC-05 RPP-PLAN-58022, Rev. 2	*Sampling and Analysis Plan for 242-A Evaporator Process Condensate* [EC-05 – Single Pass AW-102 Heel + Second Transfer from AP-104 {241-C Retrieved Waste} – Slurry to AP-104]	No Campaign EC-05 steam condensate samples taken					
Campaign EC-04 RPP-PLAN-58022, Rev. 2	*Sampling and Analysis Plan for 242-A Evaporator Cooling Water and Steam Condensate* [EC-04 – Single Pass AW-102 Heel + First Transfer from AP-104 {241-C Retrieved Waste} – Slurry to AP-103]						
Letter Report	*Re: Evaporator Process Effluent Sample Analysis Work Order: 395355*, Gel Laboratories LLC, May 10, 2016						
	Sample SCEC04-01	4.07E-01	2.28E+00	§§	4.29E-02	§	§
Campaign EC-03	EC-03 – Single Pass AY-101 + AP-103 Blend via AZ-102	No Campaign EC-03 steam condensate samples taken					
Campaign EC-02 RPP-PLAN-58022, Rev. 1	*Sampling and Analysis Plan for 242-A Evaporator Cooling Water and Steam Condensate* [EC-02 – Single Pass AW-102 – AZ-102 Blend]						
HEIS data	Sample SCEC02-01	2.36E-01	2.17E+00	§	1.54E-01	§	§
Campaign EC-01 RPP-PLAN-58022, Rev. 1	*Sampling and Analysis Plan for 242-A Evaporator Cooling Water and Steam Condensate* [EC-01 – Single Pass AW-102]						
HEIS data	Sample SCEC01-01	3.48E-01	2.13E+00	§	2.08E-01	§	§

Table 8-6. Post-2007 IAR Campaigns Steam Condensate Sample Data (3 pages)

Doc. No.	Title		Presence of Sample Analytes with Corrosion Envelope Limits				
		Cl^- (µg/mL)	SO_4^{2-} (µg/mL)	NO_2^- (µg/mL)	NO_3^- (µg/mL)	OH^- (µg/mL)	pH
Campaign 13-01 RPP-PLAN-58022, Rev. 0	*Sampling and Analysis Plan for 242-A Evaporator Cooling Water and Steam Condensate* [13-01 – Two Pass AW-102]						
HEIS data	Sample SC1301-01 – Second Pass AW-102	2.00E-01	1.74E+00	§	2.40E-01	§	§
Campaign 13-CR RPP-RPT-58561, Rev. 0	*242-A Evaporator Campaign 13-01 Post-Run Report* [13-CR]						
HEIS data	Sample B2VF50	1.96E-01	1.86E+00	§§	1.73E-01	§	6.71
Campaign 10-01/10-02 RPP-RPT-48755, Rev. 0	*242-A Evaporator Campaign 10-01/10-02 Post-Run Report* [10-01/10-02 – Two Pass AW-102]						
HEIS data	Sample B25YY0 – Second Pass AW-102	2.70E-01	2.03E+00	§§	1.06E-01	§	§
Campaign 10-CR RPP-RPT-48755, Rev. 0	*242-A Evaporator Campaign 10-01/10-02 Post-Run Report* [10-CR]						
HEIS data	Sample B23N44	3.09E-01	2.41E+00	§§	1.48E-01	§	§
Campaign 09-01/09-02 RPP-RPT-41939, Rev. 0	*242-A Evaporator Campaign 09-01/09-02 Post-Run Report* [09-01/09-02 – Single Pass AW-102 + AW-102 – AP-101 Blend]						
HEIS data	Sample B1YBY4 – Single Pass AW-102	2.93E-01	2.45E+00	§§	1.39E-01	§	§
Campaign 08-CR RPP-RPT-41939, Rev. 0	*242-A Evaporator Campaign 09-01/09-02 Post-Run Report* [08-CR]						
HEIS data	Sample B1W5L9	3.32E-01	2.81E+00	§§	1.51E-01	§	§
Campaign 07-01/07-02 RPP-RPT-37727, Rev. 0	*242-A Evaporator Campaign 07-01/07-02 Post-Run Report* [06-01 – Single Pass as AW-102 feed/ and slurry receiver, then AW-102 – AP-104 Blend]						
HEIS data	Sample B1MW68 – AW-102 feed/ and slurry receiver	1.61E-01	1.46E+00	§§	§§	§	§

Table 8-6. Post-2007 IAR Campaigns Steam Condensate Sample Data (3 pages)

Doc. No.	Title		Presence of Sample Analytes with Corrosion Envelope Limits				
		Cl^- (µg/mL)	SO_4^{2-} (µg/mL)	NO_2^- (µg/mL)	NO_3^- (µg/mL)	OH^- (µg/mL)	pH
Table Notes and References: Analyte data from Hanford Environmental Information System (HEIS) polled April 26, 2016 and May 5, 2016.							
§	Analyte not analyzed for.						
§§	Analyte analyzed for and reported as 'below detection threshold," *i.e.*, analyzed for but not detected above limiting criteria.						

Table 8-7. Post-2007 IAR Campaigns Used Raw Water Sample Data (2 pages)

Doc. No.	Title		Presence of Sample Analytes with Corrosion Envelope Limits				
		Cl^- (µg/mL)	SO_4^{2-} (µg/mL)	NO_2^- (µg/mL)	NO_3^- (µg/mL)	OH^- (µg/mL)	pH
Campaign EC-06 RPP-PLAN-58022, Rev. 2	*Sampling and Analysis Plan for 242-A Evaporator Cooling Water and Steam Condensate* [EC-06 – Single Pass AW-102 – AP-104 Blend]						
	Sample CWEC06-01						
Campaign EC-05 RPP-PLAN-58022, Rev. 2	*Sampling and Analysis Plan for 242-A Evaporator Process Condensate* [EC-05 – Single Pass AW-102 Heel + Second Transfer from AP-104 {241-C Retrieved Waste} – Slurry to AP-104]	No Campaign EC-05 raw water samples taken					
Campaign EC-04 RPP-PLAN-58022, Rev. 2	*Sampling and Analysis Plan for 242-A Evaporator Cooling Water and Steam Condensate* [EC-04 – Single Pass AW-102 Heel + First Transfer from AP-104 {241-C Retrieved Waste} – Slurry to AP-103]						
Letter Report	*Re: Evaporator Process Effluent Sample Analysis Work Order: 395355*, Gel Laboratories LLC, May 10, 2016						
	Sample CWEC04-01	1.46E+00	9.56E+00	§§	1.08E_01	§	§
Campaign EC-03	EC-03 – Single Pass AY-101 + AP-103 Blend via AZ-102						
Campaign EC-02 RPP-PLAN-58022, Rev. 1	*Sampling and Analysis Plan for 242-A Evaporator Cooling Water and Steam Condensate* [EC-02 – Single Pass AW-102 – AZ-102 Blend]						
HEIS data	Sample CWEC02-01	9.19E-01	8.70E+00	§	5.67E-01	§	§
Campaign EC-01 RPP-PLAN-58022, Rev. 1	*Sampling and Analysis Plan for 242-A Evaporator Cooling Water and Steam Condensate* [EC-01 – Single Pass AW-102]						
HEIS data	Sample CWEC01-01	1.17E+00	8.50E+00	§	3.88E-01	§	§
Campaign 13-01 RPP-RPT-58561, Rev. 0	*242-A Evaporator Campaign 13-01 Post-Run Report* [13-01 – Two Pass AW-102]						
RPP-PLAN-58022, Rev. 0	*Sampling and Analysis Plan for 242-A Evaporator Cooling Water and Steam Condensate*						

Table 8-7. Post-2007 IAR Campaigns Used Raw Water Sample Data (2 pages)

Doc. No.	Title		Presence of Sample Analytes with Corrosion Envelope Limits				
		Cl^- (µg/mL)	SO_4^{2-} (µg/mL)	NO_2^- (µg/mL)	NO_3^- (µg/mL)	OH^- (µg/mL)	pH
HEIS data	Sample CW1301-01 – Second Pass AW-102	7.98E-01	8.62E+00	§	7.71E-01	§	§
Campaign 13-CR RPP-RPT-58561, Rev. 0	*242-A Evaporator Campaign 13-01 Post-Run Report* [13-CR]						
HEIS data	Sample B2VF48	1.15E+00	1.08E+01	§§	8.72E-01	§	8.13
Campaign 10-01/10-02 RPP-RPT-48755, Rev. 0	*242-A Evaporator Campaign 10-01/10-02 Post-Run Report* [10-01/10-02– Two Pass AW-102]						
HEIS data	Samples B25YX8 – First Pass AW-102	1.18E+00	8.68E+00	§§	5.36E-01	§	§
Campaign 10-CR RPP-RPT-48755, Rev. 0	*242-A Evaporator Campaign 10-01/10-02 Post-Run Report* [10-CR]						
HEIS data	Sample B23N42	1.32E+00	1.01E+01	§	5.36E-01	§	§
Campaign 09-01/09-02 RPP-RPT-41939, Rev. 0	*242-A Evaporator Campaign 09-01/09-02 Post-Run Report* [09-01/09-02 – Single Pass AW-102 + AW-102 – AP-101 Blend]]						
HEIS data	Sample B1YBY2 – Single Pass AW-102	1.36E+00	1.01E+01	§§	4.56E-01	§	§
Campaign 08-CR RPP-RPT-41939, Rev. 0	*242-A Evaporator Campaign 09-01/09-02 Post-Run Report* [08-CR]						
HEIS data	Sample B1W5L7	1.05E+00	8.83E+00	§§	2.88E-01	§	§
Campaign 07-01/07-02 RPP-RPT-37727, Rev. 0	*242-A Evaporator Campaign 07-01/07-02 Post-Run Report* [07-01/07-02 – Single Pass as AW-102 feed and slurry receiver, then AW-102 – AP-104 Blend]						
HEIS data	Sample B1MW66 - Single Pass as AW-102 feed and slurry receiver	8.83E-01	8.01E+00	§§	§§	§	§

Table Notes and References:

Analyte data from Hanford Environmental Information System (HEIS) polled April 26, 2016 and May 5, 2016.

§ Analyte not analyzed for.

Table 8-7. Post-2007 IAR Campaigns Used Raw Water Sample Data (2 pages)

Doc. No.	Title		Presence of Sample Analytes with Corrosion Envelope Limits				
		Cl^- (µg/mL)	SO_4^{2-} (µg/mL)	NO_2^- (µg/mL)	NO_3^- (µg/mL)	OH^- (µg/mL)	pH
§§	Analyte analyzed for and reported as 'below detection threshold," *i.e.*, analyzed for but not detected above limiting criteria.						

8.2.1 Aging Mechanisms

The numerous methods of degradation can reduce the integrity of carbon steel and stainless steel structures. For the primary types of degradation that can occur include:

- Thinning of the steel walls by general corrosion that could lead to structural failure
- Pitting of the walls that could lead to through-wall leaks
- Stress corrosion cracking and fatigue-induced flaw growth that could lead to through-wall leaks

Thermal and pressure cycle fatigue of 242-A Evaporator pump room jumpers has been considered and dismissed as an issue because of the limited number of cycles imposed on the jumpers during their service life. It has been determined that the jumpers will not be subjected to greater than 7,000 cycles (*i.e.*, hot-cold and pressure) during their lifetime. Conservatively estimating twenty 242-A Evaporator campaigns per year until the evaporator's projected 2050 end of service would result in about 2,800 cycles assuming three or four starts each campaign, well below any cycle fatigue threshold (refer to RPP-RPT-42297, Rev. 12, *Safety-Significant Waste Transfer Primary Piping Systems – Functions and Requirements Evaluation Document*, and RPP-CALC-56651, Rev. 1, *P-B-2 Pump Skid Piping Calculation*).

Leak Integrity Inspections

According to WAC 173-303-640(2)(c)(v)(A), leak testing of nonenterable tanks is required. For the 242-A Evaporator system, leak tests are performed on the C-A-1 vapor-liquid separator/E-A-1 reboiler/recirculation loop/TK-C-100 condensate collection tank primary containment boundary by filling the system with raw or sanitary (potable) water and observing that the liquid level remains static while examining the external surfaces of the primary confinement boundary for visual evidence of leakage. The static leak tests are supplemented by ultrasonic wall thickness measurements at twelve fixed locations. The primary containment boundary inspection frequency is ten years. In addition to the primary containment boundary leak integrity inspection the E-A-1 reboiler receives a supplementary inspection every five years.

The last 242-A Evaporator system primary containment boundary leak integrity test was performed September 1 – 2, 2007.[7] The C-A-1 vapor-liquid separator, E-A-1 reboiler, and the recirculation loop were filled with ~ 26,500 gal of raw water, and the C-A-1 liquid level monitored via LIC-CA1-2 and the pump room sump monitored via LI-SUMP1 every hour for 24 hours. A leak from the primary containment boundary would have presented as an increase in the pump room sump liquid level. In addition, the evaporator system was visually inspected every four hours by a qualified inspector per ASME *Boiler and Pressure Vessel Code* Section XI *Rules for Inservice Inspection of Nuclear Power Plant Components*, IWA-2210 *Visual Examinations*, IWA-2212 *VT-2*

[7] The CY 2016 C-A-1 leak integrity test had not been completed as of this plan's preparation.

Examinations, and IWA-5241, *Visual Examination – Noninsulated Components* for evidence of leakage.

The only test exception was observed at Nozzle E on the recirculation loop, where flow element FE-CA1-7 was mounted – there was evidence of past leakage but none during the static leak test (refer to Work Order WFO-WO-07-1225, *242A Integrity Assessment – C-A-1 Vessel*, and IQRPE report RPP-RPT-33306, Rev. 0, *IQRPE Integrity Assessment Report for the 242-A Evaporator Tank System*). The flow ` element was removed and the 4-in horizontal nozzle blanked with a 4-in. PUREX connector, July 31, 2008 (refer to Work Order WFO-WO-07-2340, *242A Repair Nozzle "E", HV-CA1-5 & PE-CA1-8, RE-TI*).

The PC-5000 process condensate transfer primary pipeline is hydrotested for leakage every ten years. During the pressure test, upstream components and the encasement drain located at LERF are observed for signs of leakage.

The last PC-5000 system pressure test was performed September 14, 2007.[8] The test was performed using raw water under the supervision of a QC Level II Inspector who examined the external portions of the components, piping, flanges, and valves for evidence of leaks in accordance with the guidelines of ASME Section XI. Division 1. Class 3 (1989), IWA-5240, *Visual Examination (VT-2)* and IWD-5000, *System Pressure Tests (VT-2)*. The acceptance criterion for this test was a pressure decay of < - 2.5 percent per hour over the two hour test duration. The measured pressure decay during the test was - 0.55 percent, decreasing from 52.15 psig to 51.86 psig over the test duration.[9] No liquid was observed draining from the PC-5000 encasement during the pressure test (refer to Work Order WFO-WO-07-0346, *242A Perform Pressure Test of PC5000*; RPP-RPT-33307, Rev. 0, *IQRPE Integrity Assessment Report for the 242-A PC-5000 Transfer Pipeline*).

The IQRPE will review the CY 2016 leak integrity static leak tests, ultrasonic wall thickness tests, and visual inspections that have been performed according to RPP-PLAN-60780, and compare and trend the results with earlier inspections measurements from the 1994, 1998, and 2007 integrity inspections. The objective of the review to identify leak or visual inspection data trends that may indicate the onset of equipment service life deterioration. The impacts will be identified and recommendations to arrest or retard the service life deterioration included in the IAR.

Appendix A identifies the historical leak integrity inspections that have been completed. The following table expands on Appendix A by identifying the locations of inspection and UT measurement data needed to prepare the trend analysis.

[8] The CY 2016 PC-5000 hydrostatic test had not been completed as of this plan's preparation.

[9] ASME Boiler and Pressure Vessel Code, Section XI, IWD-5230, *Hydrostatic Test*, requires the test to be performed at 1.10X the system pressure, P_{sv}, when the maximum design temperature is $\leq$ 200ºF. The system pressure is defined as the lowest pressure setting of the safety or relief valves protecting the portion of the system being tested.

8.3 OVERPRESSURE TRANSIENTS (WATER HAMMER)

The 242-A Evaporator has been affected by several water hammer events during its operating history, for example:

- On July 28, 1988, water was discovered leaking from the E-C-1 primary condenser end bell gasket after raw water pressure fluctuations and a pressure increase from 97 psig to 150 psig over a two hour period. Internal tube leakage increased from 1 gal/min to 8 gal/min. In November, 1987, the E-C-1 primary condenser had been dismantled and several tubes plugged as a result of damage from earlier water hammers (TFS&O-EFS-88-093, *Fluctuating Water Pressure at 242-A Evaporator*).

- On February 28, 1992, personnel were performing an operational test on the raw water system at 242-A evaporator when back-pressure control valve, HV-EC1-2, apparently slammed closed. The Control Room Operator immediately relieved water pressure in the system by fully opening HV-EC1-2, which effectively ended all indications of water hammer. A survey of the condenser room identified several valves and gauges that were damaged (refer to Occurrence report EM-RL--WHC-TANKFARM-1992-0021, *Water Hammer in the 242-A Evaporator*).

- Following the 1996 shut down of the 284-E Powerhouse, a package boiler system was installed in 1997 by Project 4128, *Hanford Energy Savings Performance Contract*, to provide an alternate steam source for the 242-A Evaporator facility. The system consisted of three unattended operation, load-following boilers: two Cleaver-Brooks Model CB(LE) 700 hp firetube boilers rated at 12 psig, capable of generating 24,150 lbs/hr steam at 212°F, 2.34E+07 BTU/hr, and a Cleaver-Brooks Model CB(LE) 200 hp boiler rated at 100 psig, generating 6,900 lbs/hr steam at 212°F, 6.70E+06 BTU/hr; a 1,024 gal deaerating feed water tank and a water softener package shared by all three boilers; and a 40,000 gallon above ground fuel storage tank;. The 242-BA package boiler annex is located about 100-ft west of the 242-A facility (HNF-1727, Rev. 0, *Hazard Evaluation of the 242-A Package Boiler System Impact on Tank Farms;* and USQ TF-97-0694, Rev. 0, *242-A Package Boiler Operation*).

  The first recorded use of the new package boiler system was during the 1998 Cold Run, conducted August 13 – August 25, 1998 (HNF-3382, Rev. 0, *242-A Evaporator Cold Run FY98 Post-Run Document*), supplying 10 psig steam for E-A-1 reboiler, and 90 psig steam for E-C-1 primary condenser and E-C-2 inter-condenser steam jet eductors. Whereas the old 284-E Powerhouse system reduced 225 psig superheated steam to 10 psig in the 242-A Evaporator facility just upstream of the reboiler, the package system produced steam at 10 psig at discharge. With the length of the pipe run and a series of pipe size expansions from 10-in. to 16-in., the effective pressure delivered at the reboiler was ~5.5 - 6.0 psig.

  The lower pressure in reboiler steam chest prevented the three parallel, downstream, inverted bucket steam traps from operating properly. Each trap had a design flow capacity of 14,000 lbs/hr – 42,000 lbs/hr total – for a system pressure differential of 5 psig. However, at 1 psig, the three traps would only handle 25,500 lbs/hr, allowing the

condensate to back up into the shell, and reducing the boiloff. This was exacerbated the 1995 installation of a strainer upstream of the bucket traps. Since there was no room for the strainer on the first floor of the Condenser Room next to the buckets, the strainer was located in the basement. The flow of the condensate line was diverted from the first floor to the basement, and then back to the first floor. It then required 5.6 psig (13-ft water) to push condensate back up to the steam traps once it passed through the strainer. Since the steam/condensate pressure in the reboiler was only ~5.5 psig, there was not enough steam pressure to push the condensate back up to the traps. The addition of the strainer worsened the condensate drain line's ability to clear condensate from the reboiler.

After the 1998 package boiler startup, reboiler pressure oscillations was reported at steam flow rates greater than ~20,000 lbs/hr. Repeated opening and closing of the bucket traps was suspected of creating water hammer in the reboiler steam chest. Careful observations during the 2006-CR cold run and the 2006-01 production campaign confirmed that the oscillations were due to steam condensate-induced water hammer, occurring above a threshold of about 20,000 lbs/hour. Steam capacity was reduced to 13,000 – 20,000 lbs/hr from the design flow of 27,000 – 30,000 lbs/hr to minimize steam condensate water hammer events (RPP-RPT-25891, Rev. 1, *System Health Report for the 242-A Evaporator Facility for Cold Run – CY 2006*).

Technical evaluation TE-10-070, *Technical Evaluation for 242-A Condensate Induced Water Hammer in the E-A-1 Reboiler*, described the water hammer mechanism:

> "The observed oscillations in flow and pressure in the 10 psig steam is [*sic*] known as 'thermal shock.' Thermal shock is a type of condensate-induced water hammer that can occur in steam heating equipment, where heating steam comes in contact with condensate that has cooled below the temperature of the steam. Steam, which occupies a much greater volume than condensate, collapses suddenly when brought in contact with or mixes with the cooler condensate. This collapse can send shock waves through the system, which can eventually damage reboiler tubes and connected piping. ...
>
> " ... In thermal shock, a large volume of steam collapses due to sudden steam cooling (from mixing with the steam condensate in the tubes and baffles of the reboiler). When the steam collapses, more steam from the upstream steam piping rushes into the reboiler to fill the void. ... Likewise, steam condensate flow downstream of the reboiler decreases sharply, as the vacuum created by the void pulls back on the steam condensate. ... The void created by the steam collapse results in a decrease in steam pressure. ... The resulting decrease in pressure in the reboiler shell causes condensate to flash back into steam, which creates a reversal in the steam and condensate flows and pressures mentioned above, and the cycle starts all over again. Therefore, the thermal shock is self-propagating. In the 2010 event, steam flow was decreased all the way from 20,000 lbs/hr to fully closed to try to stop the thermal shock oscillations. The oscillations kept repeating until the steam was fully shut off to the reboiler. ..."

Recommendations based on a subsequent analysis of the campaign data were made to straighten the condensate piping, minimize horizontal runs, and replace the bucket traps with three, parallel float and thermostatic traps that open and close at smaller differential pressure, more easily pass air used to pressurize the steam chest between campaigns, and would be sized to handle reboiler startup when condensate flows are the greatest (refer to RPP-RPT-49198, Rev. 0, *Evaluation of 242-A Evaporator Reboiler Steam and Condensate Systems*).

These modifications were completed in 2012, and successfully hydrotested and inspected for leakage (refer to Work Orders TFC-WO-09-3425, TFC-WO-12-2764, and TFC-WO-12-4422). During the 2013-CR cold run and subsequent production campaign, the steam flow was successfully raised to 27,000 lbs/hr. Reboiler operation remained stable with no further evidence of thermal shock pressure oscillation (refer to RPP-RPT-54982, Rev. 0, *Systems, Structures, and Components (SSC) Status and Health Report for the 242-A Evaporator – Second Quarter 2013 through Second Quarter 2014*). Potential damage to the reboiler integrity from the historical thermal shock oscillations was not evaluated during the 2007 integrity assessment (refer to RPP-RPT-41041, Rev. 0, *Technical Evaluation of the 242-A Evaporator Facility Steam and Steam Condensate Systems*).

- On April 29, 2010, while initiating a raw water pressure static test of the SL-167 transfer line, the P-B-2 Overpressure Protection System rupture disk PSE-PB2-1 that provided pressure relief for the P-B-2 pump discharge piping in the 242-A Evaporator pump room ruptured. This rupture caused approximately 200 gal of raw water to discharge into the 242-A pump room sump causing a pump room sump level high – high alarm. Upon indication of the rupture, testing was secured and systems were configured in a safe condition.

  The rupture disc failure was caused by an water hammer event that occurred when raw water supply valves HV-CA1-2 and HV-CA1-2A on jumper JA-B-[C to 13] were opened to begin filling the route to SL-167. Investigation also revealed that SL-167 had partially gravity drained before the supply valves were opened leading to a possible column separation water hammer as the water rushed to fill the empty vapor space (refer to Work Order TFC-WO-10-1229, *242A Post Maintenance Testing PSV-PB2-1*; Occurrence report EM-RP--WRPS-TANKFARM-2010-0007, *242-A Evaporator Induced Water Hammer Event Does Not Represent a Potential Inadequacy of the Documented Safety Analysis;* and RPP-47138, Rev. 0, *Burst Rupture Disc PSE-PB2 at the 242-A Evaporator*).

  During August, 2013, jumper JA-B-[C to 13] was replaced with a new jumper having slower acting valve HV-CA1-2 and HV-CA1-2A operators; jumper JA-B[C to 4-40] was replaced with a new jumper having both a safety relief valve PSV-PB2-1 and a vacuum breaker PSV-CA1-4. The 2-in. vacuum breaker is located downstream of raw water supply valves HV-CA1-2 and HV-CA1-2A, at a relative high point in the JA-B[C to 4 40] jumper. Its function is to prevent the formation of a vapor bubble in the SL-167 slurry line by venting air into the slurry line at a high point when a vacuum is formed. The elevation change between the raw water supply valves to various possible waste discharge points in the tank farms is sufficient to allow the pressure at the high

point in the 242-A Evaporator slurry jumpers to fall below the vapor pressure of water or waste due to the hydrostatic head of the column and thus cause column separation (vaporization of the waste) after the HV-CA1-2 and HV-CA1-2A slurry flush valves are closed. The resulting vacuum could create a vapor bubble that could collapse and result in water hammer once HV-CA1-2 or HV-CA1-2A is re-opened (refer to RPP-RPT-52813, Rev. 2, *242-A Evaporator Jumper C to 4-40 Vacuum Breaker – Functions and Requirements Evaluation Document*).

Rupture disc PSE-PB2-1 had already been eliminated from the jumper by an earlier jumper modification. An additional pump room jumper change bypassed SN-251 nozzles J and K, permanently removing the supernatant sampler from service (refer to ECN-12-000996, Rev. 0, *242-A Pump Room Jumper Upgrade*. Work Order TFC-WO-12-4318, *242A Install Pump Room Jumpers per ECN-12-000996*). The design, fabrication, testing and installation were reviewed by an IQRPE and inspection reports issued as described in subsequent paragraphs.

Some waste transfer pumps can have unmitigated head/flow curves that exceed the waste transfer system design pressures (*i.e.*, create an overpressure condition). If the overpressure condition has the potential to fail the safety function of safety-significant waste transfer primary piping systems, isolation valves for double valve isolation, or 242-A Evaporator components, then the SSCs or specific administrative controls (SACs) required to address ASME B.31.3 code allowances are designated safety-significant support SSCs or SACs.

In some cases it is possible to re-rate the transfer system components when the maximum operating pressure exceeds the design pressure. In 2008, an evaluation of the 242-A Evaporator waste feed piping found several sections with design pressures below the maximum discharge pressure of the 242-A Evaporator feed pump located in the 241-AW-02E pit. At pump shutoff, the maximum operating pressure of the system was 275 psig for waste with a 1.3 specific gravity. Both ASME B3 1.1, *Power Piping*, and ASME B3 1.3, *Process Piping*, require that the maximum operating pressure not exceed the design pressure for systems not protected by a relief or safety valve.

The portions of the piping system at risk were the jumpers on the dilute waste feed route from the 241-AW-02E Feed Pump Pit to the 242-Evaporator recirculation line, Nozzle D. These were the 241-AW-02E jumper [1 to 4] between the feed pump and supernatant line SN-269; and 242-A jumpers [13 to K] between the line SN-269 termination at wall nozzle 13 inside the 242-A pump room and nozzle K on line SN-251; line SN-251 forming the feed sampler loop between the pump room and the sampler enclosure in the load out and hot equipment storage room, terminated in Nozzles J and K; jumper [J to 13A]; and jumper [13A to D] connected to nozzle D on the recirculation loop.

The design pressure of the sections ranged from 100 psig – 133 psig, with original hydrotest pressures of 150 psig – 240 psig. The re-rate test was performed at 300 psig between the 241-AW-02E pit valve V-105 and valve HV-CA1-1 on jumper [13A to D], and held for 30 minutes to observe for leakage, in accordance with conditions specified in ASME B31.1 Nonmandatory Appendix V, *Recommended Practice for Operation, Maintenance, and*

Modification of Power Piping Systems. No leaks were observed during the test (refer to Work Orders TFC-WO-08-0940, *241-AW/242-A Piping Hydrostatic Testing*; TFC-WO-08-1012 *242A 241-AW-02A Pit Work*; and technical evaluation TE-08-037, *Technical Evaluation to Rerate 242-A Evaporator Feed Piping to Higher Operating Pressure*).

In August, 2013, new jumpers [13-13A] and [13A-D] were installed, among others, in the pump room with the intention of permanently eliminating water hammer potential caused by rapid valve opening and closure or water column separation that was present in the April, 2010 event. The jumper design, fabrication, testing, and installation were reviewed by an IQRPE and inspection reports issued (refer to RPP-RPT-56895, Rev. 0, *Independent Qualified Registered Professional (IQRPE) Inspection Plan for 242-A [C to 4-40], [4 to 5/40 to 21], [D to 13A], [13A to 13], and [C to 13] Jumpers;* RPP-RPT-56896, Rev. 0, *Independent Qualified Registered Professional Engineer Design Assessment Report for 242-A [C to -40], [4 to 5/40 to 21], [D to 13A], [13A to 13], and [C to 13] Jumpers*; and RPP-RPT-57227, *Independent Qualified Registered Professional Engineer (IQRPE) Installation Assessment Report for 242-A [C to 4-40], [4 to 5/40 to 21], [D to 13A], [13A to 13], and [C to 13] Jumpers).*

Overpressure conditions or flow transients depend on the specific transfer route and the specific transferred waste parameters. Therefore each waste transfer has to be individually evaluated. In accordance with the requirements of TFC-OPS-OPER-C-49, *Development of Waste Retrieval and Transfer Operating Procedures (Including Water and Chemical Additions)*, the responsible engineer assigned to develop the waste transfer procedure performs an evaluation that includes the following:

- Identification of the waste transfer primary piping systems that are physically connected to the 242-A Evaporator when the C-A-1 vapor-liquid separator contains waste.
- Determination of the waste transfer primary piping systems and isolation valves for double valve isolation that are on the planned waste transfer route. The planned waste transfer route includes the gravity head from the 242-A Evaporator C-A-1 vapor-liquid separator when the vessel contains waste, up to the first closed isolation valve.
- Determination of the failure limits for the safety-significant waste transfer primary piping systems and isolation valves for double valve isolation that are physically connected to the 242-A Evaporator when the C-A-1 vapor-liquid separator contains waste.
- Determination of the unmitigated pressure due to waste transfer pump operation at physically connected waste transfer primary piping systems and isolation valves for double valve isolation that are physically connected to the 242-A Evaporator when the C-A-1 vapor-liquid separator contains waste. The determination of the unmitigated pressure due to waste transfer pump operation is based on the safety basis case methodology in TFC-ENG-DESIGN-C-60, *Preparation of Piping Analyses for* 26 *Waste Transfer Systems*.
- Determination of the unmitigated pressures/stresses resulting from applicable flow transients for waste transfer primary piping systems and isolation valves for double valve isolation on the planned waste transfer route. The determination of the unmitigated

pressures/stresses resulting from applicable flow transients is based on the safety basis case methodology in TFC-ENG-DESIGN-C-60.

- If the unmitigated pressure due to waste transfer pump operation or the unmitigated pressures/stresses from the applicable flow transients exceed the failure limits, identification of SSCs or administrative controls designated safety-significant support SSCs or SACs to limit pressure and flow transients within ASME B31.3 code allowances (refer to RPP-13033, Rev. 6, Section 4.5.7 *ff*, *Waste Transfer System Overpressure and Flow Transient Protection*).

Failure Criteria and Limits. The general failure criteria and methodology for determining specific component failure limits for waste transfer system primary piping components, and isolation valves for double valve isolation are described in RPP-RPT-52248, *Evaluation of Fitness-For-Service for Over-Pressure Events*. Limits can be based on ASME B31.3, or if a more rigorous analysis is used, are based on ASME BPVC, Section III, *Rules for Construction of Nuclear Facility Components*, Division 1, ND-3600 28, *Piping Design*, for Service Level D, excluding ND-3655(c)2, *Consideration of Level D Service Limits,* or ASME Section III, Division I, Class 3 – Code 29 Case N-155-2, *Fiberglass Reinforced Thermosetting Resin Pipe, Section III Division I*, for Service Level D for the PC-5000 line. These criteria provide a margin of safety to primary containment boundary failure that could result in a structural failure and a waste transfer leak accident.

The evaluation of waste transfer system overpressure and flow transients during waste transfers is developed, reviewed, and issued in accordance with the engineering procedures described above. These procedures meet the requirements of NQA-1 (refer to TFC-PLN-02, *Quality Assurance Program* 38 *Description*). If the waste transfer pump overpressure conditions or flow transient conditions during the waste transfer exceed the applicable failure limits, the required safety-significant support SSCs and SACs are identified and implemented or the waste transfer is not allowed.

Within the 242-A Evaporator system, operating limitations have been placed on key SSCs to significantly reduce the potential for flow transient and overpressure events.

- Feed valve HV-CA1-1 – Feed valve HV-CA1-1 controls or stops dilute waste feed flow entering the recirculation line, at Nozzle D. Water hammer may be caused by the sudden closure of feed valve HV-CA1-1. If this valve closes too quickly, a water hammer could result in the feed line and potentially damage components in the line. In order to control for water hammer, the feed valve actuation speed is slowed to 30 seconds.

- Slurry valves HV-CA1-2 and HC-CA1-2A – Water hammer may be caused by either of two operations. The first operation is the sudden closure of the HV-CA1-2 or HV-CA1-2A valves on waste or water flow. If these valves close too quickly, a water hammer could result in the slurry line and potentially damage components in the line. To control this type of water hammer, the slurry valves' actuation speed is slowed to 30 seconds.

- Vacuum breaker PSV-CA1-4 – The second slurry operation that could induce a water hammer is column separation in the line. There is a large elevation difference between

slurry valves HV-CA1-2 and HV-CA1-2A and the 241-AP tank farm. When the slurry valves are closed on waste or water flow the fluid in the top of the transfer line could vaporize due to the high negative pressures resulting from the elevation difference. Water hammer can be created when the flow to the lines is reestablished and the two fluid columns rejoin. To prevent a column separation in the slurry transfer line, vacuum breaker PSV-CA1-4 is installed on the (JA-B-[C to 4-40]) jumper in the 242-A Evaporator pump room.

- Pressure relief valve PSV-PB2-1 – This relief valve prevents potential overpressurization of both tank farm piping and 242-A slurry jumpers. A discharge line from the relief valve is routed to the pump room sump and is sized to ensure adequate relief flow for the relief valve.[10] The valve has a shelf life of 10 years from the date of ASME code certification testing (as reflected on the code data sheet) and a service life of five years from the date of installation (exposure to the tank headspace atmosphere) or two years from the date of first use for transfer of waste, whichever comes first. A two year service life was determined in Table 1 of WHC-SD-GN-TEEM-30001, *Guidelines for Periodic Testing and Repair of Pressure Relief Valves*. The pressure relieving device must be replaced if the shelf life or service life has been exceeded (refer to RPP-RPT-42119, Rev. 6, *242-A Evaporator PSV-PB2-1 Relief Valve – Functions and Requirements Evaluation Document*).

Table 8-8 lists post-CY 2007 overpressure and flow transient evaluations for transfer routes physically connected to the 242-A Evaporator System.

Table 8-8. Overpressure and Flow Transient Evaluations (3 pages)

Document No.	Title	Release Date
RPP-CALC-38222, Rev. 1	*242-A Pump P-B-2 Rupture Disk and PRV Analysis*	2008
RPP-CALC-38295, Rev. 0	*242-A Evaporator Feed Piping Re-rate Analysis*	2008
RPP-CALC-46812, Rev. 0	*242-A – Analysis of JA-B-[C to (4)-(5)-(21)] Modification to Replace PSE-PB2-1 w/ PSV-PB2-1*	2010
RPP-CALC-46983, Rev. 1	*242A PSE-PB2-1 Water Hammer Analysis*	2010
RPP-CALC-48695, Rev. 4	*Jumper Assembly D-13A Calculation Package*	2015
RPP-CALC-48762, Rev. 0	*242-A PSV-PB2 Transient Pressure Analysis*	2011
RPP-CALC-51223, Rev. 2	*General Transient Thermal Analysis for Waste Transfer Piping*	2012
RPP-CALC-51242, Rev. 0	*242-A Reboiler Condensate Hydraulic Analysis* [Size steam condensate equipment and duration of air purge]	2012
RPP-CALC-54446, Rev. 1	*19506-C-001, 242-A Evaporator Peak Pressure Estimate*	2013
RPP-CALC-54447, Rev. 1	*Piping Structural Analysis Methodology for Evaluation of Waterhammer*	2015

[10] Unless otherwise noted, information for *Overpressure and Flow Transient* section excerpted from HNF-14755, Rev. 5, Section 2.4.1.1, *Detailed Structure Descriptions Pump Room (B)*; RPP-13033, Rev. 6A, Section 4.5.7, *Waste Transfer System Overpressure and Flow Transient Protection*; and RPP-RPT-52206, Rev. 0, *Tank Farms Waste Transfer System Fitness-for-Service Requirements and Recommendations*, Section D.2, *Liquid Systems*

Table 8-8. Overpressure and Flow Transient Evaluations (3 pages)

Document No.	Title	Release Date
RPP-CALC-54450, Rev. 0	*19508-C-007, Waterhammer Analysis on 242-A Evaporator to AW-106 Flush Pit, Rev. 2*	2013
RPP-CALC-54778, Rev. 0	*242-A Evaporator Steam Line Fluid Transient Determination and Full Vacuum Design*	2014
RPP-CALC-55175, Rev. 0	*Hydraulic Analysis for 242-A to AW-02E Leak Check, 19992-C-001, Rev. 2*	2013
RPP-CALC-55176, Rev. 0	*Structural Analysis for 242-A to 241-AW-02E Leak Check, 19992-C-002*	2013
RPP-CALC-55177, Rev. 0	*Hydraulic Analysis for 242-A to 241-AW-02A, Leak Check in 241-AW-B (via SN-268), 19992-C-003, Rev. 1*	2013
RPP-CALC-55178, Rev. 0	*Structural Analysis for 242-A to 241-AW-02A, Leak Check in 241-AW-B (via SN-268), 19992-C-004, Rev. 0*	2013
RPP-CALC-55179, Rev. 0	*Hydraulic Analysis for 242-A to 241-AW-06A, Leak Check in 241-AW-B (via SL-166), 19992-C-005, Rev. 1*	2013
RPP-CALC-55180, Rev. 0	*Structural Analysis for 242-A to 241-AW-06A, Leak Check in 241-AW-B (via SL-166), 1999*2-C-006, Rev. 1*	2013
RPP-CALC-55181, Rev. 0	*Hydraulic Analysis for 242-A to AW-06A via AW-B R15 Leak Check, 19992-C-007, Rev. 1*	2013
RPP-CALC-55182, Rev. 0	*Structural Analysis for 242-A to AW-06A via AW-B R15 Leak Check, 19992-C-008, Rev. 1*	2013
RPP-RPT-51287	*Analysis of Passive Freeze Protection for Waste Transfer Systems*	2014
RPP-RPT-52248, Rev. 1	*Evaluation of Fitness-for-Service for Over-Pressure Events*	2014
RPP-RPT-52941, Rev. 0	*Pressure Transient Effects on Relief Valves and Isolation Valve Seat Material*	2012
RPP-TE-55252, Rev. 0	*Overpressure and Flow Transient Evaluation for241-AW-02E Pump Pit Leak Check*	2013
RPP-TE-56298, Rev. 0	*SAC 5.8.5, DID 23, and DID 29 Evaluation for 242-A Hot Operation (Feed Operations, Slurry Out Operations, Vessel Dump, and Sump Room Pumping) and Cold Runs*	2015
RPP-TE-56836, Rev. 0	*DID 23 Evaluation for 242-A C-A-1 Vessel Dump and Facility Drains to DST Farm for Cold Operation*	2014
RPP-TE-57104, Rev. 4	*SAC 5.8.5, DID 23, and DID 29 Evaluation for 242-A Hot Operation (Feed Operations, Slurry Out Operations, Vessel Dump, and Sump Room Pumping) and Cold Runs*	2015
RPP-TE-58143, Rev. 0	*DID 23 Evaluation for Leak Checks Supporting 242-A to 241-AP-107 Campaign*	2014
RPP-TE-58163, Rev. 0	*SAC 5.8.5, DID 29, and DID 23 Evaluation for 241-AP Tank Farm (241-AP-103, 104, 107) to 241-AW Tank Farm (241-AW-102, 106) Waste Transfers and Associated Flushes*	2014
RPP-TE-58229, Rev. 0	*DID 23 Evaluation for 242-A Deep Flush Draining Activities Controlled by Valve AW02E-WT-V-107*	2015

Table 8-8. Overpressure and Flow Transient Evaluations (3 pages)

Document No.	Title	Release Date
TE-09-013, Rev. 0	*Technical Evaluation of 242-A Raw Water Supply Piping and Equipment from 14" RW-600-M19 to 24" CMP-URW-1*)	2009
TE-10-070, Rev. 0	*Technical Evaluation for 242-A Condensate Induced Water Hammer in the E-A-1 Reboiler*	2010
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RPP-RPT-47482, Rev. 0, 2010, *242-A Slurry Jumper Modification Independent Integrity Assessment Report*, Meier Architecture & Engineering, Kennewick, Washington.	Appendix A, Appendix C
RPP-RPT-47980, Rev. 0, 2011, *Final Report for Evaporator Process Grab Samples in Support of Evaporator Campaign 10-01/10-02*, Advanced Technologies and Laboratories International, Inc., Richland, Washington.	8.2
RPP-RPT-48755, Rev. 0, 2011, *242-A Evaporator Campaign 10-01/10-02 Post-Run Report* [10-01/10-02], Washington River Protection Solutions, LLC, Richland, Washington.	8.2
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RPP-RPT-52517, Rev. 0, 2013, *242-A Evaporator Facility Assessment for Performance Category 2 Natural Phenomena Hazards*, Washington River Protection Solutions, LLC, Richland, Washington.	8.1
RPP-RPT-52791, Rev. 0, 2015, *Tank Farm Waste Transfer System Fitness-for-Service Erosion and Corrosion Basis*, Washington River Protection Solutions, LLC, Richland, Washington.	8.2, Appendix C
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RPP-RPT-57226, Rev. 0, 2014, *Independent Qualified Registered Professional Engineer (IQRPE) Installation Assessment Report for PC-550-M42 Process Condensate Line Replacement Spool Piece*, Dana Engineering, Inc., Richland, Washington.	Appendix A
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RPP-TE-56836, Rev. 0, 2014, *DID 23 Evaluation for 242-A C-A-1 Vessel Dump and Facility Drains to DST Farm for Cold Operation*, Washington River Protection Solutions, LLC, Richland, Washington.	8.3
RPP-TE-57104, Rev. 5, 2016, *SAC 5.8.5, DID 23, and DID 29 Evaluation for 242-A Hot Operation (Feed Operations, Slurry Out Operations, Vessel Dump, and Sump Room Pumping) and Cold Runs*, Washington River Protection Solutions, LLC, Richland, Washington.	8.3
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Washington Administrative Code WAC 173-303-640(2)(c)(ii), *Dangerous characteristics of the waste(s) that have been and will be handled*.	8.2
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Washington Administrative Code WAC 173-303-810, *Dangerous Waste Regulations, General Permit Conditions*.	8.1
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WHC-SD-WM-ER-112, Rev. 0, 1993, *Integrity Assessment Report for 242-A Evaporator/LERF Waste Transfer Piping*, Westinghouse Hanford Company, Richland, Washington.	7.6, Appendix A
WHC-SD-WM-ER-124, Rev. 1, 1994, *The 242-A Evaporator-Crystallizer Tank System Integrity Assessment Report*, Westinghouse Hanford Company, Richland, Washington.	1.0, 7.6, Appendix A, Appendix C

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WHC-SD-WM-WP-062, Rev. 0A, 1991, *242-A Evaporator – Crystallizer Tank System Integrity Assessment Plan*, Westinghouse Hanford Company, Richland, Washington [reference not available in IDMS].	Appendix C
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Work Order TFC-WO-08-1012, 2008, *242A 241-AW-02A Pit Work*, Washington River Protection Solutions, LLC, Richland, Washington.	8.3
Work Order TFC-WO-08-1307, 2008, *242A Perform Leak Checks During Cold/Hot Run 2008*, CH2M HILL Hanford Group, Inc., Richland, Washington.	7.1
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Work order TFC-WO-11-5323, 2013, *242-A Replace P-C-100*, Washington River Protection Solutions, LLC, Richland, Washington.	7.4
Work Order TFC-WO-12-4318, 2013, *242A Install Pump Room Jumpers per ECN-12-000996*, Washington River Protection Solutions, LLC, Richland, Washington.	8.3

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Work Order TFC-WO-12-4710, 2012, *242-A (E-C-2) Third Party Inspection Inter Condens* [E-C-2 Inter-condenser], Washington River Protection Solutions, LLC, Richland, Washington.	Appendix A
Work Order TFC-WO-12-4711, 2012, *Third Party Inspection* [E-C-3 After-condenser], Washington River Protection Solutions, LLC, Richland, Washington.	Appendix A
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Work Order TFC-WO-14-4729, 2014, *Third Party Inspection* [E-C-1 Primary condenser], Washington River Protection Solutions, LLC, Richland, Washington.	Appendix A
Work Order TFC-WO-14-4730, 2014, *242-A (E-C-2) Third Party Inspection Inter Condens* [E-C-2 Inter-condenser], Washington River Protection Solutions, LLC, Richland, Washington.	Appendix A
Work Order TFC-WO-14-4731, 2014, *Third Party Inspection* [E-C-3 After-condenser], Washington River Protection Solutions, LLC, Richland, Washington.	Appendix A
Work Order WFO-WO-07-0346, 2007, *242A Perform Pressure Test of PC5000*, CH2M HILL Hanford Group, Inc., Richland, Washington.	8.2.1
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Reference	RPP-PLAN-60799 Section
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Work Order WFO-WO-08-0863, 2008, *Third Party Inspection of the Condensers* [E-C-2 Inter-condenser], Washington River Protection Solutions, LLC, Richland, Washington.	Appendix A
Work Order WFO-WO-08-0864, 2008, *242-A Third Party Inspection* of the Condensers [E-C-3 After-condenser], Washington River Protection Solutions, LLC, Richland, Washington.	Appendix A
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WRPS-PER-2009-1964, 2009, *Potential Steam Condensate Induced Water Hammer*, Washington River Protection Solutions, LLC, Richland, Washington.	8.3
WSRC-TR-94-0250, 1994, *Recommended Nitrite Limits for Chloride and Sulfate in ESP Slurries*, Westinghouse Savannah River Company, Aiken, South Carolina	8.2

APPENDIX A

242-A EVAPORATOR SYSTEM INTEGRITY ASSESSMENTS

Table A-1. 242-A Evaporator System Integrity Assessments and Inspections Completed before January, 2008 (3 pages)

	Title	Assessment / Inspection Description	Publication Date
WHC-SD-WM-SP-056. Rev. 0	*242-A Evaporator/Reboiler System Evaluation*	Inspection Work Plan for 1994 integrity assessment.	06/29/1990
WHC-SD-WM-DP-019, Rev. 0	*Data Package for 242-A Evaporator/Crystallizer Tank System Integrity Assessment Report*	• Hydrostatic leak test data in Section 2.0, *Leak Tests* • Visual inspection and UT measurement data in Section 6.0, *Inspection/Non-Destructive Examination*	06/03/1993
WHC-SD-WM-ER-112, Rev. 0	*Integrity Assessment Report for 242-A Evaporator / LERF Waste Transfer Piping*	Post-construction integrity assessment of PC-5000 process condensate line installation, concluding that the waste transfer piping has sufficient strength and waste compatibility that it will not collapse, rupture or fail during its service life; and that adequate administrative controls are in place to ensure the pipeline will be operated within its design basis and in compliance with the WAC. • Pressure test summarized in Section 5, *Pressure Testing for Integrity.* • Appendix F, *Final Leak/Pressure Test Certification Records,* provides some information, but pressure decay data for 10-minute test were not recorded evident on data sheet.	07/20/1993
WHC-SD-WM-ER-124, Rev. 1	*The 242-A Evaporator / Crystallizer Tank System Integrity Assessment Report*	242-A Evaporator/Crystallizer system is not leaking and is fit for use. The inspections, tests, and analyses performed provide reasonable assurance that the 242-A Evaporator/Crystallizer tank system has adequate design, sufficient structural strength, and sufficient compatibility with the wastes to not collapse, rupture, or fail during service loads associated with normal operations. Leak tests, visual inspections, UT measurements summarized in Section 3.0, *Results and Data*, and Table 1, *Non-Destructive Examination Results*	04/27/1994
HNF-2331, Rev. 0	*1998 Interim 242-A Evaporator Tank System Integrity Assessment Plan*	Inspection Work Plan for 1998 integrity assessment.	03/31/1998

Table A-1. 242-A Evaporator System Integrity Assessments and Inspections Completed before January, 2008 (3 pages)

	Title	Assessment / Inspection Description	Publication Date
HNF-2905, Rev. 0	*1998 Interim 242-A Evaporator Tank System Integrity Assessment Report*	The integrity of the [242-A] tank system is adequate to prevent failure caused by corrosion or by structural loads imposed by the system's intended service. In-depth reviews of the applicable codes and standards and waste characterization were not performed due to lack of significant facility modifications or waste composition changes since the preceding 1993 integrity assessment. • Leak tests, visual inspections summarized in Section 2.5, *Leak Test and System Walkdown*. Leak tests, visual inspections, and UT measurements data in Appendix D, *Supporting Data*. • Wall thickness comparison between 1994 and 1998 integrity assessments provided in Thickness and Corrosion Rate Table, page E-5.	07/02/1998
RPP-PLAN-32530, Rev. 1	*IQRPE Integrity Assessment Plan for the 242-A Evaporator System and PC-5000 Process Condensate Transfer Line*	Inspection Work Plan for 2007 integrity assessments.	07/31/2007
RPP-RPT-33307, Rev. 0	*IQRPE Integrity Assessment Report for the 242-A PC-5000 Transfer Pipeline*	PC-5000 waste transfer piping has sufficient strength and waste compatibility that it will not collapse, rupture, or fail through the expected life-cycle of 2034 for the 242-A Evaporator unit. • Visual inspection and leak test summarized in Section 2.6, *Results of Visual Inspection*, and Section 2.7, *Leak Testing of PC-5000 Transfer Pipeline*. • Visual inspection data in Attachment F, *PC 5000 Visual Inspection Photographs.* • Raw data for the pressure test are not included in the report.	12/26/2007

Table A-1. 242-A Evaporator System Integrity Assessments and Inspections Completed before January, 2008 (3 pages)

	Title	Assessment / Inspection Description	Publication Date
RPP-RPT-33306, Rev. 0	*IQRPE Integrity Assessment Report for the 242-A Evaporator Tank System*	242-A Evaporator found to be adequately designed, with sufficient structural strength and waste compatibility that it will not collapse, rupture, or fail. Forty-four improvement recommendations were made. • Visual inspections, leak tests, UT measurement results summarized in Section 2.4, *Results of Visual Inspection*, Section 2.5, *Results of Leak Testing*, and Section 2.6, *Results of Ultrasonic Testing* • Wall thickness comparison among 1994, 1998, and 2007 integrity assessments provided in Table 2.6.1, *Thickness and Corrosion Rate*, page 101. • Leak test data in .located in Attachment 4, *TK-C-100 Leak Testing Procedures and Test Results*; Attachment 5, *Evaporator-Reboiler Loop Leak Testing Procedures and Test Results*; and Attachment 6, *Ultrasonic (UT) Testing Procedures, Results, Analyses*	12/28/2007

Table A-2. 242-A Evaporator System Integrity Assessments and Inspections Completed after December, 2007 or Not Reviewed by Previous Assessments (6 pages)

Document No.[a]	Title	Assessment / Inspection Description	Publication Date
HNF-3327, Rev. 1	*Engineering Study for the 242-A Life Extension Upgrades for Fiscal Years 2002 Thru 2005*	Appendix J includes NDE inspection of E-A-1 Reboiler and C-A-1 Vapor-Liquid Separator Bellows. No evidence was found that suggested service life limitations, although reinspection is recommended in five years to re-evaluate partial through-wall pitting, large rust-like deposit at the reboiler inlet and another on the bottom tube sheet.	09/30/2001
WFO-WO-08-(0862-0864)	• *Third Party Inspection of the Condensers* (E-C-1 Primary condenser – 0862) • *Third Party Inspection of the Condensers* (E-C-2 Inter-condenser – 0863 • *242-A Third Party Inspection* of the Condensers (E-C-3 After-condenser – 0864)	Biennial third party inspection of E-C-1 Primary condenser, E-C-2 Inter-condenser, and E-C-3 After-condenser per ASME BPVC, Section VIII, and Engineering Standard TFC-ENG-STD-17, *Third Party Inspections*	10/15/2008
RPP-RPT-45994, Rev. 0	*242-A P-B-2 Pressure Relief Modification, Independent Integrity Assessment Report*	Design, fabrication, and installation of ASME B31.3 compliant replacement jumper 21-36 in the 242-A pump room to eliminate a PRV and manual isolation valve jumper not in compliance with ASME Section VIII, Division I, UG-127 for protecting the line from over-pressurization.	04/08/2010
RPP-RPT-46117, Rev. 0 RPP-RPT-46117, Rev. 1	*242-A PC-5000 Drain Line Modifications Independent Integrity Assessment Report*	System modifications included replacement of encasement leak detectors and installation of an encasement leak catch tank at the LERF termination of PC-5000. These modifications were properly fabricated and installed in accordance with drawings, specifications, and applicable codes, based upon reviews of vendor test and	04/23/2010 10/11/2012

Table A-2. 242-A Evaporator System Integrity Assessments and Inspections Completed after December, 2007 or Not Reviewed by Previous Assessments (6 pages)

Document No.[a]	Title	Assessment / Inspection Description	Publication Date
RPP-RPT-47482, Rev. 0	*242-A Slurry Jumper Modification Independent Integrity Assessment Report*	Design, fabrication, and installation of replacement jumper JA-B-[C to (4)-(5)-(21)] in the 242-A pump room following rupture of rupture disk PSE-PB2-1 during a transient pressure surge caused by flush water introduced into the system during a transfer line integrity test.	08/26/2010
IAR PC-5000, Rev. 0 (PC5000-PTD-001, Rev. 0, Att. B)	*242-A PC-5000 Drain Line Modifications Independent Integrity Assessment Report, Rev. 0*	Integrity Assessment of design, field installation and leak-checking of PC-5000 modifications completed by Project E-528, *Trace-Tek Leak Detection System Upgrade*. The Trace-Tek continuous leak detection cable was replaced with six single-point leak detectors and a 30 gal stainless steel catch tank equipped with a seventh leak detector to collect any encasement drainage at the LERF termination of the line. The integrity assessment was limited to the modifications, taking credit for the previously issued IQRPE report, RPP-RPT-33307, Rev. 0, *IQRPE Integrity Assessment Report for the 242-A PC-5000 Transfer Pipeline*	03/15/2010
TFC-WO-10-(4363-4365)	• *Third Party Inspection* (E-C-1 Primary condenser – 4363) • *242-A (E-C-2) Third Party Inspection Inter Condens* (E-C-2 Inter-condenser – 4364) • *Third Party Inspection* (E-C-3 After-condenser – 4365)	Biennial third party inspection of E-C-1 Primary condenser, E-C-2 Inter-condenser, and E-C-3 After-condenser per ASME BPVC, Section VIII, and Engineering Standard TFC-ENG-STD-17, *Third Party Inspections*	11/04/2010
RPP-50406, Rev. 1	*Independent Qualified Registered Professional Engineer Inspection/Assessment, Rev. 0 for 242-A Pump Room Feed Jumper C to 13*	Integrity assessment for design and fabrication of 242-A Evaporator pump room jumper [C to (P-B-2) 13 Pump Suction] {[C-13]} connecting the recirculation loop to the slurry pump P-B-2 suction. Jumper installation and leak testing were covered by integrity assessment plan RPP-RPT-56895.	10/15/2012

Table A-2. 242-A Evaporator System Integrity Assessments and Inspections Completed after December, 2007 or Not Reviewed by Previous Assessments (6 pages)

Document No.[a]	Title	Assessment / Inspection Description	Publication Date
RPP-50408, Rev. 1	*Independent Qualified Registered Professional Engineer Inspection/Assessment, Rev. 0 for 242-A Pump Room Jumper D to 13A*	Integrity assessment for design and fabrication of 242-A Evaporator pump room jumper [D-13A], part of the dilute feed route from SN-269 to the recirculation loop. The jumper was equipped with a seismically-qualified feed/emergency dump valve HV-CA1-1 and a coriolis flowmeter UE-CA1-1 (Drawing H-14-107263, Sheets 1 – 5). Jumper installation and leak testing assessment were identified by integrity assessment plan RPP-RPT-56895.	10/15/2012
RPP-50163, Rev. 1	*Independent Qualified Registered Professional Engineer Inspection/Assessment, Rev. 0 for 242-A Pump Room Feed Jumper 13 to 13A*	Integrity assessment for design and fabrication of 242-A Evaporator pump room jumper [13-13A]. Installation allows bypass of the feed/slurry sample loop nozzles J and K and the sample cabinet located in the Loadout and Hot Equipment Storage Room. Jumper installation and leak testing were covered by integrity assessment plan RPP-RPT-56895.	10/16/2012
TFC-WO-12-(4709-4711)	• *Third Party Inspection* (E-C-1 Primary condenser – 4709) • *242-A (E-C-2) Third Party Inspection Inter Condens* (E-C-2 Inter-condenser – 4710) • *Third Party Inspection* (E-C-3 After-condenser – 4711)	Biennial third party inspection of E-C-1 Primary condenser, E-C-2 Inter-condenser, and E-C-3 After-condenser per ASME BPVC, Section VIII, and Engineering Standard TFC-ENG-STD-17, *Third Party Inspections*	10/30/2012
TFC-WO-13-2629	*242-A and 241-AW-02E Purex Connector Leak Checks*	Leak checks for jumpers installed during August, 2013 (refer to ECN-12-000996, Rev. 0, 242-A Pump Room Jumper Upgrade; Work Order TFC-WO-12-4318, *242A Install Pump Room Jumpers per ECN-12-000996*; and IQRPE report RPP-RPT-57227, Rev. 0, *Independent Qualified Registered Professional Engineer (IQRPE) Installation Assessment Report for 242-A [C to 4-40], [4 to 5/40 to 21], [D to 13A], [13A to 13], AND [C to 13] Jumpers*)	01/30/2014

Table A-2. 242-A Evaporator System Integrity Assessments and Inspections Completed after December, 2007 or Not Reviewed by Previous Assessments (6 pages)

Document No.[a]	Title	Assessment / Inspection Description	Publication Date
RPP-RPT-56895, Rev. 0	*Independent Qualified Registered Professional (IQRPE) Inspection Plan for 242-A [C to 4-40], [4 to 5/40 to 21], [D to 13A], [13A to 13], AND [C to 13] Jumpers*	Plan describes IQRPE and Qualified Independent Inspector oversight and review activities to be performed during procurement, fabrication, testing, installation and leak testing of new 242-A Evaporator pump room jumpers [C to 4-40], [4 to 5/40 to 21], [D to 13A], [13A to 13], and [C to 13] necessary to certify their use per WAC 173-303-640. Jumpers [D-13A] was fabricated prior to Revision 0 of this inspection plan, and [C to 13] required rework due to dimensional errors. Both received previous design and fabrication certifications (RPP-50408 and RPP-50406).	04/17/2014
RPP-RPT-56897, Rev. 0	*Independent Qualified Registered Professional Engineer (IQRPE) Inspection Plan for PC-550-M42 Process Condensate Line Replacement Spool Piece*	Plan describes IQRPE and Qualified Independent Inspector oversight and review activities to be performed during procurement, fabrication and installation of a replacement process condensate line spool piece PC-550-M42 and condensate flowmeter FIT-EC1-2 downstream of primary condenser E-C-1.	04/17/2014
RPP-RPT-56898, Rev. 0	*Independent Qualified Registered Professional Engineer (IQRPE) Design Assessment Report for PC-550-M42 Process Condensate Line Replacement Spool Piece*	Integrity assessment and IQRPE certification that design of spool piece PC-550-M42 and flowmeter FIT-EC1-2 were in compliance with applicable sections of WAC 173-303-640. Spool piece design assessment was identified in integrity assessment plan RPP-RPT-56897.	04/17/2014
RPP-RPT-57226, Rev. 0	*Independent Qualified Registered Professional Engineer (IQRPE) Installation Assessment Report for PC-550-M42 Process Condensate Line Replacement Spool Piece*	Integrity assessment concluded that equipment associated with the PC-550-M42 Process Condensate Line Replacement Spool Piece, including all secondary containment design features, was correctly installed and meets the requirements of WAC 173-303-640(3). Spool piece installation assessment was identified in integrity assessment plan RPP-RPT-56897.	04/17/2014
RPP-RPT-57257, Rev. 1	*Test Report for Leak-Tightness of Reboiler Vessel E-A-1 at 242-A Evaporator Facility*	Four of five post-test samples indicated fluorescein had entered the steam condensate line; a leak rate was calculated. All levels were below the established leak tightness performance standard derived in RPP-RPT-56931, and E-A-1 was declared leak-tight.	04/22/2014

Table A-2. 242-A Evaporator System Integrity Assessments and Inspections Completed after December, 2007 or Not Reviewed by Previous Assessments (6 pages)

Document No.[a]	Title	Assessment / Inspection Description	Publication Date
RPP-RPT-57213, Rev. 0	*FFS Evaluation of the 242-A-JA-B-[C to 4-40] Jumper*	Analysis of a newly installed jumper containing flanged joints indicated potential over-stressing of all the flanges. Both the bolting material and flange material had been changed from the original design. The bolting material change was directed by the piping designer, but the flange material change was not known by the designer until "as-built" information was being incorporated. All piping joints were successfully pressure tested with water (no leaks) and a field Fitness-For-Service inspection indicated there was no physical damage to the flanges to prevent satisfactory operation.	04/30/2014
RPP-RPT-56896, Rev. 0	*Independent Qualified Registered Professional Engineer Design Assessment Report for 242-A [C to 4-40], [4 to 5/40 to 21], [D to 13A], [13A to 13], AND [C to 13] Jumpers*	Integrity assessment and IQRPE certification of design of jumpers [C to 4-40], [4 to 5/40 to 21], [D to 13A], [13A to 13], and [C to 13], identified in RPP-RPT-56895. Assessment concluded jumper designs were in compliance with applicable sections of WAC 173-303-640. Jumper design assessment were identified by integrity assessment plan RPP-RPT-56895.	05/06/2014
RPP-RPT-57227, Rev. 0	*Independent Qualified Registered Professional Engineer (IQRPE) Installation Assessment Report for 242-A [C to 4-40], [4 to 5/40 to 21], [D to 13A], [13A to 13], AND [C to 13] Jumpers*	Integrity assessment concluded that procurement, fabrication, installation and leak testing of 242-A jumpers *[C to 4-40], [4 to 5/40 to 21], [D to 13A], [13A to 13], and [C to 13]* were in compliance with WAC 173-303-640. Assessment scope was identified by integrity assessment plan RPP-RPT-56895.	05/06/2014
TFC-WO-14-(4729-4731)	• *Third Party Inspection* (E-C-1 Primary condenser – 4729) • *242-A (E-C-2) Third Party Inspection Inter Condens* (E-C-2 Inter-condenser – 4730) • *Third Party Inspection* (E-C-3 After-condenser – 4731)	Biennial third party inspection of E-C-1 Primary condenser, E-C-2 Inter-condenser, and E-C-3 After-condenser per ASME BPVC, Section VIII, and Engineering Standard TFC-ENG-STD-17, *Third Party Inspections*	11/24/2014

Table A-2. 242-A Evaporator System Integrity Assessments and Inspections Completed after December, 2007 or Not Reviewed by Previous Assessments (6 pages)

Document No.[a]	Title	Assessment / Inspection Description	Publication Date
RPP-PLAN-60068, Rev. 0	*IQRPE Inspection Plan Report P-B-2 Pump Skid Assembly*	Plan describes IQRPE and Qualified Independent Inspector oversight and review activities to be performed during procurement and fabrication of a spare P-B-2 Pump Skid Assembly. A spare AGI P-B-2 slurry pump, procured with American Recovery and Reinvestment Act funding, did not include a skid assembly. The spare P-B-2 pump will be attached to a newly fabricated skid assembly making it a functional spare.	01/05/2015
RPP-PLAN-60212, Rev. 0	*IQRPE Fabrication Assessment Report P-B-2 Pump Skid Assembly*	Scope of integrity assessment covered fabrication of the spare P-B-2 slurry pump skid, consisting of the AGI Engineering P-B-2 slurry pump assembly, the Pump Upper Frame Assembly, and fabrication and testing of new piping for the Pump Skid Assembly. The fabrication was certified compliant with the requirements of WAC 173-303-640. The fabrication assessment was identified in integrity assessment plan RPP-PLAN-60068.	04/08/2015
RPP-PLAN-60211, Rev. 0	*IQRPE Design Assessment Report P-B-2 Pump Skid Assembly*	Integrity assessment of the design of the P-B-2 Pump Skid Assembly and ancillary equipment (*i.e.,* the spare P-B-2 slurry pump, Model No. 3x1.5-SPVF150 Slurry Pump with Variable Frequency Drive, AGI Engineering, P.O. #40768; and PUREX 2-in. and 3-in. connectors). The design complies with applicable sections of WAC 173-303-640, with the exception of the P-B-2 pump pressure control system. The maximum P-B-2 pump pressure is higher than the design pressure of the system; pressure relief valve PSV-PB2-1 is credited with protecting the system from overpressurization. In order to meet WAC-173-303-640 requirements, the design will have to be modified to ensure the maximum design pressure is not exceeded. The design assessment was identified in integrity assessment plan RPP-PLAN-60068.	04/09/2015

Table A-2. 242-A Evaporator System Integrity Assessments and Inspections Completed after December, 2007 or Not Reviewed by Previous Assessments (6 pages)

Document No.[a]	Title	Assessment / Inspection Description	Publication Date
RPP-PLAN-60779, Rev. 0	*242-A Evaporator Independent Registered Qualified Engineer Assessment Plan FY 2017*	Plan for conducting 2017 integrity assessment in accordance with WAC 173-303-640(2) *Assessment of Existing Tank System's Integrity*	[Draft]
RPP-PLAN-60780, Rev. 0	*242-A Evaporator Inspection Plan*	Plan for visual inspection of primary and secondary containment boundaries, primary containment ultrasonic wall thickness measurements at grid positions used during previous assessments, and pressure test of PC-5000 process condensate system. Results will be available for review and historical trending during 2017 Integrity Assessment.	[Draft]

Table Notes and References:

[a] Table reflects all 242-A Evaporator integrity assessments performed after December, 2007, through March 28, 2016.

APPENDIX B

RPP-RPT-33306 2007 IQRPE INTEGRITY ASSESSMENT RECOMMENDATION STATUS

The last integrity assessment of 242-A Evaporator System was completed in December, 2007. Forty-five deficiencies were identified. Those identified by the IQRPE as requiring resolution prior to the next 242-A Evaporator campaign were completed. Minor deficiencies identified in the Integrity Assessment Report were determined by the IQRPE as not impacting the safe operation of the facility and were to be addressed as part of scheduled, routine maintenance and are not required to be addressed prior to 242-A Evaporator operation. All priority 1 repairs identified in RPP-RPT-33306 were completed prior to the 08-CR Cold Run (RPP-38856, *242-A Evaporator Startup Report: Cold Run Campaign 2008-CR*). Condenser Room secondary containment special protective coating deficiencies identified by the IQRPE and deficiencies identified following removal of the rubber floor matting were repaired prior to Campaign 09-0 1/09-02 in 2009 [RPP-44603, Rev. 1, *242-A Evaporator Startup Report: Campaigns 2010-01 & 2010-02 (AW-102/AW-106 Slurry*)].

Table B-1. RPP-RPT-33306 IQRPE Integrity Assessment Recommendations (6 pages)
(Source: RPP-RPT-33306, Rev. 0, Table 3.1 / RPP-44603, Rev. 1, Appendix A)

Item	Location	Observation	Recommendation	Priority	Work Package	Status
33306-11	Evaporator Room Basement (see also Secondary Containment System)	Multiple chips in floor coating (approx. 1" X 1”).	Repair coating over chips.	1	WFO-WO-07-1602	COMPLETE 08/03/08
33306-45	Pump Room	Nozzle E Leak	Tighten or replace in accordance with WFO-WO-07-2340.	1	WFO-WO-07-2340	COMPLETE 07/25/08
33306-44	Secondary Containment System, Evaporator Basement (see also evaporator room basement)	There are several small chips in the floor of the Evaporator Basement that could potentially impact to the integrity of the secondary containment subsystem in the future if not addressed. Chips of various sizes were observed; the larger chips measuring from 1” by 1” to 1” by 2”.	Repair and recoat chips.	1	WFO-WO-07-1602	COMPLETE 08/03/08
33306-32	Condensate Collection Subsystem	Damage to coating on the First Floor North Wall of condenser room.	Recoat.	2		COMPLETE 03/03/09
33306-33	Condensate Collection Subsystem	Staining on bottom 6” support wall on the First Floor West Wall.	Clean and recoat.	2	WFO-WO-07-1602	COMPLETE 03/03/09
33306-34	Condensate Collection Subsystem	Surface staining near drain and tank walls.	Clean and recoat.	2	WFO-WO-07-1602	COMPLETE 03/03/09
33306-4	Evaporator Pump Room	Paint chipped on P-B-1 support, crack in wall/wall coating.	Recoat supports.	2	WFO-WO-09-0233	NOT REQUIRED TO OPERATE

Table B-1. RPP-RPT-33306 IQRPE Integrity Assessment Recommendations (6 pages)
(Source: RPP-RPT-33306, Rev. 0, Table 3.1 / RPP-44603, Rev. 1, Appendix A)

Item	Location	Observation	Recommendation	Priority	Work Package	Status
33306-6	Evaporator Room Basement	Pipe hanger and bolts show surface corrosion; bolt pulled free from wall; nut loose; U-bracket corroded.	Identify line, re-anchor conduit hanger to wall, remove corrosion from hanger and replace bolts,	2	WFO-WO-07-1195	COMPLETE
33306-12	I Evaporator Room Basement	SS pressure line sensor not attached to uni-strut hanger; line is open ended.	Attach line to hanger or if abandoned, remove line.	2	WFO-WO-07-1195	COMPLETE
33306-18	Evaporator Room First Floor	2” SS Water line anchor bolt pulled out of wall.	Identify line, re-anchor conduit hanger to wall, remove corrosion from hanger, and replace bolts.	2	WFO-WO-07-1195	COMPLETE
33306-19	Evaporator Room First Floor	Concrete spalling and anchor possibly pulled away from wall, 2” SS Water line.	Identify line, inspect concrete and anchor to determine if anchor is firmly attached; repair if needed.	2	WFO-WO-07-1195	COMPLETE
33306-20	Evaporator Room First Floor	¾” Line unistrut™ anchor pulled away from north wall.	Identify line, reattach unistrut anchor.	2	WFO-WO-07-1195	COMPLETE
33306-23	Evaporator Room Fourth Floor	Pipeline appears to span two or more floors vertically with no anchoring (NW comer).	Verify adequate anchoring, support (anchor) vertical piping at every floor if necessary.	2	WFO-WO-07-1195	COMPLETE
33306-24	Evaporator Room Fourth Floor	Inner line sitting on anchor strut without bracket.	Secure line to anchor strut; identify line shown (appears to be a ½” FRW).	2	WFO-WO-07-1195	COMPLETE
33306-25	Evaporator Room Fourth Floor	Vertical structural support missing bolt.	Replace bolt.	2	WFO-WO-07-1195	COMPLETE
33306-13	Evaporator Room Ground Floor	Anchor bolt pulled out of wall.	Identify line, reanchor conduit hanger to wall, remove corrosion from hanger, and replace bolts.	2	WFO-WO-07-1195	COMPLETE

Table B-1. RPP-RPT-33306 IQRPE Integrity Assessment Recommendations (6 pages)
(Source: RPP-RPT-33306, Rev. 0, Table 3.1 / RPP-44603, Rev. 1, Appendix A)

Item	Location	Observation	Recommendation	Priority	Work Package	Status
33306-14	Evaporator Room Ground Floor	Loose U-anchor.	Replace U-bracket, ensure anchor nuts are tight.	2	WFO-WO-07-1195	COMPLETE
33306-15	Evaporator Room Ground Floor	Missing bolts; two bolts in four bolt flange, ¾ SS line connection.	Install any and all missing bolts.	2	WFO-WO-07-1195	COMPLETE
33306-16	Evaporator Room Ground Floor	Unistrut™ hanger for ¾ SS line pulling away from wall.	Secure hanger to wall.	2	WFO-WO-07-1195	COMPLETE
33306-21	Evaporator Room Third Floor	Bent hanger/anchor bolt pulled away from wall, 2” SS line (east wall)	Identify line, replace/re-anchor SS line.	2	WFO-WO-07-1195	COMPLETE
33306-22	Evaporator Room Third Floor	Nut on U-bolt appears to have pulled through 2” SS line anchor due to missing washers, U-bolt corroded. Anchor has pulled away from wall (east wall).	Place washers behind nuts, replace U-bolt, secure anchor to wall.	2	WFO-WO-07-1195	COMPLETE
33306-26	Condensate Collection Subsystem	Minor surface contamination/staining, possible scaling on the tank skirt of TK-C-100 condensate collection tank.	Recommended to clean the surface, monitor, and reassess the surface.	3		NOT REQUIRED TO OPERATE
33306-27	Condensate Collection Subsystem	Surface corrosion on cast iron (CS) flange bolts; rust on vent and drain lines; housing of F-C-1 is chipped.	Replace CS flange bolts with stainless steel (SS) when servicing; monitor and reassess; recoat chipped and corroded surface.	3		NOT REQUIRED TO OPERATE
33306-28	Condensate Collection Subsystem	Surface corrosion on CS flange bolts on foreground flange cover.	Replace CS flange bolts with SS when flange serviced; monitor flange connections for bolt breakage or flange leak.	3		NOT REQUIRED TO OPERATE

Table B-1. RPP-RPT-33306 IQRPE Integrity Assessment Recommendations (6 pages)
(Source: RPP-RPT-33306, Rev. 0, Table 3.1 / RPP-44603, Rev. 1, Appendix A)

Item	Location	Observation	Recommendation	Priority	Work Package	Status
33306-29	Condensate Collection Subsystem	Tool marks on foreground bolts.	Repaint bolts.	3		NOT REQUIRED TO OPERATE
33306-30	Condensate Collection Subsystem	Flange bolts on top flange on the 6” vapor line are corroded.	Replace bolts when flanges or lines are serviced/monitor flange connections for bolt breakage or flange leak.	3		NOT REQUIRED TO OPERATE
33306-31	Condensate Collection Subsystem	Appearance of missing and chipped paint on and near upper elbow, 6” vapor line.	Clean surface and repair coating.	3		NOT REQUIRED TO OPERATE
33306-35	Condensate Collection Subsystem	Lube oil leak below pump and motor.	Needs monitoring and maintenance.	3		NOT REQUIRED TO OPERATE
33306-36	Condensate Collection Subsystem	Staining below E-C-2.	Needs cleaning and painting if necessary.	3		NOT REQUIRED TO OPERATE
33306-37	Condensate Collection Subsystem	Staining and rust inside the tray at F-C-3.	Clean or replace tray.	3		NOT REQUIRED TO OPERATE
33306-38	Condensate Collection Subsystem	Surface staining on tank wall at several walls.	Needs cleaning and painting if necessary.	3		NOT REQUIRED TO OPERATE
33306-39	Condensate Collection Subsystem	Surface staining on support walls for P-C-100 and P-C-106.	Needs cleaning and painting if necessary.	3		NOT REQUIRED TO OPERATE

Table B-1. RPP-RPT-33306 IQRPE Integrity Assessment Recommendations (6 pages)
(Source: RPP-RPT-33306, Rev. 0, Table 3.1 / RPP-44603, Rev. 1, Appendix A)

Item	Location	Observation	Recommendation	Priority	Work Package	Status
33306-40	Condensate Collection Subsystem	Rust on seal pot bottom flange bolts.	Needs monitoring and maintenance.	3		NOT REQUIRED TO OPERATE
33306-41	Condensate Collection Subsystem	Lube oil leak below motoratTK-C-100 agitator flange.	Needs monitoring and maintenance.	3		NOT REQUIRED TO OPERATE
33306-42	Condensate Collection Subsystem	Surface staining on TK-C-100 tank top at flanges E, F, and H.	Needs monitoring and maintenance.	3		NOT REQUIRED TO OPERATE
33306-43	Condensate Collection Subsystem	White powder spots on valve #2 -33.	Needs cleaning and maintenance.	3		NOT REQUIRED TO OPERATE
33306-1	Evaporator Pump Room	Dark fluid in sump; scaling, white stain on floor; minor surface corrosion on floor; hairline crack on western wall	Clean floor surface to remove surface staining and corrosion; repair coating over crack.	3		NOT REQUIRED TO OPERATE
33306-2	Evaporator Pump Room	Minor surface corrosion P-B-1 pump CS flange bolts.	Monitor; replace CS flange bolts with SS when servicing.	3		NOT REQUIRED TO OPERATE
33306-3	Evaporator Pump Room	Minor dark staining on P-B-2 pump mounts and under pump.	Determine cause of staining and remove stains.	3		NOT REQUIRED TO OPERATE
33306-5	Evaporator Room Basement	Minor surface rust on valve actuator linkage.	Identify valve actuator shown; remove rust, recoat valve actuator linkage.	3		NOT REQUIRED TO OPERATE

Table B-1. RPP-RPT-33306 IQRPE Integrity Assessment Recommendations (6 pages)
(Source: RPP-RPT-33306, Rev. 0, Table 3.1 / RPP-44603, Rev. 1, Appendix A)

Item	Location	Observation	Recommendation	Priority	Work Package	Status
33306-7	Evaporator Room Basement	Surface corrosion on valve actuator to CA1-7 and supports.	Remove corrosion and recoat.	3		NOT REQUIRED TO OPERATE
33306-8	Evaporator Room Basement	Actuator linkage to CA1-7 is supported by pipe stand and restrained by U-hanger and loose pad underneath, creating groove in actuator linkage; support appears adequate (no stresses evident at base).	Another restraint or means to prevent grooving the actuator linkage should be considered.	3		NOT REQUIRED TO OPERATE
33306-9	Evaporator Room Basement	White staining on flange (upstream of Location 15, Line 6”DR-335-M9.	Identify source of staining and remove staining.	3		NOT REQUIRED TO OPERATE
33306-10	Evaporator Room Basement	Surface corrosion on actuator linkage and linkage support (valve ZS-CAI-9-2).	Remove corrosion and recoat.	3		NOT REQUIRED TO OPERATE
33306-17	Evaporator Room First Floor	Support nuts and bolts show surface corrosion.	Monitor; replace when support is serviced.	3		NOT REQUIRED TO OPERATE

Table Notes and References:

IQRPE Priority 1: Implement recommendation prior to next campaign.
IQRPE Priority 2: Implement recommendation as part of routine maintenance.
IQRPE Priority 3: Implementation of recommendation at the discretion of the unit.

APPENDIX C

242-A EVAPORATOR SYSTEM INTEGRITY ASSESSMENT – WAC 173-303-640(2) COMPLIANCE MATRIX

Table C-1. 242-A Evaporator System Integrity Assessment – WAC 173-303-640(2) Compliance Matrix (6 pages)

No.	WAC 173-303-640[b]	Plan for compliance per RPP-PLAN-60799
1	(2) Assessment of existing tank system's integrity (a) For each existing tank system, the owner or operator must determine that the tank system is not leaking or is unfit for use. Except as provided in (b) of this subsection, the owner or operator must obtain and keep on file at the facility a written assessment reviewed and certified by an IQRPE, in accordance with WAC 173-303-810(13)(a), that attests to the tank system's integrity by January 12, 1988, for underground tanks that do not meet the requirements of subsection (4) of this section and that cannot be entered for inspection, or by January 12, 1990, for all other tank systems.	• Tank system components will be assessed for compatibility with the various waste types to be treated, raw water used for system flushes, package boiler steam supply, and supplemental chemicals added to facilitate treatment. A comparison will be made of the waste types with the material compatibility tables published by NACE, ASME, or other applicable sources of material degradation data. The streams' chemical and physical characteristics will be assessed to demonstrate that the care and cautions used to maintain Evaporator System leak and structural integrity are appropriate. • Previous integrity assessments are documented in WHC-SD-WM-ER-124, 1994[a]; HNF-2905, 1998[b]; RPP-RPT-33306, 2007[c]; and RPP-RPT-33307, 2007[d]. These will be reviewed and additional emphasis placed on topics or features determined by the IQRPE to present chronic system concerns. • 242-A Evaporator System leak-tightness will be verified by the sump liquid level leak detection system, tank liquid level monitoring, and visual examination of the accessible external tank and piping and jumper surfaces.
2	(2)(b) Tank systems that store or treat materials that become dangerous wastes subsequent to January 12, 1989, must conduct this assessment within 12 months after the date that the waste becomes a dangerous waste.	• The 242-A Evaporator was shut down April, 1989 for upgrades, and resumed operation in April, 1994. The initial integrity assessment required for the 242-A Evaporator System, reported in WHC-SD-WM-ER-124, was completed during the extended outage. • Both the initial Integrity Assessment Plan, WHC-SD-WM-WP-062 and the Integrity Assessment Report, WHC-SD-WM-ER-124, were issued and approved by the IQRPE[e,f]. • The initial 242-A Evaporator System RCRA Dangerous Waste Permit Application was submitted to Ecology and the U.S. Environmental Protection Agency, June 26, 1991[g,h,i]. The Dangerous Waste Permit Application was submitted in fulfillment of HFFACO ("Tri-Party Agreement") milestone M-20-17 during the five-year outage, April, 1989 – April, 1994. • Subsequent 242-A Evaporator System integrity assessments were reported in 1998 (HNF-2905) and 2007 (RPP-RPT-33306 and RPP-RPT-33307).

Table C-1. 242-A Evaporator System Integrity Assessment – WAC 173-303-640(2) Compliance Matrix (6 pages)

No.	WAC 173-303-640[b]	Plan for compliance per RPP-PLAN-60799
3	(2) (c) This assessment must determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated, to ensure that it will not collapse, rupture, or fail. At a minimum, this assessment must consider the following: (i) design standard(s), if available, according to which the tank system was constructed.	Design codes, standards and analysis • The IQRPE will assess structural evaluations and loading conditions, processes and conclusions. The evaluation of adequacy of design will provide a thorough description of the national codes and standards used during design, construction, and inspection, calculations employed to determine the design strength of each structure, materials used in construction, construction methods employed, quality control, and testing performed on materials and the final structure, prior to being placed in service. Where archived codes are not available, current equivalent codes will be used • The structural stability of the ancillary equipment design will be assessed by reviewing the national codes and standards used during design, construction, and inspection, and verifying compliance with those codes and the design loads documents. • The IQRPE will review operation of the 242-A Evaporator System and DST system interfaces to the 242-A System for operating evolutions and designs having potential to generate overpressure transient (*i.e.*, water hammer) scenarios potentially compromising the primary confinement boundary, similar to the event documented in EM-RP--WRPS-TANKFARM-2010-0007. The evaluation, at the minimum, should consider the following analyses and assessments: RPP-RPT-45994[k]; RPP-47138[l]; RPP-CALC-54446[m]; RPP-RPT-47482[n]; RPP-CALC-54450[o]; RPP-CALC-54778[p]. • The IQRPE will review Occurrence and Off-Normal Reports that have affected the primary or secondary containment boundaries, their implications for service life, and effectiveness of their corrective actions to prevent reoccurrence. Reports are listed in Appendix D. • The design adequacy of the 242-A Evaporator System relative to the normal, off-normal, upset, or accident conditions has been assessed by design calculations or use of experience data, or the consequence of failure will be precluded by administrative controls. The structural analyses of record will be assessed and will include temperature effects on material properties and aging. • The detail and completeness of the design calculations and the quality control, testing, and inspection during construction will be assessed. • Where appropriate, analyses will be performed to demonstrate, by a combination of material behavior analyses and historical data, that 242-A Evaporator

Table C-1. 242-A Evaporator System Integrity Assessment – WAC 173-303-640(2) Compliance Matrix (6 pages)

No.	WAC 173-303-640[b]	Plan for compliance per RPP-PLAN-60799
		System components either have not experienced excessive general corrosion, pitting corrosion, flow-induced erosion, or SCC damage from the wastes, or have experienced damage at a slow rate. • Information obtained during the integrity assessment inspections and testing will be incorporated into this determination. An assessment will be performed that will permit conclusions to be made about current conditions and life expectancy of the tank system. • An overall plan will be developed for evaluation of the 242-A Evaporator System, including the PC-5000 process condensate system primary and secondary piping and leak detection.
4	(ii) Dangerous characteristics of the waste(s) that have been and will be handled	Waste characterization • The *Hanford Facility Resource Conservation and Recovery Act Permit*, WA7890008967, Part III, Operating Unit Group 4 Addendum B, *Waste Analysis Plan* identifies dangerous waste characteristics for the treatment process. • The waste characterization activities will be assessed to determine the extent to which the elements satisfy the permit requirements, and ensure compliance with specific administrative controls, safety, regulatory, programmatic and operational rules related to waste chemistry and waste properties.
5	(iii) Existing corrosion protection measures	Corrosion methodology and corrosion protection • The 242-A Evaporator System primary and secondary containment barrier design and materials of construction corrosion prevention effectiveness will be evaluated with respect to the system's operating practices and operating limits, DST waste feed characteristics, water and steam supply characteristics and liquid effluent discharges to determine effectiveness of existing corrosion protection practices. • 242-A Evaporator System primary confinement barrier wall thickness inspections performed in 1994, 1998, 2007 and 2016 will be analyzed and trended to identify service life limitations and areas subject to increased surveillance. • RPP-RPT-58646, Rev. 0, *Analysis of 242-A Evaporator Jumper Ultrasonic Testing Results*, reports wall thickness inspections of five 242-A Evaporator 2-in. and 3-in. ASTM A312 TP304L stainless steel Schedule 40 pipe jumpers (18-4, 19-5, C-4 and C-5, 13-K, and J-13A)

Table C-1. 242-A Evaporator System Integrity Assessment – WAC 173-303-640(2) Compliance Matrix (6 pages)

No.	WAC 173-303-640[b]	Plan for compliance per RPP-PLAN-60799
		completed in 2013. After inspection, Jumper 19-5 was reinstalled; the others were packaged for disposal[q]. • Acceptance envelope inferred as 7.4 ≤ pH ≤ 8.4 (RPP-RPT-58179, Section 4.4.1). 242-A Evaporator System raw water deep flush required ≤ 14 days of emptying C-A-1 of waste unless 242-A restarted within that time period. Deep flush consists of filling C-A-1 and recirculation loop with raw water, heating to 130ºF - 140ºF under ~165 torr vacuum four hours then dumping water to tank AW-102 (RPP-RPT-58179, Section 3.4; RPP-PLAN-60462[v], Section 3.3.6). • 242-A Evaporator System raw water supply acceptance envelope can also can be inferred from waste water effluent limits specified in State Waste Discharge Permit ST0004502, Section S1, from HNF-SD-W049H-ICD-001[x], Tables 1 – 3; and HNF-3172[aa], Sections 2.1 and 2.2. Corrosion methodology and corrosion protection • Process steam supply acceptance envelope for 90 psig and two 15 psig steam supplied by package boilers located in 242-BA is specified for E-A-1 Reboiler, E-C-2 inter-condenser and E-C-3 after-condenser discharge jet in TOC-ICD-JCI-00030, Rev. 1, Section 3.4.[ff] • 242-A Evaporator System process steam supply acceptance envelope can be inferred from waste water effluent limits specified in State Waste Discharge Permit ST0004502, Section S1, and HNF-3172, Sections 2.1 and 2.2. • Process condensate acceptance envelope can be inferred from the Effluent Treatment Facility process condensate effluent acceptance envelope specified in State RCRA Permit Part III, Operating Unit Group 3, Chapter 3.0, *Waste Analysis Plan*, Section III.3.C, *Waste Analysis, Part* I; *;* HNF-SD-W049H-ICD-001, Tables 1 – 3; and HNF-3172, Sections 2.1 and 2.2. • The use of antifoam delivered from tank E-102 to sprays located above the C-A-1 Vapor-Liquid Separator are discussed in HNF-14755[bb], Section 2.5.8.7.1; RPP-RPT-58179[u], Section 4.4.1; RPP-RPT-33491[u], *Section 3.3.1.0; and* CPS-T-149-00012[dd], Rev. C, Maximum volume specified. The maximum allowable volume per campaign is addressed in the campaign process control plan (*e.g.*, RPP-PLAN-60257[ee], Sections 3.1.2.1, 3.3.7 and 3.3.8).

Table C-1. 242-A Evaporator System Integrity Assessment – WAC 173-303-640(2) Compliance Matrix (6 pages)

No.	WAC 173-303-640[b]	Plan for compliance per RPP-PLAN-60799
6	(iv) Documented age of the tank system, if available (otherwise, an estimate of the age)	Age of 242-A System Primary Containment Boundary Equipment • RPP-RPT-33306, Section 2.8, discusses 242-A Evaporator system age, noting that the then current mission planning cycle included 242-A Evaporator System operation through 2034, 47 years beyond its original 10 year design life. • RPP-RPT-59046[y], Section 2.2 summarizes upgrades that have occurred since initial operation in 1977. • HNF-3327[z] Rev. 2 identifies upgrades necessary to extend the 242-A Evaporator System service life from 2019 to 2052. • RPP-RPT-33307, Section 2.5, PC-5000 process condensate transfer pipeline system age.
7	(v) Results of a leak test, internal inspection, or other tank system integrity examination such that: (A) For nonenterable underground tanks, the assessment must include a leak test that is capable of taking into account the effects of temperature variations, tank end deflection, vapor pockets, and high water table effects; and (B) For other than nonenterable underground tanks and for ancillary equipment, this assessment must include either a leak test, as described above, or other integrity examination, that is certified by an IQRPE, in accordance with WAC 173-303-810 (13)(a),[d] that addresses cracks, leaks, corrosion, and erosion.	Tank system integrity inspections • 242-A Evaporator System primary confinement barrier leak integrity tests performed in 1994, 1998, 2007 and 2016 will be analyzed and trended to identify service life limitations and areas subject to increased surveillance. • 242-A Evaporator System secondary confinement barrier leak integrity inspections performed in 1994, 1998, 2007 and 2016 will be analyzed and trended to identify service life limitations and areas subject to increased surveillance. • RPP-RPT-33306, Rev. 0, Table 3.1 identifies 45 deficiencies noted during the 2007 integrity assessment. RPP-44603, Rev. 1, Appendix A provides a disposition for each of the deficiences, including reference to the completion records.[gg] Minor deficiencies were determined by the IQRPE as not impacting the safe operation of the facility. These were to be addressed as part of scheduled, routine maintenance and were not required to be addressed prior to 242-A Evaporator operation. The IQRPE will review the adequacy of the completion actions, and bring forward to the 2017 IAR any 2007 IAR deficiencies found to be incompletely or inadequately addressed.
8	(2) (d) If, as a result of the assessment conducted in accordance with (a) of this subsection, a tank system is found to be leaking or unfit for use, the owner or operator must comply with the requirements of subsection (7) of this section.	During the assessment, the IQRPE will immediately notify WRPS of any component found to be leaking or unfit for use.

Table C-1. 242-A Evaporator System Integrity Assessment – WAC 173-303-640(2) Compliance Matrix (6 pages)

No.	WAC 173-303-640[b]	Plan for compliance per RPP-PLAN-60799
9	(2) (e) The owner or operator must develop a schedule for conducting integrity assessments over the life of the tank to ensure that the tank retains its structural integrity and will not collapse, rupture, or fail. The schedule must be based on the results of past integrity assessments, age of the tank system, materials of construction, characteristics of the waste, and any other relevant factors.	The assessment report will contain a recommendation for the repeat assessment schedule (*e.g.*, every 10 years).

Table Notes and References:

a. WHC-SD-WM-ER-124, Rev. 1, *The 242-A Evaporator-Crystallizer Tank System Integrity Assessment Report*

b. HNF-2905, Rev. 0, *1998 242-A Interim Evaporator Tank System Integrity Assessment Report*

c. RPP-RPT-33306, Rev. 0, *IQRPE Integrity Assessment Report for the 242-A Evaporator Tank System*

d. RPP-RPT-33307, Rev. 0, *IQRPE Integrity Assessment Report for the 242-A PC-5000 Transfer Pipeline*

e. WHC-SD-WM-AP-017, Rev. 1, *Tank Waste Remediation System Tank System Integrity Assessments Program Plan*

f. WHC-SD-WM-ER-124, Rev. 1, *The 242-A Evaporator/Crystallizer Tank System Integrity Assessment Report*

g. DOE/RL-90-42, Rev. 0, *242 Evaporator Dangerous Waste Permit Application*

h. Letter 91-EAB-157, *242-A Evaporator Dangerous Waste Permit Application (TSD: T-2-6)*

i. Letter 91-TPA-158, *242-A Evaporator Restart and Impacts on Hanford Federal Facility Agreement and Consent Order Milestone Commitments*

j. EM-RP--WRPS-TANKFARM-2010-0007, *242-A Evaporator Induced Water Hammer Event Does Not Represent a Potential Inadequacy of the Documented Safety Analysis*

k. RPP-RPT-45994, Rev. 0, *242-A PB-2 Pressure Relief Modification, Independent Integrity Assessment Report*

l. RPP-47138, Rev. 0, *Burst Rupture Disc PSE-PB2-1 at the 242-A Evaporator*RPP-CALC-54446, Rev. 0, *242-A Evaporator Peak Pressure Estimate*

m. RPP-CALC-54446, Rev. 0, *242-A Evaporator Peak Pressure Estimate*

n. RPP-RPT-47482, Rev. 0, *242-A Evaporator Slurry Jumper Modification Independent Integrity Assessment Report*

o. RPP-CALC-54450, Rev. 0, *Waterhammer Analysis on 242-A Evaporator to AW-106 Flush Pit*

p. RPP-CALC-54778, Rev. 0, *242-A Evaporator Steam Line Fluid Transient Determination and Full Vacuum Design*

q. *RPP-RPT-58646, Rev. 0, Analysis of 242-A Evaporator Jumper Ultrasonic Testing Results*

r. *RPP-RPT-52791, Rev. 0, Tank Farm Waste Transfer System Fitness-for-Service Erosion and Corrosion Bases*

s. OSD-T-151-00012, *Operating Specifications for the 242-A Evaporator*

t. OSD-T-151-00007, *Operating Specifications for the Double-Shell Tanks*

u. RPP-RPT-58179, Rev. 1, *Evaluation of Halide Stress Corrosion Cracking and Pitting in the 242-A E-A-1 Reboiler as it Relates to Operating Parameters and Tank Waste Chemistry*

Table C-1. 242-A Evaporator System Integrity Assessment – WAC 173-303-640(2) Compliance Matrix (6 pages)

No.	WAC 173-303-640[b]	Plan for compliance per RPP-PLAN-60799
v.	RPP-PLAN-60462, Rev. 0, *Process Control Plan for 242-A Evaporator Campaign EC-03 to Concentrate 241-AZ-102 Waste Blend*	
w.	State Waste Discharge Permit ST0004502 (200 Area Treated Effluent Disposal Facility)	
x.	HNF-SD-W049H-001, Rev. 11, *200 Area Treated Effluent Disposal Facility Interface Control Document*	
y.	RPP-RPT-59046, Rev. 0, *Capability of the 242-A Evaporator to Support A and AX Farm Retrieval*	
z.	HNF-3327, Rev. 2, *Engineering Study for the 242-A Life Extension Upgrades for Fiscal Years 2010 Through 2052*	
aa.	HNF-3172, Rev. 7, *Liquid Waste Processing Facilities Waste Acceptance Criteria*	
bb.	HNF-14755, Rev. 05, *242-A Evaporator Documented Safety Analysis*	
cc.	RPP-RPT-33491, Rev. 0, *Discussion of Antifoam and Foaming Issues at the 242-A Evaporator*	
dd.	CPS-T-149-00012, Rev. C, *Criticality Prevention Specification for Tank Farms Facilities*	
ee.	RPP-PLAN-60257, Rev. 0, *Process Control Plan for 242-A Evaporator Campaign EC-01 to Concentrate 241-AW-102 Waste*	
ff.	TOC-ICD-JCI-00030, Rev. 1, *Interface Control Document between Washington River protection Solutions (WRPS) The Tank Operations Contractor Contract No DE-AC27-08RV14800 and Johnson Controls, Inc (JCI) Hanford Energy Saving Performance Contractor Contract No. DE-AC06-97RL13184 Steam Deliver to the 242-A Evaporator*	
gg.	RPP-44603, Rev. 1, *242-A Evaporator Startup Report: Campaigns 2010-01 & 2010-02 (AW-102/AW-106 Slurry)*	

APPENDIX D

242-A EVAPORATOR SYSTEM POST-2007 EVENTS AFFECTING PRIMARY OR SECONDARY CONTAINMENT BOUNDARIES

Table D-1. 242-A Evaporator System Post-2007 Events Affecting Primary or Secondary Containment Boundaries (2 pages)

Report No.	Event Date	Title	Description
EM-RP--CHG-TANKFARM-2007-0014	11/09/2007	*242-A Evaporator Recirculation Pump P-B-1 Inadvertently Started And Operated Without Seal Water*	On Friday, November 9, 2007, the 242-A Evaporator recirculation pump PB-1 was inadvertently started and operated undetected without seal lubrication, monitoring or interlocks in violation of Operating Specifications Document (OSD) for the 242-A Evaporator Crystallizer. PB-1 was discovered running at 2150 hours on November 9, 2007. Immediate action was taken to open the pump disconnect (motor control center MCC-3), shutting down the pump. After opening the MCC disconnect, the PB-1 motor could be heard winding down. Management directed 242-A Evaporator maintenance and construction activities be immediately suspended. The cause of the pump start was determined to be a failed MCS relay. On February 4, 2008, CH2M HILL Hanford Group, Inc., received from the U.S. Department of Energy Office of River Protection (ORP), the results of the "Assessment of the 242-A Evaporator Recirculation Pump PB-1 Inadvertent Startup," conducted December 3 through December 7, 2007 (A-08-AMTF-TANKFARM-003).
EM-RP--WRPS-TANKFARM-2010-0002	03/15/2010	*Washington State Department of Ecology Issues Notice of Violation Following Dangerous Waste Permit Inspection of 242-A Evaporator*	On March 15, 2010, the Washington State Department of Ecology (Ecology) issued a Notice of Violation (NOV) to the U.S. Department of Energy, Office of River Protection (ORP) and Washington River Protection Solutions LLC (WRPS) resulting from the dangerous waste permit inspection of the 242-A Evaporator facility in July of 2009. Ecology found that ORP and WRPS were not in compliance with Revision 8C of the Hanford Facility Dangerous Waste Permit # WA7890008967 issued in accordance with the Hazardous Waste Management Act, Chapter 70.105 Revised Code of Washington and the dangerous waste regulations stated in Washington Administrative Code (WAC), Chapter 173-303. The NOV identified three permit violations and two concerns based on the permit conditions for dangerous waste management and review of the 242-A Evaporator operating records.
EM-RP--WRPS-TANKFARM-2010-0007	04/29/2010	*242-A Evaporator Induced Water Hammer Event Does Not Represent a Potential Inadequacy of the Documented Safety Analysis*	On April 29, 2010, while performing a pressure test of the SL-167 transfer line, the P-B-2 Overpressure Protection System rupture disk (PSE-PB2-1) providing pressure relief for the P-B-2 pump discharge piping located in the 242-A Evaporator Pump Room ruptured. This rupture caused approximately 200 gallons of raw water to discharge into the 242-A Pump Room sump causing a pump room sump level high- high alarm. Upon indication of the rupture, pressure testing was secured and systems were configured in a safe condition. The rupture disc actuation was caused by an induced water hammer event.

Table D-1. 242-A Evaporator System Post-2007 Events Affecting Primary or Secondary Containment Boundaries (2 pages)

Report No.	Event Date	Title	Description
EM-RP--WRPS-TANKFARM-2011-0002	01/19/2011	*Primary Jumper Piping Hydrostatic Leak Test Pressures May Not Be ASME B31.3 Compliant (Positive USQ)*	Certain waste transfer primary piping jumpers use a stainless steel whose allowable yield stress is decreased at design temperatures relative to hydrostatic leak test temperatures. For this situation, ASME B31.3 requires the hydrostatic leak test pressure to be increased. It has been discovered that the leak test pressure used for some affected piping jumpers is less than required by ASME B31.3. This calls into question compliance with ASME B31.3. The functional requirement of waste transfer primary piping systems is to prevent leaks. The Documented Safety Analysis (DSA) states that compliance with this functional requirement is demonstrated, in part, by performing leak testing in accordance with ASME B31.3. Because compliance with ASME B31.3 leak test requirements is in question, the piping jumpers' ability to perform their safety function is called into question without additional evaluation.
EM-RP--WRPS-TANKFARM-2011-0011	05/05/2011	*Potential To Exceed Safety Significant Primary Piping Systems Published Test Pressure Represents a Positive Unreviewed Safety Question (USQ)*	Water hammer is a dynamic effect that could affect the structural integrity of the safety-significant primary piping systems. A water hammer occurred at the 242-A Evaporator on April 29, 2010 resulting in the failure of a rupture disc during leak testing of a piping system. As a result of the rupture disc failure, flow transients that could result in water hammer were evaluated for all of tank farms in technical evaluation TE-10-059, Rev. 0, *Technical Evaluation for Transient Flow.* On May 05, 2011, Base Operations' Shift Operations was notified that the Plant Review Committee (PRC) has determined the condition documented in Problem Evaluation Request WRPS-PER-2011-0793, *Potential for Exceeding Published Test Pressure*, represented a potential inadequacy in the documented safety analysis (PISA) to the Tank Farm Documented Safety Analysis (DSA). As a result of the required unreviewed safety question (USQ) determination, a positive USQ was later declared on July 26, 2011.
EM-RP--WRPS-TANKFARM-2014-0005	04/02/2014	*242-A Evaporator C-A-1 Vessel Feed Or Dump Valve Failure Due To High Temperature May Prevent Controlled Shutdown (USQ)*	Based on the locations of the safety-significant structures, systems, and components (SSC) comprising the C-A-1 evaporator vessel's flammable gas control system, waste high level control system, and seismic dump system, and the postulated fires described in the 242-A Evaporator's hazards analysis document HNF-SD-WM-FHA-024, "Fire Hazards Analysis for the Evaporator Facility (242-A)," a new failure mechanism has been identified where a fire in the 242-A Evaporator's condenser room may prevent the safe shutdown of the 242-A Evaporator (*i.e.*, achieving the Shutdown Mode or Limited Waste Mode) due to a high temperature failure of the solenoids that actuate the feed valve (HY-CA1-1A) and the dump valves (HY-CA1-7A and HY-CA1-9A) that are located in the condenser room.