REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**116-8054**
SRP Section:	**14.03.08 – Radiation Protection Inspections, Tests, Analyses, and Acceptance Criteria**
Application Section:	**Tier 1, Various Sections**
Date of RAI Issue:	**07/27/2015**

Question No. 14.03.08-7

10 CFR 20.1406(b) requires that applicants for standard design certifications, standard design approvals, and manufacturing licenses under part 52 of this chapter, whose applications are submitted after August 20, 1997, shall describe in the application how facility design will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

SRP Section 14.3 indicates that the purpose of inspections, tests, analysis, and acceptance criteria (ITAAC), is to verify that a facility referencing the design certification is built and operates in accordance with the design certification and applicable regulations.

In addition, SRP Section 14.3.8 indicates that the reviewer should ensure that Tier 1 identifies and describes, commensurate with their safety significance, those SSCs that provide radiation shielding, confinement or containment of radioactivity, ventilation of airborne contamination, or radiation (or radioactivity concentration) monitoring for normal operations and during accidents.

In reviewing Tier 1 ITAAC, staff could not find any ITAAC for design features to minimize contamination. In accordance with 10 CFR 20.1406(b), please provide ITAAC for significant design features to address leaks from high specific activity fluids (such as Reactor

Coolant System water, Spent Fuel Pool coolant or concentrated liquid waste) or from high volume, low specific activity fluids (such as diluted liquid radioactive waste).

Response – (Rev.1)

The following ITAAC, summarized in Table 1 below, will be added to the corresponding DCD Tier 1 subsections and ITAAC Tables to ensure significant design features are built to minimize contamination.

Reactor Coolant System

DCD Tier 2 Subsection 5.2.5 describes reactor coolant pressure boundary leakage detection methods for unidentified and identified leakages. DCD Tier 1 Subsection 2.4.7 summarizes the leakage detection systems used for the RCS. ITAAC for some of the significant leak detection features are presented in Table 2.4.7-1 and include the containment sump level monitor, containment airborne particulate radioactivity monitor, and containment atmosphere humidity monitor.

In addition, steam generator blowdown radiation monitors are discussed in DCD Tier 2 Subsection 11.5.2.3, sub-item c, and are included in DCD Tier 1 Subsection 2.7.6.4, Table 2.7.6.4-1. It has been determined that the ITAAC to test the N-16 monitors will not be added as originally proposed since it is expected to be repetitive to other more general ITAAC in Table 2.7.6.4-3 which are being revised as the result of various Chapter 11 RAIs.

Chemical and Volume Control System (CVCS)

CVCS is designed to comply with 10 CFR 20.1406 as discussed in DCD Tier 2 Subsection 9.3.4.2.10. The holdup tank, boric acid storage tank (BAST), and reactor makeup water tank (RMWT) are located outside in a tank house which is designed with a sloped floor coated with epoxy to facilitate draining and cleaning. The tank house is equipped with a sump that contains level switches to detect leakage and overflow. This leak detection design feature is considered significant and additional ITAAC will be added to DCD Tier 1 Subsection 2.7.2.5 Table 2.7.2.5-4 as presented in Table 3 below.

Spent Fuel Pool Liner (SFP) Leak Detection

The spent fuel pool is designed to be equipped with a leakage detection feature for the liner seam welds, which is discussed in DCD Tier 2 Subsection 9.1.3.2.3 and DCD Tier 1 Subsection 2.7.4.3. An ITAAC will be added to Table 2.7.4.3-4 for the SFP liner leak detection system as presented in Table 4 below.

Liquid Waste Management System (LWMS)

The LWMS is designed in accordance with NRC RG 4.21 and is discussed in DCD Tier 2 Section 11.2. Waste collection tanks are located in cubicles designed with early leak detection features to minimize spread of contamination and discharge as discussed in Subsection 11.2.2.4. Radioactive effluent releases are monitored by redundant radiation monitors on the single discharge line. ITAAC for the dual radiation monitors is included in DCD Tier 1 subsection 2.7.6.1 Table 2.7.6.1-2, sub-item 6. Three additional ITAAC will be added for the leak detection design of the floor drain tanks, equipment drain tanks, and monitor tanks as presented in Table 5 below.

Table 1 Summary List of Additional ITAAC

System	Significant Leak Detection Feature	DCD Tier 1 Subsection	DCD Tier 1 Table
Reactor Coolant System	Steam generator blowdown radiation monitor	2.7.6.4	Table 2.7.6.4-3
	Main Steam line N-16 radiation monitor	2.7.6.4	Table 2.7.6.4-3
Chemical and Volume Control System	Tank house sump for holdup tank, BAST, and RMWT leak detection system	2.7.2.5	Table 2.7.2.5-4
SFPCCS	Spent fuel pool liner leak detection system	2.7.4.3	Table 2.7.4.3-4
Liquid Waste Management System	Floor drain tank leak detection system	2.7.6	Table 2.7.6.1-2
	Equipment drain tank leak detection system	2.7.6	Table 2.7.6.1-2
	Monitor tank leak detection system	2.7.6	Table 2.7.6.1-2

Table 2 Description of Additional RCS ITAAC for DCD Tier 1 Table 2.7.6.4-3

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
8. The steam generator blowdown radiation monitor provides an alarm in the MCR of high radioactive contamination and isolation signal to blowdown valve	8. A signal test is conducted to verify the radiation monitor setpoint and alarm and isolation functions in the MCR.	8. Upon detection of high radiation levels above the predetermined setpoint, the steam generator blowdown monitor provides an alarm in the MCR and closes the blowdown valve, isolating the blowdown system.

Table 3 Description of Additional CVCS ITAAC for DCD Tier 1 Table 2.7.2.5-4

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
9. Leak detection design for the tank house sump for holdup tank, BAST and RMWT provides an alarm in MCR of liquid detection	9. Inspection of the as-built leak detection system and signal test is conducted to verify the alarm in the MCR.	9. The as built leak detection instrumentation is installed as designed; and the alarm is verified in the MCR.

Table 4 Description of Additional SFP ITAAC for DCD Tier 1 Table 2.7.4.3-4

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
13. Spent fuel pool liner leak detection design provides visual indication of liner leak	13. Inspection of integrity of glass gauge to assure clarity and upstream valve position to facilitate liquid collection for leak detection.	13. A report concludes that the as-built leak detection is installed as designed; and leak detection glass gauge and valves are verified for clarity and open position to facilitate leakage inspection.

Table 5 Description of Additional LWMS ITAAC for DCD Tier 1 Table 2.7.6.1-2

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
7. Leak detection design for floor drain tanks provides an alarm in MCR and RCR of liquid detection	7. Inspection of the as-built leak detection system, and signal test will be conducted to verify the alarm in the MCR and radwaste control room	7. The as built leak detection instrumentation is installed as designed; and the alarm is verified in the MCR and radwaste control room
8. Leak detection design for equipment waste tanks provides an alarm in MCR and RCR of liquid detection	8. Inspection of as-built leak detection system, and signal test will be conducted to verify alarm in MCR and radwaste control room	8. The as built leak detection instrumentation is installed as designed; and the alarm is verified in the MCR and radwaste control room
9. Leak detection design for monitor tanks provides an alarm in MCR and RCR of liquid detection	9. Inspection of as-built leak detection system, and signal test will be conducted to verify alarm in radwaste control room	9. The as built leak detection instrumentation is installed as designed; and the alarm is verified in the MCR and radwaste control room

---

Impact on DCD

DCD Tier 1, Table 2.7.2.5-4, 2.7.4.3-4, 2.7.6.1-2, 2.7.6.4-3 and the corresponding subsections will be revised,as indicated in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical or Environmental Report.

2.7.2.5 Equipment and Floor Drainage System

2.7.2.5.1 Design Description

The equipment and floor drainage system (EFDS) has no safety function except the containment isolation and flooding level detection capability. The EFDS collects radioactive and potentially radioactive liquid waste at atmospheric pressure, from equipment and floor drainage of the reactor containment building, auxiliary building, compound building, and the turbine generator building, and transports liquid waste to the liquid waste management system (LWMS). All drainages are conveyed by gravity to their respective building sumps and are then pumped to the LWMS. Radioactive contamination in turbine generator building sump is continuously monitored by a radiation monitor and alarmed in the main control room (MCR) during normal operations for radioactivity. Upon detecting any radioactivity in the discharge, the discharge is manually terminated and is routed to the floor drain tanks of LWMS.

CVCS yard tanks.

The EFDS has the following safety-related functions:

1. Preserve containment integrity by the one fail-closed and the one fail-lock air operated containment isolation valves of the EFDS lines penetrating the containment.

2. Preserve flooding level detection capability by means of measuring flooding level in the engineering safety feature (ESF) pump rooms and the floors of Quadrants A, B, C, and D in auxiliary building.

To meet above functional requirements, the EFDS is designed as follows:

1. The functional arrangement of the EFDS is as described in the Design Description of Subsection 2.7.2.5.1 and in Table 2.7.2.5-1 and as shown in Figure 2.7.2.5-1.

2.a The ASME Code components identified in Table 2.7.2.5-2 are designed and constructed in accordance with ASME Section III requirements.

2.b The ASME Code piping including supports identified in Table 2.7.2.5-1 is designed and constructed in accordance with ASME Section III requirements.

7.c All displays and alarms required by the design exist in the MCR as defined in Table 2.7.2.5-3.

7.d All displays and alarms required by the design exist in the RSR defined in Table 2.7.2.5-3.

8. The moderate-energy piping systems are reconciled with pipe rupture hazards analyses report to ensure that the safety-related SSCs are protected against or are qualified to withstand the environmental effects associated with postulate failures of these piping systems.

9. Leak detection design for the tank house sump for holdup tank, BAST, and RMWT provides an alarm in MCR of liquid detection.

2.7.2.5.2 Inspections, Tests, Analyses, and Acceptance Criteria

The inspections, tests, analyses, and associated acceptance criteria for the equipment and floor drainage system specified in Table 2.7.2.5-4.

The ITAAC associated with the EFDS components and piping that comprise a portion of the containment isolation system are described in Table 2.11.3-2.

Table 2.7.2.5-4 (4 of 4)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
6.a MOV and AOV identified in Table 2.7.2.5-2 perform an active safety function to change position as indicated in the table.	6.a.i MOV and AOV will be performed that demonstrate the capability of the valve to operate under its design conditions.	6.a.i A test report exists and concludes that each MOV or AOV changes position as indicated in Table 2.7.2.5-2 under design conditions.
	6.a.ii Test and/or analyses of the as-built MOV and AOV will be performed under pre-operational flow, differential pressure, and temperature conditions.	6.a.ii Upon receipt of the actuating signal, each MOV or AOV changes position as indicated in Table 2.7.2.5-2 under pre-operational test conditions.
6.b After loss of motive power, MOV and AOV identified in Table 2.7.2.5-2 assume the indicated loss of motive power position.	6.b Test of the as-built MOV and AOV will be performed under the conditions of loss of motive power.	6.b Upon loss of motive power, each as-built MOV or AOV identified in Table 2.7.2.5-2 assumes the indicated loss of motive power position.
7.a All controls required by the design exist in the MCR to open and close MOV and AOV identified in Table 2.7.2.5-2.	7.a Tests will be performed using the controls in the MCR.	7.a All controls in the as-built MCR open and close the MOV and AOV identified in Table 2.7.2.5-2.
7.b All controls required by the design exist in the RSR to open and close MOV and AOV identified in Table 2.7.2.5-2.	7.b Tests will be performed using the controls in the RSR.	7.b All controls in the as-built RSR open and close the MOV and AOV identified in Table 2.7.2.5-2.
7.c All displays and alarms required by the design exist in the MCR as defined in Table 2.7.2.5-3.	7.c Inspections will be performed on the displays and alarms in the MCR.	7.c All displays and alarms exist and can be retrieved in the MCR as defined in Table 2.7.2.5-3.
7.d All displays and alarms required by the design exist in the RSR as defined in Table 2.7.2.5-3.	7.d Inspections will be performed on the displays and alarms in the RSR.	7.d All displays and alarms exist and can be retrieved in the RSR as defined in Table 2.7.2.5-3.
8. The moderate-energy piping systems are reconciled with pipe rupture hazards analyses report to ensure that the safety-related SSCs are protected against or are qualified to withstand the environmental effects associated with postulate failures of these piping systems.	8. Inspections and analyses of the as-built moderate-energy piping and safety-related SSCs will be performed.	8. Pipe rupture hazard analysis report exits and concludes that the as-built safety-related SSCs are protected against or are qualified to withstand the effects of postulated pipe failures of the as-built moderate-energy piping system.

Add "A" after this table

RAI 116-8054 - Question 14.03.08-7

RAI 116-8054 - Question 14.03.08-7, Rev.1

A

9. Leak detection design for the tank house sump for holdup tank, BAST, and RMWT provides an alarm in MCR of liquid detection	9. Inspection of the as-built leak detection system and signal test is conducted to verify the alarm in the MCR.	9. ~~A report concludes that the as-built leak detection is installed as designed; and concludes that the alarm is consistent with the setpoint.~~

The as built leak detection instrumentation is installed as designed; and the alarm is verified in the MCR

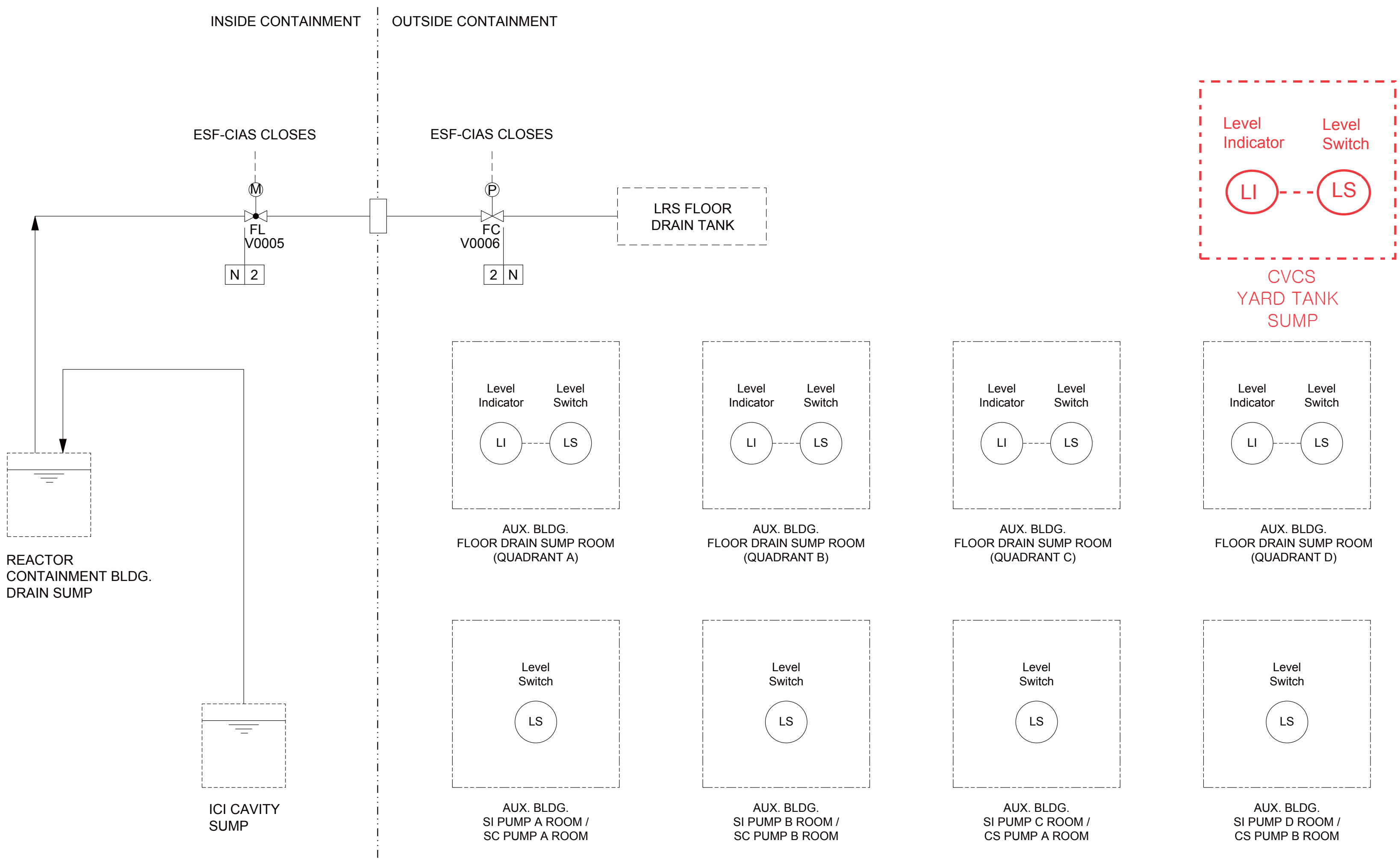

Figure 2.7.2.5-1 Equipment and Floor Drainage System

8.d All displays and alarms exist in the RSR as defined in Tables 2.7.4.3-2 and 2.7.4.3-3.

9. The two mechanical divisions of the SFPCS are physically separated except for the cross-connect line between SFP cooling pump suction, discharge lines.

10. The SFPCCS provides heat removal capacity to remove the decay heat generated by spent fuel assemblies.

11. The SFP cooling pumps have sufficient net positive suction head (NPSH).

12. The moderate-energy piping systems are reconciled with pipe rupture hazards analyses report to ensure that the safety-related SSCs are protected against or are qualified to withstand the environmental effects associated with postulate failures of these piping systems.

13. Spent fuel pool liner leak detection design provides visual indication of liner leak.

2.7.4.3.2 Inspections, Tests, Analyses, and Acceptance Criteria

The inspections, tests, analyses, and associated acceptance criteria for the SFPCCS are specified in Table 2.7.4.3-4.

The ITAAC related to the CIVs and the piping between CIVs of the SFPCCS are described in Table 2.11.3-2.

Table 2.7.4.3-4 (6 of 6)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
11. The SFP cooling pumps have sufficient net positive suction head (NPSH).	11. Test to measure the as-built SFP cooling pump suction pressure will be performed. Inspection and analysis to determine NPSH available to each pump will be performed based on test data and as-built data.	11. A report exists and concludes that the as-built calculated NPSH available exceeds each SFP cooling pump's required NPSH.
12. The moderate-energy piping systems are reconciled with pipe rupture hazards analyses report to ensure that the safety-related SSCs are protected against or are qualified to withstand the environmental effects associated with postulate failures of these piping systems.	12. Inspections and analyses of the as-built moderate-energy piping and safety-related SSCs will be performed.	12. Pipe rupture hazard analysis report exits and concludes that the as-built safety-related SSCs are protected against or are qualified to withstand the effects of postulated pipe failures of the as-built moderate-energy piping system.

Add "B" after this table

B

13. Spent fuel pool liner leak detection design provides visual indication of liner leak	13. Inspection of integrity of glass gauge to assure clarity and upstream valve position to facilitate liquid collection for leak detection.	13. A report concludes that the as-built leak detection is installed as designed; and leak detection glass gauge and valves are verified for clarity and open position to facilitate leakage inspection.

1. The functional arrangement of the LWMS is as described in the Design Description of Subsection 2.7.6.1.1 and in Table 2.7.6.1-1 and as shown in Figure 2.7.6.1-1.

2. The LWMS has the sole liquid discharge line which is equipped with dual radiation monitors and an automatic discharge valve. The valve is to automatically close upon detection of a high radioactivity level in the liquid effluent that exceeds a predetermined setpoint.

3. The LWMS uses two (2) trains of industry-proven R/O technologies. The R/O trains are sized adequately to remove radionuclides to maintain radioactivity in the liquid releases within regulatory limits. Three (3) demineralizers in each demineralizer module are added to polish the permeate to further remove any residual nuclides in the effluent.

4. The LWMS uses two (2) sets of monitor tanks and pumps. The tanks are provided with eductors to thoroughly mix the tank content for sampling and analysis to confirm that the contamination level in the treated effluent is below the regulatory limits for discharge. Dual radiation monitors are provided to continuously monitor the radiation levels during discharge operation and alarm in the MCR and radwaste control room upon detection of a high radioactivity level.

5. The LWMS components are classified as RW-IIa, RW-IIb and RW-IIc in accordance with NRC RG 1.143 and designed to the corresponding requirements in order to maintain structural integrity under the design basis loads. Component Radiation Safety Classification is summarized in Table 2.7.6.1-1.

6. Dual radiation monitors and an isolation valve are provided on the LWMS sole discharge line.

7. Leak detection design for floor drain tank provides an alarm in MCR and RCR of liquid detection.
8. Leak detection design for equipment waste tank provides an alarm in MCR and RCR of liquid detection.
9. Leak detection design for monitor tank provides an alarm in MCR and RCR of liquid detection.

2.7.6.1.2 <u>Inspections, Tests, Analyses, and Acceptance Criteria</u>

The ITAAC for the LWMS is described in Table 2.7.6.1-2.

s

Table 2.7.6.1-2 (2 of 2)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
4. The LWMS uses two (2) sets of monitor tanks and pumps. The tanks are provided with eductors to thoroughly mix the tank content for sampling and analysis to confirm that the contamination level in the treated effluent is below the regulatory limits for discharge. Dual radiation monitors are provided to continuously monitor the radiation levels during discharge operation and alarm in the MCR and radwaste control room upon detection of a high radioactivity level.	4. Tests of the radiation monitor alarm signal will be performed to verify that signal is annunciated in the MCR and radwaste control room using simulated test signals at the required setpoint.	4. An alarm from the radiation monitor at the liquid waste discharge line can be retrieved in the as-built MCR.
5. The LWMS components are classified as RW-IIa, RW-IIb and RW-IIc in accordance with NRC RG 1.143 and designed to the corresponding requirements in order to maintain structural integrity under the design basis loads. Component Radiation Safety Classification is summarized in Table 2.7.6.1-1.	5. Inspection will be performed for the as-built equipment per design specifications to verify that the as-built equipment construction (thicknesses and supports) and anchor bolt sizes meet or exceed the design specifications and Owner Engineer approved fabrication drawings.	5. A report concludes that the equipment classified as RW-IIa, RW-IIb and RW-IIc in Table 2.7.6.1-1 maintains structural integrity under the design basis loads.
6. Dual radiation monitors and an isolation valve are provided on the LWMS sole discharge line.	6. Inspection will be performed for the installation of dual radiation monitors and an isolation valve, and signal tests will be conducted to verify alarm, pump shut-off, and valve closure.	6. A report concludes that the as-built radiation monitors and isolation valve are installed as designed and verify alarm, pump shut-off, and valve closure by signal tests that are established consistent with the radiation monitor setpoints.

ADD "C" after this table

RAI 116-8054 - Question 14.03.08-7

RAI 116-8054 - Question 14.03.08-7, Rev.1

C

7. Leak detection design for floor drain ~~tank~~ provides an alarm in MCR and RCR of liquid detection	7. Inspection of the as-built leak detection system, and signal test will be conducted to verify the alarm in the MCR and radwaste control room	7. ~~A report concludes that the as-built leak detection is installed as designed and concludes that the alarm is consistent with the leak detection setpoint~~.
8. Leak detection design for equipment waste ~~tank~~ provides an alarm in MCR and RCR of liquid detection	8. Inspection of as-built leak detection system, and signal test will be conducted to verify alarm in MCR and radwaste control room	8. ~~A report concludes that the as-built leak detection are installed as designed and verify alarm by signal tests that are consistent with the leak detection setpoint.~~
9. Leak detection design for monitor ~~tank~~ provides an alarm in MCR and RCR of liquid detection	9. Inspection of as-built leak detection system, and signal test will be conducted to verify alarm in radwaste control room	9. ~~A report concludes that the as-built leak detection are installed as designed and verify alarm by signal tests that are consistent with the leak detection setpoint.~~

tanks

The as built leak detection instrumentation is installed as designed; and the alarm is verified in the MCR and radwaste control room

5. The safety-related divisional cabinet (SRDC) of the PERMSS provides an automatic ESF initiation signals, as shown on Table 2.7.6.4-2.

6. The seismic category I monitors identified in Table 2.7.6.4-1 can withstand seismic design basis loads without loss of safety function.

7. Separation is provided between Class 1E divisions, and between Class 1E division and non-Class 1E division.

8. The steam generator blowdown radiation monitor provides an alarm in the MCR of high radioactive contamination and isolation signal to blowdown valve.

9. ~~Main steam line N-16 radiation monitor provides an alarm in MCR of high radioactive contamination.~~

2.7.6.4.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.7.6.4-3 specifies the inspections, tests, analyses, and associated acceptance criteria for the process and effluent radiation monitoring and sampling system.

Table 2.7.6.4-3 (2 of 2)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
6. The seismic Category I monitors identified in Table 2.7.6.4-1 can withstand seismic design basis loads without loss of safety function.	6.a. Inspections will be performed to verify that the as-built seismic Category I monitor identified in Table 2.7.6.4-1 is located in seismic Category I structure	6.a. The as-built seismic Category I monitor identified in Table 2.7.6.4-1 is located in a seismic Category I structure.
	6.b. Type test, analyses, or a combination of type tests and analyses of seismic Category I monitor identified in Table 2.7.6.4-1 will be performed.	6.b. A report exists and concludes that the seismic Category I monitor identified in Table 2.7.6.4-1 withstands seismic design basis loads without loss of safety function.
	6.c. Inspections and analyses will be performed to verify that the as-built seismic Category I monitor identified in Table 2.7.6.4-1 including anchorages is seismically bounded by the tested or analyzed conditions.	6.c. A report exists and concludes that the seismic Category I monitor identified in Table 2.7.6.4-1 including anchorages is seismically bounded by the tested or analyzed conditions.
7. Separation is provided between Class 1E divisions, and between Class 1E division and non-Class 1E division.	7. Inspection of the as-built Class 1E divisions will be performed.	7. Physical separation or electrical isolation exists in accordance with NRC RG 1.75 between these Class 1E divisions, and also between class 1E division and non-class 1E division.

Add "D" after this table

RAI 116-8054 - Question 14.03.08-7

RAI 116-8054 - Question 14.03.08-7, Rev.1

D

8. The steam generator blowdown radiation monitor provides an alarm in the MCR of high radioactive contamination and isolation signal to blowdown valve	8. A signal test is conducted to verify the radiation monitor setpoint and alarm and isolation functions in the MCR.	8. ~~A report concludes that the as-built radiation detection is functional as designed; and verifies radiation detection alarm by signal tests to be consistent with the setpoint.~~
9. ~~Main Steam line N-16 radiation monitor provides an alarm in MCR of high radioactive contamination~~	~~9. A signal test is conducted to verify the radiation monitor setpoint and alarm function in the MCR.~~	~~9.~~ ~~A report concludes that the as-built radiation detection is functional as designed; and concludes that the radiation detection alarm to be consistent with the setpoint.~~

Delete

Delete

Delete

Upon detection of high radiation levels above the predetermined setpoint, the steam generator blowdown monitor provides an alarm in the MCR and closes the blowdown valve, isolating the blowdown system.