From:	WELLS Russell D (AREVA NP INC) [Russell.Wells@areva.com]
Sent:	Thursday, August 27, 2009 6:27 PM
To:	Tesfaye, Getachew
Cc:	Pederson Ronda M (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); SLIVA Dana (AREVA NP INC)
Subject:	Response to U.S. EPR Design Certification Application RAI No. 228, FSAR Ch 12, Supplement 1
Attachments:	RAI 228 Supplement 1 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to Part 1 of one of the two questions of RAI No. 228 on July 7, 2009. The attached file, "RAI 228 Supplement 1 Response US EPR DC.pdf " provides technically correct and complete responses to the remaining 2 questions, as committed.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 228 Questions 12.03-12.04-9 (Parts 2 – 4) and 12.03-12.04-10.

The following table indicates the respective pages in the response document, "RAI 228 Supplement 1 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 228 — 12.03-12.04-9	2	6
RAI 228 — 12.03-12.04-10	7	9

This concludes the formal AREVA NP response to RAI 228, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

(Russ Wells on behalf of)
Ronda Pederson

ronda.pederson@areva.com
Licensing Manager, U.S. EPR Design Certification
New Plants Deployment
AREVA NP, Inc.
An AREVA and Siemens company
3315 Old Forest Road
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From: Pederson Ronda M (AREVA NP INC)
Sent: Tuesday, July 07, 2009 5:53 PM
To: 'Getachew Tesfaye'
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); WILLIFORD Dennis C (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 228, FSARCh. 12

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 228 Response US EPR DC.pdf" provides a technically correct and complete response to Part 1 of one of the two questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 228 Question 12.03-12.04-9.

The following table indicates the respective pages in the response document, "RAI 228 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 228 — 12.03-12.04-9	2	3
RAI 228 — 12.03-12.04-10	4	5

A complete answer is not provided for 2 of the questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 228 — 12.03-12.04-9 (Parts 2 – 4)	August 27, 2009
RAI 228 — 12.03-12.04-10	August 27, 2009

Sincerely,

Ronda Pederson

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From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Friday, June 05, 2009 5:44 PM
To: ZZ-DL-A-USEPR-DL
Cc: Sara Bernal; Timothy Frye; Jason Jennings; Joseph Colaccino; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 228 (2755), FSARCh. 12

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on May 15, 2009, and on May 27, 2009, you informed us that the RAI is clear and no further clarification is needed. As a result, no change is made to the draft RAI. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP

(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 766

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Subject: Response to U.S. EPR Design Certification Application RAI No. 228, FSAR Ch 12, Supplement 1
Sent Date: 8/27/2009 6:27:12 PM
Received Date: 8/27/2009 6:27:16 PM
From: WELLS Russell D (AREVA NP INC)

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Priority: Standard
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Reply Requested: No
Sensitivity: Normal
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Response to

Request for Additional Information No. 228, Supplement 1

6/05/2009

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 12.03-12.04 - Radiation Protection Design Features
Application Section: 12.03-12.04, Radiation Protection Design Features

QUESTIONS for Health Physics Branch (CHPB)

Question 12.03-12.04-9:

The applicant's response to RAI 23 Question 12.03-12.04-1 (reference 1) did not fully address the need for FSAR changes to address compliance with 10 CFR 20.1406. Due to the cross-cutting nature of 10 CFR 20.1406 and its applicability to all radioactive and potentially contaminated systems, revise section 12 of the FSAR as follows:

1. Incorporate into Section 12.3 of the FSAR the applicant's response to Question 12.03-12.04-1 (Reference 1) with regard to the Coolant Storage and Transfer System (specifically the 1st, 2nd and last paragraphs under "(i) Facility Contamination") as well as the applicant's response provided with regard to the Nuclear Island Drain and Vent System (specifically the 5th paragraph under "(i) Facility Contamination" and the 2nd and 3rd paragraph under "(ii) Environmental Contamination").
2. RAI 23 Question 12.03-12.04-1 (reference 1) states that "the compartment where the coolant storage tanks are installed is designed with a leak retention capability equivalent to the complete drainage of one tank." Provide more detail as to how this leak retention capability will be achieved. For example, will the compartment be lined with stainless steel?
3. Incorporate into Section 12.3 of the FSAR 10 CFR 20.1406 design features that were provided in response to 20.1406 Questions issued under other FSAR sections (for example, for the Seal Water Supply System, the Component Cooling Water System, Essential Service Water System, Compressed Air System, and the spent fuel pool leakage detection system). Alternatively, provide pointers in section 12.3 of the FSAR to the specific section under which the Question was issued and which, as a result of the RAI, contains some discussion on that system's compliance with 20.1406.
4. For each system who's 20.1406 design features are addressed in Section 12.3 of the FSAR, provide a pointer in the system-specific FSAR Section referencing the reader to Section 12.3 for a description of that system's design features which demonstrate compliance with the requirements of 10 CFR 20.1406 (for example, in Section 9.3.3, Equipment and Floor Drainage System).

References

Response to Request for Additional Information No. 23, Supplement 1, Revision 0, 06/24/2008 U.S. EPR Standard Design Certification AREVA NP Inc. Docket No. 52-020 SRP Section : 12.03-12.04 – Radiation Protection Design Features Application Section: 12 CHPB Branch (ADAMS Accession No. ML083091032)

Response to Question 12.03-12.04-9 (Part 2):

The compartments containing the coolant storage tanks are concrete compartments coated with a sealant, such as epoxy, up to a level sufficient to retain the contents of one coolant storage tank. Piping penetrations through the floor are equipped with sealing devices. Floor drains are normally closed. The new section added to U.S. EPR FSAR Tier 2, Section 12.3.6.5, as a result of Part 3 of this question, will include clarification on how the leak retention capability in the compartment containing the coolant storage tanks is achieved.

The first level of the compartment (i.e., elevation -21 ft. level of the Nuclear Auxiliary Building) is designed like a collecting pan at elevation -19 ft 4-1/4 of the Nuclear Auxiliary Building. The access door is located on the second level (i.e., elevation -11 ft. level of the Nuclear Auxiliary

Building) with access ladders to the floor as shown in Figure 12.03-12.04-9 (Part 2). The grating floor is at elevation -11 feet. The door of the four-tank compartment is approximately 1 foot above the grating and the door of the two-tank compartment is approximately 1 ¾ feet above the grating. The protected volume, from the bottom of the compartment to the bottom of the access door, is sufficient in both compartments to retain the liquid volume of one coolant storage tank.

Figure 12.03-12.04-9 (Part 2) —Coolant Storage Compartment Facing North - Exterior Wall Removed

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 12.3.6.5.3 [added in response to Part 3 of this question] will include additional information as described in the response and indicated on the enclosed markup.

Response to Question 12.03-12.04-9 (Part 3):

Design features that were provided in the Response to 20.1406 Questions issued under other FSAR sections have been incorporated into U.S. EPR FSAR Tier 2, Section 12.3.6 by adding a new section (i.e., Section 12.3.6.5, Contamination Control for Systems). Section 12.3.6.5 includes the following subsections:

1) Fuel Storage and Handling System.
2) Process Sampling System.
3) Coolant Storage and Transfer System.
4) Radioactive Waste Management System.
5) Equipment, Floor, Chemical, and Detergent Drain Systems.
6) Building HVAC Systems.
7) Essential Service Water Systems.
8) Seal Water Supply Systems.
9) Safety Chilled Water System.
10) Compressed Air System.
11) Demineralized Water Distribution System.

Table 12.03-12.04-9 (Part 3) shows prior RAI responses that are incorporated into the new section in U.S. EPR FSAR Tier 2, Section 12.3.6.

Table 12.03-12.04-9 (Part 3)— RAI Responses Incorporated

RAI Set	RAI No.
23	12.03-12.04-1
113	09.03.02-8
119	09.02.01-14
163	09.02.02-2
174	09.02.02-30 09.02.02-51
175	09.02.05-14
219	09.03.01-7
228	12.03-12.04-10

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 12.3.6 will be revised as described in the response and indicated on the enclosed markup.

Response to Question 12.03-12.04-9 (Part 4):

For each system in which 10 CFR 20.1406 design features are addressed in U.S EPR FSAR Tier 2, Section 12.3, pointers have been added to the system-specific U.S. EPR FSAR Tier 2, sections. The pointers reference the appropriate subsection of Section 12.3 for a description of that system's design features which demonstrate compliance with the requirements of 10 CFR 20.1406:

1) The new and spent fuel storage system facilities description in U.S. EPR FSAR Tier 2, Section 9.1.2.2 points to U.S. EPR FSAR Tier 2, Section 12.3.6.5.1 for fuel handling and storage system design features.
2) The process sampling system description in U.S. EPR FSAR Tier 2, Section 9.3.2.2 points to U.S. EPR FSAR Tier 2, Section 12.3.6.5.2 for process sampling system design features.
3) The chemical and volume control system description, which includes the coolant supply and storage system, in U.S. EPR FSAR Tier 2, Section 9.3.4.2 points to U.S. EPR FSAR Tier 2, Section12.3.6.5.3 for coolant supply and storage system design features.
4) The radioactive waste management system, which includes the liquid waste management system description, in U.S. EPR FSAR Tier 2, Section 11.2.2; the gaseous waste management system description in U.S. EPR FSAR Tier 2, Section 11.3.2; and the solid waste management system description in U.S. EPR FSAR Tier 2, Section 11.4.2 each point to Section 12.3.6.5.4 for radioactive waste management system design features.
5) The equipment and floor drainage system description in U.S. EPR FSAR Tier 2, Section 9.3.3.2 points to U.S. EPR FSAR Tier 2, Section 12.3.6.5.5 for equipment, floor, chemical, and detergent drain system design features.
6) The air conditioning, heating, cooling and ventilation system which includes the containment building ventilation system description in U.S. EPR FSAR Tier 2, Section 9.4.7.2, the fuel building ventilation system description, U.S. EPR FSAR Tier 2, Section 9.4.2.2, the safeguard building ventilation system description, U.S. EPR FSAR Tier 2, Section 9.4.5.2, the nuclear auxiliary building ventilation system description, U.S. EPR FSAR Tier 2, Section 9.4.3.2, and the radioactive waste building ventilation system description, U.S. EPR FSAR Tier 2, Section 9.4.8.2 each point to U.S. EPR FSAR Tier 2, Section 12.3.6.5.6 for ventilation system design features.
7) The essential service water system description in U.S. EPR FSAR Tier 2, Section 9.2.1.2 points to U.S. EPR FSAR Tier 2, Section 12.3.6.5.7 for essential service water system design features.
8) The seal water supply system description in U.S. EPR FSAR Tier 2, Section 9.2.7.2 points to U.S. EPR FSAR Tier 2, Section 12.3.6.5.8 for seal water supply system design features.
9) The safety chilled water system description in U.S. EPR FSAR Tier 2, Section 9.2.8.2 points to U.S. EPR FSAR Tier 2, Section 12.3.6.5.9 for safety chilled water system design features.

10) The compressed air system in U.S. EPR FSAR Tier 2, Section 9.3.1.2 points to U.S. EPR FSAR Tier 2, Section 12.3.6.5.10 for compressed air system design features.
11) The demineralized water distribution system in U.S. EPR FSAR Tier 2, Section 9.2.3 points to U.S. EPR FSAR Tier 2, Section 12.3.6.5.11 for demineralized water distribution system design features.

FSAR Impact:

U.S. EPR FSAR Tier 2, Sections 9.1.2.2, 9.3.2.3, 9.3.4.2, 11.2.2, 11.3.2, 11.4.2, 9.3.3.2, 9.4.7.2, 9.4.2.2, 9.4.5.2, 9.4.3.2, 9.4.8.2, 9.2.1.2, 9.2.7.2, 9.2.8.2, 9.3.1.2, and 9.2.3 will be revised as described in the response and indicated on the enclosed markup.

Question 12.03-12.04-10:

Background:

10 CFR 20.1406, “Minimization of Contamination,” requires design certification applicants to provide design features for minimizing contamination of the facility and the environment and for minimizing radioactive waste generation and facilitating decommissioning. RG 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning," provides guidance on an acceptable method of complying with the requirements of 10 CFR 20.1406 based on nuclear industry experience, such as that provided in NRC Bulletin 80-10, “Contamination of Nonradioactive Systems and Resulting Potential for Unmonitored, Uncontrolled Release to the Environment.”

NRC Bulletin 80-10, “Contamination of Nonradioactive Systems and Resulting Potential for Unmonitored, Uncontrolled Release to the Environment” discusses operational experience concerning the contamination of nonradioactive systems (such as the demineralized water system, the auxiliary boiler system, the isolation condenser system, secondary water clean-up system, the instrument air system and the sanitary waste system) through leakage, valving errors, or other operating conditions in radioactive systems. As described in Bulletin 80-10, in the past this type of cross-contamination has resulted in unmonitored, uncontrolled releases of radioactivity to the environment with significant environmental impact. One approach to addressing this operating experience is provided in Appendix A to RG 4.21 item (a) under A-1, "Minimizing Facility Contamination," which states that applicants should provide a minimum of two barriers between radioactive and nonradioactive systems, including one that can be a pressure differential, and/or instrumentation to detect and control cross-contamination.

Question:

The applicant’s response to RAI 23 Question 12.3-12.4-1 (reference 1) states that the Demineralized Water Distribution System (DWDS) is isolated from the Coolant Storage and Transfer System by manual isolation valves. However, PWR nuclear industry operating experience has shown that the coolant storage and transfer systems (and to a lesser degree the condensate storage and transfer system) over time becomes significantly contaminated with tritium, particularly if tritiated water is recycled, as is the case with the EPR design (see FSAR Section 9.3.4, "Chemical and Volume Control System (including Boron Recovery System)). This tritiated water can contaminate interfacing clean systems, such as the DWDS, through diffusion, valve leakage, valving errors or other operating conditions, resulting in possible unmonitored releases of radioactivity to the environment. Therefore provide the following information to address the DWDS’s compliance with 10 CFR 20.1406:

i) Describe any contaminated systems which the DWDS interfaces with in addition to the Coolant Supply and Storage System.

ii) In accordance with the RG 4.21 guidance discussed above, provide information on the location, type and number of barriers (check valves, isolation valves, etc) that prevent back flow and isolate the DWDS from the Coolant Supply and Storage System and any other contaminated system provided in response to (i).

iii) Describe where the demineralized water storage tanks will be located, and whether there will be any buried piping connecting this system to a contaminated system like CSSS. If there is buried piping, discuss how this piping will be monitored for leakage.

iv) Update Section 12 of the FSAR to include the information provided for parts (i), (ii) and (iii).

References

1. Response to Request for Additional Information No. 23, Supplement 1, Revision 0, 06/24/2008 U.S. EPR Standard Design Certification AREVA NP Inc. Docket No. 52-020 SRP Section : 12.03-12.04 – Radiation Protection Design Features Application Section: 12 CHPB Branch (ADAMS Accession No. ML083091032)

Response to Question 12.03-12.04-10:

i) The DWDS supplies demineralized water to many users in the Nuclear Island (NI). The following are radioactive contaminated systems with an interface to the DWDS:

- Coolant degasification system.
- Coolant treatment system.
- Coolant purification system.
- NI drain and vent systems.
- Coolant supply and storage system.
- Nuclear sampling system.
- Fuel pool cooling and purification system.
- Reactor boron and water makeup system.
- Chemical control system.
- Pressure relief discharge system.
- Reactor coolant pump.
- In-containment refueling water storage tank system.
- Liquid waste processing/storage system.
- Decontamination equipment for apparatus and vessels.
- Decontamination system for small machine components.
- Solid waste system.
- Severe accident sampling system.

ii) The DWDS supplies demineralized water to the NI radioactive contaminated systems identified in the Response to Question 12.03-12.04-10(i). The DWDS interfaces with these systems in the Reactor Building, Safeguard Buildings, Nuclear Auxiliary Building, Fuel Building and Radioactive Waste Processing Building. The DWDS is protected from contamination by the system design and multiple interface barriers. The DWDS operating pressure is higher than the interfacing systems; this system pressure differential at the interface will prevent contamination of the DWDS. Contamination of the DWDS during pressure loss is prevented by defense-in-depth consisting of multiple barriers such as isolating valves, check valves, air gaps, and anti-siphoning features that isolate and prevent back flow. These mechanical barriers are part of the interfacing systems or DWDS to prevent contamination from reaching the DWDS. Additional barriers are in the DWDS to prevent upstream contamination such as isolating valves and check valves located at the NI building entrances to further prevent upstream contamination outside of the NI. The overall design configuration of the DWDS and the contaminated interfacing systems contain sufficient barriers to prevent radioactive contamination of the DWDS.

iii) The DWDS storage tanks (UGC) complex is west of the Turbine Island (TI) as shown in U.S. EPR FSAR Tier 2, Figure 1.2-3. DWDS piping configuration will not be buried where it interfaces with radioactive contaminated systems. This prevents direct uncontrolled releases of radioactivity to the environment in the event of pipe wall degradation and confirms the DWDS compliance with 10 CFR 20.1406.

iv) U.S. EPR FSAR Tier 2, Chapter 12 has been revised as part of the Response to Question 12.03-12.04-9(3). The revision consists of a new section (i.e., U.S. EPR FSAR Tier 2, Section 12.3.6.5, Contamination Control for Systems). U.S. EPR FSAR Tier 2, Section 12.3.6.5 includes a subsection specific to the DWDS which incorporates the Response to Parts (i), (ii) and (iii) of this question.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 12.3.6.5 (added in the Response to Question 12.03-12.04-9(3)) will include additional information as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

- A leak chase and collection system is provided for the detection of leaks in the spent fuel pool liner plate.

9.1.2.2 Facilities Description

9.1.2.2.1 New Fuel Storage

The NFSF is enclosed by the reinforced concrete structure of the Fuel Building. New fuel storage racks are located in the new fuel dry storage area inside the Fuel Building. These racks are designed to provide vertical storage of new fuel assemblies, either with or without rod cluster control assemblies. The design of the new fuel storage racks are the responsibility of the COL applicant. A COL applicant that references the U.S. EPR design certification will describe the new fuel storage racks, including a description of confirmatory structural dynamic and stress analyses. The racks must be shown to meet Seismic Category I requirements.

The new fuel storage rack location is shown in Figure 9.1.2-1—New Fuel and Spent Fuel Storage Rack Representative Layout. These representative new fuel storage racks provide support for the fuel assemblies and incorporate guide funnels at the top to facilitate insertion of the new fuel assemblies. Figure 9.1.2-2—Typical New and Spent Fuel Storage Rack Cross-Sections, provides a typical sketch of the new and spent fuel storage racks. Fuel assemblies are handled using the auxiliary crane equipped with the new fuel handling tool, as detailed further in Section 9.1.4.

Building features such as door thresholds, curbs, and floor openings are provided to prevent entry of water or other moderation media into the NFSF.

Refer to Section 3.2 for the seismic and system quality group classification of the new fuel racks. Non-safety-related equipment or structures not designed to Seismic Category I criteria that are located in the vicinity of the NFSF are evaluated to confirm that their failure could not cause an increase in the k_{eff} value beyond the maximum allowable.

9.1.2.2.2 Spent Fuel Storage

The spent fuel pool provides storage space for a minimum of 10 years worth of irradiated fuel assemblies, plus the capability for a full core offload from the reactor. The pool is a reinforced concrete structure (refer to Section 3.8.4) with a stainless steel liner having a nominal depth of 45 feet, 7 inches (29 feet above the tops of the stored fuel assemblies). Borated water is used in the spent fuel pool and is maintained at 1700 ppm. The concentration required for sub-criticality for spent fuel is approximately 1334 ppm (nominal enriched boron at ≥37 percent B-10). Figure 3.8-42 through Figure 3.8-46 and Figure 3.8-50 through Figure 3.8-52 show the spent fuel pool and other related fuel handling areas. Fresh unirradiated fuel assemblies are either stored in the NFSF or in the fuel storage pool (or both). Unirradiated rod control clusters and thimble plug assemblies are normally stored in the fuel assemblies in the SFP.

The underwater fuel storage racks are located in the spent fuel storage pool inside the Fuel Building. The design of the spent fuel storage racks are the responsibility of the COL applicant. A COL applicant that references the U.S. EPR design certification will describe the spent fuel storage racks, including a description of confirmatory structural dynamic and stress analyses and thermal-hydraulic cooling analyses. The racks must be shown to meet Seismic Category I requirements. Spent fuel rack materials will be compatible with the pool storage environment. Rack structural materials must be corrosion-resistant and compatible with the expected water chemistry of the SFP.

Figure 9.1.2-1 shows the spent fuel rack storage location within the spent fuel pool.

Figure 9.1.2-2 provides a typical sketch of the new and spent fuel storage racks. The rack modules will be designed as cellular structures so that each storage cell has a square opening with conforming lateral support and a flat horizontal bearing surface. Each storage cell will have a hole in or near the bottom and a rectangular opening on the top of the cell to allow cooling water to flow through the storage cell. To provide reasonable assurance that no fuel can be damaged, each storage cell will be designed to prevent any portion of a fuel assembly or core component from extending above the top of the rack. The spent fuel storage racks will also be designed to withstand the impact resulting from a falling fuel assembly under normal loading and unloading conditions and will be designed to meet Seismic Category I requirements.

The design of the SFP is such that inadvertent draining of water from the pool is prevented (see Section 9.1.3). The concrete structures for the SFP, SFP liner, and fuel transfer canal are designed in accordance with the criteria for Seismic Category I structures contained in Section 3.7 and Section 3.8. As such, they are designed to maintain leak-tight integrity to prevent the loss of cooling water from the pool. In addition, all piping penetrations into the pool are designed to preclude draining the pool down to an unacceptable limit, as described in Section 9.1.3.

The spent fuel pool liner leak chase system consists of either half pipes, structural steel channels, or similar configurations embedded in the concrete, segregated into sectors, and interconnected to the exterior side of the pool liner. Leakage, if any, from the stainless steel pool liner plate welds is monitored and routed to collection areas in order to determine the amount of leakage, its location, and proper disposal. The design of the system is such that it provides easy accessibility for inspections, removal of blockages, and testing. The stainless steel liner plate welds are tested for leak-tightness during fabrication, after erection, and during plant life at discreet intervals.

Borated demineralized reactor makeup water is used to fill and to supplement water inventory in the spent fuel pool, but boration is not essential for maintaining the subcriticality of the stored fuel assemblies.

Adjacent to the SFP is a separate spent fuel cask loading pit. This pit is used when the spent fuel is to be shipped offsite. ~~The pit area is only filled with water during spent fuel removal procedures. A gate separates the cask loading pit from the SFP, and is opened only for cask loading operations.~~Two gates separate the cask loading pit from the spent fuel storage area and are only opened for cask loading operations. The gates allow isolation of the cask loading pit from the spent fuel storage area so that the cask loading pit can be drained. Both gates are designed to maintain leak-tight integrity to prevent the loss of cooling water from the spent fuel storage area. The gates and the weir, shown in Figure 3.8-52, are arranged so that the bottoms of the gates are higher than the top of the stored fuel assemblies.

The Reactor Building and the Fuel Building are connected by a fuel transfer tube. This tube is fitted with a blind flange, two gate valves, one on each end.

The Fuel Pool Cooling and Purification System (FPCPS) functions to limit the spent fuel storage pool temperature to 140°F during non-refueling plant conditions, and to remove impurities from the water to improve visual clarity. A description of the FPCPS is provided in Section 9.1.3.

During fuel handling operations, a controlled and monitored ventilation system removes gaseous radioactivity from the atmosphere above the spent fuel pool and processes it through high efficiency particulate air (HEPA) filters and charcoal adsorber units to the unit vent. Refer to Section 9.4.2 for a description of the spent fuel pool area ventilation system operation and to Section 11.5 for the process ventilation monitors.

Section 9.1.4 details the load-bearing capability of the cranes serving the SFSF. Section 9.1.4 also provides an evaluation that demonstrates that the maximum uplift force is due to the SFP bridge crane and the maximum impact load is due to a dropped fuel assembly. The racks will be designed to withstand the maximum uplift force and the maximum impact load with no increase in k_{eff}.

Refer to Section 3.2 for the seismic and system quality group classification of the spent fuel racks. Non-safety-related equipment or structures not designed to Seismic Category I criteria that are located in the vicinity of the SFSF will be evaluated to confirm that their failure could not cause an increase in the k_{eff} value beyond the maximum allowable k_{eff}..

12.03-12.04-9
(Part 4)

Refer to Section 12.3.6.5.1 for fuel handling and storage system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

ESWS are powered by Class 1E electrical buses and are emergency powered by the EDGs.

The non-safety-related dedicated division contains a dedicated ESWS pump, debris filter, piping, valves, controls, and instrumentation. The non-safety related ESWS pumps cooling water from the division four UHS cooling tower basin to the dedicated CCWS HX and back to the division four UHS cooling tower during severe accidents (SA). The dedicated ESWS pump is powered by 1E electrical buses and is emergency powered by the station blackout diesel generators (SBODG).

12.03-12.04-9 (Part 4)

Refer to Section 12.3.6.5.7 for essential service water system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

9.2.1.3 Component Description

9.2.1.3.1 Safety-Related Essential Service Water Pumps

Each of the four safety-related cooling divisions contains one 100 percent capacity pump. During normal operating conditions, two of the four divisions are operating. The required flow rate of each ESWS pump is defined by the heat to be removed from the system loads. Design parameters are listed in Table 9.2.1-1. The pumps are designed to fulfill the corresponding minimal required design mass flow rate under the following conditions:

- Minimal water level without cavitation.
- Head losses in the cooling water inlet piping according to full power plant operation.
- Fluctuations in the supplied electrical frequency.
- Increased pipe roughness due to aging and fouling.
- Fouled debris filters.
- Maximum pressure drop through the system HXs.
- Minimum water level in cooling tower basin considers minimum submergence requirements to prevent vortex effects, and net positive suction head to prevent cavitation of the ESWS pump.

Determination of the discharge head of the pumps is based on the dynamic pressure losses, the minimum/maximum water levels of the water source, and the head losses of the mechanical equipment of the associated ESWS at full load operation.

9.2.3 Demineralized Water Distribution System

The demineralized water distribution system (DWDS) stores water in the demineralized water storage tanks and delivers it to the consumers in the power plant. For the U.S. EPR, none of the users of demineralized water depend on the system for safety-related functions or backup. Containment isolation for the DWDS is provided per Section 6.2.4.

12.03-12.04-9 (Part 4)

Refer to Section 12.3.6.5.11 for demineralized water distribution system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

Next File

The seal water system consumers can be isolated from the seal water supply by a motor-operated isolation valve located in the NAB.

The SEWSS provides a reliable supply of seal water to pumps in radioactive fluid carrying systems and feeds the gaseous waste processing system liquid tanks. The SEWSS supplies the plant consumers requiring seal water from the following systems:

- Decontamination equipment for apparatus and vessels.
- Decontamination system for small machine components.
- Severe accident heat removal system.
- Chemical and volume control system (CVCS).
- Coolant purification system.
- Coolant treatment system.
- Radioactive concentrates processing system.
- Liquid waste processing system.
- Liquid waste storage system.
- Operational chilled water system (OCWS) for gaseous waste processing system.

12.03-12.04-9
(Part 4)

Refer to Section 12.3.6.5.8 for seal water supply system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

9.2.7.2.2 Component Description

Seal Water Pumps

There are 2 x 100 percent seal water pumps designed to operate during normal plant operation and during outages. Normally, one pump is running continuously at minimum flow, with the excess discharge flow returned to the demineralized water tank. The second pump is in standby.

Buffer Tanks

The buffer tanks provide a stored volume of seal water to the chemical and volume control system pump seals during normal plant operation and loss of offsite power (LOOP) conditions, and to the severe accident heat removal system in the event of a severe accident. Each buffer tank has a nitrogen gas cushion of sufficient pressure to provide the required seal pressure for any seal water level in the tank. Each buffer tank is protected from excessive nitrogen pressure by a safety valve in the nitrogen supply line.

9.2.8.2 System Description

9.2.8.2.1 General Description

The SCWS consists of four separate, physically separated independent divisions, numbered 1 to 4. Each is located in one of the four SBs. Each SCWS division is a closed loop system that supplies chilled cooling water for specified area HVAC air handling units (AHU) and, where required, process systems cooling. Each division consists of a refrigeration chiller unit, two pumps, expansion tank, user loads, and the associated piping and controls.

The SCWS provides chilled water to the HVAC cooling coils of the main control room (MCR), the electrical division rooms (SBVSE) in the SBs, SB controlled-area ventilation system (SBVS), Fuel Building (FB) ventilation system (FBVS), and the low head safety injection system (LHSI) pump motors in SB Divisions 1 and 4.

System design parameters are listed on Table 9.2.8-1—Safety Chill Water Design Parameters. The SCWS flow diagram is shown in Figure 9.2.8-1—Safety Chilled Water System Diagram.

12.03-12.04-9
(Part 4)

Refer to Section 12.3.6.5.9 for safety chilled water system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

9.2.8.2.2 Component Description

The general description of the component design features for the SCWS is provided below. Refer to Section 3.2 for details of the seismic and system quality group classification of the SCWS.

Chilled Water Pumps

Two 100 percent SCWS pumps, with one in standby, in each of the four divisions circulates chilled water between the HVAC users and the evaporator of the chiller refrigeration unit in each division.

The required flow rate of each SCWS pump is defined by the heat to be removed from the system loads. As a minimum, the pumps are designed to fulfill the corresponding minimal required design mass flow rate under the following conditions:

- Fluctuations in the supplied electrical frequency.
- Increased pipe roughness due to aging and fouling.
- Fouled debris filters.
- Maximum pressure drop through the system heat exchangers.

9.3 Process Auxiliaries

9.3.1 Compressed Air System

The compressed air system (CAS) consists of compressors, dryers, filters, receivers and other equipment required for performing its non-safety-related functions.

9.3.1.1 Design Bases

The CAS provides compressed air for the following services:

- Instrument air for non-safety-related valves and other equipment located in the Conventional Island (CI).
- Instrument air for opening the containment ventilation purge dampers.
- Instrument air to valves, pumps and other equipment located in the radioactive waste, decontamination, blowdown demineralization, fuel handling and other systems for non-safety-related functions.
- Service air throughout the plant (for using air-operated tools and purging tanks).

The containment isolation features for the containment penetrations in the CAS are described in Section 6.2.4.

There are no air-operated valves (AOV) or air-operated equipment required to function in response to an accident where the compressed air is provided by the CAS.

The design of the CAS is in compliance with the resolution of NUREG-0933, Generic Safety Issue 43, Reliability of Air Systems (Reference 1).

The CAS is designed for a single unit and is not shared with other units.

Instrument air is designed to meet ANSI/ISA 7.0.01-1996 (Reference 3).

9.3.1.2 System Description

9.3.1.2.1 General Description

The CAS consists of a compressed air generation system and a compressed air distribution system. The compressed air generation system is located entirely in the Turbine Building (TB). It supplies compressed air to the compressed air distribution systems in the Nuclear Island (NI) and CI. The location of the compressed air generation system in the TB minimizes the likelihood of leakage from radioactive systems being ingested into the CAS.

Figure 9.3.1-1—Compressed Air Generation System, shows a schematic diagram of the compressed air generation system while Figure 9.3.1-2—Compressed Air Distribution

System, shows a schematic diagram of the NI and CI compressed air distribution system.

12.03-12.04-9
(Part 4)

Refer to Section 12.3.6.5.10 for compressed air system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

Component Description

Table 3.2.2-1 provides the quality group and seismic design classification of components and equipment in the CAS. The containment isolation valves (CIV) and penetrations are the only safety-related components in the CAS.

Instrument Air

Two 100 percent oil-free rotary screw compressors are provided. They are connected for parallel operation and provide clean, dry, oil-free instrument air. During normal plant operation, one instrument air compressor operates continuously, loaded and unloaded depending on the system demand. The other instrument air compressor is in standby and is started in the event the operating compressor fails or if the system pressure drops below a preset value. Each compressor is equipped with an inlet air filter, aftercooler and moisture separator to condition the compressed air.

Two instrument air receivers serve as a storage volume to supply a limited amount of compressed air following a compressor failure. Overpressure protection is provided via pressure relief valves located on the air receivers.

Duplex prefilters are provided at the instrument air dryer inlet in order to protect the adsorption dryer units. Prefilter elements are constructed of corrosion-resistant materials.

Duplex afterfilters are provided at the instrument air dryer outlet to prevent the carryover of desiccant dust. These filters also remove rust, scale and dirt. Afterfilter elements are constructed of corrosion resistant materials. The duplex afterfilters have an automatic drain trap to remove accumulated condensate.

An air dryer is installed downstream of each instrument air compressor to remove moisture from the air.

Service Air

A single oil-free rotary screw compressor provides service air. During normal operation, the service air compressor operates continuously, loaded and unloaded depending on the system demand. The compressor is equipped with an inlet air filter, aftercooler and moisture separator to condition the compressed air.

- Obtain liquid and gaseous samples from the primary coolant, liquid and gaseous waste treatment systems, auxiliary systems and inside containment.
- Purge sampling lines and reduce plateout (buildup of chemical residue) in sample lines.
- Size RCS sample lines to minimize loss of reactor coolant following rupture of sample line.
- Recycle primary side samples according to their source to minimize waste.
- Continuously monitor secondary side activity and chemistry.
- Recycle secondary side samples to steam generator blowdown demineralizing system.
- Continuously monitor and obtain manual grab samples from selected points in the secondary side, main cycle and auxiliary systems.

9.3.2.2 System Description

12.03-12.04-9
(Part 4)

9.3.2.2.1 General Description

Refer to Section 12.3.6.5.2 for process sampling system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

9.3.2.2.1.1 Nuclear Sampling System

The NSS obtains liquid and gaseous samples from the primary coolant, liquid and gaseous waste treatment systems, and auxiliary systems, in order to determine the characteristics of these samples by measurements and analyses. NSS samples are categorized as active liquid samples, slightly active liquid samples and gaseous samples. The NSS is contained within the Nuclear Island (NI).

Active Liquid Samples

The NSS continuously collects active liquid samples from the RCS at three different locations:

- Crossover leg loop 3.
- Pressurizer (liquid phase).
- Hot leg loop 1.

Each line is equipped with a motor-operated sampling isolation valve in close proximity to the sampling point and two containment isolation valves (CIV).

- For certain beyond design basis events (DBE), store highly contaminated liquid samples collected in the Nuclear Auxiliary Building (NAB) within the Reactor Building (RB) to delay their treatment.
- Detect and identify (to a practical extent) the location of the source of reactor coolant leakage within the RB.

9.3.3.2 System Description

9.3.3.2.1 General Description

The NIDVS is connected to a variety of systems by means of temporary and permanent connections. Permanent connections to systems of high design pressures are protected by means of flow restrictors and safety valves to maintain the pressure below the allowable design pressure of the drain system. Piping is principally arranged for gravitational flow from the drain collectors to the drain tanks. Wherever gravity drainage is impractical, mobile (portable) pumps are used. Mobile pumps are connected to the permanent piping using temporary flexible hoses. The general arrangement of the NIDVS is provided in Figure 9.3.3-1—Nuclear Island Drain and Vent System.

Effluents are classified in different groups according to their processing requirements and by whether or not they are recycled. They are collected according to their state (liquid or gaseous) and origin (primary drains, process drains, floor drains and decontamination effluents). Leakage to reactor containment from identified sources is collected so that flow rates are monitored separately from unidentified leakage and the total flow rate of each type is established and monitored. Leakage to reactor containment from unidentified sources is collected and the flow rate monitored with an accuracy of one gallon per minute or better. NIDVS pumps, tanks and sumps are sized to process the maximum expected rate of influx and total volume of expected leakage.

12.03-12.04-9
(Part 4)

Refer to Section 12.3.6.5.5 for nuclear island drain/vent system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

9.3.3.2.2 Component Description

Table 3.2.2-1 provides the quality group and seismic design classification of components and equipment in the NIDVS. Components are designed to the codes and standards applicable to their equipment class. The NIDVS is divided into five subsystems:

which requires the discharge of reactor coolant to the CSSS. As reactor coolant discharges, water transfers sequentially into tank 16 of the CSSS first and then into tank 15. When tank 16 is approximately 55 percent full, a signal is initiated to generate processing water from the tank in the coolant treatment system (CTS). The CTS produces demineralized water and recovers the boron for reuse.

12.03-12.04-9
(Part 4)

Refer to Section12.3.6.5.3 for coolant supply and storage system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

Coolant Treatment and Boron Recovery

The CVCS discharges water to the CSSS, which contains boron ranging from refueling concentration to approximately zero ppm. The CTS processes this water. A flow diagram of the CTS is shown in Figure 9.3.4-6—Coolant Treatment System.

In general, evaporation separates the coolant into a concentrated boric acid solution at four percent H_3BO_3 and demineralized water. Due to the low vapor pressure of boric acid at the boiling temperature of water, the vapor generated by the evaporator has a low boric acid concentration. The vapor passes through a series of trays in the boric acid column, which further removes boric acid from the vapor.

An evaporator feed pump pumps borated water from the CSSS tank through a mixed bed ion exchanger in the purification system. Following purification, the water is preheated and fed into the boric acid column. The water in the column sump circulates through the tube side of the evaporator by natural circulation and is evaporated. Most of the heat required for evaporation leaves the column with the vapor. This vapor heat is utilized by compressing the vapor, which increases its temperature. Then the vapor is discharged to the shell side of the evaporator. This process condenses the vapor so it can be collected in a condensate tank. The condensate pumps transfer the condensate to the CSSS for reuse in the CVCS makeup.

The boric acid solution in the boric acid column is measured and controlled to maintain its boric acid concentration at an approximately constant four percent by weight which corresponds to 7000 ± 100 ppm boron. The boric acid solution is cooled and transferred to the RBWMS storage tanks for reuse in the CVCS makeup.

If the condensate produced by the evaporator requires degasification, it can be discharged to the degasification unit prior to its discharge to the CSSS tanks.

9.3.4.2.2 Component Description

A summary of design data for the major components of the CVCS is provided in Table 9.3.4-1—Major CVCS Component Design Data.

- Maintains the airborne radioactivity levels within the FB below the maximum permissible concentrations limits of 10CFR20 and consistent with the as low as reasonably achievable (ALARA) dose objectives of 10CFR50, Appendix I (refer also to Section 12.1 and Section 12.3.3).

9.4.2.2 System Description

A simplified diagram of the FBVS is shown in Figure 9.4.2-1—Fuel Building Ventilation System.

12.03-12.04-9 (Part 4)

Refer to Section 12.3.6.5.6 for ventilation system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

9.4.2.2.1 General Description

The FBVS provides air distribution for ventilation of the FB. The air supply to, and exhaust from, each room of the FB is provided by a network of supply and exhaust ducts which are connected to the NABVS. The conditioned air is supplied to all levels of the building through a duct distribution network. The flow rate to each room is calculated based on the minimum air renewal rate, equipment heat loads, and heat balance between the rooms. This maintains ambient conditions during normal operation within prescribed limits for operation of equipment and personnel safety and comfort.

The supply air is the conditioned outside air that is filtered, cooled or heated, humidified by the NABVS, and delivered to the FB rooms through the FBVS supply duct network.

The FBVS exhaust system is designed to limit spread of the airborne contaminants and to maintain a negative pressure in the FB with respect to the outside environment. The FBVS exhaust is processed through the filtration trains of the NABVS prior to discharge through the plant stack. The FBVS is divided into two subsystems referred to as Cell 4 and Cell 5. The cells separate the ventilation systems serving the redundant systems in the FB and each cell serves approximately half of the building. The supply and exhaust duct branches to each room are fed from the main supply and exhaust HVAC shafts in the building. These HVAC shafts are connected to the NABVS.

If high radiation is detected within the FB, the exhaust air is diverted to the iodine filtration trains of the NABVS prior to discharge through the plant stack (refer to Section 9.4.3).

Isolation dampers are provided to isolate the supply and exhaust ducts of the room in front of the equipment hatch, fuel pool area, and the room in front of the emergency airlock.

9.4.3.2 System Description

9.4.3.2.1 General Description

The NABVS is divided into the following subsystems:

- Supply air.
- NAB air supply.
- Exhaust air.

12.03-12.04-9 (Part 4)

Refer to Section 12.3.6.5.6 for ventilation system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

Supply Air Subsystem

The outside-conditioned air is supplied through a set of redundant filter trains consisting of HEPA filters, humidifiers, heating coils, and cooling coils. See Figure 9.4.3-1—Nuclear Auxiliary Building Supply Air Filtration and A/C Trains. The conditioned supply air maintains ambient conditions in the areas served by this system within prescribed limits for operation of equipment, and personnel safety and comfort. The NABVS provides conditioned air to the following areas:

- NABVS air distribution supply air shafts and ductwork.
- Containment building ventilation system (refer to Section 9.4.7).
- Fuel building ventilation system (refer to Section 9.4.2).
- Annulus ventilation system (refer to Section 6.2.3).

The outside air is provided through intake mesh grills and louver dampers. The outside air intake openings are equipped with electrically heated and weather protected grills to prevent ice formation and ingress of insects and debris. The intakes are designed to provide adequate outside air to meet the distribution requirements of supply air under design conditions of the plant.

The air intake plenum supplies air through three filtration trains. Each train consists of a preheater, prefilter, cooling coil, heater, silencer, humidifier, and air dampers. Four supply air fans take suction from the supply fan inlet plenum and supply air to the outlet air shaft for further distribution to the supply shafts of different buildings.

The design supply air flow to serve the NAB, FB, annulus ventilation system, and Containment Building would require all three trains to be in operation. However, during normal operation, a reduced air flow rate can be used that requires only one supply train to be in operation.

- Valve rooms in the SB, divisions one through four, where component cooling water system and emergency feedwater system components are installed.
- Rooms where hydrogen and containment atmosphere monitoring system (divisions one and four), and severe accident sampling system (division four) components are installed.

Electric air heating convectors are provided in the service corridors, interconnecting passageway, and stairways to maintain the minimum allowable temperatures in these areas.

The SBVS is designed to circulate sufficient air to prevent accumulation of flammable or explosive gas or fuel-vapor mixture from components such as storage batteries and stored fuel.

12.03-12.04-9
(Part 4)

Refer to Section 12.3.6.5.6 for ventilation system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

9.4.5.2.2 Component Description

The major components of the SBVS are listed below, along with the applicable code and standards. Refer to Section 3.2 for the seismic and system quality group classification of these components.

Ductwork and Accessories

The main supply and exhaust air shafts are constructed of concrete with painted surfaces. The air supply and exhaust duct branches for each area are fed from the main supply and exhaust air shafts. These ducts are constructed of steel and structurally designed for fan shutoff pressures. The ductwork meets the design, testing and construction requirements per ASME AG-1-2003 (Reference 2).

Electric Air Heating Convectors (Area Heaters)

The electrical air heating convectors are installed to maintain room ambient conditions. The convectors are controlled by local room temperature sensors and control circuits.

Moisture Separator

The moisture separator is a combination of moisture separator and prefilter. The moisture separator must meet the requirements of RG 1.52 (Reference 10), ASME N509 (Reference 9), and ASME AG-1 (Reference 2). The moisture separator is located upstream of the filter air heater and the HEPA prefilter. The moisture separator shall be a design that has been qualified by testing in accordance with the procedures described in Reference 9.

  - 30 percent to 70 percent humidity.
- Maintains the following ambient conditions in the equipment compartments for protection and safe operation of the equipment:
  - A minimum temperature of 59°F.
  - A maximum temperature of 131°F.
  - Supports reactor coolant pressure boundary (RCPB) leakage detection.

9.4.7.2 System Description

9.4.7.2.1 General Description

The supply air for the containment building ventilation system is conditioned outside air that is filtered, cooled or heated, and humidified by the nuclear auxiliary building ventilation system (NABVS) as described in Section 9.4.3. The supply air is delivered to the Containment Building through the Fuel Building plenum. The supply air is then distributed through the CBVS supply duct network if the containment purge subsystem is operating.

The CBVS is composed of the following separate subsystems:

- Containment purge subsystem.
- Internal filtration subsystem.
- Containment Building cooling subsystem.
- Service and equipment compartment cooling subsystem.

12.03-12.04-9
(Part 4)

The containment isolation system is addressed in Section 6.2.4.

Refer to Section 12.3.6.5.6 for ventilation system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

Containment Purge Subsystem

The containment purge subsystem includes low-flow and full-flow purge supply and exhaust systems. See Figure 9.4.7-1—Containment Building Low Flow and Full Flow Purge Supply Subsystem and Figure 9.4.7-2—Containment Building Low Flow and Full Flow Purge Exhaust Subsystem.

The containment low-flow purge subsystem is normally not in operation during the plant normal operation. However, the low-flow purge subsystem can be used during normal operation and outage conditions. The containment full-flow purge subsystem is used during plant outages. The supply side ducts receive air from NABVS (refer to

During normal operation, the RWBVS provides fresh air to the RWB stairwells. In the event of a fire, the smoke confinement system (SCS) provides fresh air to the RWB stairwells. The smoke confinement system provides a positive pressure in the stairwells to prevent smoke intrusion in the event of a fire. This system is used only in the event of a fire in the RWB. Refer to Section 9.4.13 for smoke confinement system functional details.

The RWB has two exhaust air systems–system exhaust air and room exhaust air (see Figure 9.4.8-2).

System exhaust air draws air from RWB locations where radioactivity is likely. The exhaust air and gases from activity-bearing systems, vented air from tanks and releases from working areas and machinery are collected by the system exhaust air. The exhaust air is monitored by the sampling activity monitoring system (SAMS) prior to entering the system exhaust air filtration system. System exhaust air is continuously filtered by two filter systems consisting of prefilters, HEPA filters, and iodine adsorption charcoal filters. The treated air is then exhausted to the plant stack by two exhaust fans located in the RWB at elevation +36 ft. Air temperature and relative humidity are maintained within design requirements by water droplet separators and electrical heaters installed upstream of the filter trains. The system exhaust air has no automatic isolation functions. In the event of a high radiation alarm from the SAMS, operators can manually shutdown the RWBVS from the main control room (MCR).

Room exhaust air serves rooms in the RWB that are not normally expected to contain radioactivity. Room exhaust air is monitored by the SAMS prior to entering the filter section. The room exhaust air is continuously filtered by five parallel filter trains. Each filter train consists of a prefilter and a HEPA filter. Room exhaust air from these filter trains can be directed to two room exhaust fans or to a filter system consisting of a carbon adsorber and a HEPA filter. Normal operation of the room exhaust air bypasses the carbon adsorber and HEPA filter system. If radioactivity is detected by the SAMS in any of the rooms served by the room exhaust air system, the contaminated air is manually rerouted to pass through the iodine filtration system.

The iodine filter unit, installed at the RWB at elevation +36 ft, consists of one air train equipped with two manually operated isolation dampers, one electric heater, one carbon adsorber, one HEPA filter, and two booster fans connected in parallel.

12.03-12.04-9
(Part 4)

Refer to Section 12.3.6.5.6 for ventilation system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

9.4.8.2.2 Component Description

The major components of the RWBVS are described in the following paragraphs. Refer to Section 3.2 for the seismic and system quality group classification of these components.

demineralizer receives treated wastewater from both the evaporator and the centrifuge waste processing subsystems or directly from the liquid waste storage tanks. Piping and control valves allow liquid wastes to be passed through either unit, or through both units consecutively. Contaminants are retained in the filter media and resin and the treated wastewater is returned to the liquid waste storage system.

Both the liquid waste storage and liquid waste processing systems are located entirely within the Radioactive Waste Processing Building. Interfacing system piping delivers influent liquid wastes from the adjacent Nuclear Auxiliary Building. The Radioactive Waste Processing Building is also sized to provide space and support services to optional, site-specific mobile or vendor-supplied processing equipment. However, such optional mobile or vendor-supplied systems are site-specific design features and are outside design certification scope.

Table 11.2-1—Liquid Waste Management System Design Parameters, lists the key design parameters for the liquid waste storage and processing systems. Table 11.2-2—Liquid Waste Management System Component Data, lists specific component data for the major components of the liquid waste storage and processing systems.

12.03-12.04-9
(Part 4)

Section 11.4 provides additional information on the expected volumes, activity levels, and processing of wet and solid wastes produced throughout the plant.

Refer to Section 12.3.6.5.4 for radioactive waste management system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

11.2.2.1 Liquid Waste Storage System Operation

11.2.2.1.1 Waste Input Streams

Group I wastes are those wastes expected to contain radioactivity and boron, but little or no organic substances or solids. Sources of Group I liquid wastes include the following:

- Wastewater from the fuel pool cooling and fuel pool purification systems.
- Wastewater from decontamination systems, for apparatus and vessels, and for small machine components.
- Wastewater from process drains and sumps collected in the Nuclear Auxiliary Building.
- Wastewater drained from the evaporator column in the liquid waste processing system.
- Wastewater decanted from the concentrate tanks and wastewater returned from the radioactive concentrates processing system.

- Recombiner.
- Gas cooler.

The purge system also includes a gas supply subsystem, gas measuring subsystems, and compressor sealing subsystems. The purge gas is nitrogen; small quantities of hydrogen and oxygen, and trace quantities of noble gas fission products also are present in the purge gas stream.

The delay system includes a gel drier, delay beds, gas filter, and discharge gas reducing station. The delay system discharges processed gaseous waste to the nuclear auxiliary building ventilation system for release to the ambient atmosphere via the ventilation exhaust stack.

The components of the gaseous waste processing system and the majority of the components of connected systems are located in the Nuclear Auxiliary Building. Several components that are continually swept by gaseous waste processing purge gas flow are located in other buildings. The volume control tank and two of seven Nuclear Island (NI) drain and vent system primary effluent tanks are located in the Fuel Building. Four more NI drain and vent systems are located in each of the four Safeguard Buildings. The pressurizer relief tank and the reactor coolant drain tank are located in the Reactor Building. Gaseous waste processing system piping is routed among the buildings.

Table 11.3-1—Gaseous Waste Processing System Parameters lists key design parameters for the gaseous waste processing system. Table 11.3-2—Gaseous Waste Processing System Component Data. Figure 11.3-2—Gaseous Waste Processing System - Gaseous Waste Sources shows the sources of input, and point of discharge for the gaseous waste processing system.

12.03-12.04-9
(Part 4)

Refer to Section 12.3.6.5.4 for radioactive waste management system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

11.3.2.1 Normal Operation

The gaseous waste processing system is designed to operate continuously during normal plant operation. For the majority of this time, with the plant operating at full power, the gaseous waste processing system operates in a steady state mode, with a constant flow rate through the purge system and a small, constant discharge rate from the delay system.

11.3.2.1.1 Normal Operation—Purge System

The circulation of purge gas is maintained by the operation of one or both waste gas compressors. The gaseous waste processing system operates at positive pressure from the waste gas compressors to the reducing stations and the volume control tank. The

Wastes are initially classified as combustible, compressible or noncombustible and noncompressible. Compressible waste is compacted to reduce its volume. The wastes are further segregated based on properties, sizes, materials, and activity of the waste material. Waste containing moisture is collected and stored separately to avoid wetting dry active waste and to allow short-term treatment to prevent decomposition and hydrogen formation.

The combustible and compressible wastes are transferred from the storage rooms to the treatment area (e.g., compaction and compression), placed into storage drums, and compacted for temporary storage. The noncombustible and noncompressible wastes (thick metal parts, for example) are transported to the hot workshop, fragmented, and transferred into a drum.

Drums containing low-level radioactive waste are stored in the drum store area of the Radioactive Waste Processing Building until they are ready to be transported to offsite disposal. Drums stored in the drum store area have an activity level low enough that they meet ALARA dose criteria. Tubular shaft storage is provided for higher-level radioactive waste such as filter cartridges and treated resin waste.

The solid waste management processing and storage system is shown in Figure 11.4-1—Solid Waste Management Flow Diagram. Table 11.4-14—Solid Waste Management System Component Data lists the major equipment ~~and corresponding nominal design parameters.~~ designed to comply with the codes and standards referenced in RG 1.143, Table 1. Tables are provided showing the expected and maximum annual activities by nuclide for the noncompressible, compressible, and combustible dry active waste (DAW) in Tables 11.4-2 through 11.4-4. A summary total of the annual activity from dry active wastes is given in Table 11.4-5—Total Dry Active Waste Annual Activity.

12.03-12.04-9
(Part 4)

Refer to Section 12.3.6.5.4 for radioactive waste management system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

11.4.2.2 Radioactive Concentrates Processing System (Wet Solid Wastes)

The radioactive concentrates processing system, as shown in Figure 11.4-2—Radioactive Concentrates Processing System, receives concentrates and sludges from other waste treatment systems and dries these influents to produce a monolithic salt block inside a storage drum. Evaporator concentrates from the concentrate tanks and contaminated sludge from the storage tanks of the liquid waste storage system are transferred to the concentrate buffer tank. These wastes are mixed, sampled, and analyzed for proper pretreatment before leaving the concentrate buffer tank.

Spent resins are stored in the resin waste tanks of the coolant purification system for an extended length of time to allow short-lived activity to decay away. These resins are then transferred into the resin proportioning tank or into a HIC. Depending upon

12.03-12.04-9
(Part 3)

12.3.6.5 Contamination Control for Systems

The U.S. EPR design complies with the requirements of 10 CFR 20.1406 by applying a contaminant management philosophy to the design of structures, systems, and components (SSC) which have the potential to contain radioactive materials. The following principles are embodied in this philosophy:

- Prevention of an unintended release.
- Early detection if there is an unintended release.
- Prompt and aggressive cleanup, should there be an unintended release.

In accordance with these principles, tanks that potentially contain radioactive liquids are located inside the Nuclear Island structures, are located above floor level, and can be inspected and repaired in the event of a leak. Interfaces between radiological systems and non-radiological systems have been minimized. Where these interfaces do exist, at least two barriers are included in the design to minimize the potential for cross-contamination, and instrumentation is provided for prompt detection of potential cross-contamination.

The following design features have been incorporated into the U.S. EPR to minimize facility contamination:

- Extensive compartmentalization to minimize the spreading of contamination through the facility by containing potential contamination within a compartment and providing ventilation in these compartments. Ventilation to these compartments promotes air flow towards compartments with the greater potential for contamination minimizing the spread of airborne contamination in the facility.
- A smooth epoxy or, in high temperature exposure areas, an inorganic coating on surfaces that could potentially become contaminated to facilitate decontamination. A maintenance program maintains control and qualification of these applied coatings.
- Personnel decontamination areas located near the exit side of the primary access control facility of the Access Building and supplied with sinks and showers with drains that are routed to the liquid waste management system.
- A facility in the Access Building for decontamination and cleaning of personnel protective equipment, instrumentation, and small items. This facility provides a washdown area and sink that drains to the liquid waste management system. A positive air flow is maintained into the decontamination facility and exhausted into a monitored building ventilation system. Walls and floors in this area are coated to facilitate cleanup and decontamination.
- A core melt stabilization system to stabilize molten core debris resulting from the most severe category of reactor accidents by providing temporary retention and

12.03-12.04-9
(Part 3)

conditioning of molten core debris, an area for corium to spread, features that limit potential energetic fuel-coolant interactions, and immobilizing and containing radionuclides.

The following design features have been incorporated into the U.S. EPR to minimize contamination of the environment:

- The nuclear island foundation basemat acting together with the reactor coolant boundary to maintain an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment.
- Reinforcing steel bars in the concrete containment walls and dome for crack control and strength to accommodate seismic and other loads (e.g., thermal cycling) to minimize potential leak paths to the environment.
- Containment penetrations that are paths for potential bypass leakage terminate in areas of the surrounding buildings that are filtered during a postulated accident. The U.S. EPR design has no primary containment penetrations or seals that terminate outside the secondary containment to the general environment.
- Sufficient space in the facility layout for tools and equipment staging and to easily disassemble and reassemble components.

12.3.6.5.1 Fuel Storage and Handling System

The fuel handling and storage systems are designed to minimize contamination of the facility and the environment as described by the general protective design features listed in Sections 12.3.6.1 and 12.3.6.2.

Design Provisions for Minimizing Contamination of the Facility

To minimize the potential to contaminate the facility, the spent fuel pool is designed so that no postulated event could cause excessive loss-of-pool water inventory, including designing in accordance with the criteria for Seismic Category I structures and locating piping connections near the top of the spent fuel pool. The spent fuel pool is a reinforced concrete structure with a stainless steel liner plate. Leak detection channels are provided behind seams in the liner plate for collection and monitoring of potential pool leaks. Any water collected is directed to the floor and equipment drain system and transferred to the liquid radwaste system for processing.

Based on the historical plant issues dealing with clogged pool liner channels and the eventual seepage of contaminated liquid releases into the surrounding concrete structures and groundwater, the U.S. EPR pool liner leakage monitoring system is an alternate design in accordance with NEI 07-07, “Industry Groundwater Protection Initiative – Final Guidance Document” (Reference 11). The pool liner collection channels (both vertical and horizontal) are accessible for monitoring, maintenance, testing, and inspections other than terminal end (discharge) at the pool liner leakage monitoring drain collection points, prior to disposal into the plant drain system.

12.03-12.04-9
(Part 3)

The U.S. EPR spent fuel pool does not interface with the environment. Figure 3.8-50—Fuel Building Plan Section A-A, Figure 3.8-51—Fuel Building Plan Section B-B, and Figure 3.8-52—Fuel Building Plan Section C-C, show that the U.S. EPR spent fuel pool is located above grade with several floors of accessible rooms located beneath it. Figure 3.8-42—Fuel Building Plan Elevation +12 Feet, Figure 3.8-43—Fuel Building Plan Elevation +24 Feet, Figure 3.8-44—Fuel Building Plan Elevation +36 Feet, and Figure 3.8- 45—Fuel Building Plan Elevation +49 Feet show that the spent fuel pool is located in the interior of the Fuel Building (FB) and has no walls interfacing with external walls that interface with the environment. A leakage from the spent fuel pool will not directly reach the environment and is collected in a tank or sump located above the lowest building elevations. The FB sits on the common basemat providing additional protection for the environment.

Sumps for drain lines that may collect potentially contaminated liquids are lined with stainless steel over the potentially wetted surface. Concrete surfaces are protected by a smooth epoxy coated surface where there is potential for contamination.

Instrumentation is provided to detect and to alarm in the main control room (MCR) when low water level occurs in the spent fuel pool. Area radiation monitors are located in the fuel storage area for personnel and facility contamination protection. These area monitors alarm locally and in the MCR.

The concrete structure for the fuel transfer canal (and the spent fuel pool) is designed in accordance with the criteria for Seismic Category I structures. As such, it is designed to maintain leak-tight integrity to prevent the loss of cooling water from the pool. The fuel transfer canal is lined with stainless steel liner plates. Expansion joints are provided for the fuel transfer tube on the Reactor Building (RB) and FB side to accommodate the differential movement and provide leak-tight sealing. These expansion joints are equipped with a sensor for detecting leaks and providing an alarm in the MCR. In addition, to minimize potential facility contamination due to an event in the Containment Building, the fuel transfer tube between the fuel transfer canal and the spent fuel pool is equipped with isolation valves to provide containment isolation. This fuel transfer tube consists of a stainless steel pipe installed inside a large sleeve that is anchored to the concrete of the Containment Building and welded to the containment liner plate. Bellows and water-tight seals are provided around the fuel transfer tube where it passes through the RB internal structures refueling canal concrete and the Reactor Shield Building and FB concrete. Where the potential exists for contamination, concrete surfaces are protected by a smooth epoxy.

To minimize facility contamination associated with the maintenance and replacement of contaminated fuel handling equipment, this equipment is designed for the life of the

12.03-12.04-9
(Part 3)

plant. In addition, the materials of construction, surface finish (for contamination prevention), and lubricant use are designed in accordance with the recommendations prescribed in ANS 57.1-1992 (Reference 12) for the fuel handling equipment.

Design Provisions for Minimizing Contamination of the Environment

To minimize airborne contamination of the environment, the fuel building ventilation system provides appropriate ventilation and filtration to limit potential release of airborne radioactivity to the environment from the fuel storage facility under normal operation and in the event of a fuel handling accident in the spent fuel pool area. This ventilation system is continuously monitored by gaseous, particulate, and radio-iodine radiation monitors, which alarm locally and in the MCR. Isolation dampers isolate the ventilation system for specific rooms within the FB to mitigate the consequences of a fuel handling accident. Further information on the fuel building ventilation system is provided in Section 9.4.2.

The structural design and leak detection system features of the spent fuel pool and the fuel transfer tube also help protect the environment from contamination. During fuel handling operations, a controlled and monitored ventilation system removes gaseous radioactivity from the atmosphere above the spent fuel pool and processes it through high efficiency particulate air filters and charcoal adsorber units to the unit vent.

There are no portions of the spent fuel pool system handling potentially contaminated material that are buried or routed through exterior boundaries. Leak detection under the spent fuel pool provides full coverage in case of a leak, and leak detection equipment in channels aid in identifying the location of the leak. Sumps that collect potential spent fuel pool leakage are double lined with non-porous material. In addition, walls and curbs are used in areas with potential leaks of contaminated fluids to prevent the spread of these fluids.

12.3.6.5.2 Process Sampling System

The process sampling systems of the U.S. EPR are designed to minimize contamination of the facility and the environment as described in the general protective design features listed in Sections 12.3.6.1 and 12.3.6.2. Nuclear sampling, sample activity monitoring, and radiation monitoring comprise the process sampling system.

Design Provisions for Minimizing Contamination of the Facility

To minimize potential contamination of the facility, the process sampling systems are designed to:

- Monitor for potential higher than normal levels of radiation in the facility, and thereby, provide a means to mitigate it from spreading to other parts of the facility.

12.03-12.04-9
(Part 3)

- Monitor variables and systems over their anticipated ranges to assure adequate safety, including those variables and systems that can affect the integrity of the reactor core and the reactor coolant pressure boundary.

- Provide a confinement boundary against any releases from the sampling system.

- Confirm that contaminated fluids are not transferred to non-contaminated fluids.

The process sampling systems monitor radioactivity levels in plant process streams and atmospheres, indicate and alarm excessive radioactivity levels, and in some cases automatically initiate protective isolation actions to minimize potential contamination of the facility. The systems consist of permanently installed, continuous monitoring devices together with a program of, and provisions for, specific sample collections and laboratory analyses. For example, area radiation monitors located in the Safeguard and Radioactive Waste Processing Buildings are provided to continually monitor radiation levels in the spaces which contain components for recirculation of loss of coolant accident (LOCA) fluids and components for processing radioactive wastes. In case of high levels of radiation, both local alarms and signals to the MCR are provided. Additional process monitoring functions are detailed in Section 11.5.4. The process sampling systems also provide information regarding the release of radioactive materials during normal operations, anticipated operational occurrences, and postulated accidents to provide an early indication of the need to initiate other protective actions to minimize potential facility contamination. For example, under accident conditions samples of the containment atmosphere can be taken via the sampling activity monitoring system to provide data on airborne radioactive concentrations within the containment.

The process sampling system obtains and analyzes key chemistry parameters such as chloride, hydrogen, and oxygen concentrations in the reactor coolant. The control of corrosive chemicals decreases the potential for facility contamination by decreasing the probability that the reactor coolant pressure boundary or fuel cladding are compromised due to degradation from corrosive chemical attack.

To minimize the potential for facility contamination due to a leak from the process sampling systems, sample lines penetrating the containment are capable of isolation upon receipt of a containment isolation signal from the reactor protection system. In addition, the portion of the process sampling system that includes the reactor coolant pressure boundary is designed, fabricated, erected, and tested to have a low probability of abnormal leakage, rapidly propagating failure and gross rupture. Motor-operated isolation valves in the three nuclear sampling lines connected to the reactor coolant system (RCS) maintain the reactor coolant pressure boundary integrity. Sample (glove) boxes are used to collect active liquid grab samples to confine any spills. Safety-related portions of the process sampling systems are designed to withstand the effects of natural phenomena. Non-safety-related portions of the process sampling systems are designed to have provisions for a leakage detection and control program to minimize

12.03-12.04-9
(Part 3)

the leakage from those portions of the process sampling systems outside of the containment that contain or may contain radioactive material following an accident.

The design of the process sampling system prevents the inadvertent transfer of contaminated fluids to non-contaminated drainage systems. This is accomplished by transferring contaminated fluids either back to the system being sampled or to an appropriate radwaste system.

The components are designed to permit periodic testing and in-service inspections during plant operation and are designed for the life of the plant. The piping connections and joints in these systems are welded except where flanged or screwed connections are required to facilitate equipment removal for inspection, maintenance, or pressure testing .The pipes inside containment are routed with a continuous slope without low points and each sample line is equipped with an inner and outer containment isolation valve. In addition, there is a sampling isolation valve in each line that belongs to the RCS. Sample lines are flushed for a sufficient period of time prior to sample extraction to remove sediment deposits and air and gas pockets. In addition, samples from tanks are taken from the bulk volume to avoid low points and sediment traps. Decontamination fluid can be injected via dedicated nozzles to vessels in the process sampling systems.

Design Provisions for Minimizing Contamination of the Environment

The process sampling systems minimize contamination of the environment by: (1) monitoring the atmosphere in various locations of the facility and taking actions to minimize potential releases from the facility; (2) monitoring the effluents discharged from the various ventilation systems addressed in Section 9.4 and taking actions to minimize potential releases from the facility; (3) controlling and potentially reducing the concentration and quality of fission products potentially released following postulated accidents; and (4) providing protection against leaks from sampling equipment.

The process sampling systems provide radiation and airborne monitors at various plant locations to assist in the detection of abnormal operational conditions. Upon detection of contamination, these monitors provide indication and alarms in the MCR and health physics office to initiate actions to minimize environmental contamination. For example, the containment atmosphere is monitored during normal and transient operations by containment gaseous radiation monitors and under accident conditions, can initiate RB containment isolation, and thereby, minimize any releases to the environment. In addition, sampling points are located on the process radiological monitoring and sampling systems to permit representative sampling for radiochemical analysis to indicate the existence of and, to the extent possible, the magnitude of reactor coolant and reactor auxiliary system leakage to the containment atmosphere, cooling water systems, and the secondary side of the steam generators. Process

12.03-12.04-9
(Part 3)

monitors also provide an alarm and gross indication of the extent of failed fuel. They also monitor radioactive waste systems and associated handling areas to detect and alarm under conditions that may result in a loss of residual heat removal capability and excessive radiation levels. In each of these cases, the process sampling system has monitors that provide indications and alarms to the MCR to initiate actions to minimize potential environmental contamination.

The process sampling systems also continuously monitor facility radioactivity levels in the effluent discharge paths during normal and accident conditions. The gaseous effluent monitoring and sampling system monitors the Reactor Containment Building, the FB, the Nuclear Auxiliary Building, the mechanical area of the Safeguard Buildings, the controlled area of the Access and Radioactive Waste Processing Buildings and the vent stack. Sampling points are located on effluent radiological monitoring and sampling systems to permit representative sampling for radiochemical analysis. The gaseous effluent radiological monitoring and sampling systems alarm but perform no automatic actions, when radionuclide concentrations exceed the specified limits. As stated in Section 11.5.2, a COL applicant will describe in the Offsite Dose Calculation Manual (ODCM) how a gaseous radiological release will be controlled.

The liquid effluent radioactive waste monitoring and sampling system measures the concentration of radioactive materials in liquids to be discharged to the environment in batches from waste monitoring tanks. Prior to release of a liquid radioactive waste from a monitoring tank, the system obtains a representative sample which is radiochemically analyzed. If the sample is acceptable, flow from these tanks to the environment is permitted. The flow is monitored and if radionuclide concentrations exceed the specified limits, the discharge to the environment is isolated upstream prior to any unacceptable release to the environment.

The non-safety-related portions of the process sampling systems are designed to control fission products, chloride, hydrogen, oxygen, and other substances that may be released into the reactor containment and also, reduce the concentration and quality of fission products released to the environment following postulated accidents. The control of corrosive chemicals decreases the potential for a release to the environment by decreasing the probability that the reactor coolant pressure boundary is compromised due to degradation from corrosive chemical attack. Non-safety-related portions of the process sampling systems include means to suitably control the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences.

There are no buried pipes in the process sampling systems that handle potentially contaminated liquids, and hence, no means to contaminate the environment from a leaking pipe. There are also no by-pass lines around the radiation monitors for the liquid effluents released from the waste monitoring tanks. Gases that may potentially

12.03-12.04-9
(Part 3)

leak from these process sampling systems are collected by one of the HVAC systems described in Section 9.4 and subsequently filtered prior to a release from the plant stack.

12.3.6.5.3 Coolant Supply and Storage System

The coolant supply and storage system is designed to minimize contamination of the facility and the environment as described in the general protective design features listed in Sections 12.3.6.1 and 12.3.6.2.

Design Provisions for Minimizing Contamination of the Facility

To minimize the potential to contaminate the facility, the coolant supply and storage system is designed so that any leakage is detected, quantified, and the location of the leak determined by the leakage detection system. The RCS pressure boundary provides the first barrier against reactor coolant contaminating the facility and the second barrier against the release of radioactivity from the fission products of the fuel into the facility. The coolant supply and storage system is designed to provide a secure envelope for the retention of reactor coolant and associated gases. This system uses vessels and welded piping (including for the local sampling system) to provide a barrier against leakage and is equipped with manual valves to provide system isolation from non-contaminated support systems such as the demineralized water system. The piping and equipment exposed to coolant are austenitic stainless steel to avoid corrosion issues. In addition, level measurements in the vessels of this system prevent high levels by automatically isolating inlet supplies to the vessels and preventing cross contamination of interfacing support systems. In case of a leak, these level measurements also identify the vessel that is leaking by a low level measurement. The compartment where the coolant storage tanks are installed is designed with a leak retention capability equivalent to the complete drainage of one tank. If the leak is due to a steam tube leak, it is detected by continuous process radiation monitors or radiochemical grab sampling.

The leakage detection systems, in combination with instrumentation from other interconnected systems, detect, quantify, and determine the location of leakage from the reactor coolant pressure boundary. These systems provide a method of collecting and quantifying reactor coolant pressure boundary leakage. These leakage detection systems include diverse measurement methods such as sump level and discharge flow monitors, containment atmosphere radiation monitors, containment air cooler condensate flow monitors, containment humidity monitors, temperature monitors of the reactor vessel closure joint, and reactor coolant inventory monitors at the pressurizer, volume control tank, and coolant drain collection tank. Provisions are also incorporated into the U.S. EPR to isolate, capture, and quantify leakage from known potential sources, such as flanges and relief valves, so that such leakage may be

12.03-12.04-9
(Part 3)

monitored separately from unidentified leakage. Each of these monitoring systems provide indications of leak rates and leak locations to the plant operators in the MCR.

Leakage of reactor coolant into the component cooling water system (CCWS) from a residual heat removal heat exchanger tube, reactor coolant pressure seal thermal barrier, or other source is identified by increased activity in the CCWS fluid as detected by a continuous monitor or routine sampling, and is also indicated by an unexpected increasing level in the surge tank. The dedicated CCWS surge tank is charged by nitrogen over-pressurization, resulting in potential component coolant leakage into, rather than out of, most interfaces with contaminated fluids (e.g., the severe accident heat removal system). For potentially contaminated systems operating at pressures greater than the CCWS, radiation and flow monitors in the CCWS detect and allow actions to be taken to limit the leakage into the system. For example, the chemical volume and control system (CVCS) high pressure coolers operate at pressures greater than the CCWS, and upon a high pressure cooler tube rupture results in a leak of reactor coolant into the CCWS. This leakage into the CCWS is detected by the CCWS flow meters (increased flow) or radiation monitors (increased radioactivity) and the high activity measurement generates a signal to automatically close the cooler isolation valves isolating the CVCS HP cooler from the CCWS to minimize the leakage into CCWS.

In addition to maintaining the confinement barriers of the reactor coolant, facility contamination is minimized by the compartmentalization of buildings that contain portions of the reactor coolant pressure boundary. The Containment Building is divided into two compartments: an inner equipment compartment and an outer service compartment. The inner compartment contains the steam generators, reactor coolant pumps, and primary loop piping. The outer compartment contains support equipment. In the event of a reactor coolant leak, facility contamination is minimized by containing the majority of the contamination in the inner compartment. Similarly, the portion of the Safeguard Buildings that coolant passes through is in the radiological controlled areas of these buildings which are separated from the non-radiological areas (i.e., uncontrolled areas) that contain items such as instrumentation, control equipment, and switchgear. To minimize the spread of contamination, these two areas of the Safeguard Buildings are served by separate ventilation systems with the radiological controlled area ventilated by the safeguards building ventilation system described in Section 9.4.5. The reactor coolant storage tanks that reside in the Nuclear Auxiliary Building are located in a similarly compartmentalized area within this building. This potentially contaminated area is ventilated by the nuclear auxiliary building ventilation system described in Section 9.4.2.

12.03-12.04-9
(Part 2)

To minimize facility contamination caused by leaks of contaminated fluids, coatings such as sealers or special paint are used on walls, ceilings, and floors potentially exposed to these leaks to permit easy decontamination. The coating-sealed first level of the concrete compartments housing the coolant storage tanks contain elevated access

12.03-12.04-9 (Part 2)

doors, sealed floor penetrations, and floor drains that are normally closed so that each compartment has the capability of retaining the complete drainage of one coolant storage tank. This feature minimizes the spread of contamination in the unlikely event of such a leak.

12.03-12.04-9 (Part 3)

To minimize facility contamination due to maintenance activities involving the reactor coolant pumps, design features such as a removable shaft and permanently installed decontamination equipment are provided. A dedicated room for maintenance of the reactor coolant pumps is provided in the U.S. EPR. In addition, bolted flanges are provided on the piping system only where removal is required for inspection, maintenance, or repair. For the tanks in the coolant supply and storage system, system inspection, and maintenance can be conducted during plant operations as any one tank may be isolated, drained, purged, and opened independently of other tanks while maintaining the normal functions of the system. Prior to performing maintenance activities, the decontamination of the coolant storage tanks can be performed using the system for decontamination of apparatus and vessels. The monitoring instruments of the coolant supply and storage system are located in accessible rooms for ease of inspection and maintenance.

Design Provisions for Minimizing Contamination of the Environment

The coolant supply and storage system is designed to minimize contamination of the environment by providing multiple barriers against radiological material reaching the environment. The coolant supply and storage system is designed to provide a secure envelope to retain reactor coolant and associated gases through the use of welded vessels and piping to provide a barrier against leakage of radiological material from this system. In case of a leak from this barrier, leakage detection and collection are provided to allow for identification of the location of the leak and to collect the leakage within the facility and prevent leakage from reaching the environment. Ventilation systems collect and filter releases from leaks to minimize the potential contamination released to the environment.

To minimize contamination of the environment from the reactor coolant, the Nuclear Island foundation basemat acts together with the reactor coolant pressure boundary to maintain an essentially leak-tight barrier. The concrete radiological shielding and the leak-tight steel liner plate within the containment limit the uncontrolled release of radioactivity to the environment. Additionally, the Reactor Shield Building completely encloses the Reactor Containment Building and provides a second containment barrier to the release of airborne radioactive material from containment. The space between these two buildings forms an annulus, which is maintained at a sub-atmospheric pressure and is filtered by the annulus ventilation system (refer to Section 6.2.3 for a description).

12.03-12.04-9
(Part 3)

There are no portions of the coolant supply and storage system handling potentially contaminated material that are buried or routed through exterior boundaries. However, sections of the safety injection system (SIS) / residual heat removal system (RHRS) are outside containment; hence, these systems are designed to control and detect leakage outside containment following an accident. Upon detection of leakage, the section of these systems located outside confinement can be isolated.

12.3.6.5.4 Radioactive Waste Management Systems

The U.S. EPR radioactive waste management systems include the liquid waste, gaseous waste, and solid waste systems.

Design Provisions for Minimizing Contamination of the Facility

As described in Section 12.3.6.1, the design of the U.S. EPR minimizes facility contamination through the use of compartmentalization, heating, ventilation, air conditioning (HVAC) systems to control airborne dispersion, spill prevention features, and leak detection and mitigation features.

Design features are provided to control and collect radioactive material spills from liquid vessels and pipes. Tanks are designed with level measurements and overflows to prevent uncontrolled overflow paths to the environment; they are contained in rooms with drains to collect any spills, and to prevent uncontrolled releases to the environment. These rooms have no doors leading directly to the outside environment. The radioactive resins of the purification system are stored in two tanks located in separate, dedicated rooms on the bottom floor of the Radioactive Waste Processing Building. Each of these rooms is designed to contain leakage from these tanks using curbs located at the entrance doorway to each room. Other rooms drain to sumps equipped with leak detection systems that provide a signal to automatically isolate the affected system or provide an indication to the MCR to initiate operator action from within the MCR or locally.

The Radioactive Waste Processing Building is sized to provide space and support services for optional site-specific mobile or vendor-supplied processing equipment. Flexible hose or pipe used with site-specific mobile or vendor-supplied solid waste processing systems is subject to the hydrostatic test requirements in accordance with requirements specified in Section 11.4.1.2.5. A mobile or vendor-supplied system is a site-specific design feature that is outside the scope of the design certification.

The U.S. EPR liquid waste management system receives degasified liquids in the storage tanks. These tanks are continuously vented to the radioactive waste processing building ventilation system so that any generation of gaseous activity is continually removed. The primary design functions of the gaseous waste processing system are to collect radioactive waste gases from the various systems in which they are released, to process these waste gases and provide sufficient holdup time for radioactive decay to

12.03-12.04-9
(Part 3)

reduce the activity present, and to control the subsequent release of processed waste gases to the atmosphere in compliance with regulatory limits. To continuously vent the tanks, the system maintains a negative pressure to prevent the escape of radioactive gases from components connected to the building air.

Releases from the gaseous waste processing system are continuously monitored by radiation sensors in the delay system discharge line. The system also provides grab sample collections for analysis from several different points on the process stream, and from each of the delay beds along the discharge line. Gaseous waste processing system releases are routed through the filtration system of the nuclear auxiliary building ventilation system. The gaseous waste processing system operates at a negative pressure relative to its surroundings, preventing radioactive gases from leaking and contaminating the facility.

In the drum drying station of the solid waste treatment unit, a vacuum seal is established on the drum and heaters are energized to evaporate the water from the drum. The vacuum in the drum allows the water to boil off at a lower required heating temperature. The water vapor is condensed, collected, and the volume measured before it is drained to the condensate collection tank. The air and radioactive non-condensable gases are routed to the radioactive waste processing building ventilation system for processing. Process monitors installed on the drum drying system detect in-process radiation levels to keep the operator informed.

The solid waste management system is equipped with a sorting box that is used to sort the various dry actives wastes produced in the controlled areas of the plant. The sorting box contains hand holes with rubber gloves for sorting the wastes. The sorting box is connected to the radioactive waste processing building ventilation system through a filling hood. Any airborne contaminants created during the sorting, shredding, or compaction processes are captured by the filling hood and subsequently treated in the radioactive waste building ventilation system.

The sampling box serves as the sampling point for the concentrate buffer tank. The box enclosure is equipped with gloves and a gate for inserting and removing the sample bottles. Inside the box are the sample valve and a demineralized water valve used to flush the inside of the box and the sample bottles. A ventilation connection is provided to maintain a negative pressure within the sampling box.

Area radiation monitors throughout the Radioactive Waste Processing Building detect excessive radiation levels and alert the operators to this condition. Any released gases that escape from the radioactive waste management systems are collected by the building ventilation HVAC systems, as described in Section 9.4. The piping and equipment for these components are constructed of stainless steel to avoid corrosion caused by wastewater, demineralized water, chemicals, and decontamination wastes. In addition, the liquid waste processing system is designed to allow the addition of a

12.03-12.04-9
(Part 3)

chelating agent to help remove any encrusted solids in the process (e.g., evaporator column) to prevent their buildup. Contamination of the facility potentially caused during filter change outs is minimized by the design of the U.S. EPR's filter changing equipment, which uses a filter changing machine to automatically and remotely perform filter change outs. The spent filters to be disposed from the filter changing unit are placed in a waste drum which is contained within a shielding cask to reduce exposure to personnel and mitigate potential contamination of the facility due to a spill during transport from the Nuclear Auxiliary Building to the Radioactive Waste Building. The filter changing machine is also equipped with seals to prevent leakage of contaminated gases into the room, and contain any leakage from the filters so that it drains from the bottom of the machine.

Similarly, contamination of the facility potentially caused during the removal of spent resins from the fuel pool purification mixed bed ion exchanger or the demineralizers is minimized by remotely removing these resins. These resins are remotely flushed and hydraulically transferred to the spent resin waste tanks and subsequently to the liquid waste treatment unit. Each of the radioactive waste management systems have been designed to allow maintenance during operations. For example, the filter changing unit is designed to confirm that the spent filter cartridges are always found in shielded equipment (i.e., the filter changing machine or one of the two shielding casks) and, in case the equipment gets contaminated, can be decontaminated by a mobile decontamination system. In addition, a dose rate monitor is also included in this area to provide maintenance workers notification of higher than normal exhaust rates.

The radioactive waste management systems have a design life of 60 years and, therefore, large component removal and its potential for facility contamination are minimized. The shielding casks of the filter changing unit are steel castings and the majority of the components of the filter changing equipment in this unit are stainless steel.

Design Provisions for Minimizing Contamination of the Environment

The radioactive waste management system is designed to minimize contamination of the environment by providing multiple barriers against radiological material reaching the environment and by meeting regulatory requirements for liquid effluent discharged to the environment. The U.S. EPR is designed to control the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, which includes anticipated operational occurrences. The radioactive waste management systems are designed to minimize inadvertent releases of radioactivity from the facility and to maintain permitted radioactive waste discharges below the regulatory limits of 10 CFR 50, Appendix I, during normal operation. Most of the operations for these units occur within the Radioactive Waste Building with the exception of portions of the liquid

12.03-12.04-9 (Part 3)

waste system (transferring releasable waste water to the environment) and portions of the solid waste system (transferring disposable wastes into disposal containers).

For the U.S. EPR, releases of radioactive effluent via the liquid pathway occur only via discharges from the monitoring tanks in the liquid waste storage system. In the monitoring tanks of the liquid waste system, the treated wastewater is chemically adjusted to an optimum pH and checked for activity prior to its discharge from the plant. The pH adjustment of wastewater in the liquid waste storage tanks and of the treated wastewater in the monitoring tanks also significantly reduces or eliminates the discharge of boric acid to the environment. The line releasing these effluents to the environment contains an administratively controlled, locked-closed upstream isolation valve. Personnel in the MCR maintain custody of the key to this valve and only issue the key upon receipt of a completed analysis demonstrating that the treated wastewater in a monitoring tank is within limits for release. When this valve is opened, the treated wastewater enters the activity measurement tank in the release line. Radiation sensors in this tank continuously measure and record the activity as the treated wastewater is released. Flow sensors downstream of the activity measurement tank continuously measure and record the volume and flow rate as the treated wastewater is released. If the total activity indicated by sensors exceeds predetermined limits, control signals are generated automatically to close two redundant downstream isolation valves, close the upstream isolation valve, and shut down the operating recirculation and discharge pump(s). The content of the monitoring tanks is then sent back to the processing system for further treatment.

For gases, the U.S. EPR liquid waste management system receives degasified liquids in the storage tanks. These tanks are continuously vented to the radioactive waste processing building ventilation system (refer to Section 9.4.8) so that any generation of gaseous activity is continually removed. The gaseous waste processing system is primarily designed to collect radioactive waste gases from the various systems in which they are released, to process these waste gases and provide sufficient holdup time for radioactive decay to reduce the activity present, and to control the subsequent release of processed waste gases to the environment in compliance with regulatory limits. This system maintains a negative system pressure to prevent the escape of radioactive gases from the components connected to it.

Releases from the gaseous waste processing system are continuously monitored by radiation sensors in the delay system discharge line. The system also provides grab sample collections for analysis from several different points on the process stream, and from each of the delay beds along the discharge line. Gaseous waste processing system releases are routed through the filtration system of the nuclear auxiliary building ventilation system (refer to Section 9.4.2 for information on this HVAC system).

For spills from liquid tanks outside of containment, the U.S. EPR provides design features to control and collect radioactive material spills. The tanks for these systems

12.03-12.04-9
(Part 3)

are contained in rooms with drains to collect any spills and to prevent any uncontrolled release to the environment (refer to Section 9.3.3). If a leak escapes into the room containing a waste system vessel, then the room contains the leak or drains the leak to a nearby sump. The floor drain from a room can be opened to drain the leakage into a sump. From the sump, the liquid is pumped into a storage tank in the liquid waste storage system.

For the gaseous release associated with spills from these systems, the U.S. EPR provides the radioactive waste building ventilation system which is addressed in Section 9.4.8. Other portions of the solid waste treatment system contain sorting boxes used to sort the various dry active wastes produced in the controlled areas of the plant. These sorting boxes contain hand holes with rubber gloves for sorting the wastes and are connected to the radioactive waste processing building ventilation system through a filling hood. Any airborne contaminants created during the sorting, shredding, or compaction processes are captured by the filling hood and subsequently treated in the radioactive waste building ventilation system.

These radioactive waste treatment systems are contained in rooms that have no doors leading directly to the outside environment, which further prevents an environmental release. The piping and equipment for these systems are constructed of stainless steel to avoid corrosion caused by wastewater, demineralized water, chemicals, and decontamination wastes.

12.3.6.5.5 Equipment, Floor, Chemical, and Detergent Drain Systems

The equipment, floor, chemical, and detergent drain systems of the U.S. EPR are designed to minimize contamination of the facility and the environment as described by the general protective design features listed in Sections 12.3.6.1 and 12.3.6.2.

Design Provisions for Minimizing Contamination of the Facility

To minimize the potential to contaminate the facility, the nuclear island drain and vent system (NIDVS) is designed to collect, temporarily store, and discharge in a controlled manner any leakage from equipment located on the Nuclear Island. In addition, this system is provided with leak detection equipment used to mitigate consequences associated with postulated leaks. Section 3.4 provides an assessment of the potential causes for internal flooding and how the NIDVS is designed to prevent such an event and how this system prevents backflow into areas of the plant that contain safety-related equipment through the use of check valves.

To minimize the spread of contamination of the facility created by a leak, the NIDVS is designed to include curbs and drain catch trays to provide drainage control. The NIDVS also includes leak detection and isolation measures to mitigate the consequences of leaks. Liquid leakages or discharges drain by gravity to the sumps as shown in Figure 9.3.3-1. Sump pumps automatically or manually transfer their

12.03-12.04-9 (Part 3)

contents to storage tanks. Mobile pumps are used only where drainage is impractical and are connected to the permanent piping using temporary flexible hoses. The water level instrumentation within sumps and storage tanks and other leak detection measures detect leaks. These leak detection systems provide a signal to automatically isolate the affected system or to provide indication to the MCR to initiate operator action from within the MCR or locally. For example, the sump pumps inside the Safeguard Buildings and FB are equipped with a double level measurement device for detection of leakage with an indication provided to the MCR.

The NIDVS is also designed with containment isolation valves to provide isolation of containment in case of a radiological release within containment, thereby, removing a potential leak path from containment to the rest of the facility. Additionally, the RB floor drains are designed to collect leakage from contaminated spaces in the RB and from process drains that cannot be recycled. The reactor coolant pressure boundary leakage drains to the floor drains system and ultimately to the sump where it is identified and quantified by the sump instrumentation. The NIDVS pumps, tanks, and sumps are sized to process the maximum expected rate of influx and total volume of expected leakage.

The NIDVS is designed and equipped with provisions to permit testing for operability and calibration. The storage tanks contained in this system are located in vessel pits which are equipped with alarming level detectors to detect their failure. These storage tanks can also be decontaminated via temporary connections. Components of the NIDVS are designed to operate for 60 years, thereby minimizing the potential generation of waste associated with operating and maintaining this system. The materials used in this system are compatible with the services required. Most components of this system are constructed of 304 stainless steel for corrosion resistance.

Eyewash stations and shower wastewater in the Access Building are routed to a tank in the NIDVS. Liquid effluent from the decontamination facilities (showers, floor washing) are also collected and stored in the storage tanks of the NIDVS.

Coatings such as sealers or special paint permit easy decontamination and are used on walls, ceilings, and floors where the potential for surface contamination exists.

Design Provisions for Minimizing Contamination of the Environment

The NIDVS is designed to minimize contamination of the environment by providing multiple barriers to prevent radiological material from reaching the environment. The floor drain pipes at the lowest elevation that are embedded in concrete include a concentric guard pipe fitted with an alarm moisture detection monitor. Sumps in the facility are constructed of nonporous material. The inner surfaces of sumps that are in contact with the radioactive fluid are lined with an impermeable coating to reduce

12.03-12.04-9
(Part 3)

corrosion. Sumps that are at the lowest building elevations are double lined and fitted with alarmed leakage detection instrumentation.

To prevent a contaminated liquid release to the environment and to mitigate the airborne consequences of a leak to the environment, the NIDVS provides leak detection and isolation measures. Level instrumentation and other leak detection measures detect leaks that could result in internal flooding. These leak detection systems provide a signal to automatically isolate the affected system or to provide indication to the MCR to initiate operator action from within the MCR or locally.

To prevent the potential of contaminating the environment through the release of a normally non-contaminated liquid, the NIDVS is designed to prevent the inadvertent transfer of contaminated fluids to non-contaminated drainage systems. Portions of this system that are located in areas that may contain radioactive effluents are physically separated from the plant areas that do not contain radioactive effluents.

In addition to the NIDVS, the CVCS has provisions for a leakage detection and control program to minimize the leakage from those portions of the CVCS outside of the containment that contain or may contain radioactive material following an accident. The CVCS drains are piped to the NIDVS for storage and processing of the discharged liquids.

An oil collection system is also provided to collect and drain the motor lube oil (upper and lower bearing lube oil systems) in the event of leakage from the motor lubrication system to prevent any leakage to the environment.

No access openings or tunnels penetrate the exterior walls of the nuclear island below grade. In addition, pipes embedded in concrete structures are minimized to the extent practical as the concrete impedes inspections, impedes repairs, and increases dose and waste during decommissioning.

12.3.6.5.6 Building HVAC Systems

The building HVAC systems are designed to minimize contamination of the facility and the environment as described in the general protective design features and the air filtration system design listed in Sections 12.3.6.1 and 12.3.6.2.

Design Provisions for Minimizing Contamination of the Facility

The containment building ventilation system (CBVS), the fuel building ventilation system (FBVS), the safeguard building controlled-area ventilation system (SBVS), the nuclear auxiliary building ventilation system (NABVS), and the radioactive waste building ventilation system (RWBVS) are designed to minimize contamination of the facility. For each of these systems, this design objective is attained by maintaining a minimal air change rate and controlling the building pressurization. By maintaining a

12.03-12.04-9 (Part 3)

minimal air change rate, radiological material is less susceptible to becoming airborne and spreading to other portions of the building. Similarly, by maintaining pressures higher in areas of lower contamination relative to pressures in areas with the potential for higher contamination, the air flow travels from the lower to the higher areas of contamination, thereby minimizing the spread of contamination in the facility. For example, when the purge subsystem of CBVS is in operation, a differential pressure is maintained between the equipment compartment and the service compartment within the Containment Building, with the equipment compartment maintained at a slightly more negative pressure to allow any radiological activity to be contained in this compartment and prevent spreading contamination to the service compartment. For each of these systems, this design function is described in the following sections:

- For CBVS, Section 9.4.7.2.
- For FBVS, Section 9.4.2.2.
- For SBVS, Section 9.4.5.2.
- For NABVS, Section 9.4.3.2.
- For RWBVS, Section 9.4.8.2.

As described in Section 9.4.7.2.1, the CBVS also provides internal filtration to reduce radioactive contamination inside the equipment compartment of the Containment Building. This filtration system is designed to allow periodic inspection and maintenance.

To detect potential leaks in the facility, each of these ventilation systems, plus the annulus ventilation system (AVS), is equipped with airborne radioactivity monitors to allow monitoring of airborne radiation levels in the system. Area radiation monitors are also located throughout the facility to provide local readouts, audible alarms, and visual alarms to alert operating personnel. Section 12.3.4 provides additional details for these monitors and their actions. These monitors are located in accessible areas to allow maintenance, inspection, and replacement without significant personnel exposure occurring.

In addition to these radioactivity monitors, ventilation systems are designed to verify proper system behavior through the use of local instruments that measure properties such as differential pressures across filters, flows, temperatures, and pressures. Furthermore, indication of the operational status of the CBVS equipment, position of dampers, instrument indications, and alarms are provided in the MCR.

The design and installation of the components of these ventilation systems shall confirm that adequate clearance is provided for removal, maintenance, and inspections. However, to minimize the need to remove components from these

12.03-12.04-9
(Part 3)

ventilation systems, these components are designed to operate, with proper maintenance, for 60 years with the exception of some components such as motors and filters, which are monitored and replaced as necessary. Maintenance on the FBVS isolation dampers located in the fuel pool room can only be performed when no fuel handling activities are taking place in the FB. The containment purge subsystem of the CBVS is designed to clean up containment prior to an entry. The exhaust section of this portion of the CBVS is designed with redundant components allowing maintenance to be performed on a portion of this system during normal plant operation.

In general, these ventilation systems are not susceptible to streams that have the potential to encrust or crystallize in the ducting. However, as described in Section 9.4.2.1, the FBVS is equipped with electrical heaters in the boron rooms specifically designed to prevent crystallization in the borating system piping. Due to the continuous operation of these ventilation systems, blockages are not likely to occur in the ducting as airborne material collected by these systems are drawn towards the fans/exhausters and not allowed to settle and accumulate in the ducting. Airborne material may clog filters in these ventilation systems; therefore, these systems are designed with instruments to measure differential pressure across filters to avert clogging.

Facility contamination associated with potentially contaminated condensate from cooling coils in the CBVS, FBVS, NABVS, SBVS, and RWBVS is minimized by the inclusion of moisture separators and collection trays underneath the coils which collect and drain the condensate to the nuclear island drainage system.

The materials of the equipment used in these ventilation systems are compatible with the material in the process and facilitate decontamination. The exhaust and supply ductwork for these units are made of galvanized steel with the following exceptions:

- For CBVS, the exhaust ducts of the iodine filtration trains have airtight housings and all the ducts located outside the Containment Building are airtight and welded.
- For AVS, the accident train exhaust ducts are ferritic steel and the ducts of the normal ventilation train are concrete inside of the annulus and ferritic steel outside of the annulus.
- For FBVS, the main supply and exhaust duct chases are constructed of painted concrete and the ductwork for the fuel pool room is welded and constructed from stainless steel or from carbon steel with a coated surface suitable for decontamination.
- For SBVS, the main supply and exhaust air shafts are constructed of painted concrete and the surfaces of the metal and concrete exhaust ductwork which could

be exposed to airborne contamination are painted with a special paint that allows easy decontamination.

12.03-12.04-9
(Part 3)

The ductwork meets the design, testing, and construction requirements, per ASME AG-1-2003 (Reference 13). Components for each of these ventilation systems are designed with consideration of minimizing deposits of material on component surfaces and ease of decontamination. For the CBVS and FBVS, all exhaust portions of ducts are capable of being decontaminated. Removal and transfer of contaminated filters are implemented under the Radiation Protection Program (see Section 12.5).

Design Provisions for Minimizing Contamination of the Environment

The filtered exhaust and the negative differential pressures with respect to the environment produced by the CBVS, AVS, FBVS, SBVS, NABVS, and RWBVS provide the primary protection against contamination of the environment. During normal operation, these ventilation systems produce a sub-atmospheric pressure in their ventilated zones and filter the air from these zones for removal of potential contaminants prior to release to the environment via the plant stack. The AVS provides isolation of the secondary containment and collects containment building leakage. Following a design basis accident, the AVS removes particulates from the contaminated air prior to release to the environment. The normal exhaust from the CBVS, FBVS, AVS, and SBVS are processed by the NABVS through a filtration train and the exhausted air is directed to the plant stack. The RWBVS draws air from locations in the Radioactive Waste Building where radioactivity is likely, and also collects air from activity-bearing systems, vented tanks, and work areas and machinery which may produce airborne releases.

Upon receipt of a containment isolation signal or a high radiation alarm in the mechanical areas of the Safeguard Buildings, the SBVS is isolated from its supply and the NABVS exhaust system, directing its exhaust air through the SBVS activated charcoal filtration beds located in the FB prior to release to the environment through the plant stack. Similarly, upon receipt of a containment isolation signal, the FBVS is isolated from the NABVS and the exhaust is processed through these same filtration trains of the SBVS. A containment isolation signal also isolates the normal operation trains from the NABVS and starts the AVS accident trains to draw a negative pressure in the annulus and filter the exhaust air through activated charcoal filtration beds located in the FB prior to release to the environment through the plant stack. The containment isolation signal also causes the CBVS to automatically isolate the containment atmosphere by quick closure of the system containment isolation valves to maintain the integrity of the containment boundary and to limit the potential release of radioactive material to the environment. The SBVS supply and exhaust duct network for the hot mechanical areas in the Safeguard Buildings are equipped with isolation dampers to isolate these areas during design bases accident conditions. SBVS also confines the volume of the fuel hall by maintaining negative pressure and removes

12.03-12.04-9 (Part 3)

iodine released in the event of a fuel handling accident in the FB. SBVS also confines the containment volume and removes iodine released in the event of a fuel handling accident in the RB. During fuel handling operations, a controlled and monitored ventilation system removes gaseous radioactivity from the atmosphere above the spent fuel pool and processes it through high efficiency particulate air (HEPA) filters and charcoal adsorber units of NABVS.

Details of the filter alignments for each ventilation system can be found in the following FSAR Sections: for CBVS Section 9.4.7, for AVS Section 6.2.3, for FBVS Section 9.4.2, for SBVS Section 9.4.5, for NABVS Section 9.4.3, and for RWBVS Section 9.4.8.

The filtration systems used by these ventilation units provides the final barrier against a release to the environment and consist of HEPA filters, pre-filters, adsorbers for iodine, heaters, fans, dampers, and ductwork that remove particulate and gaseous radioactive material from the atmosphere. Local instruments are provided to measure differential pressure across filters to confirm that they are effectively removing potential contaminants from the exhaust. The effectiveness of the filters is further confirmed by monitors on the air exhausted from these filtration trains. In the event of a high radioactivity level alarm, a system can be manually shut down and isolated.

These filtration systems are also designed to permit periodic inspection and periodic pressure and functional testing per ASME AG-1-2003 (Reference 13). The filters are contained in housings and a dedicated, ventilated room to minimize the potential for facility and environmental contamination. For some units, lighting is also available inside filter banks between the rows of filters and inspection portholes in the filter housing doors to enable viewing while in operation.

There are certain containment penetrations that introduce the potential for primary containment leakage to bypass the filtered annulus and escape directly to the environment. These potential bypass leakage paths exist through the double seals of the equipment hatch, personnel airlocks, fuel transfer tube, and containment ventilation system isolation valves. The negative pressure difference between the annulus and the environment provides a driving force to route these bypass leakage paths to the annulus, thereby providing an additional barrier against a release to the environment.

For these ventilation systems, there are no buried pipes handling potentially contaminated exhaust gases and therefore, no means to contaminate the environment from a leaking pipe. Gases that may potentially leak from these ventilation systems upstream of the HEPA filters are collected and subsequently filtered by one of these ventilation systems, which are providing a sub-atmospheric pressure in the room where the leak may occur.

12.03-12.04-9
(Part 3)

The registers of the ventilation systems are placed in each area to deliver the supply air high in the room or corridor, and to draw the air into the exhaust register high in the room or area served by the HVAC system. As a general design rule, the HVAC register placement is high above the flood plain.

12.3.6.5.7 Essential Service Water System

The essential service water system (ESWS) is designed to minimize contamination of the facility and the environment as described in the general protective design features listed in Sections 12.3.6.1 and 12.3.6.2.

The ESWS is free of radioactivity resulting from plant operation. The ESWS design is consistent with the U.S. EPR contaminant management philosophy in compliance with 10 CFR 20.1406. Migration of radioactive material from potentially radioactive systems is prevented with a minimum of two barriers. The ESWS supplies water to the CCWS heat exchangers (HX) and returns the water to the ultimate heat sink (UHS) cooling tower basins. The CCWS is between the ESWS and RHRS. In addition to the CCWS/ESWS HX, there is a second HX barrier between the CCWS and RHRS. Radiation monitors in the CCWS detect radioactive contaminants migrating through the system. With two barriers between the ESWS and RHRS, as well as radiation monitoring provisions provided in the CCWS, additional radiation monitors in the ESWS design are not required.

12.3.6.5.8 Seal Water Supply System

The seal water supply system (SEWSS) is designed to minimize contamination of the facility and the environment as described in the general protective design features listed in Sections 12.3.6.1 and 12.3.6.2.

The SEWSS is free of radioactivity, and its design is consistent with the requirements of 10 CFR 20.1406. Radioactive material release from potentially radioactive systems is prevented with a minimum of two barriers, which are provided by an arrangement of check valves between SEWSS users and the demineralized water system.

12.3.6.5.9 Safety Chilled Water System

The safety chilled water system is designed to minimize contamination of the facility and the environment as described in the general protective design features listed in Sections 12.3.6.1 and 12.3.6.2.

A process radiation monitor is provided in Trains 1 and 4 of the SCWS, downstream of the low head safety injection (LHSI) pump mechanical seal HX, to monitor for possible leakage of radioactive fluid from the HX. The LHSI pump mechanical seal is directly cooled by reactor coolant. This process radiation monitor satisfies the requirements of GDC 64, 10 CFR 52.47(a)(6), and 10 CFR 20.1406. Other than the previously

12.03-12.04-9 (Part 3)

mentioned potential for possible leakage, the SCWS is free of any radioactivity resulting from plant operation. The SCWS design is consistent with the U.S. EPR contaminant management philosophy to comply with the requirements of 10 CFR 20.1406. Migration of radioactive material from potentially radioactive systems is prevented with a minimum of two barriers. The CCWS is located between the SCWS and the RHRS. In addition to the CCWS/SCWS HX, there is a second HX barrier between the CCWS and RHRS. To directly transfer contaminated water to the SCWS, two HXs must fail simultaneously. It is unlikely that two monitored systems will fail simultaneously and remain undetected. Radiation monitors are located in the CCWS to detect radioactive contamination in the system.

12.3.6.5.10 Compressed Air System

The compressed air system is designed to minimize contamination of the facility and the environment as described in the general protective design features listed in Sections 12.3.6.1 and 12.3.6.2.

The connections to instrument air are temporary in nature involving hose connections and quick release connectors. Immediately upstream of the quick connects are branch isolation valves used to isolate individual connections from the remainder of the instrument air header. Each instrument air sub-header contains an isolation valve that isolates the sub-header from the remainder of the instrument air system. These connections preclude contamination of other systems and components if contamination is detected. The instrument air system is normally pressurized and does not recycle air. There is no path for contamination to be picked up from interfacing systems and carried back through the instrument air system.

12.3.6.5.11 Demineralized Water Distribution System

12.03-12.04-9 (Part 3) and 12.03-12.04-10

The demineralized water distribution system (DWDS) storage tanks complex is west of the Turbine Island as shown in Figure 1.2-3. DWDS piping configuration is not buried where it interfaces with radioactive contaminated systems. This prevents direct uncontrolled releases of radioactivity to the environment in the event of pipe wall degradation and confirms the DWDS compliance with 10 CFR 20.1406. The DWDS supplies demineralized water to the following Nuclear Island contaminated consumers:

- Coolant degasification system.
- Coolant treatment system.
- Coolant purification system.
- Nuclear island drain and vent systems.
- Coolant supply and storage system.

12.03-12.04-9 (Part 3) and 12.03-12.04-10

- Nuclear sampling system.
- Fuel pool cooling and purification system.
- Reactor boron and water makeup system.
- Chemical control system.
- Pressure relief discharge system.
- Reactor coolant pump.
- In-containment refueling water storage tank system.
- Liquid waste processing/storage system.
- Decontamination equipment for apparatus and vessels.
- Decontamination system for small machine components.
- Solid waste system.
- Severe accident sampling system.

The DWDS interfaces with these contaminated systems in the RB, Safeguard Buildings, Nuclear Auxiliary Building, FB, and Radioactive Waste Processing Building. The DWDS is protected from contamination by system design and multiple interface barriers. The DWDS operating pressure is higher than the interfacing systems. The system pressure differential at the interface prevents contamination of the DWDS. Contamination of the DWDS when pressure is lost is prevented by defense in depth consisting of multiple barriers such as isolating valves, check valves, air gaps, and anti-siphoning features that isolate and prevent back flow. These mechanical barriers are part of the interfacing systems or DWDS to prevent contamination from reaching the DWDS. Additional barriers are in the DWDS to prevent upstream contamination such as isolating valves and check valves located at the NI Building entrances to further prevent upstream contamination outside of the NI. The overall design configuration of the DWDS and the contaminated interfacing systems contain sufficient barriers to prevent radioactive contamination of the DWDS.

12.3.7 References

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12.03-12.04-9
(Part 3)

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