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

Question 12.03 – 12.04-1:

Background

The staff developed Regulatory Guide 4.21 (issued in draft as DG-4012) in order to provide guidance to the industry on how to meet the requirements of 10 CFR 20.1406 with respect to minimizing, to the extent practicable, contamination of the facility and the environment, facilitating eventual decommissioning, and minimizing, to the extent practicable, the generation of radioactive waste.

The following 9 design and operational objectives summarize the objectives contained in the Regulatory Position section of RG 4.21. Appendix A of RG 4.21 contains examples of measures that might be taken to address the requirements of 10 CFR 20.1406.

1. Minimize leaks and spills and provide containment in areas where such events may occur,
2. Provide for adequate leak detection capability to provide prompt detection of leakage for any structure, system, or component which has the potential for leakage,
3. Use leak detection methods (e.g., instrumentation, automated samplers) capable of early detection of leaks in areas where it is difficult or impossible to conduct regular inspections (such as for spent fuel pools, tanks that are in contact with the ground, and buried, embedded, or subterranean piping) to avoid release of contamination from undetected leaks and to minimize contamination of the environment,
4. Reduce the need to decontaminate equipment and structures by decreasing the probability of any release, reducing any amounts released, and decreasing the spread of the contaminant from the source,
5. Periodically review operational practices to ensure that, operating procedures are revised to reflect the installation of new or modified equipment, personnel qualification and training are kept current, and facility personnel are following the operating procedures,
6. Facilitate decommissioning by a) maintenance of records relating to facility design and construction, facility design changes, site conditions before and after construction, onsite waste disposal and contamination and results of radiological surveys, b) minimizing embedded and buried piping, and c) designing the facility to facilitate the removal of any equipment and/or components that may require removal and/or replacement during facility operation or decommissioning,
7. Minimize the generation and volume of radioactive waste both during operation and during decommissioning (by minimizing the volume of components and structures that become contaminated during plant operation)
8. Develop a conceptual site model (based on site characterization and facility design and construction) which will aid in the understanding of the interface with environmental systems and the features that will control the movement of contamination in the environment,
9. Evaluate the final site configuration after construction to assist in preventing the migration of radio-nuclides offsite via unmonitored pathways,

The above list contains a mixture of design and operational objectives. Since Chapter 12 deals with radiation protection related issues, some of these objectives are partially addressed in various Sections of Chapter 12 of the DCD. The subject matter of others (e.g., item number 8 on the conceptual site model) dictates that they be addressed in detail in other sections of the DCD.

A. For those objectives which are more operational or procedural in nature, provide COL action items in the appropriate section of the DCD where the system or concept is described and include a reference to these sections in Chapter 12.3 of the DCD.

B. The information presented in Chapter 12 of DCD Tier 2, Rev. 0 identifies EPR general design features that would minimize the contamination of the facility and environment and would minimize the generation of radioactive waste. However, this information does not address design features that are unique to system designs or their locations in the plant warranting more technical details, and does not identify issues that should be addressed as COL action items. For each of the systems listed below (and for any other plant systems which may generate radioactive waste or could result in the contamination of non-radioactive systems), describe specific design features which are incorporated into the EPR design to comply with the requirements of 10 CFR 20.1406.

1) Fuel Storage and Handling, including fuel transfer tube
2) Process Sampling System
3) Coolant Storage and Transfer System
4) Radioactive Waste Management Systems
5) Equipment, Floor, Chemical, and Detergent Drain Systems
6) Building heating, ventilating and air conditioning systems used to process radioactive process and effluent streams

List these specific design features and/or COL action items in the appropriate section of the DCD where the system is described and include a reference to these sections in Chapter 12.3 of the DCD.

Response to Question 12.03 – 12.04-1, Parts A and B:

As AREVA NP committed in the July 24, 2008 response to this question, a partial response is provided describing the specific design features that are incorporated into the U.S. EPR for the systems listed in the question.

The operational elements of the question and the associated RG 4.21 are those for which the nuclear industry has proposed resolution through the use of a generic industry approach. To support generic resolution, the Nuclear Energy Institute (NEI) has initiated development of NEI 08-08, which will include a generic FSAR template for the operational programs for implementing 10 CFR 20.1406. AREVA NP reaffirms its intention to use this generic template to establish the operational elements for the U.S. EPR.

As committed in the initial response, elements of the response that pertain to operational objectives will be provided within 45 days of NRC approval of the generic template NEI 08-08; corresponding FSAR changes will be included.

The U.S. EPR complies with the requirements of 10 CFR 20.1406 by applying a contaminant management philosophy to the design of structures, systems, and components (SSC) that have the potential to contain radioactive materials. As stated in U.S. EPR FSAR Tier 2, Section 12.3.6, the principles embodied in this philosophy are threefold:

- Prevention of an unintended release.
- Early detection if there is an unintended release.
- Prompt and aggressive cleanup, should there be an unintended release. The cleanup provisions will be included in the operational programs.

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. There is no mobile or temporary vendor supplied equipment (e.g., mobile demineralizer) proposed to be used in the U.S. EPR, thereby minimizing the potential for leaks from temporary fittings or connections. Interfaces between radiological and non-radiological systems have been minimized. At location where the interfaces do exist, at least two barriers are included to minimize the potential for cross-contamination, and instrumentation is provided for prompt detection of potential cross-contamination.

Details of the implementation of this design philosophy into the design of the systems specified in this question and listed in Table 12.03–12.04—Mapping of U.S. EPR Systems to RAI Systems are presented below. In addition, design features of the U.S. EPR not necessarily captured by these systems, but intended to comply with the requirements of 10 CFR 20.1406, are included in the first portion of this response.

U.S. EPR General Design Features

To minimize facility contamination, the U.S. EPR includes the following general and specific design features:

- As seen in the “Plan View” figures of U.S. EPR FSAR Tier 2, Section 3.8 and the radiation zone figures of U.S. EPR FSAR Tier 2, Section 12.3, the U.S. EPR is a compartmentalized facility. This feature minimizes the potential for spreading contamination throughout the facility by containing potential contamination within a compartment and by providing ventilation in these compartments to promote air flow towards compartments with the greater potential for contamination.
- As described in U.S. EPR FSAR Tier 2, Section 6.1.2.1, the U.S. EPR uses a smooth epoxy or, in high temperature exposure areas, an inorganic coating on surfaces that could potentially become contaminated. This process minimizes the potential spread of contamination in the facility due to transfer by personnel and equipment. U.S. EPR FSAR Tier 2, Section 6.1.2.3.5 describes the maintenance program that will maintain control and qualification of these applied coatings.
- The U.S. EPR is designed with a facility in the Access Building for decontamination and cleaning of personnel protective equipment, instrumentation, and small items. As described in U.S. EPR FSAR Tier 2, Section 12.3.1.6, this facility provides:
    - A washdown area and sink which drains to the liquid waste management system.

- A positive airflow into the decontamination facility which is exhausted into a monitored building ventilation system. The walls and floors in this area are coated to facilitate cleanup and decontamination.

- The U.S. EPR has a core melt stabilization system to stabilize molten core debris resulting from the most severe category of reactor accidents. The core melt stabilization system provides temporary retention and conditioning of molten core debris, an area for corium to spread, features that limit potential energetic fuel-coolant interactions, and features for immobilizing and containing radionuclides. This system is described in U.S. EPR FSAR Tier 2, Section 19.2.3.3.3.1 and will minimize facility and environmental contamination by limiting and containing the spread of radioactive material from this region of the plant.

For minimization of environmental contamination, the U.S. EPR includes the following general design features:

- The nuclear island foundation basemat of the U.S. EPR, as described in U.S. EPR FSAR Tier 2, Section 3.8.1.1, and the reactor coolant boundary (described below) provide a leaktight barrier that protects against the uncontrolled release of radioactivity into the environment beneath the plant.

- The containment walls and dome and the reactor coolant boundary provide the primary barrier against a release to the environment above the basemat. As described in U.S. EPR FSAR Tier 2, Section 3.8.1.1.1, the reinforcing steel bars in the concrete containment walls and dome provide crack control and strength to accommodate seismic and other loads (e.g., thermal cycling). The reinforcing steel bars also prevent the formation of leak paths to the environment.

- As described in U.S. EPR FSAR Tier 2, Section 6.2.6.5, the design of the U.S. EPR contains no primary containment penetrations or seals that terminate outside the secondary containment to the environment. As described in U.S. EPR FSAR Tier 2, Section 6.2.3.2.3, containment penetrations that are paths for potential bypass leakage terminate in areas of the surrounding buildings that collect leaked radioactive material and filter radioactive release during a postulated accident event.

- To minimize the need to perform activities outside of the U.S. EPR facilities, the layout of the U.S. EPR has been designed (as described in U.S. EPR FSAR Tier 2, Section 12.1.2.1.1) to provide sufficient space for tools and equipment and for easily disassembling or reassembling components that may be contaminated.

To facilitate decommissioning, the U.S. EPR includes the following general design features:

- As described in U.S. EPR FSAR Tier 2, Section 3.8.1.4.9 and Section 3.8.3.1.5, the U.S. EPR is designed to facilitate the removal of large equipment with large containment penetrations (e.g., the equipment hatch, airlocks, and construction opening).

- The U.S. EPR uses modular construction methods to the extent practical for portions of the containment liner, equipment hatch, airlocks, penetrations, reinforcing steel, tendon conduits, in-containment refueling water storage tank liner, refueling canal liner, reinforcing, concrete formwork, spent fuel pool liner, other tank liners, and distribution system supports as described in U.S. EPR FSAR Tier 2, Section 3.8.1.6.8, Section 3.8.3.6.5, Section 3.8.4.6.3, and Section 3.8.5.6.3. These methods facilitate decommissioning by reducing the size of the material required to be removed from the plant, allow for a greater degree of separation of contaminated and non-contaminated waste materials, and reduce the quantity of contaminated waste produced during decommissioning.

System Specific Design Features

- Fuel Storage and Handling

The fuel handling and storage systems, including the fuel transfer tube and canal, are designed to minimize contamination of the facility and the environment as described by the general protective design features contained in U.S. EPR FSAR Tier 2, Section 12.3.1.3 and Section 12.3.6.1.4. The following text provides additional details on the features in these systems designed to satisfy the requirements of 10 CFR 20.1406.

(i) Facility Contamination

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 fuel pool. The spent fuel pool is a reinforced concrete structure with a stainless steel liner plate. In case of a leak, leak detection channels are provided behind seams in the liner plate for collection and monitoring of potential pool leaks. Any water collected is routed to the floor and equipment drain system and transferred to the liquid radwaste system for processing. Instrumentation is provided to detect and to alarm the main control room (MCR) when low water level occurs in the spent fuel pool, and area radiation monitors are provided in the fuel storage area for personnel and facility contamination protection. These area monitors alarm locally and in the MCR. Additional information related to these spent fuel pool features are provided in U.S. EPR FSAR Tier 2, Section 3.1.6.2.1, Section 3.1.6.4.1, Section 3.4.3.5, Section 3.8.4.1.2, Section 9.1.2.1, Section 9.1.2.2.2, and Section 9.1.2.3.

The concrete structure for the fuel transfer canal is designed in accordance with the criteria for Seismic Category I structures. As such, it is designed to maintain leaktight integrity to prevent the loss of cooling water from the pool. The fuel transfer canal is lined with stainless steel plates. The fuel transfer tube consists of a stainless steel pipe installed inside a 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 Reactor Building (RB) internal structures refueling canal concrete and the Reactor Shield Building and Fuel Building concrete. Expansion joints are provided for the fuel transfer tube on the RB and Fuel Building side to accommodate the differential movement and provide leaktight sealing. These expansion joints are equipped with sensors for detecting leaks, and the sensors provide an alarm in the MCR. 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. Additional information on these features of the fuel transfer canal and fuel transfer tube are provided in U.S. EPR FSAR Tier 2, Section 3.1.5.5.1, Section 3.8.2.1.4, Section 3.8.2.4.2, Section 3.8.3.1.7, Section 9.1.2.2.2, Section 9.1.4.2.2, and Section 9.1.4.3.1.

To minimize facility contamination associated with the maintenance and replacement of contaminated fuel handling equipment, this equipment is designed for the life of the plant. The materials of construction, surface finish (for contamination prevention), and lubricant used are designed in accordance with the recommendations prescribed in ANS 57.1-1992, R1998; R2005 for the fuel handling equipment.

(ii) Environmental Contamination

To minimize the airborne contamination of the environment by the fuel storage and handling systems, the fuel building ventilation system provides appropriate ventilation and filtration to limit potential releases of airborne radioactivity to the environment under normal operation, and in the event of a leak or a fuel handling accident in the fuel pool area. This ventilation system is continuously monitored by gaseous, particulate, and radio-iodine radiation monitors that alarm locally and in the MCR. This ventilation system processes these gaseous releases through high-efficiency particulate air filters and charcoal adsorber units and transfers them to the unit vent. As described in U.S. EPR FSAR Tier 2, Section 3.1.6.4.1, isolation dampers provide isolation of this ventilation system for specific rooms within the Fuel Building to mitigate the consequences of a fuel handling accident. Additional information on the fuel building ventilation system is provided in this response under the HVAC section.

To minimize the contamination of the environment of a potential leak from the spent fuel pool, fuel transfer canal, or fuel transfer tube, the leak detection systems described above and as described in U.S. EPR FSAR Tier 2, Section 3.8.4.1.2 and Section 9.1.2.2.2 are credited. There are no portions of the spent fuel pool system handling potentially contaminated material that are buried or routed through exterior boundaries. The leak detection system under the spent fuel pool provides 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 around locations of potential leaks of contaminated fluids to prevent the spread of these fluids.

(iii) Decommissioning

The spent fuel storage and handling systems are designed to facilitate decommissioning by providing operations for draining, filling, and filtering the spent fuel pool. In addition, there is no embedded piping in this system that handles potentially contaminated fluids.

(iv) Waste Minimization

Components of the fuel handling and storage systems are designed to operate for 60 years, minimizing the potential generation of waste associated with operating and maintaining this system. The fuel handling system is designed in accordance with ANS-57.1-1992, R1998 and R2005, which includes taking into consideration decontamination activities during operation.

- 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 by the general protective design features and the air filtration system design contained in U.S. EPR FSAR Tier 2, Section 12.3.1.4, Section 12.3.1.9.2, Section 12.3.5.2, and Section 12.3.6.2. U.S. EPR FSAR Tier 2, Section 12.3.4 describes the area radiation and airborne radioactivity monitoring instrumentation designed to assess and indicate radioactivity levels throughout the plant. The following text provides additional details on the features in these systems designed to satisfy the requirements of 10 CFR 20.1406.

(i) Facility Contamination

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

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

- Monitor variables and systems over their anticipated ranges to confirm 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 releases from the sampling system itself.

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

As described in U.S. EPR FSAR Tier 2, Section 11.5, the process sampling systems monitor radioactivity levels in plant process streams and atmospheres, indicate and alarm excessive radioactivity levels, and will either automatically initiate protective isolation actions or alert the operator to initiate manual actions to minimize potential contamination of the facility. These 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 that contain components for recirculation of loss of coolant accident fluids and components for processing radioactive wastes. In the event of high levels of radiation, both local alarms and signals to the MCR are provided. Additional process monitoring function details are provided in U.S. EPR FSAR Tier 2, 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. This information enables early indication to initiate other protective actions for minimizing potential facility contamination. For example, as described in U.S. EPR FSAR Tier 2, Section 3.1.6.5.1 and Section 9.3.2.3, 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. When airborne radioactive concentrations within containment are acceptable, access may be attained without contaminating other portions of the plant.

The process sampling systems also obtain and analyze key chemistry parameters such as chloride, hydrogen, and oxygen concentrations in the reactor coolant. The control of these concentrations 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, the portion of the process sampling system that includes the reactor coolant pressure boundary is designed, fabricated, erected and tested to maintain a low probability of abnormal leakage, rapidly propagating failure, and gross rupture. In addition, the sample lines penetrating the containment are capable of isolating upon receipt of a containment isolation signal from the reactor protection system. For sampling systems collecting active liquid samples, sample gloveboxes are used to confine spills. The safety-related portions of the process sampling systems are designed to withstand the effects of natural phenomena, whereas the non-safety-related portions of the process sampling systems are designed to have provisions for a leakage detection and control program to minimize the leakage from those portions of the process sampling systems outside of the containment that contain or may contain radioactive material following an accident. Information related to these design features of the process sampling systems are provided in U.S. EPR FSAR Tier 2, Section 9.3.2.1, Section 9.3.2.2.1.1, and Section 9.3.2.3.

As described in U.S. EPR FSAR Tier 2, Section 9.3.2.3, the process sampling systems also prevent the inadvertent transfer of contaminated fluids to non-contaminated drainage systems by sending contaminated fluids either back to the system being sampled or to an appropriate radwaste system.

The components of the process sampling systems 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 using a continuous slope without low points. Each sample line is equipped with an inner and outer containment isolation valve. Additionally, there is a sampling isolation valve in each line that belongs to the reactor coolant system. Sample lines are flushed prior to sample extraction in order to remove sediment deposits and air and gas pockets. 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, and high level annunciations will be provided to prevent high levels in these vessels.

(ii) Environmental Contamination

The process sampling systems minimize contamination of the environment by:

- Monitoring the atmosphere in various locations of the facility and taking actions to minimize potential releases from the facility.
- Monitoring the effluents discharged from various ventilation systems and taking actions to minimize potential releases from the facility.
- Controlling and potentially reducing the concentration and quality of fission products released following postulated accidents.
- 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. In the event that contamination is detected, the process sampling systems provide indication and alarms in the MCR and health physics office to allow actions for minimizing environmental contamination. For example, the containment atmosphere is monitored during normal and transient operations by the containment gaseous radiation monitors. Under accident conditions, the containment atmosphere initiates RB containment isolation and minimizes releases to the environment. Sampling points are located on the process radiological monitoring and sampling systems to enable representative sampling for radiochemical analysis. This analysis indicates the existence 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 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 for 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 monitors provide indications and alarms to the MCR to allow actions for minimizing potential environmental contamination. U.S. EPR FSAR Tier 2, Section 11.5.1.2 provides additional information for these features.

The process sampling systems continuously monitor facility radioactivity levels in the effluent discharge paths during normal and accident conditions. As described in U.S. EPR FSAR Tier 2, Section 11.5.3.1, the gaseous effluent monitoring and sampling system monitors the Reactor Containment Building, the Fuel Building, the Nuclear Auxiliary Building, the mechanical area of the Safeguard Buildings, and 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. A COL applicant that references the U.S. EPR Design Certification will fully describe, through the Offsite Dose Calculation Manual (ODCM), how a gaseous radiological release will be controlled (per Section 11.5.2 of the FSAR).

As described in U.S. EPR FSAR Tier 2, Section 11.5.3.2, 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 and the sample is radiochemically analyzed. If the sample is acceptable, then flow from these tanks to the environment is permitted. The flow is monitored, and if radionuclide concentrations exceed the specified limits, then the discharge to the environment is isolated upstream prior to any unacceptable release to the environment.

As described in U.S. EPR FSAR Tier 2, Section 9.3.2.1 and Section 9.3.2.3, the non-safety-related portions of the process sampling systems are designed to aid in the control of 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 these 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 a corrosive chemical attack. Non-safety-related portions of the process sampling systems also 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.

The process sampling systems are designed to minimize the potential to leak into the facility and subsequently to the environment. Sample gloveboxes are used to limit any liquid or gaseous releases to the environment, safety-related portions of the sample lines are designed to withstand the effects of natural phenomena, and non-safety portions of the sample lines are designed to have provisions for a leakage detection and control program to minimize leakage for those portions of the lines outside of containment. Leakages from these systems are collected by the floor drains and monitored sumps.

There are no buried pipes in the process sampling systems that handle potentially contaminated liquids, which prevents environmental contamination from a leaking pipe. There are no by-pass lines around the radiation monitors for the liquid effluents released from the waste monitoring tanks. Gases that may potentially leak from these process sampling systems would be collected by one of the HVAC systems and subsequently filtered prior to a release from the plant stack.

(iii) Decommissioning

The process sampling system is designed to facilitate decommissioning by minimizing potential buildup of contaminants in the system and not using embedded piping. As described in U.S. EPR FSAR Tier 2, Section 9.3.2.1, the sample lines of these systems are purged to reduce plateout (i.e., buildup of chemical residue), and for gas samples, the sample pipes are kept as short as possible. There are no low points in the lines to avoid water pockets.

(iv) Waste Minimization

Components of the process sampling systems are designed to operate for 60 years, minimizing the potential generation of waste associated with operating and maintaining this system. As described in U.S. EPR FSAR Tier 2, Section 9.3.2.1, primary side samples taken by these systems are recycled back to their source as much as possible to minimize generation of waste. Similarly, as much liquid as practical from steam generator blowdown samples is routed to the sample backfeed tank to minimize liquid waste.

- Coolant Storage and Transfer Systems

The coolant storage and transfer systems is designed to minimize contamination of the facility and the environment as described by the general protective design features in U.S. EPR FSAR Tier 2, Section 12.3.1. The following text provides more details on the features in these systems designed to satisfy the requirements of 10 CFR 20.1406.

(i) Facility Contamination

To minimize the potential to contaminate the facility, the coolant storage and transfer systems are designed so that leakage is detected and quantified, and the location of the leak is identified by the leakage detection system. As described in U.S. EPR FSAR Tier 2, Section 5.1.1, the reactor coolant system 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 storage and transfer 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. As described in U.S. EPR FSAR Tier 2, Section 6.1.1.1, the piping and equipment exposed to coolant are austenitic stainless steel to avoid corrosion issues.

To prevent cross-contamination of interfacing support systems, level measurements in the vessels of this system will prevent high levels by automatically isolating inlet supplies to the vessels. In the event of a leak, these level measurements identify the vessel that is leaking by a low-level measurement, and 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 then it will be detected by continuous process radiation monitors or radiochemical grab sampling on the secondary side of the steam generator as described in U.S. EPR FSAR Tier 2, Section 5.4.2.5.2.5.

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, as described in U.S. EPR FSAR Tier 2, Section 3.1.4.1.1 and Section 5.2.5, 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 design to isolate, capture, and quantify leakage from known potential sources, such as flanges and relief valves, so that such leakage may be 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.

To minimize potential contamination of the facility due to leaks of reactor coolant into the component cooling water system (CCWS), leakage of reactor coolant into the CCWS from a residual heat removal heat exchanger tube, reactor coolant pressure seal thermal barrier, or other sources will be 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. As described in U.S EPR FSAR Tier 2, Section 9.2.2.2.1, leakage of reactor coolant into this system is also mitigated by the dedicated CCWS surge tank which is charged by nitrogen over pressurization. This over-pressurization causes potential component coolant leakage to flow into, rather than out of, most of the interfaces with contaminated fluids (e.g., the severe accident heat removal system). For potentially contaminated systems operating at pressures greater than the CCWS, the aforementioned radiation and flow monitors in the CCWS will 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. A high pressure cooler tube rupture would result in a leak of reactor coolant into the CCWS. This leakage into the CCWS would be detected by the CCWS flow meters (increased flow) or radiation monitors (increased radioactivity), and the high activity measurement will generate a signal to automatically close the cooler isolation valves to isolate the CVCS high pressure cooler from the CCWS, thereby minimizing the leakage into CCWS. U.S. EPR FSAR Tier 2, Section 9.3.4.2.3.5 and Section 9.3.4.3 describe these features of the CCWS.

In addition to maintaining the confinement barriers of the reactor coolant, facility contamination is minimized by the compartmentalization of the buildings that contain portions of the reactor coolant pressure boundary. U.S. EPR FSAR Tier 2, Section 12.3.1.1 describes that 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. 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 (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. 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.

As described U.S. EPR FSAR Tier 2, Section 12.3.1.3 and Section 12.3.9.1.2, 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. In addition, a dedicated room for reactor coolant pump maintenance is provided in the U.S. EPR design. For portions of the piping system potentially requiring inspections, maintenance, or repairs, bolted flanges are provided. For the tanks in the coolant storage and transfer systems, 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 storage and transfer systems are located in accessible rooms for ease of inspection and maintenance.

(ii) Environmental Contamination

The coolant storage and transfer systems are designed to minimize contamination of the environment by providing multiple barriers against radiological material from these systems. The coolant storage and transfer systems are designed to provide a secure envelope for the retention of reactor coolant and associated gases through the utilization of welded vessels and piping to provide a barrier against leakage of radiological material from this system. In the event of a leak from this barrier, leakage detection and collection are provided so that the location of the leak is identified and the leak is collected within the facility. Ventilation systems will collect and filter airborne releases from leaks to minimize the potential contamination released to the environment.

To minimize contamination of the environment from the reactor coolant and as described in U.S. EPR FSAR Tier 2, Section 3.8.1.1, the nuclear island foundation basemat works 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. The Reactor Shielding Building completely encloses the Reactor Containment Building and provides a second containment barrier against 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.

There are no portions of the coolant storage and transfer system handling potentially contaminated material that are buried or routed through exterior boundaries. However, sections of the safety injection system/residual heat removal system are contained outside containment. These systems are designed to control and detect leakage outside containment following an accident. As described in U.S. EPR FSAR Tier 2, Section 5.4.7.1, upon detection of leakage the section of these systems located outside confinement can be isolated.

(iii) Decommissioning

The coolant storage and transfer systems are designed to facilitate decommissioning by providing drain valves to allow for system drainage and a means to decontaminate and drain its storage tanks. There is no embedded piping in this system that handles potentially contaminated fluids.

(iv) Waste Minimization

The coolant storage and transfer systems are designed to operate for 60 years, minimizing the potential generation of wastes associated with operating and maintaining this system. The system contains bolted flanges that are provided where the removal of equipment may be required for inspection, maintenance, or repair to minimize the waste associated with the cutting out of equipment. Prior to performing maintenance activities, the decontamination of the coolant storage tanks can be performed using the system for decontamination of apparatus and vessels, which minimizes, to the extent possible, the waste generated from maintenance activities involving this system.

- Radioactive Waste Management Systems

The U.S. EPR radioactive waste management systems include: the coolant purification system, the filter changing equipment system, the liquid waste processing system, the solid waste processing system, and the gaseous waste processing system. These systems are designed to minimize contamination of the facility and environment as described by the general protective features listed in U.S. EPR FSAR Tier 2, Section 12.3.1.4, Section 12.3.1.5, Section 12.3.1.6, Section 12.3.1.7, and Section 12.3.6. The following text provides more details on the features in these systems designed to satisfy the requirements of 10 CFR 20.1406.

(i) Facility Contamination

As described in U.S. EPR FSAR Tier 2, Section 12.3.6.1, the design of the U.S. EPR minimizes facility contamination through the use of compartmentalization, HVAC systems to control airborne dispersion, spill prevention features, and leak detection and mitigation features. The radioactive waste management systems implement each one of these concepts to minimize contamination of the facility.

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. The tanks in these systems are located in rooms designed to either contain spills (using walls and curbs) or drain the spills to sumps equipped with leak detection systems. These detection systems provide a signal to automatically isolate the affected system or provide an indication to the MCR to initiate operator action either from within the MCR or locally. As described in U.S. EPR FSAR Tier 2, Section 11.2.1, these rooms have no doors leading directly to the outside environment. Therefore, contamination cannot be spread to the environment due to a spill or leakage.

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 U.S. EPR FSAR Tier 2, Section 11.4.1.2.5. However, such an optional mobile or vendor-supplied system is a site-specific design feature that is outside the scope of design certification.

The 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 reduce the activity present, and to control the subsequent release of processed waste gases to the atmosphere in compliance with regulatory limits. To confirm that the tanks are continuously vented, the system maintains a negative system pressure to prevent the escape of radioactive gases from components connected to the building air. Additional details are provided in U.S. EPR FSAR Tier 2, Section 11.3.

Releases from the gaseous waste processing system are continuously monitored by radiation sensors in the delay system discharge line. The system also enables grab sample collection 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 and prevents radioactive gases leakage that could contaminate the facility. Additional details are provided in U.S. EPR FSAR Tier 2, Section 11.3.

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 at a lower required heating temperature. The water vapor is condensed, collected, and the volume is 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 (U.S. EPR FSAR Tier 2, Section 11.4.2.2). Process monitors installed on the drum drying system detects in-process radiation levels to keep the operator informed of the process radiation levels (U.S. EPR FSAR Tier 2, Section 11.4.1.2.4).

The solid waste management system is also 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 and 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 (U.S. EPR FSAR Tier 2, Section 11.4.2.3.1).

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. The sampling box contains 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 (U.S. EPR FSAR Tier 2, Section 11.4.2.3.2).

In addition, area radiation monitors throughout the Radioactive Waste Processing Building detect excessive radiation levels and alert the operators to this condition (U.S. EPR FSAR Tier 2, Section 11.4.1.2.4 and Section 12.3.4). Any released gases from leaks from the radioactive waste management systems are collected by the building ventilation HVAC systems as described in U.S. EPR FSAR Tier 2, Section 3.7.

The piping and equipment for these components are stainless steel to avoid corrosion caused by wastewater, demineralized water, chemicals, and decontamination wastes (U.S. EPR FSAR Tier 2, Section 11.4.2.3.2). The liquid waste processing system is designed to allow for the addition of a chelating agent to help remove any encrusted solids in the process (e.g., evaporator column) to prevent buildup (U.S. EPR FSAR Tier 2, Section 11.2.2.1.3).

Contamination of the facility caused during filter change-outs is minimized by the U.S. EPR filter changing equipment design. This design 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, and reduces exposure to personnel and mitigates 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, contain the leakage from the filters, and drain the leakage through the bottom of the machine.

Contamination of the facility 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 (U.S. EPR FSAR Tier 2, Section 9.1.3.2.6 and Section 12.3.1.9.2). These resins are remotely flushed and hydraulically transferred to the spent resin waste tanks and subsequently to the liquid waste treatment unit (U.S. EPR FSAR Tier 2, Section 9.1.3.3.1 and Section 12.3.1.9.2).

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 found in shielded equipment (i.e., the filter changing machine or one of the two shielding casks) and in the event that the equipment gets contaminated the changing unit can be decontaminated by a mobile decontamination system (U.S. EPR FSAR Tier 2, Section 11.4.2.3.1, Section 12.3.1.9.2, Section 3.2.1.4, and Section 4.2). 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 a 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.

The radioactive waste management system is designed to minimize contamination of the environment by providing multiple barriers against radiological material from reaching the environment and by confirming that liquid effluent discharged to the environment meets regulatory requirements. 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 operations for these units occur within the Radioactive Waste Building with the exception of portions of the liquid waste system (transferring releasable waste water to the environment) and the solid waste system (transferring disposable wastes into disposal containers).

For the U.S. EPR, releases of radioactive effluent via the liquid pathway only occur by discharges from the monitoring tanks in the liquid waste storage system (U.S. EPR FSAR Tier 2, Section 11.2.3.3). 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) (U.S. EPR FSAR Tier 2, Section 11.2, Section 11.2.1.1, Section 11.2.3, and Section 11.2.2.1.6). The content of the monitoring tanks is then sent back to the processing system for further treatment (U.S. EPR FSAR Tier 2, Section 11.2).

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 (U.S. EPR FSAR Tier 2, Section 3.7) so that any generation of gaseous activity is continually removed (U.S. EPR FSAR Tier 2, Section 11.2.3.6). The gaseous waste processing system is 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 (U.S. EPR FSAR Tier 2, Section 11.3). This system maintains a negative system pressure to prevent the escape of radioactive gases from the connecting components (U.S. EPR FSAR Tier 2, Section 11.3.1.1 and Section 11.3.2.1.1).

Releases from the gaseous waste processing system are continuously monitored by radiation sensors in the delay system discharge line. The system also enables grab sample collection 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 (see U.S. EPR FSAR Tier 2, Section 3.7 for a discussion of this HVAC system, and see U.S. EPR FSAR Tier 2, Section 11.3.1.2.3).

The U.S. EPR provides design features to control and collect radioactive material spills. The tanks for these systems are contained in rooms with drains to collect any spills and to prevent any uncontrolled release to the environment (U.S. EPR FSAR Tier 2, Section 3.6). If a leak occurs in the room with 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. The liquid is pumped from the sump into a storage tank in the liquid waste storage system (U.S. EPR FSAR Tier 2, Section 11.4.2.2).

For the gaseous release associated with these spills from these systems, the U.S. EPR provides the radioactive waste building ventilation system, which is addressed in U.S. EPR FSAR Tier 2, Section 3.7. 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. 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 (U.S. EPR FSAR Tier 2, Section 11.4.2.3.1).

These radioactive waste treatment systems are contained in rooms that have no doors leading directly to the outside environment and thereby further prevent an environmental release (U.S. EPR FSAR Tier 2, Section 11.2.1). The piping and equipment for these systems are stainless steel to avoid corrosion caused by wastewater, demineralized water, chemicals, and decontamination wastes (U.S. EPR FSAR Tier 2, Section 11.4.2.3.2).

The radioactive waste treatment systems are designed to facilitate decommissioning by providing a means to decontaminate larger equipment in these units (e.g., filter change out machine and waste collection tanks). In addition, there is no embedded piping in these systems that handle potentially contaminated fluids.

In the large tanks, manholes are used. In smaller tanks, hand holes are used to gain access to the interior of the tank. These holes provide access to decontaminate the vessels and eventually to prepare them for decommissioning.

The radioactive waste treatment systems are designed to operate for 60 years, minimizing the potential generation of wastes associated with operating and maintaining this system. These systems provide decontamination solutions to promote the removal of radiological material from their equipment and thereby reducing the quantity of contaminated wastes.

The solid waste processing system is designed to minimize the volume of waste generated by the U.S. EPR through the use of equipment such as the drum drying units and demineralizer unit (U.S. EPR FSAR Tier 2, Section 11.4.2.2).

- 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 in U.S. EPR FSAR Tier 2, Section 12.3.1.7.4, Section 12.3.1.9.2, Section 12.3.3.3, and Section 12.3.6.2. In this section, design provisions are described for minimizing contamination of the facility and environment, facilitating decommissioning, and minimizing waste generation for the nuclear island drain and vent systems, which for the U.S. EPR are covered by one system as listed in Table 12.03–12.04—Mapping of U.S. EPR Systems to RAI Systems.

(i) Facility Contamination

To minimize the potential to contaminate the facility, the nuclear island drain and vent system is designed to collect, temporarily store, and discharge in a controlled manner leakage from equipment located on the nuclear island (U.S. EPR FSAR Tier 2, Section 9.3.3.). In addition, this system is provided with leak detection equipment used to mitigate consequences associated with postulated leaks. U.S. EPR FSAR Tier 2, Section 3.4 provides an assessment of the potential causes for internal flooding and how the nuclear island drain and vent system 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 potentially created by a leak, the nuclear island drain and vent system is designed to include curbs and drain catch trays to provide drainage control, and leak detection and isolation measures to mitigate the consequences of leaks (U.S. EPR FSAR Tier 2, Section 12.3.1.9.2). Liquid leakages or discharges drain by gravity to the sumps shown in U.S. EPR FSAR Tier 2, Figure 9.3.3-1. Sump pumps automatically or manually transfer their contents to storage tanks. Mobile pumps are used only where drainage is impractical. When mobile pumps are used they are connected to the permanent piping using temporary flexible hoses (U.S. EPR FSAR Tier 2, Section 9.3.3.2). The water level instrumentation within sumps and storage tanks and other leak detection measures detected leaks (U.S. EPR FSAR Tier 2, Section 3.4.1, Section 5.2.5.1.1, and Section 9.3.3.2). 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 (U.S. EPR FSAR Tier 2, Section 3.4.1 and Section 5.2.5.1.1). For example, the sump pumps inside the Safeguard Buildings and Fuel

Building are equipped with a double level measurement for detecting leaks and providing an indication to the MCR (U.S. EPR FSAR Tier 2, Section 9.3.3.3).

The nuclear island drain and vent system is also designed with containment isolation valves to provide isolation of containment in the event of a radiological release within containment, thereby removing a potential leak path from containment to the rest of the facility (U.S. EPR FSAR Tier 2, Section 9.3.3.1). 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. The nuclear island drain and vent system pumps, tanks, and sumps are sized to process the maximum expected rate of influx and total volume of expected leakage (U.S. EPR FSAR Tier 2, Section 5.2.5.1.1, Section 9.3.3.1, and Section 9.3.3.2.1).

The nuclear island drain and vent system is designed and equipped with provisions to permit testing for operability and calibration (U.S. EPR FSAR Tier 2, Section 5.2.5.1.1). The storage tanks contained in this system are located in vessel pits that are equipped with alarming level detectors to detect their failure. These storage tanks can also be decontaminated via temporary connections. Components of the nuclear island drain and vent system are designed to operate for 60 years, 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. Components of this system are typically 304 stainless steel for corrosion resistance.

Eyewash stations and shower wastewater in the Access Building are routed to a tank in the nuclear island drain and vent system. Liquid effluent from the decontamination facilities (e.g., showers, floor washing) will be collected and stored in the storage tanks of the nuclear island drain and vent system.

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 (U.S. EPR FSAR Tier 2, Section 12.3.1.7.2).

(ii) Environmental Contamination

The nuclear island drain and vent system is designed to minimize contamination of the environment by providing multiple barriers against 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 nonporous. The inner surfaces of sumps that are in contact with the radioactive fluid are lined with an impermeable coating to reduce corrosion. Sumps that are at the lowest building elevations are double lined and fitted with alarmed leakage detection instrumentation (U.S. EPR FSAR Tier 2, Section 12.3.1.7.4).

To prevent a contaminated liquid release to the environment and to mitigate the airborne consequences of a leak to the environment, the nuclear island drain and vent system 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 (U.S. EPR FSAR Tier 2, Section 3.4.1).

To prevent the potential of contaminating the environment through the release of a normally non-contaminated liquid, the nuclear island drain and vent system is designed to prevent the inadvertent transfer of contaminated fluids to non-contaminated drainage systems (U.S. EPR FSAR Tier 2, Table 11.5-1). 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.

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 (U.S. EPR FSAR Tier 2, Section 9.3.4.1). The CVCS drains are piped to the nuclear island drain and vent system to allow for storage and processing of the discharged liquids (U.S. EPR FSAR Tier 2, Section 9.3.4.3).

An oil collection system is 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 (U.S. EPR FSAR Tier 2, Section 5.4.1.2.2).

No access openings or tunnels penetrate the exterior walls of the nuclear island below grade (U.S. EPR FSAR Tier 2, Section 3.4.2). 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 (U.S. EPR FSAR Tier 2, Section 12.3.1.7.4).

(iii) Decommissioning

The nuclear island drain and vent system is designed, to the extent possible, to facilitate decommissioning by minimizing embedded pipes and providing a means to decontaminate its storage tanks (U.S. EPR FSAR Tier 2, Section 12.3.1.7.4). There are no access openings or tunnels that penetrate the exterior walls of the nuclear island below grade (U.S. EPR FSAR Tier 2, Section 3.4.2).

(iv) Waste Minimization

The nuclear island drain and vent system is designed to minimize the generation of waste by collecting different categories of liquid effluents into separate portions of the system as described in U.S. EPR FSAR Tier 2, Section 9.3.3.2.2. The nuclear island drain and vent system is designed to prevent the inadvertent transfer of contaminated fluids to non-contaminated drainage systems as areas that may contain radioactive effluents are physically separated from the plant areas that do not contain radioactive effluents (U.S. EPR FSAR Tier 2, Section 9.3.3.3).

The nuclear island drain and vent system is designed to operate for 60 years, minimizing the potential generation of wastes associated with operating and maintaining this system.

- Building HVAC Systems

HVAC systems are designed to minimize contamination of the facility and the environment as described by the general protective design features and the air filtration system design listed in U.S. EPR FSAR Tier 2, Section 12.3.3.3 and Section 12.3.3.4. U.S. EPR FSAR Tier 2, Section 12.3.4 describes the area radiation and airborne radioactivity monitoring instrumentation designed to assess and indicate radioactivity levels throughout the plant. In this section, design provisions are described for minimizing contamination of the facility and environment, facilitating decommissioning, and minimizing waste generation for the six HVAC systems listed in Table 12.03–12.04—Mapping of U.S. EPR Systems to RAI Systems.

(i) Facility Contamination

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 minimal air change rate, radiological material is less susceptible to becoming airborne and spreading to other portions of the building. By maintaining pressures higher in areas of lower contamination relative to pressures in areas with the potential for higher contamination, the air will flow 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 for 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 of the U.S. EPR FSAR:

- For CBVS, U.S. EPR FSAR Tier 2, Section 9.4.7.2.
- For FBVS, U.S. EPR FSAR Tier 2, Section 9.4.2.2.
- For SBVS, U.S. EPR FSAR Tier 2, Section 9.4.5.2.
- For NABVS, U.S. EPR FSAR Tier 2, Section 9.4.3.2.
- For RWBVS, U.S. EPR FSAR Tier 2, Section 9.4.8.2.

As described in U.S. EPR FSAR Tier 2, 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 monitor airborne radiation levels in the system. In addition to these monitors, area radiation monitors are located throughout the facility to provide local readouts, audible alarms, and visual alarms to alert operating personnel. These monitors are located in accessible areas for maintenance, inspection, and replacement without significant personnel exposure occurring. U.S. EPR FSAR Tier 2, Section 12.3.4 provides additional details for these monitors and their functions.

In addition to these radioactivity monitors, ventilation systems are designed to verify proper system behavior through the use of local instruments that measure parameters such as differential pressures across filters, flows, temperatures, and pressures. Indication of the operational status of the CBVS equipment, position of dampers, instrument indications, and alarms are provided in the MCR (CBVS: U.S. EPR FSAR Tier 2, Section 9.4.7.5; AVS: U.S. EPR FSAR Tier 2, Section 6.2.3.5; FBVS: U.S. EPR FSAR Tier 2, Section 9.4.2.5; SBVS: and U.S. EPR FSAR Tier 2, Section 9.4.5.5; NABVS: U.S. EPR FSAR Tier 2, Section 9.4.3.5; and RWBVS: U.S. EPR FSAR Tier 2, Section 9.4.8.5).

The design and installation of the components of these ventilation systems will confirm that adequate clearance is provided for removal, maintenance, and inspections. To minimize the need to remove components from these 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 AVS, SBVS, and portions of the CBVS can only be performed when the plant is shut down. Maintenance on the FBVS isolation dampers located in the fuel pool room can only be performed when no fuel handling activities in the Fuel Building occur. The containment purge subsystem of the CBVS is designed to clean up containment prior to an entry. The exhaust portion of this portion of the CBVS is designed with redundant components and maintenance can be performed on a portion of this system during normal plant operation (U.S. EPR FSAR Tier 2, Section 9.4.7.2.1).

These ventilation systems are not susceptible to streams that have the potential to encrust or crystallize in the ducting. However, as described in U.S. EPR FSAR Tier 2, 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. Furthermore, due to the continuous operation of these ventilation systems, blockages are not likely to occur in the ducting because airborne material collected by these systems will be drawn towards the fans or 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 will collect and drain the condensate to the nuclear island drainage system (CBVS: U.S. EPR FSAR Tier 2, Section 9.4.7.2.2; FBVS: U.S. EPR FSAR Tier 2, Section 9.4.2.2.2; SBVS: U.S. EPR FSAR Tier 2, Section 9.4.5.2.2).

The materials of the equipment used in these ventilation systems are compatible with potential off-gases they remove, and facilitate decontamination. The exhaust and supply ductwork for these units are made of galvanized steel (CBVS: U.S. EPR FSAR Tier 2, Section 9.4.7.2.2; FBVS: U.S. EPR FSAR Tier 2, Section 9.4.2.2.2; SBVS: U.S. EPR FSAR Tier 2, Section 9.4.5.2.2; NABVS: U.S. EPR FSAR Tier 2, Section 9.4.3.2.2) with the following exceptions:

- For CBVS, the exhaust ducts of the iodine filtration trains have airtight housings and 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 the annulus and ferritic steel outside the annulus.

- For FBVS, the main supply and exhaust duct chases are painted concrete and the ductwork for the fuel pool room shall be welded stainless steel or carbon steel with a coated surface suitable for decontamination (U.S. EPR FSAR Tier 2, Section 9.4.2.2.2).

- For SBVS, the main supply and exhaust air shafts are painted concrete and the surfaces are metal and concrete. The exhaust ductwork, which could be exposed to airborne contamination, is painted with a special paint that allows for easy decontamination (U.S. EPR FSAR Tier 2, Section 9.4.5.2.2).

The ductwork meets the design, testing, and construction requirements of ASME AG-1-2003.

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, exhaust portions of ducts are capable of being decontaminated. Removal and transfer of contaminated filters will be implemented under the Radiation Protection Program.

(ii) Environmental Contamination

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 protections 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 to remove potential contaminants prior to being released to the environment via the plant stack (CBVS: U.S. EPR FSAR Tier 2, Section 9.4.7.2.1; AVS: U.S. EPR FSAR Tier 2, Section 6.2.3.1; FBVS: U.S. EPR FSAR Tier 2, Section 9.4.2.2.1; SBVS: U.S. EPR FSAR Tier 2, Section 9.4.5.1; NABVS: U.S. EPR FSAR Tier 2, Section 9.4.3.2.1; and RWBVS: U.S. EPR FSAR Tier 2, Section 9.4.8.2.1). The AVS specifically 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 (U.S. EPR FSAR Tier 2, Section 6.2.3.2.2). The normal exhaust from the CBVS, FBVS, AVS, and SBVS is processed by the NABVS through a filtration train and the exhausted air is directed to the plant stack (CBVS: U.S. EPR FSAR Tier 2, Section 9.4.7.2.1; FBVS: U.S. EPR FSAR Tier 2, Section 9.4.2.1; AVS: U.S. EPR FSAR Tier 2, Section 6.2.3.2.2.1; and SBVS: U.S. EPR FSAR Tier 2, Section 9.4.5.1). 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 that may produce airborne releases (U.S. EPR FSAR Tier 2, Section 9.4.8.2.1).

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 Fuel Building prior to release to the environment through the plant stack (U.S. EPR FSAR Tier 2, Section 9.4.5.1). 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 (FBVS: U.S. EPR FSAR Tier 2, Section 9.4.2.2.2, and NABVS:

U.S. EPR FSAR Tier 2, Section 9.4.3.2.3). 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 Fuel Building prior to release to the environment through the plant stack (AVS: U.S. EPR FSAR Tier 2, Section 6.2.3.2.2.2). 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 (U.S. EPR FSAR Tier 2, Section 9.4.7.1). 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 (U.S. EPR FSAR Tier 2, Section 9.4.5.2.1). SBVS also confines the volume of the fuel hall by maintaining negative pressure and removes iodine released in the event of a fuel handling accident in the Fuel Building (U.S. EPR FSAR Tier 2, Section 9.4.5.2.1). SBVS also confines the containment volume and removes iodine released in the event of a fuel handling accident in the RB (U.S. EPR FSAR Tier 2, Section 9.4.5.2.1). 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 (FBVS: U.S. EPR FSAR Tier 2, Section 9.4.2.2.1).

Details of the filter alignments for each ventilation system can be found in the following sections: for CBVS U.S. EPR FSAR Tier 2, Section 9.4.7, for AVS U.S. EPR FSAR Tier 2, Section 6.2.3, for FBVS U.S. EPR FSAR Tier 2, Section 9.4.2, for SBVS U.S. EPR FSAR Tier 2, Section 9.4.5, for NABVS U.S. EPR FSAR Tier 2, Section 9.4.3, and for RWBVS U.S. EPR FSAR Tier 2, Section 9.4.8.

The filtration systems used by these ventilation units provide 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 in accordance with ASME AG-1-2003. These 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 for viewing while in operation (U.S. EPR FSAR Tier 2, Section 6.2.3.4).

There are certain containment penetrations which 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 (U.S. EPR FSAR Tier 2, Section 6.2.3.2.3).

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 ventilation systems upstream of the HEPA filters will be 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.

(iii) Decommissioning

There is no embedded piping in these ventilation systems that handle potentially contaminated exhaust gases and these systems are designed to operate at a negative pressure that facilitates the movement of airborne radioactivity to the filters minimizing the potential residual radioactivity that may remain in these systems, and that may require remediation at the time of decommissioning. In addition, the design and installation of the components of these ventilation systems confirm that adequate clearance is provided for removal, maintenance, and inspections and these systems will be easily decommissioned.

(iv) Waste Minimization

Components of these ventilation systems are designed to operate for 60 years, minimizing the potential generation of waste associated with operating and maintaining this system. Filters are monitored to confirm effectiveness and can be replaced and treated as described in the solid waste management system (U.S. EPR FSAR Tier 2, Section 11.4.2).

FSAR Impact:

As committed in the initial response, elements of the response that pertain to operational objectives will be provided within 45 days of NRC approval of the NEI 08-08 generic template; corresponding FSAR changes will be included.

Table 12.03–12.04—Mapping of U.S. EPR Systems to RAI Systems

RAI System	U.S. EPR System(s)
Fuel Storage and Handling, including fuel transfer tube	Fuel Handling and Storage (FHS)
Process Sampling System	Nuclear Sampling (KU) Sample Activity Monitoring (KLK) Radiation Monitoring (JYK)
Coolant Storage and Transfer System	Coolant Supply and Storage (KBB)
Radioactive Waste Management Systems	Coolant Purification (KBE) Filter Changing Equipment (KPD) Liquid Waste Processing (KPF) Solid Waste Processing (KPC) Gaseous Waste Processing (KPL)
Equipment, Floor, Chemical, and Detergent Drain Systems	Nuclear Island Drain and Vent (KT)
Building Heating, Ventilating, and Air Conditioning (HVAC) Systems used to process radioactive process and effluent streams	Annulus HVAC (KLB) Containment Building HVAC (KLA) Fuel Building HVAC (KLL) Nuclear Auxiliary Building HVAC (KLE) Radioactive Waste Processing Building HVAC (KLF) Safeguard Building Controlled Area HVAC (KLC)