11.5 Process and Effluent Radiological Monitoring and Sampling Systems

The process and effluent radiological monitoring and sampling systems monitor, record, and (for certain subsystems) control the release of radioactive materials that may be generated during normal operation, anticipated operational occurrences (AOO), and postulated accidents. These systems monitor and record radioactivity levels in plant process streams and atmospheres, indicate and alarm excessive radioactivity levels, automatically initiate protective isolation actions, and record the rate of release of radioactive materials to the environment. The systems consist of permanently installed, continuous monitoring devices together with a program of, and provisions for, specific sample collections and laboratory analyses.

Process sampling systems are summarized in this section; a detailed description of these systems is included in Section 9.3.2. In addition to the process and effluent monitoring and sampling systems described in this section, the U.S. EPR also uses the following radioactivity monitoring systems:

- Area radioactivity and airborne monitoring (addressed in Section 12.3).
- Personnel monitoring (addressed in Section 12.5).
- Contamination monitoring (addressed in Section 12.5).
- Radiation monitoring of waste packages (addressed in Section 11.4).

11.5.1 Design Basis

AREVA NP Inc. has designed the process and effluent radiological monitoring and sampling systems in accordance with the requirements of 10 CFR Parts 20, 10 CFR 50.34(a), 10 CFR 50.34(f)(2)(xvii) and 10 CFR 50.34 (f)(2)(xxvii) as these requirements relate to TMI action items and 50.36(a). Additionally, the design for these systems complies with the ANSI standards N13.1-1999 (Reference 1) and ANSI N42.18-2004 (Reference 2), as well as the guidance in RGs 1.21, 1.33, 1.97, 4.15, 1.206, IE Bulletin 80-10, GDC 60, GDC 63, GDC 64, 10 CFR Part 50, Appendix I, 10 CFR 20.1301(e), 10 CFR 20.1302, and NUREG-0800, BTP 7-10 (Reference 3), NUREG-0737 (Reference 4), NUREG-0718 (Reference 5), Generic Letter 89-01 (Reference 6), and Appendix 11.5-A of NUREG-0800 (Reference 7).

Consistent with the requirements of 10 CFR 20.1406, the U.S. EPR, including the process and effluent radiological monitoring and sampling systems, is designed to minimize, to the extent practicable, contamination of the facility and the environment; facilitate eventual decommissioning; and minimize, to the extent practicable, the generation of radioactive waste. Minimization of contamination and radioactive waste generation is described in Section 12.3.6.

11.5.1.1 Design Objectives

Portions of the process and effluent radiological monitoring and sampling systems perform safety related functions. For those portions of the systems, the safety design bases functions are as follows:

- Initiate main control room air conditioning system supplemental filtration in the event of abnormally high gaseous radioactivity in the main control room supply air.
- Initiate fuel handling area ventilation isolation on high exhaust activity from fuel handling area.
- Provide long-term post-accident monitoring (using both safety-related and non-safety-related monitors) in the event of a postulated accident.

11.5.1.2 Design Criteria

The process and effluent radiological monitoring and sampling systems monitor the containment atmosphere; spaces containing components for recirculation of loss of coolant accident fluids; and effluent discharge paths for radioactivity released from normal operations, AOOs, and postulated accidents. Sampling points are located on both process and effluent radiological monitoring and sampling systems to permit representative sampling for radiochemical analysis. The process and effluent radiological monitoring and sampling systems measure, record and provide a readout in the control room for containment radiation levels, and noble gas effluents at all potential, accident release points. The process and effluent radiological monitoring and sampling systems continuously sample for radioactive iodines and particulates in gaseous effluents from all potential accident release points, and provides for onsite capability to analyze and measure these samples. The monitoring of inplant radiation and airborne radioactivity is provided for a broad range of routine and accident conditions.

This design complies with applicable portions of 10 CFR 50.34(f)(2)(xvii) and 10 CFR 50.34(f)(2)(xxvii), 10 CFR Part 50, Appendix A, GDC 64, and RG 1.97.

The process radiological monitoring and sampling systems indicate 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 alarm and gross indication of the extent of failed fuel. They also monitor radioactive waste systems and associated handling areas to detect and alarm conditions that may result in loss of residual heat removal capability and excessive radiation levels. The process monitors that provide a signal for the actuation of engineered safety feature (ESF) systems are designed and qualified to the same criteria as the ESF system. Similarly, the monitors that provide for the actuation of non-ESF systems are designed and qualified to the same criteria as the non-ESF system. This function complies with applicable portions of 10 CFR Part 50, Appendix A, GDC 63.

The effluent radiological monitoring and sampling systems operate continuously during both intermittent and continuous discharges of potentially radioactive plant effluents, in compliance with RG 1.21. The system allows verification of several discharge requirements:

- The most restrictive anticipated radionuclides are at effluent concentrations below the limits specified in Table 2 of Appendix B of 10 CFR Part 20.
- Effluents meet ALARA design objectives of 10 CFR Part, 50 Appendix I.
- Effluents comply with 10 CFR 20.1302 dose limits.
- Effluents comply with EPA environmental radiation standards contained in 40 CFR Part 190.

The effluent radiological monitoring and sampling systems alarm and automatically terminate the release of effluents when radionuclide concentrations exceed the specified limits. The effluent monitors that provide a signal for the actuation of ESF systems are designed and qualified to the same criteria as the ESF system. Similarly, the monitors that provide for the actuation of non-ESF systems are designed and qualified to the same criteria as the non-ESF system. This design complies with 10 CFR Part 50, Appendix A, GDC 60, which requires that "the design shall include means to control suitably the release of radioactive materials in gaseous and liquid effluents." Effluent radiological monitors provide sufficient radioactivity release data to prepare effluent release reports required by RG 1.21.

11.5.2 System Description

The effluent and process radiological monitoring and sampling systems consist of radiation detectors connected to local black boxes. Each black box processes the detector signal, performs alarm or control functions, and transmits the signal to a control room information and control system. Monitoring systems alarm when setpoint limits are exceeded or when the system becomes inoperable. Alarms are located both locally and in the control room.

AREVA NP Inc. has designed safety-related process and effluent radiological monitoring and sampling systems in accordance with the following criteria:

- Radiation detectors and black boxes are powered from the uninterruptible power supply system; sample pumps and heat-tracing systems are powered from Class 1E power.
- Components are environmentally qualified as applicable. Section 3.11 addresses the environmental qualification of instrumentation.

- Components are seismically qualified as applicable. Sections 3.10 and 3.11 address the qualification of instrumentation.
- Systems comply with the fire protection criteria addressed in Section 9.5.
- Multiple (redundant) systems are used and are physically separated in accordance with criteria addressed in Section 8.3.2.

Process and effluent radiological monitoring and sampling systems that sample airborne radioactive materials are designed in accordance with the general principles and guidance contained in ANSI Standard N.13.1-1999 (Reference 1). Use of this ANSI standard is in accordance with RG 1.21.

A COL applicant that references the U.S. EPR will fully describe, at the functional level, elements of the process and effluent monitoring and sampling programs required by 10 CFR Part 50, Appendix I and 10 CFR 52.79(a)(16). This program description, Offsite Dose Calculation Manual (ODCM), will specify how a licensee controls, monitors, and performs radiological evaluations of releases. The program will also document and report radiological effluents discharged to the environment.

11.5.3 Effluent Monitoring and Sampling

Sections 12.1 and 12.3 describe how the ALARA provisions of RG 8.8 and RG 8.10 are implemented in system designs and operation to comply with occupational dose limits of 10 CFR 20.1201 and 10 CFR 20.1202 and occupational limits of Table 1, annual limit on intake (ALI) and derived air concentration (DAC), of Appendix B to 10 CFR Part 20.

11.5.3.1 Gaseous Effluents

Compartment exhaust air from the controlled area and system exhaust air are discharged into the vent stack exhaust. 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, the controlled area of the Access and Radioactive Waste Processing Buildings and the vent stack. The U.S. EPR ventilation systems are described in Section 9.4.

Continuously operating measurement devices monitor vent stack gaseous effluent for noble gases, aerosol, and iodine. Samples are also collected for laboratory analysis of tritium, noble gases, aerosols and iodine. Two permanently installed monitoring and sampling systems provide gaseous samples from the vent stack to the measurement devices. Each sampling system has separate sample lines and independent nozzle arrays, located within the vent stack, to retrieve gaseous samples. The system is designed in accordance with ANSI N13.1-1999 (Reference 1) to provide extraction of a representative gaseous sample. The vent stack gaseous effluent monitoring system functional location is shown in Figure 11.5-1—Radioactive Effluent Flow Paths With

Process and Effluent Radiation Monitors, as well as Figure 11.3-1—Gaseous Waste Processing System - Normal Operation, and Figure 11.3-2—Gaseous Waste Processing System - Gaseous Waste Sources.

The ODCM (see Section 11.5.2) includes the following information for each location subject to routine gaseous effluent sampling: the sampling frequency and the analytical process and sensitivity for selected radioanalytical methods and types of sampling media.

The gaseous effluent monitoring and sampling system has the following general characteristics:

- Noble gas activity is monitored with gamma and beta-sensitive detectors. The gross output of the monitor is periodically normalized to the radionuclide composition by performing a gamma-spectroscopic analysis on a representative grab sample.
- Aerosol activity is monitored with the use of an aerosol filter through which sample flow is continuously maintained. Aerosol particles are removed by the filter, which is monitored by a gamma-sensitive detector.
- Iodine activity is monitored by a dual filter for organic and inorganic iodine. Gamma-sensitive detectors monitor each filter.

For both aerosol and iodine monitoring, the gross outputs of the monitors are normalized by laboratory analysis of a duplicate set of filters installed in parallel with the primary ones. Measurement ranges of noble gas, aerosol, and iodine monitors are shown in Table 11.5-1—Radiation Monitor Detector Parameters. The gaseous effluent radiological monitoring and sampling for the vent stack does not perform automatic actions. The system monitors, records, and alarms in the control room if monitored radiation levels increase beyond specified setpoints.

The ODCM (see Section 11.5.2) contains the standard radiological gaseous effluent controls for the plant. This includes a description of how effluent release rates will be derived and parameters used in setting instrumentation alarm setpoints to control or terminate effluent releases in unrestricted areas that are above the effluent concentrations in Table 2 of Appendix B to 10 CFR Part 20. In addition, the ODCM describes how the guidance of NUREG-1301 (Reference 8) and NUREG-0133 (Reference 9) were used in developing the bases of alarm setpoints. NEI 07-09A (Reference 10) is an alternate means of demonstrating compliance with GL 89-01 and SECY 05-0197 until a plant and site-specific ODCM is developed under a license condition.

11.5.3.2 Liquid Effluents

The liquid effluent radioactive waste monitoring and sampling system measures the concentration of radioactive materials in liquids released to the environment. Liquid radionuclide concentration levels are designed to comply with 10 CFR Part 20 and dose requirements specified in 10 CFR Part 50. Liquid radioactive waste is discharged 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. The ODCM (see Section 11.5.2) includes the following information for each location subject to routine liquid effluent sampling: (1) the sampling frequency, and (2) the analytical process and sensitivity for selected radioanalytical methods and types of sampling media. Results of this analysis are used in conjunction with dilution factor data to determine a release setpoint for the liquid waste monitoring system. Two continuously operating radiation sensors monitor the release line from the monitoring tanks. If a set limit is exceeded or if the monitoring system is inoperable, the release is automatically terminated. To terminate a release, one of the radiation sensors closes both isolation valves.

The liquid effluent radioactive waste monitoring system functional location is shown on Figure 11.2-1. Measurement ranges of the liquid radioactive waste monitoring system are shown in Table 11.5-1. The ODCM contains the plant's standard radiological effluent controls. This includes a description of how liquid effluent release rates are derived and parameters used in setting instrumentation alarm setpoints to control or terminate effluent releases in unrestricted areas that are above the effluent concentrations in Table 2 of Appendix B to 10 CFR Part 20. In addition, the ODCM describes how the guidance of NUREG-1301 (Reference 8) and NUREG-0133 (Reference 9) were used in developing the bases of alarm setpoints.

11.5.4 Process Monitoring and Sampling

Process radiation monitoring detects, at an early stage, the escape of radioactive materials from radioactivity-containing systems into systems that are normally free of activity. Process radiation monitors generally operate continuously and provide both local and control room indication and alarm. Certain systems automatically initiate isolation actions along with control room alarm upon the detection of high radiation levels.

11.5.4.1 Main Steam Radiation Monitoring System

Radioactivity releases from the reactor coolant system (RCS) to the main steam system (nitrogen-16, noble gases) can occur because of steam generator tube leakage. Radioactivity in the main steam system is monitored over a wide power range by four redundant measuring arrangements per main steam line, for a total of 16 detectors for the system. The gamma sensitive detectors are mounted adjacent to the main steam lines within the main steam and feedwater valve compartments. At low power levels, radioactivity is detected in the main steam due to the presence of noble gas. At high power levels, radiation is detected from the strong gamma from nitrogen-16. Shielding of detectors helps to prevent false readings from the detectors on the other main steam lines. The redundant measurement signals are processed, and provide alarm in the control room upon detection of radioactivity.

The main steam radiation monitoring system is also used in conjunction with the condenser air removal and steam generator blowdown radiation monitoring systems to identify a steam generator tube leak. The main steam radiation monitoring system provides alarms and signals to the protection system for automatic isolation of an affected steam generator. Measurement ranges of the main steam radiation monitoring system are shown in Table 11.5-1—Radiation Monitor Detector Parameters.

11.5.4.2 Condenser Air Removal Radiation Monitoring System

Noncondensable gases (air and noble gases) in the secondary steam system are continuously removed during operation by the main condenser evacuation system (see Section 10.4.2). These gases discharge to the vent stack via a vent line. To monitor noble gas radioactivity, the monitoring system extracts part of the flow from the vent line (see Figure 10.4.2-2) and passes it through a measuring vessel with a beta-sensitive detector. If the monitoring system detects noble gas radioactivity in the secondary steam system, then it provides local and control room alarm. This alarm is an indication of breach of fuel cladding, primary coolant boundary, or containment leak. Table 11.5-1 shows the measurement ranges of the condenser air removal radiation monitoring system. This system does not initiate automatic actions.

11.5.4.3 Steam Generator Blowdown Radiation Monitoring System

The evaporation process within the steam generator results in the concentration of contaminants in the liquid phase. These contaminants include non-gaseous radioactive substances that have entered the secondary system from the RCS due to tube leakage in a steam generator.

Sampling lines extract blowdown water from the individual blowdown lines for chemical analysis. These lines are located ahead of the primary isolation valve within the reactor containment. Flow is continuously extracted from each of these lines and fed to gamma activity measurement equipment. This configuration allows each steam generator to be monitored separately and continuously for radioactivity carryover to the secondary side.

The steam generator blowdown radiation monitoring system provides a second means to identify and verify a steam generator with a tube leak. These monitors detect a steam generator tube leak if there is no response from the main steam line radiation monitors because the activity level is too low. Together with manually extracted samples analyzed in the laboratory, this system also allows the calculation of radioactivity discharged from the secondary system due to leakage into the Turbine Building atmosphere. This system does not initiate automatic actions.

The steam generator blowdown radiation monitoring system functional location is shown on Figure 11.5-1. Measurement ranges of the steam generator radiation monitoring system are shown in Table 11.5-1.

11.5.4.4 Component Cooling Water Radiation Monitoring System

The component cooling water system consists of a closed-loop system of coolers (heat exchangers) used to transfer heat from nuclear components to service water. Since it is a closed-loop system, the component cooling water system does not release radioactivity to the service water (and subsequently to the environment) in the event of leaks in the associated coolers. The system consists of two subsystems: the general component cooling water radiation monitoring subsystem and the high-pressure (HP) cooling water radiation monitoring subsystem. The component cooling water radiation monitoring system functional location (including subsystems) is shown in Figure 11.5-1. Measurement ranges of the component cooling water radiation monitoring system are shown in Table 11.5-1.

The general component cooling water radiation monitoring subsystem uses gamma-sensitive radiation detectors in each of its four separate safety-related trains to monitor the fluid for the escape of radioactivity from the various radioactivity-containing systems that make up the nuclear components served by the component cooling circuits. The gamma-sensitive detectors are lead-shielded and are installed adjacent to the piping in this subsystem. This subsystem provides local and control room alarms in the event that component cooling water gamma radiation levels exceed the monitor setpoint, but does not initiate automatic actions.

The HP cooling water radiation monitoring subsystem consists of two gamma-sensitive radiation detectors upstream and two gamma-sensitive radiation detectors downstream on the component cooling water lines feeding/exiting the two high-pressure coolers of the volume control system. In the event of a leak in an HP cooler, in which high-activity primary coolant leaks into the component cooling water system, the radiation detector downstream of the defective cooler indicates the entry of radioactivity from this HP cooler into the component cooling loop that is running at the time. If the radioactivity exceeds a pre-determined limit, the defective HP cooler is automatically isolated on the primary side and an associated control room alarm is activated. This automatic action is suppressed if the limit value of the radiation detector at the inlet of the cooler has already triggered a high activity signal. This action is also suppressed during inservice inspection of the measuring points.

11.5.4.5 Gaseous Waste Disposal Radiation Monitoring System

Gamma-sensitive radiation detectors continuously monitor the gaseous waste delay beds. A gamma-sensitive radiation detector is located upstream of the beds and a beta-sensitive radiation detector is located downstream. The upstream monitor measures the gamma radiation emitted by the radionuclides entering the beds, and provides station personnel with an indication of the amount of radioactivity entering the beds. The downstream monitor is a beta-sensitive instrument, since krypton-85 generally forms the main constituent (about 95 percent) of the radioactive noble gases. The gaseous waste disposal radiation monitoring system provides control room and local indication only. This system does not initiate automatic action.

The radiation monitors in the gaseous waste processing system are shown on Figures 11.3-1 and 11.3-2. In addition, Section 9.4 includes simplified diagrams of the ventilation systems that show the radiation monitors. Measurement ranges of the gaseous waste disposal radiation monitoring system are shown in Table 11.5-1.

11.5.4.6 Reactor Coolant Radiation Monitoring and Sampling System

The reactor coolant radiation monitoring system uses a beta-sensitive radiation detector to provide continuous monitoring of the integral noble gas activity concentration of the coolant. The system monitors the noble gas activity concentration in the gaseous flow to the de-gasifier for primary coolant of the nuclear sampling system and allows in the early detection of fuel element failures. The measuring range of the system allows monitoring of noble gas activity concentrations in the RCS coolant up to the TS value. The reactor coolant radiation monitoring system provides indication only and does not initiate action. A diagram of the reactor coolant radiation monitoring and sampling system is shown in Figure 11.5-1. Measurement ranges of the reactor coolant radiation monitoring system are shown in Table 11.5-1.

The reactor coolant radiation and sampling system provides representative samples of reactor coolant to the radiochemistry laboratory for analysis. Results of these analyses are used to demonstrate compliance with reactor coolant chemistry limits. These analyses are also used to provide information to detect failed fuel.

11.5.4.7 Chilled Water Supply for the Gaseous Waste Disposal Sampling System

The closed-loop chilled water system serves various components in the gaseous waste disposal system and the coolant degasification system. The radioactive sides of these operational components are separated from the chilled water system by means of both material and pressure barriers. The higher pressure on the non-contaminated side prevents radioactivity from escaping to the chilled water system except in the event of coincident failure of both of these barriers. The sampling point for extracting samples from this system for radiochemistry laboratory evaluation is provided in the return manifold of the chilled water system.

11.5.5 References

1. ANSI/HPS N13.1-1999, “Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities,” American National Standards Institute/Health Physics Society, 1999.

2. ANSI N42.18-2004, "Specifications and Performance of On-site Instrumentation for Continuously Monitoring Radioactivity in Effluents," American National Standards Institute, 2004.

3. NUREG-0800, BTP 7-10, “Guidance on Application of Regulatory Guide 1.97,” Revision 5, U.S. Nuclear Regulatory Commission, March 2007.

4. NUREG-0737, “Clarification of TMI Action Plan Requirements,” U.S. Nuclear Regulatory Commission, November 1980.

5. NUREG-0718, “Licensing Requirements for Pending Applications for Construction Permits and Manufacturing Licenses,” U.S. Nuclear Regulatory Commission, March 1981.

6. Generic Letter 89-01, “Implementation of Programmatic Controls for Radiological Effluent Technical Specifications in the Administrative Controls Section of the Technical Specifications and the Relocation of Procedural Details of RETS to the Offsite Dose Calculation Manual or to the Process Control Program,” U.S. Nuclear Regulatory Commission, January 1989.

7. NUREG-0800, “U.S. NRC Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants,” U.S. Nuclear Regulatory Commission, March 2007.

8. NUREG-1301, “Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors,” U.S. Nuclear Regulatory Commission, April 1991.

9. NUREG-0133, “Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants,” U.S. Nuclear Regulatory Commission, October 1978.

10. NEI 07-09A, “Generic FSAR Template Guidance for Offsite Dose Calculation Manual (ODCM) Program Description,” Nuclear Energy Institute, March 2009.

Table 11.5-1—Radiation Monitor Detector Parameters[1]
Sheet 1 of 9

Process System[2]	Monitor Provisions			Sample Provisions			Range
	In Process Continuous	ACF	In Effluent Continuous	In Process Grab sample	In Effluent Grab sample	Continuous	
Gaseous Streams							
Gaseous Waste Processing System (Waste Gas Holdup System)	1 noble gas monitor upstream of the delay beds	---	---	---	---	---	1E+0 - 1E+4 cps (Kr-85, Xe-133)
	---	---	1 noble gas monitor downstream of the delay beds	---	---	---	1E-06 - 1E+2 µCi/cc (Kr-85, Xe-133)
Condenser Evacuation System	1 noble gas monitor on the condenser exhaust	---	---	---	---	---	3E-6 - 1E-2 µCi/cc (Kr-85, Xe-133)
Sampling Activity Monitoring System (Vent & Stack Release Point System)	---	---	5 noble gas monitors in the stack	---	3 noble gas sample points in the stack	3 noble gas sample points in the stack	3E-6 - 1E-2 µCi/cc (Kr-85, Xe-133)
	---	---	2 iodine monitors, 2 aerosol monitors in the stack	---	4 iodine and 4 aerosol, and 2 H-3, C14 sample points in the stack	4 iodine, 4 aerosol and 2 H-3, C-14 sample points in the stack	---

Table 11.5-1—Radiation Monitor Detector Parameters[1]
Sheet 2 of 9

Process System[2]	Monitor Provisions			Sample Provisions			Range
	In Process Continuous	ACF	In Effluent Continuous	In Process Grab sample	In Effluent Grab sample	Continuous	
Containment Building Ventilation System – Containment Purge Subsystem (Containment Purge System)	1* noble gas, 1* aerosol, 1* iodine, and 1* H-3 monitor		2* noble gas monitors	1 aerosol sample point		1 aerosol sample point	3E-7 - 1E-2 μCi/cc (Kr-85, Xe-133)
Containment Building Ventilation System – Internal Filtration Subsystem	1* noble gas, 1* aerosol, 1* iodine monitor			1 aerosol sampler		1 aerosol sampler	3E-7 - 1E-2 μCi/cc (Kr-85, Xe-133)
Nuclear Auxiliary Building Ventilation System	3* noble gas, 3* iodine, and 5* aerosol monitors on ventilation exhaust	---	---	5 aerosol sample points in the ventilation exhaust	1 iodine and 1 aerosol sample points in the ventilation exhaust	1 iodine and 6 aerosol sample points in the ventilation exhaust	3E-7 - 1E-2 μCi/cc (Kr-85, Xe-133)
Fuel Building Ventilation System (Fuel Storage Area Ventilation System)	4* noble gas, 2* aerosol, and 2* iodine monitors on ventilation exhaust	isolate fuel handling area ventilation on high exhaust activity, 1 noble gas monitor supplies the signal	---	2 aerosol sample points in the ventilation exhaust	---	2 aerosol sample points in the ventilation exhaust	3E-7 - 1E-2 μCi/cc (Kr-85, Xe-133)

Table 11.5-1—Radiation Monitor Detector Parameters[1]
Sheet 3 of 9

Process System[2]	Monitor Provisions			Sample Provisions			Range
	In Process Continuous	ACF	In Effluent Continuous	In Process Grab sample	In Effluent Grab sample	Continuous	
Radioactive Waste Processing Building Ventilation System (Radwaste Area Vent Systems)	2* iodine and 4* aerosol monitors upstream of ventilation filters	---	---	4 aerosol sample points in the ventilation exhaust	1 aerosol and 1 iodine sample points in the ventilation exhaust	5 aerosol and 1 iodine sample points in the ventilation exhaust	
Turbine Gland Seal Condenser Vent System	The design provides monitors for the main steam system presented below. These instruments provide sufficient monitoring of the steam system to warn the operator of primary to secondary leakage and measure the effluent as would similar monitors on the turbine gland seal condenser vent system.						
Mech. Vacuum Pump Exhaust (Hogging System)	This system is used only during plant startup when an accident that could release gaseous radioactive material that could reach this system is unlikely and is therefore not monitored.						
Evaporator Vent Systems	The boron recovery evaporator in the coolant treatment system vents to the ventilation cell in which it is located in the Nuclear Auxiliary Building. The exhaust from the cell is monitored as shown above in the auxiliary building ventilation system. The evaporator in the Radwaste Building is monitored by the radwaste building ventilation system, which is described above.						
Liquid Waste Processing System (Pretreatment Liquid Radwaste Tank Vent Gas Systems)	All liquid radwaste processes are monitored by the radwaste building ventilation, which is described above.						
Steam Generator Blowdown System (Flash Tank and Steam Generator Blowdown Vent Systems)	There are no vents to atmosphere in the steam generator blowdown system. The steam generator blowdown flash tank is vented to the feedwater tank where the vented vapor is mixed with the incoming feedwater and is conveyed to the steam generator.						

Table 11.5-1—Radiation Monitor Detector Parameters[1]
Sheet 4 of 9

Process System[2]	Monitor Provisions: In Process Continuous	Monitor Provisions: ACF	Monitor Provisions: In Effluent Continuous	Sample Provisions: In Process Grab sample	Sample Provisions: In Effluent Grab sample	Sample Provisions: Continuous	Range
Pressurizer & Boron Recovery Vent Systems	The pressurizer is vented to the nuclear island drains and vents system, which routes gaseous radioactive wastes to the gaseous waste processing system. The coolant treatment system, which contains the boron recovery subsystem is vented to the gaseous waste processing system.						
Solid Waste System (Waste compactors, shredders, etc. (as permanently installed or mobile systems))	Solid waste components that could generate airborne wastes are monitored by the radwaste building ventilation system, which is described above.						
Safeguard Building Controlled Area Ventilation System	1* noble gas, 1* aerosol and 1* iodine monitors on ventilation exhaust	---	2* noble gas monitors on ventilation exhaust	1 aerosol sample points in the ventilation exhaust	1 iodine and 1 aerosol sample points in the ventilation exhaust	1 iodine and 2 aerosol sample points in the ventilation exhaust	3E-7 - 1E-2 µCi/cc (Kr-85, Xe-133)
Annulus Ventilation System	---	---	2* noble gas monitors in the ventilation exhaust	---	2 iodine sample points in the ventilation exhaust	2 iodine sample points in the ventilation exhaust	---
Control Room Air Conditioning System	4* radiation monitors	isolates MCR ventilation intakes and initiates emergency habitability and supplemental filtration	---	---	---	---	1E-5 - 1E+1 rad/hr

Table 11.5-1—Radiation Monitor Detector Parameters[1]
Sheet 5 of 9

Process System[2]	Monitor Provisions			Sample Provisions			Range
	In Process Continuous	ACF	In Effluent Continuous	In Process Grab sample	In Effluent Grab sample	Continuous	
Access Building Ventilation System	---	---	---	1 iodine and 1 aerosol in the ventilation exhaust	---	---	
Liquid Streams							
Liquid Radwaste (Batch) Effluent System	---	close the discharge valve on high activity	2 redundant monitors on the liquid radwaste release line	sample and analysis	sample and analysis, H-3 analysis	---	5E-6 - 1E-3 µCi/ml
Liquid Radwaste (Continuous) Effluent System	The U.S. EPR uses a batch liquid radwaste effluent discharge, which is monitored as described above.						
Service Water System and/or Circulating Water System	For U.S. EPR, the CWS has no contact with the TBPD except that the TBPD and the cooling tower blowdown each discharge separately to the "lined retention pond."						
Component Cooling Water System	1 radiation monitor on each loop	---	---	---	sample and analysis, H-3 analysis	---	1E-6 - 1E-3 µCi/ml
Fuel Pool Purification System (Spent Fuel Pool Treatment System)	---	---	---	---	sample and analysis, H-3 analysis	---	---

Table 11.5-1—Radiation Monitor Detector Parameters[1]
Sheet 6 of 9

Process System[2]	Monitor Provisions			Sample Provisions			Range
	In Process Continuous	ACF	In Effluent Continuous	In Process Grab sample	In Effluent Grab sample	Continuous	
Nuclear Island Drain and Vent Systems (Equipment & Floor Drain Collection and Treatment Systems)	---	---	---	---	sample and analysis, H-3 analysis	---	---
Phase Separator Decant & Holding Basin Systems	For the U.S. EPR, this is handled by the solid radwaste system.						
Chemical & Regeneration Solution Waste Systems	For the U.S. EPR, these waste streams are collected by the nuclear island drains and vents system, which is, routed to the liquid radwaste storage tanks.						
Nuclear Sampling and Severe Accident Sampling (Laboratory & Sample System Waste Systems)	---	---	---	---	sample and analysis, H-3 analysis	---	---
Laundry Room (Laundry & Decontamination Waste Systems)	1 protective clothing monitor (no laundry processing on site)	---	---	---	decontamination waste sample and analysis, H-3 analysis	---	---

Table 11.5-1—Radiation Monitor Detector Parameters[1]
Sheet 7 of 9

Process System[2]	Monitor Provisions			Sample Provisions			Range
	In Process Continuous	ACF	In Effluent Continuous	In Process Grab sample	In Effluent Grab sample	Continuous	
Solid Radwaste System (Resin Slurry, Solidification, & Baling Drain Systems)	---	---	---	---	sample and analysis, H-3 analysis	---	---
Radwaste Liquid Tanks (outside the buildings)	Not applicable to the U.S. EPR.						
Rainwater Collection and Drainage System (Storm & Underdrain Water System)	Potentially radioactive systems are segregated from non-radioactive systems, such as rainwater collection and drainage systems, to minimize the migration of radioactive material across systems. Monitoring is not required.						
Nuclear Island Drains and Vents System (Tanks and Sumps Inside Reactor Building)	---	---	---	---	sample and analysis, H-3 analysis	---	---
Reactor Boron and Makeup Water System (Boron Recovery System Liquid Effluent)	---	---	---	---	sample and analysis, H-3 analysis	---	---

Table 11.5-1—Radiation Monitor Detector Parameters[1]
Sheet 8 of 9

Process System[2]	Monitor Provisions			Sample Provisions			Range
	In Process Continuous	ACF	In Effluent Continuous	In Process Grab sample	In Effluent Grab sample	Continuous	
Steam Generator Blowdown System (Steam Generator Blowdown (Batch) Liquid Effluent System)	1 radiation monitor on each steam generator blowdown line	diverts blowdown to radwaste	---	---	sample and analysis, H-3 analysis	---	3E-6 -1E-2 µCi/ml
Steam Generator Blowdown System (Steam Generator Blowdown (Continuous) Liquid Effluent System)	1 radiation monitor on each steam generator blowdown line	diverts blowdown to radwaste	---	---	sample and analysis, H-3 analysis	---	3E-6 -1E-2 µCi/ml
Turbine Drains and Vents System (Secondary Coolant Treatment Waste & Turbine Building Drain Systems)	---	---	---	---	sample and analysis, H-3 analysis	---	---
Clean Drains System (Noncontaminated Wastewater & PWR Turbine Building Clean Drain System)	---	---	1 radiation monitor on the common release line	---	sample and analysis, H-3 analysis	---	3E-6 -1E-2 µCi/ml
Reverse Osmosis Systems	Not applicable to the U.S. EPR.						

Table 11.5-1—Radiation Monitor Detector Parameters[1]
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Process System[2]	Monitor Provisions			Sample Provisions			Range
	In Process Continuous	ACF	In Effluent Continuous	In Process Grab sample	In Effluent Grab sample	Continuous	
Mobile Liquid and Wet Waste Processing Systems	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 would be site-specific design features and are outside design certification scope.						
Chemical and Volume Control System High Pressure Coolers	radiation monitors are on the component cooling inlet and outlet of each cooler	---	---	---	---	---	3E-5 - 3E+0 µCi/ml
Main Steam System	4 N-16 monitors on each main steam line	---	---	---	---	---	1E-1 - 1E+4 cps (N-16)

NOTES:

1. The instruments with an * asterisk are duplicated in Table 12.3-4.
2. Where a difference exists between the name of a system in the U.S. EPR and that listed in NUREG-0800, SRP 11.5, Tables 1 and 2 (Reference 7), the U.S. EPR system name is listed first, followed by the SRP name in parentheses.

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