11.5 Process and Effluent Radiation Monitoring and Sampling Systems

Process and effluent radiation monitoring and sampling systems (PERMSS) are used to measure, record, and sample in order to control releases of radioactive materials of the liquid and gaseous process streams and effluents from the liquid waste management system (LWMS), gaseous waste management system (GWMS), and solid waste management system (SWMS) as a result of normal operations, including AOOs, and during postulated accidents.

Radiation monitoring and sampling systems consist of a process and effluent radiation monitoring system and sampling system (PERMSS) and an area radiation monitoring system (ARMS). The PERMSS is divided into a gaseous and liquid process and an effluent monitoring system, which are described in Subsections 11.5.2.2 and 11.5.2.3, respectively. The locations of the monitoring and sampling points, types of instruments, and locations of the alarms are provided in Table 11.5-1 and Figure 11.5-2. The monitoring and sampling systems for area radiation are described in Chapter 12.

The sampling system that collects representative samples of liquids and gases and delivers them to a facility for chemical and radiological analysis is described in Subsection 9.3.2. The subsection includes sampling locations, methodology, and frequency of continuous and grab sampling.

Flow diagrams of all radiation monitors for PERMSS and ARMS are presented in Figure 11.5-1.

11.5.1 Design Bases

11.5.1.1 Design Objective

The radiation monitoring system (RMS) is designed in accordance with the acceptance criteria in Section 11.5 of Chapter 15 of the Standard Review Plan (Reference 1).

Continuous monitoring equipment is located in selected airborne, gaseous, and liquid process and effluent streams to detect activity generated during normal operations, including AOOs, and during postulated accidents.

The RMS assists plant operators in evaluating and controlling the radiological consequences of potential equipment failures, system malfunctions, or system misoperations. Tables 11.5-1 and 11.5-2 list the gaseous and liquid process and effluent radiation monitors. The tables also show the monitoring parameters.

11.5.1.2 Design Criteria

The RMS is designed to perform the following functions:

a. Provide early warning to station personnel of malfunction or misoperation of the systems or potential radiological hazards according to 10 CFR 20 (Reference 2) and 10 CFR 50, Appendix I (Reference 3).

b. Provide continuous monitoring of radioactive liquid and airborne releases according to 10 CFR 20; 10 CFR 50, GDC 13, 60, 61, 63, and 64 (Reference 4); and the guidelines of NRC RG 1.21 (Reference 5).

c. Provide monitoring of liquid and airborne activity in selected locations and effluent paths for postulated accidents in accordance with the requirements of 10 CFR 50, Appendix I (Reference 3), NUREG-0737 (Reference 6), and the guidance of NRC RGs 1.45 (Reference 7) and 1.97 (Reference 8).

d. The design of the process and effluent radiation monitoring and sampling systems provides instrumentation to measure, record, and indicate in the MCR as well as to control releases of radioactive materials in plant process systems and effluent streams.

e. These systems are designed to provide continuous sampling and monitoring of radioactive iodine, particulates, and gases as well as the capability to obtain grab samples in gaseous process or effluent streams in all potential accident release points.

f. The capability to take grab samples from HVAC system exhausts is provided at radiation monitor locations. Grab samples are used for analysis during normal operating and post-accident conditions.

g. Continuous sampling of all potential post-accident release points is provided by vent samplers. These samplers are designed to be used during normal operating and post-accident conditions to meet the sampling requirements in 10 CFR 50.34(f)(2)(xvii) and 50.34(f)(2)(xxvii) (Reference 9) and the guidance in NUREG- 0718 (Reference 10), NUREG 0737, Appendix 2, Section II.F.1.

h. The process and effluent monitoring and sampling system is designed with a continuous MCR interface via the information processing system (IPS) and qualified indication and alarm system (QIAS) systems.

i. Guidance on the selection of instrumentation for use of continuous radiation monitoring equipment and performance requirements are in accordance with ANSI N42.18-2004 (Reference 11). The qualification is also in accordance with NRC RG 1.143 (Reference 12).

j. Instrument setpoints are determined in accordance with NUREG-1301 (Reference 13) and NUREG-0133 (Reference 14). The effluent concentration limits in Table 2 of Appendix B to 10 CFR 20 (Reference 15) are used so that the release to unrestricted areas is not exceeded.

k. PERMSSs are designed to comply with 10 CFR 20.1301 (Reference 16); 10 CFR 20.1302 (Reference 17); 40 CFR 190 (Reference 18); 10 CFR 20, Appendix B; and the numerical guides in 10 CFR 50, Appendix I. An annual report that specifies the quantity of each principal radionuclide released to unrestricted areas in liquid and in gaseous effluents is provided to comply with 10 CFR 50.36a (Reference 19). The COL applicant is to develop an annual report that specifies the quantity of each principal radionuclide released to unrestricted areas in liquid and in gaseous effluents (COL 11.5 (1)) and site-specific procedures on equipment inspection, calibration, and maintenance and regulated record keeping. The COL applicant is to provide site-specific procedures that comply with the numerical guides of 10 CFR 50.34a (Reference 20) and 10 CFR 50, Appendix I (COL 11.5 (2)).

l. The COL applicant is to prepare an offsite dose calculation manual (ODCM) that contains a description of the methodology and parameters for calculation of the offsite doses for the gaseous and liquid effluents (COL 11.5 (3)). NEI 07-09A

(Reference 21) is an alternative and provides a radiological and environmental monitoring program. The ODCM is to be in accordance with NRC RGs 1.109 (Reference 22), 1.111 (Reference 23), and 1.113 (Reference 24). The COL applicant is to provide analytical procedures and sensitivity for selected radio-analytical methods and type of sampling media for site-specific matter (COL 11.5 (4)).

m. The COL applicant is to develop a radiological and environmental monitoring program (REMP) in accordance with NUREG-1301 and also NUREG-0133, which describes the scope of the program, taking into account local and land use census data in identifying all potential radiation exposure pathways, associated radioactive materials present in liquid and gaseous effluent, and direct external radiation from SSC. The COL applicant is also to develop calibration procedures in accordance with NRC RG 1.33 (Reference 25) and NRC RG 4.15 (Reference 26) (COL 11.5 (5)).

The RMS monitors normal and potential paths for release of radioactive materials to provide continuous indication and recording of radioactivity levels of the gaseous and liquid waste leaving the plant.

Continuous representative sampling is provided for airborne particulate and iodine radioactivity in discharge paths. The gaseous PERMSS is designed in accordance with ANSI/HPS N13.1 (Reference 27). The RMS also initiates control actions as shown on Tables 11.5-1 and 11.5-2 to control or reduce continuous effluent releases or to terminate releases.

The RMS is installed in the HVAC systems to monitor the airborne radioactivity resulting from system malfunction or misoperation, or from maintenance activities that could cause radioactivity to reach unacceptable levels. Portable airborne radiation monitors are available for use in areas where work activities or surveillance poses an unacceptable risk to plant personnel of exposure to airborne radioactive material.

Radiation monitoring equipment is provided to detect primary-to-secondary system leakage and leakage from the primary system to the containment atmosphere. These monitoring systems are designed to be consistent with the recommendations of NRC RG 1.45 for detection of primary system leakage. Leakage detection methods, instrumentation, relevant systems, sensitivity, response time, testing, and calibration are described in Subsection 5.2.5.

Other systems that interface via heat exchangers with the primary system or other normally radioactive systems are also monitored to detect leakage between the systems so that appropriate actions can be taken to mitigate any potential consequences. The reactor coolant gross activity levels are also monitored or sampled during normal operation to maintain reactor coolant system (RCS) activity within acceptable levels.

This provides reasonable assurance that activity levels in other normally radioactive auxiliary systems are also maintained at acceptable levels. Under accident conditions, the RMS provides indication to plant operators if a breach of a fission product barrier has occurred and provides information to evaluate the magnitude of actual or potential releases of radioactive materials in order that appropriate emergency actions are taken to protect plant personnel and the health and safety of the public. The RMS monitors gross radioactivity to detect and evaluate a breach of the fuel cladding or potential core melt conditions for the RCS.

The containment atmosphere is monitored for particulate, iodine, and gaseous activity resulting from a breach of the reactor coolant pressure boundary (RCPB), a fuel handling accident, or other equipment failures that could release significant activity. Indication of high containment activity automatically initiates containment purge isolation.

In order to maintain MCR habitability, the outside air supply to the MCR is monitored by automatically isolating one or both intakes if radioactivity is detected in the MCR intake plenums. The exhaust air in the fuel handling area is monitored in the unlikely event of a radiological release in order to divert the exhaust through a filter train before being released to the environment.

The ranges and sensitivities of the monitors are based on the maximum and minimum expected concentrations of radioactive material for normal plant operation including AOOs and postulated accidents in accordance with 10 CFR 20 limits and regulatory guidance.

11.5.2 System Description

11.5.2.1 Monitor Design and Configuration

Process, effluent, and airborne radiation monitors typically consist of components such as a microprocessor, one or more detectors, a shielded detection chamber, a sample pump, flow instrumentation, and associated tubing and cabling.

Each process, effluent, and airborne radiation monitor is located in an easily accessible area and has sufficient shielding to provide reasonable assurance that the required sensitivity is achieved at the design background radiation level for the area. This approach is consistent with NRC RG 8.8 (Reference 28) and NRC RG 8.10 (Reference 29). Instrumentation and sensors are provided to detect component failures such as loss of power, loss of sample flow, check source response failure, and loss of detector signal.

Radiation level signals, alarms, and operation status alarms are generated by each monitor microprocessor and are transmitted to IPS, QIAS, and other interfacing systems. Alarm relay contacts are provided for alert-radiation, high-radiation, and operation status alarms.

For some monitors, the high-radiation alarm contacts are used to initiate control functions to terminate batch releases or to divert flow from one location to another. The operation status alarm is initiated by the microprocessor if conditions indicate that the monitor is not operating properly.

Radiation monitoring equipment is designed for service based on expected environmental conditions during normal operation and AOOs. These conditions include temperature, pressure, humidity, chemical spray (where applicable), and radiation exposure. Post-accident radiation monitors conform to NRC RG 1.97 including equipment qualification, redundancy, power source, channel availability, quality assurance, display and recording, range, interfaces, testing, calibration, and human factors engineering recommendations. Further description of conformance to NRC RG 1.97 is contained in Subsections 7.1.2.44 and 7.5.2.1.

Safety-related monitors are powered from a Class 1E 120 VAC distribution panel in the instrument power system. Information on instrumentation and control power is provided in Subsection 8.3.2.

11.5.2.2 Gaseous PERMSS

In accordance with ANSI/HPS N13.1, sample tubing for gaseous monitors is installed and routed to minimize interference with sample integrity.

The following paragraphs contain descriptions of the monitors in the gaseous process and effluent radiation monitoring system. Each monitor is listed along with associated parameters (also refer to Table 11.5-1).

a. High-energy line break area HVAC effluent monitors (RE-006, 007)

   A monitor at the exhaust ACU inlet in the auxiliary building detects particulate, iodine and noble gas activities, and the other monitor at the outlet of the exhaust ACU has a particulate and iodine sampler.

b. Auxiliary building controlled area I, II HVAC normal/emergency exhaust ACU inlet effluent monitors (RE-013, 014, 017, and 018)

   Four monitors with particulate, gas, and iodine channels are provided to monitor HVAC effluent from the auxiliary building.

c. Auxiliary building controlled area HVAC normal/emergency exhaust effluent monitors (RE-015, 016, 019, and 020)

   Four samplers for particulate and iodine are provided to monitor HVAC effluent from the auxiliary building controlled area HVAC filter discharge.

d. Containment purge effluent monitor (RE-037)

   A monitor with air particulate, gas, and iodine channels is provided to monitor containment purge effluent.

e. Containment air monitors (RE-039A and 040B)

Two monitors with air particulate, gas, and iodine channels are provided to monitor the radiation level in the containment. The wet parts of the detectors maintain pressure boundary integrity during normal conditions. The containment air monitors continuously measure, indicate, and record the radioactivity of particulate, iodine, and noble gas in a sample of air extracted from the containment. The sample lines of these offline monitors are provided with heat tracing to prevent dew condensation and are purged before sampling to provide reasonable assurance that samples are representative. The purge gas is routed back to the containment atmosphere.

f. Fuel handling area HVAC effluent monitor (RE-043)

A monitor with air particulate, gas, and iodine channels is provided to monitor the fuel handling area HVAC effluent.

g. Condenser vacuum pump vent effluent monitor (RE-063)

A monitor with a gas channel, air particulate, and iodine sampler is provided to monitor the condenser vacuum system effluent.

h. MCR air intake monitors (RE-071A, 072B, 073B, and 074B)

Two monitors per division (a total of four monitors) are provided with gas channels to monitor each of the intakes. The monitors are interlocked with the makeup air cleaning unit and MCR air intake dampers. On a high-radiation emergency signal, the outside air intake damper, which is open for normal operation, automatically closes and the air is routed through the makeup air-cleaning unit. The channels used for monitoring are Class 1E.

i. Gaseous radwaste system exhaust monitor (RE-080)

A monitor with gas channels is provided to monitor the radiation level of gaseous radwaste system exhaust to the compound building vent stack.

j. Compound building HVAC effluent monitor (RE-082)

One monitor with air particulate and iodine sampler is provided to monitor compound building HVAC effluent.

k. Compound building exhaust ACU inlet monitor (RE-083)

A monitor with air particulate, iodine, and gas channels is provided to monitor the compound building plant area.

l. Compound building hot machine shop monitor (RE-084)

One monitor with air particulate, iodine, and gas channels is provided to monitor the compound building hot machine shop.

m. Main steam line area and N-16 radiation monitors (RE-217, 218, 219, and 220)

These monitors are located near the main steam safety valves and main steam atmospheric dump valves. Alarms are provided in the MCR to alert the operator when these monitors detect the PTS leakage due to a steam generator tube rupture. The method of detecting the steam generator leak rate is described in Appendix 11B.

11.5.2.3 Liquid PERMSS

Each liquid process and effluent monitor is described in the following paragraphs. A list of each monitor and associated parameters is given in Table 11.5-2.

a. Component cooling water supply header monitors (RE-111 and 112)

Homogeneous isokinetic sampling is considered in the sample location and flow rate in accordance with ANSI/HPS N13.1.

Component cooling water is sampled downstream of the component cooling water pumps and is continuously monitored by a gamma scintillation detector mounted in a shielded liquid sampler. After passing through the monitor, the sample is returned to the component cooling water system.

Activity detected above a predetermined setpoint is indicative of a leak into the component cooling water system from the RCS or one of the other systems containing radioactive fluids.

b. Liquid radwaste system effluent monitors (RE-183 and 184)

Two radiation monitors for waste monitor tank effluent, are installed. In the event that radioactivity in excess of a preset limit is detected in the waste liquid discharge flow, the liquid radwaste system effluent monitors actuate an alarm in the MCR/radwaste control room and terminate the discharge.

c. Steam generator blowdown and downcomer monitors (RE-104, 185, and 186)

These offline monitors sample the steam generator blowdown and downcomer for radioactivity, which is indicative of PTS leakage. Samples from each of the steam generators are continuously monitored by a detector mounted in a shielded liquid sampler. Samples are cooled down through secondary sample cooler rack, which is a part of the secondary sampling system described in Subsection 9.3.2.2.3, before coming to local unit. After being monitored, the sample is passed back to the steam generator blowdown and downcomer systems.

d. Condensate polishing area sump water monitor (RE-164)

This monitor is an offline monitor that continuously monitors the condensate polishing area sump water for gross gamma activity. Upon receipt of a high-radiation signal, the discharge flow is automatically diverted to the liquid waste management system (LWMS) prior to release to the environment.

e. Condensate receiver tank monitor (RE-103)

This monitor uses an offline shielded liquid sampler and a gamma scintillation detection system to continuously monitor the effluent from the condensate receiver tank in the auxiliary steam system. Detection of high activity automatically terminates releases from the system; the effluent is routed to the equipment waste tank in the LWMS and initiates alarms to plant operators.

f. Collective sewage treatment sump area monitor (RE-109)

This is an offline monitor to detect gross gamma activity at the outlet of the collective sewage treatment sump area. Upon receipt of a high-radiation signal, the discharge flow is automatically diverted to the LWMS prior to release to the environment, and the high-radiation alarm is provided to the operator. This monitor is also used to detect gross gamma activity at the outlet of the condenser pit sumps.

g. Miscellaneous process liquid monitors (RE-204 and 265)

Two monitors are provided to continuously monitor the radiation levels of the letdown and gas stripper outlets in the CVCS. Detailed information for these monitors is presented in Subsection 9.3.4.5.5.

h. Essential service water pump discharge header monitors (RE-113 and 114)

Two monitors for essential service water discharge header are installed. The essential service water is sampled downstream of the component cooling water heat exchangers and is continuously monitored by a gamma scintillation detector mounted in a shielded liquid sampler. After passing through the monitor, the sample is returned to the essential service water system. Activity detected above background is indicative of a leak into the essential service water system from the ultimate heat sink basins or one of the other systems containing radioactive fluids.

The sample lines for gaseous PERMSS are sloped down toward the monitor skid, and the use of sample line fittings such as unions, elbows, and tees are avoided to the extent practical. Setpoints, the calibration method, and the frequency for safety-related monitors are described in Subsections 12.3.4.1.6 and 12.3.4.1.1.

11.5.2.4 Design Features for Minimization of Contamination

The APR1400 is designed with features that meet the requirements of 10 CFR 20.1406 (Reference 30) and NRC RG 4.21 (Reference 31). The basic principles and the methods of control suggested in the regulations are delineated into four design objectives and two operational objectives, which are defined in Subsection 12.3.1.10. The information below is a summary of the primary features that address the design and operational objectives for the process and effluent radiation monitoring and sampling system.

The PERMSS has been evaluated for leakage identification from the SSCs that contain radioactive or potentially radioactive materials, the areas and pathways where probable leakage may occur, and the methods of leakage control incorporated into the design of the system. The leak identification evaluation indicated that the system is designed to facilitate early leak detection and has the capability to assess collected fluids and respond to manage the collected fluids quickly. Thus, unintended contamination of the facility and the environment is minimized and/or prevented by the SSC design and supplemented by operational procedures and programs and inspection and maintenance activities.

Prevention/Minimization of Unintended Contamination

a. The process sampling piping is designed to return unused portions of the sampling fluid to the process lines. The piping is fabricated from stainless steel material and is of welded construction for life-cycle planning, thus minimizing leakage and unintended contamination of the facility and the environment.

b. The process sampling system components for normal operation, including anticipated operational occurrences, are located inside the auxiliary building and compound building. The secondary cooler rack, grab sample sink, continuous sample sink, chiller, analyzer rack, condenser hotwell sample sink and rack, secondary local grab sample cooler racks, feedwater corrosion sample panel, liquid radwaste sample sink, and gaseous radwaste sample panel are equipped with drain lines piped to the local drain piping. A hood is provided to remove radioactive gases from samples during analysis in order to minimize the spread of contamination.

c. Sampling piping sizes and components are designed to provide the desired flow and sampling conditions in order to obtain representative samples. All sampling piping is sloped to facilitate drainage and to prevent fluid accumulation and crud buildup, thus reducing the level of contamination. The sinks, racks, and panels listed above are constructed of stainless steel material. The sample pumps are fabricated from stainless steel material and of welded construction for life-cycle planning, thus minimizing leakage and unintended contamination of the facility and the environment.

d. The piping and components of gaseous and liquid PERMSS are located in the reactor containment building, compound building, and turbine building. Adequate space is provided around the components to enable prompt assessment and response when required.

<u>Adequate and Early Leak Detection</u>

The process and effluent radiation monitoring and sampling system is designed for automated operation. Adequate instrumentation is provided to enable effective control of sampling operations.

<u>Reduction of Cross Contamination, Decontamination, and Waste Generation</u>

a. The SSCs are designed with life-cycle planning through the use of nuclear-industry-proven materials that are compatible with the chemical, physical, and radiological environment, thus minimizing waste generation.

b. Demineralized water is provided for the decontamination of the piping.

c. Sample sinks are provided to collect all spillage. The sink is designed to include a drain line directly connected to the local floor drain subsystem, from which the drains are sent to the LWMS for processing and release. This design reduces the potential for the spread of contamination in the plant.

Decommissioning Planning

a. Structure system components (SSCs) are designed for the full service life and are fabricated as individual assemblies for easy removal.

b. SSCs are designed with decontamination capabilities. Design features such as welding techniques and surface finishes are implemented in order to minimize the need for decontamination and the resultant waste generation.

c. The process and effluent radiation monitoring and sampling system is designed without any embedded or buried piping, thus preventing unintended contamination to the environment.

d. System components are provided with polished surfaces for ease of decontamination.

Operations and Documentation

Operational procedures and maintenance programs related to leak detection and contamination control are to be prepared by the COL applicant (COL 11.5 (6)). Procedures and maintenance programs are to be completed before fuel is loaded for commissioning.

Site Radiological Environmental Monitoring

The process and effluent radiation monitoring and sampling system is part of the plant, and the data collected through the use of this system can be used in the radiological environmental monitoring program to monitor the level of potential environmental contamination. The COL applicant is to develop a radiological environmental monitoring program (COL 11.5 (7)).

11.5.3 Effluent Monitoring and Sampling

Effluent monitoring and sampling instruments are provided for monitoring the containment atmosphere, spaces containing components for recirculation of loss-of coolant accident fluids, effluent discharge paths, and the plant environs for radioactivity that may be released from normal operations, including AOO and from postulated accidents as shown on Tables 11.5-1 and 11.5-2.

Periodic sampling is performed to supplement the function of the process and effluent radiation monitors. The sampling programs conform to NRC RG 1.21 and the sampling requirements defined in the Technical Specifications.

Special provisions are made for post-accident sampling of effluent pathways in accordance with the guidelines of NUREG-0737, 10 CFR 50, Appendix I, and NRC RG 1.97. See Subsection 9.3.2 for additional post-accident sampling details.

Sampling locations conform to NRC RG 1.21 and NUREG-0800. Post-accident sampling points and equipment conform to NUREG-0737 and NRC RG 1.97.

The containment atmosphere and the liquid radioactive waste tanks are sampled prior to release to the environment. An analysis is performed to determine constituent radionuclides in the liquid radioactive waste tanks, in order to set the proper release rates and isolation setpoints in accordance with 10 CFR 20 limits. The containment purge isolation setpoint is determined so that reasonable assurance that 10 CFR 20 limits are met.

Sampling equipment is designed to prevent the spread of contaminants and radiation exposure to operating personnel while taking grab samples and to include provisions for a rapid change-out of filter elements in order to limit possible radiation exposure to operating personnel. Sampling equipment is modularized to the maximum extent possible for quick component change-out and calibration.

Design requirements regarding the ALARA provisions of NRC RG 8.8 and 8.10 provide reasonable assurance of compliance with the occupational dose limits of 10 CFR 20.1201, 10 CFR 20.1202, and the occupational limits (ALI and DAC) in Table 1 of Appendix B to 10 CFR 20. Sufficient shielding is provided to all equipment of the PERMSS, and any equipment that requires frequent maintenance, inspections, testing, and calibration is designed so that radiation exposures to operating and maintenance personnel are maintained ALARA. In addition, instrument locations provide sufficient space for easy access, operation, inspections, testing, and maintenance to maintain personnel exposures

ALARA. High-radiation alarms and interlock signals are provided to operating and maintenance personnel to meet ALARA requirements.

11.5.4 Process Monitoring and Sampling

Process and effluent monitoring and sampling instruments include the means to control the release of radioactive materials to meet the requirements of 10 CFR 50, Appendix A, GDC 60 during normal operation and AOO. Automatic isolation functions are also implemented to comply with 10 CFR 50, Appendix A, GDC 60.

Radiological monitoring and sampling instruments for fuel and waste storage are provided to detect conditions that may result in the loss of residual heat removal capability and excessive radiation levels and to initiate appropriate safety actions. These are to meet the requirements of 10 CFR 50, Appendix A, GDC 63.

11.5.5 Combined License Information

COL 11.5(1) The COL applicant is to develop an annual report that specifies the quantity of each principal radionuclide released to unrestricted areas in liquid and gaseous effluents.

COL 11.5(2) The COL applicant is to provide site-specific procedures that comply with the numerical guides of 10 CFR 50.34a and 10 CFR 50, Appendix I.

COL 11.5(3) The COL applicant is to prepare an offsite dose calculation manual that contains a description of the methodology and parameters for calculation of the offsite doses for the gaseous and liquid effluents. The COL applicant is to follow NEI 07-09A as an alternative to providing an offsite dose calculation manual.

COL 11.5(4) The COL applicant is to provide analytical procedures and sensitivity for selected radioanalytical methods and types of sampling media for site-specific matter.

COL 11.5(5) The COL applicant is to develop the calibration procedures in accordance with NRC RG 1.33 and 4.15.

COL 11.5(6) The COL applicant is to provide operational procedures and maintenance programs related to leak detection and contamination control.

COL 11.5(7) The COL applicant is to develop a radiological and environmental monitoring program, taking into consideration local land use and census data in identifying all potential radiation exposure pathways. The COL applicant is to follow NEI 07-09A as an alternative to providing a radiological and environmental monitoring program.

11.5.6 References

1. NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," U.S. Nuclear Regulatory Commission.

2. 10 CFR 20, "Standard for Protection Against Radiation," January 1992.

3. 10 CFR 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion."

4. 10 CFR 50, Appendix A, GDC 13, 60, 61, 63, 64, "Domestic Licensing of Production and Utilization Facilities," January 1992.

5. NRC RG 1.21, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste," June 2009.

6. NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980.

7. NRC RG 1.45, "Reactor Coolant Pressure Boundary Leakage Detection Systems," Rev. 1, U.S. Nuclear Regulatory Commission, May 2008.

8. NRC RG 1.97, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident," Rev. 4, U.S. Nuclear Regulatory Commission, June 2006.

9. 10 CFR 50.34, "Contents of applications; technical information, Domestic Licensing of Production and Utilization Facilities," 1997

10. NUREG-0718, "Licensing Requirements for Pending Applications for Construction Permits and Manufacturing Licenses."

11. ANSI N42.18, "Specification and Performance of On-site Instrumentation for Continuously Monitoring Radioactivity in Effluents," 2004.

12. NRC RG 1.143, "Design Guide for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants," Rev. 2, U.S. Nuclear Regulatory Commission, November 2001.

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

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

15. 10 CFR 20, Appendix B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Concentrations for Release to Sewerage," December 2002.

16. 10 CFR 20.1301, "Dose Limits for Individual Members of the Public," May 1991.

17. 10 CFR 20.1302, "Compliance with Dose Limits for Individual Members of the Public."

18. 40 CFR 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

19. 10 CFR 50.36a, "Technical Specifications on Effluents from Nuclear Power Reactors."

20. 10 CFR50.34a, "Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents-Nuclear Power Reactors."

21. NEI 07-09A, "Generic Template Guidance for Offsite Dose Calculation Manual Program Description."

22. NRC RG 1.109, "Calculation of Annual Doses to Man from Routine Release of Reactor Effluents for the Purpose of Evaluating Compliance with 10 Code of Federal Regulations Part 50, Appendix I," Rev. 1, U.S. Nuclear Regulatory Commission, October 1977.

23. NRC RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous effluents in Routine Releases from Light-Water-Cooled Reactors," Rev. 1, U.S. Nuclear Regulatory Commission, July 1977.

24. NRC RG 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," Rev. 1, U.S. Nuclear Regulatory Commission, April 1997.

25. NRC RG 1.33, "Quality Assurance Program Requirements (Operation)," U.S. Nuclear Regulatory Commission, February 1978.

26. NRC RG 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations)-Effluent Streams and the Environment," May 2008. Rev. 2, U.S. Nuclear Regulatory Commission, July 2007.

27. ANSI/HPS N13.1, "Sampling and Monitoring Releases of Airborne Radioactive Substance from the Stack and Ducts of Nuclear Facilities," January 1999.

28. NRC RG 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable," Rev. 3, U.S. Nuclear Regulatory Commission, June 1978.

29. NRC RG 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as low as Is Reasonably Achievable," Rev. 1, U.S. Nuclear Regulatory Commission, May 1977.

30. 10 CFR 20.1406," Minimization of Contamination."

31. NRC RG 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning," June 2008.

32. ANSI/ANS 51.1, "American National Standard Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants," 1983.

Table 11.5-1 (1 of 3)

Gaseous Process and Effluent Radiation Monitors

Location	Tag No.	Class(1)				Range (Bq/cc)(2)					Function and Remarks
		S	SE	Q	E	Particulate Gross β	I-131 γ	Gas Gross β	Liquid Gross γ	Area	
High-energy line break area HVAC effluent (offline)	RE-006	N	III	A	N	Sampler	Sampler	N/A	N/A	N/A	Analysis
High-energy line break area exhaust ACU inlet (offline)	RE-007	N	III	A	N	3.7×10^{-7} to 3.7×10^{-1}	3.7×10^{-7} to 3.7×10^{-1}	3.7×10^{-2} to 3.7×10^{7}	N/A	N/A	Alarm (MCR)
Auxiliary building controlled area (I, II) HVAC normal/emergency exhaust ACU inlet (offline)	RE-013 RE-014 RE-017 RE-018	N	II	A	N	3.7×10^{-7} to 3.7×10^{6}	3.7×10^{-7} to 3.7×10^{6}	3.7×10^{-2} to 3.7×10^{7}	N/A	N/A	Alarm (MCR)
Auxiliary building controlled area (I, II) HVAC normal/emergency exhaust ACU effluent (offline)	RE-015 RE-016 RE-019 RE-020	N	II	A	N	Sampler	Sampler	N/A	N/A	N/A	Analysis
Containment purge effluent(offline)	RE-037	N	II	A	N	$3.7\text{x}10^{-7}$ to $3.7\text{x}10^{6}$	$3.7\text{x}10^{-7}$ to $3.7\text{x}10^{6}$	$3.7\text{x}10^{-2}$ to $3.7\text{x}10^{9}$	N/A	N/A	Alarm (MCR), containment building purge stop

Table 11.5-1 (2 of 3)

Location	Tag No.	Class[(1)]				Range (Bq/cc)[(2)]					Function and Remarks
		S	SE	Q	E	Particulate Gross β	I-131 γ	Gas Gross β	Liquid Gross γ	Area	
Containment air (offline)	RE-039A RE-040B	3	I	Q	B	3.7×10^{-5} to 3.7×10^{1}	3.7×10^{-5} to 3.7×10^{1}	3.7×10^{-2} to 3.7×10^{5}	N/A	N/A	Alarm (MCR), leak detection
Fuel handling area HVAC effluent (offline)	RE-043	N	II	A	N	3.7×10^{-7} to 3.7×10^{-1}	3.7×10^{-7} to 3.7×10^{-1}	3.7×10^{-2} to 3.7×10^{7}	N/A	N/A	Alarm (MCR) isolation interlock diversion interlock
Condenser vacuum pump vent effluent (offline)	RE-063	N	III	A	N	Sampler	Sampler	3.7×10^{-2} to 3.7×10^{3}	N/A	N/A	Alarm (MCR), diversion interlock analysis
MCR air intake (inline)	RE-071A RE-072B RE-073A RE-074B	3	I	Q	A B A B	3.7×10^{-7} to 3.7×10^{-1}	3.7×10^{-7} to 3.7×10^{-1}	3.7×10^{-2} to 3.7×10^{3}	N/A	N/A	Alarm (MCR), CREVAS
Gaseous radwaste system exhaust (offline)	RE-080	N	III	A	N	3.7×10^{-7} to 3.7×10^{-1}	3.7×10^{-7} to 3.7×10^{-1}	3.7×10^{1} to 3.7×10^{6}	N/A	N/A	Alarm (MCR) isolation interlock
Compound building HVAC effluent (offline)	RE-082	N	III	A	N	Sampler	Sampler	N/A	N/A	N/A	Analysis
Main Steam Line	RE-217 RE-218 RE-219 RE-220	N	II	T	N	N/A	N/A	N/A	N/A	$10^{-4} \sim 10^{2}$ (Note 3)	Alarm(MCR, Local)

Table 11.5-1 (3 of 3)

Location	Tag No.	Class(1)				Range (Bq/cc)(2)					Function and Remarks
		S	SE	Q	E	Particulate Gross β	I-131 γ	Gas Gross β	Liquid Gross γ	Area	
Compound building exhaust ACU inlet (offline)	RE-083	N	III	A	N	3.7×10^{-7} to 3.7×10^{-1}	3.7×10^{-7} to 3.7×10^{-1}	3.7×10^{-2} to 3.7×10^{6}	N/A	N/A	Alarm (MCR), isolation interlock, diversion interlock from normal to emergency ventilation
Compound building hot machine shop	RE-084	N	III	A	N	3.7×10^{-7} to 3.7×10^{-1}	3.7×10^{-7} to 3.7×10^{-1}	3.7×10^{-2} to 3.7×10^{3}	N/A	N/A	Alarm (MCR)

(1) S = Safety Class per ANSI/ANS 51.1 (Reference 32): 1 = SC-1, 2 = SC-2, 3 = SC-3, N = NNS
SE = Seismic Category: I, II, III
E = Electrical Class: A, B, C, D=Class 1E Separation Division, N = Non-Class 1E
Q = Quality Class: Q, A, S

(2) Detector type and calibration nuclide for each measurement:
Particulate Gross β = β scintillator with Cs-137
Gas Gross β = β scintillator with Kr-85
Liquid Gross γ = γ scintillator with Cs-137
Iodine γ = γ scintillator with Ba-133

(3) Detector type for area radiation monitor is GM tube or ionization chamber

Table 11.5-2 (1 of 2)

Liquid Process and Effluent Radiation Monitors

Location	Tag No.	Class (1)				Range (Bq/cc) (2)					Function and Remarks
		S	SE	Q	E	Particulate Gross β	I-131 γ	Gas Gross β	Liquid Gross γ	Area	
CVCS letdown	CV-RE-204	N	II	A	N	N/A	N/A	N/A	3.7×10^{0} to 3.7×10^{6}	N/A	Alarm (MCR)
CVCS gas stripper effluent	CV-RE-265	N	II	A	N	N/A	N/A	N/A	3.7×10^{0} to 3.7×10^{5}	N/A	Alarm (MCR)
Condensate receiver tank	RE-103	N	III	S	N	N/A	N/A	N/A	3.7×10^{-2} to 3.7×10^{3}	N/A	Alarm (MCR), diversion interlock
Steam generator blowdown and downcomer	RE-104 RE-185 RE-186	N	II III III	A	N	N/A	N/A	N/A	3.7×10^{-2} to 3.7×10^{3}	N/A	Alarm (MCR), leak detection isolation interlock
CCW supply header	RE-111 RE-112	N	II	A	N	N/A	N/A	N/A	3.7×10^{-2} to 3.7×10^{3}	N/A	Alarm (MCR), leak detection isolation of inlet/outlet valve of heat exchanger
ESW pump discharge headers	RE-113 RE-114	N	II	A	N	N/A	N/A	N/A	3.7×10^{-2} to 3.7×10^{3}	N/A	Alarm (MCR) Leak Detection

Table 11.5-2 (2 of 2)

Location	Tag No.	Class(1)				Range (Bq/cc)(2)					Function and Remarks
		S	SE	Q	E	Particulate Gross β	I-131 γ	Gas Gross β	Liquid Gross γ	Area	
CPP area sump water	RE-164	N	III	S	N	N/A	N/A	N/A	3.7×10^{-2} to 3.7×10^{3}	N/A	Alarm (MCR), pump stop signal
Liquid radwaste system effluent	RE-183 RE-184	N	III	A	N	N/A	N/A	N/A	3.7×10^{-2} to 3.7×10^{3}	N/A	Alarm (MCR), isolation interlock
[Collective sewage treatment sump]	RE-190	N	III	A	N	N/A	N/A	N/A	3.7×10^{-3} to 3.7×10^{3}	N/A	Alarm, pump stop signal

(1) S = Safety Class per ANSI/ANS 51.1 (Reference 32): 1 = SC-1, 2 = SC-2, 3 = SC-3, N = NNS
SE = Seismic Category: I, II, III
E = Electrical Class: A, B, C, D = Class 1E Separation Division, N = Non-Class 1E
Q = Quality Class: Q, A, S

(2) Detector type and calibration nuclide for each measurement:
Particulate Gross β = β scintillator with Cs-137
Gas Gross β = β scintillator with Kr-85
Liquid Gross γ = γ scintillator with Cs-137
Iodine γ = γ scintillator with Ba-133