11.5 PROCESS AND EFFLUENT RADIOLOGICAL MONITORING AND SAMPLING SYSTEMS

The process and effluent radiological monitoring and sampling systems are provided to monitor releases of radioactive material in the plant gaseous and liquid process and effluent streams in order to control these releases.

11.5.1 DESIGN BASES

11.5.1.1 Design Objectives

The design objectives of the systems described in this section are to generally conform with the requirements of General Design Criteria 60, 63 and 64; and Regulatory Guide 1.21, Rev. 1, 6-74.

Certain of the effluent systems described provide initiating circuits for the Engineered Safety Feature Systems. These systems are designed to be in compliance with IEEE 279-1971 to assure performance of the protective action required. References to Chapter 7 are provided for these systems.

Provision for monitoring postulated accidents is primarily provided by the measuring range of the channel provided. These ranges are noted in Table 11.5-1.

11.5.1.2 Design Criteria

Design Criteria are General Design Criteria 60, 63 and 64, Regulatory Guide 1.21, Rev. 1, 6-74, IEEE 279-1971, and NUREG 0737.

11.5.2 PROCESS AND EFFLUENT RADIOLOGICAL MONITORING SYSTEM DESCRIPTION

11.5.2.1 Continuous Process and Effluent Monitoring Systems

Process and effluent radiological monitoring systems (RMS) are identified below. Systems which provide safety-related functions are noted and appropriate references are made. One influent system is listed since it is the same basic equipment.

(1) Gaseous effluent stream monitoring:

a) Reactor Building Vent Stack Exhaust Monitoring and Sample RMS

b) Turbine Building and Radwaste Vent Stack Exhaust Monitor and Sample RMS.

c) Standby Gas Treatment Vent Stack Exhaust Monitor and Sample RMS

d) Standby Gas Treatment Vent Duct Exhaust RMS: a safety-related system also discussed in Subsections 7.3.1.1b.4, 6.5.1.1 and 9.4.2

e) Refueling Floor Wall Duct Exhaust RMS: a safety-related system also discussed in Subsections 7.3.1.1b.5, 6.5.3 and 9.4.2

f) Refueling Floor High Exhaust Duct RMS: a safety-related system also discussed in Subsections 7.3.1.1b.5, 6.5.3 and 9.4.2

g) Railroad Access Exhaust Duct RMS: a safety-related system also discussed in Subsections 7.3.1.1b.5, 6.5.3 and 9.4.2

h) Outside Air Intake Duct (Influent) RMS: a safety-related system also discussed in Subsections 7.3.1.1b.7, 9.4.2 and Section 6.4.

(2) Liquid effluent monitor systems

a) Plant Radwaste Effluent
b) Service Water Discharge/Supplemental DH Removal

(3) Gaseous process streams monitoring

a) Offgas Pretreatment
b) Main Steamline Radiation Monitoring System (see Subsection 7.3.1)

4) Liquid Process Monitor Systems

a) RHR Service Water RMS
b) Reactor Bldg. Closed Cooling Water RMS

5) Containment Radiation Monitoring System

a) Primary Containment Atmospheric Monitoring System discussed in Subsection 5.2.5.1.2.3.

b) Primary Containment Radiation Monitoring System (High Range) discussed in Subsection 7.6.1b.1.5.

11.5.2.1.1 Reactor Building Vent Stack Exhaust Monitor and Sample RMS

The Reactor Building Vent Effluent Radiation Monitoring System (VERMS) is a General Atomics -ESI Gas Monitor system. A sample representative of the exhaust stream is continuously extracted using a sampling probe array mounted in the exhaust duct. This system utilizes both sampling filters/cartridges and a radiation detector to continually monitor effluent from the reactor building ventilation exhaust zones as noted on Dwgs. VC-175, Sh. 1, VC-175, Sh. 2 and VC-175, Sh. 3. The system is shown on drawing M-165, Sh. 5.

The sample is passed through filters/cartridges located on the Gas Monitor Skid assemblies, 1C216B/2C216B for collection of radioactive particulate and iodine. Radiation detectors mounted on the skids continuously measure noble gas activity in the sample stream.

VERMS uses constant flow rate sampling because flow rate variations in the tubing have a greater affect on sample composition than the corresponding affect due to deviation from true isokinetic flow at the sample nozzle as vent flow varies from nominal flow rate. Sample tubing size is optimized to minimize losses at the sample flow rate. This approach provides the most representative vent sample at the filter holders as required by ANSI N13.1-1969.

The sample then splits into 2 streams. One stream passes through the Bypass Pump Skid Assembly, 1C299C/2C299C. The two bypass pumps on this skid provide the additional flow necessary to maintain a representative sample flow through the sample probe. The second stream, a continuous fixed flow, is passed through the Gas Monitor Skid Assembly, 1C299B/2C299B, for collection of radioactive particulate and iodine samples and continuous monitoring of noble gas activity. Downstream of the skids the two streams are combined and returned to the Reactor Building vent for release. The Gas Monitor Skid Assembly includes connections for collecting a sample volume for laboratory analysis of noble gas activity and calibration of the radiation detector. Provisions are included in the system design for the temporary connection and powering of an alternate sample cart and tritium sample collector.

For the Reactor Building VERMS a single low range radiation detector is used. It has a range which extends from minimum sensitivity to normal operation and up through all operational occurrences and postulated accidents for which the reactor building ventilation system remains operational. For the more severe accidents the reactor building ventilation systems are automatically shutdown and isolated and reactor building ventilation is provided by the Standby Gas Treatment System which has a separate vent and a separate wide range radiation monitoring system (see Section 11.5.2.1.3).

System control is provided by a microprocessor based controller mounted locally on the Gas Monitor Skid Assembly. This controller also provides the radiation monitoring signal processing. The controller provides a local information display, local alarms, system status information and interface with the rest of the plant. This controller communicates system information to a remote control and display assembly located on panel 0C658 in the Control Room. The remote controller provides the same information displays and can provide the same control functions as the local controller. Vent flow and release rate information is continuously recorded by a separate Control Room recorder. An independent communications network provides Reactor Building VERMS information to the Technical Support Center.

Each Reactor Building VERMS provides Inputs to the 3 common plant exhaust vent alarms on Control Room panel 0C653; Vent Monitoring TROUBLE, HIGH RADIATION, HI-HI RADIATION. The plant operator can determine which vent is alarming by observing the remote control and display assemblies on control room panel 0C658.

Representative samples from the Reactor Building exhaust vents are drawn continuously and filters/cartridges replace and analyzed at least weekly to monitor particulate and iodine effluent releases. Radionuclide analyses of samples is also performed when continuous monitoring of noble gases shows an unexplained variance from an established norm which may be indicative of a change in the concentration and composition. The norm is established as a range of readings that may be expected due to normal operating conditions including anticipated operational occurrences. Radionuclide analysis of samples is also performed following each refueling, process change, or other occurrence that could alter the mixture of radionuclides.

11.5.2.1.2 Turbine Building and Radwaste Vent Stack Exhaust Monitor and Sample RMS

The Turbine Building Vent Effluent Radiation Monitoring System (VERMS) is a General Atomics -ESI Wide Range Gas Monitor system. A sample representative of the exhaust stream is continuously extracted using a sampling probe array mounted in the exhaust duct. This system utilizes both sampling filters/cartridges and radiation detectors to continually monitor effluent from the turbine building ventilation exhaust and the processed and filtered reactor gaseous radwaste from the Radwaste Building as shown on drawing VC-174, Sh. 1. The system is shown on drawing M-165, Sh. 4.

VERMS uses constant flow rate sampling because flow rate variations in the tubing have a greater affect on sample composition than the corresponding affect due to deviation from true isokinetic flow at the sample nozzle as vent flow varies from nominal flow rate. Sample tubing size is optimized to minimize sample transport losses. The sample then splits into 2 streams. One stream passes through the Bypass Pump Skid Assembly, 1C1108C/2C1108C. The two bypass pumps on this skid provide the additional flow necessary to maintain a representative sample flow through the sample probe. The second stream, a continuous fixed flow, passes through sample filter/cartridges and radiation detectors for sample collection and radiation monitoring. The two flow streams then recombine and are returned to the Turbine Building vent for release. Provisions are included in the system design for the temporary connection and powering of an alternate sample cart and tritium sample collector.

The sample filters/cartridges and detectors used for monitoring change depending on noble gas activity in the sample stream. During normal power generation operation the sample is drawn through sample cartridges on the Normal Sample Conditioning Skid Assembly, 1C2108/2C2108 located on the refuel floor, and then through the low range radiation detector on Sample Detection Skid Assembly, 1C1108B/2C1108B located on Turbine Building El. 729'. If radiation levels in the sample rise to levels indicating an accident and that Refuel Floor habitability may become a problem motor operated valves in the system automatically transfer the sample flow to sample collection cartridges located on Turbine Building El. 729" in Conditioning Skid Assembly, 1C1108A/2C1108A. At this first stage of accident alignment the flow will continue through the low range radiation detector on Sample Detection Skid Assembly, 1C1108B/2C1108B. If radiation levels in the sample continue to rise the sample flow will be reduced and transferred to shielded sample cartridges on the Sample Conditioning Skid Assembly and pass from there to Mid and High range radiation detectors on the Sample Detection Skid Assembly. The Sample Detection Skid Assembly includes connections for collecting a sample volume for laboratory analysis of noble gas activity and calibration of the radiation detectors.

Three overlapping ranges of radiation detectors are necessary in the Turbine Building VERMS to provide monitoring for the full range of potential radiation, from normal operation to the most severe postulated accident. To reduce maximum radiation exposure to equipment and personnel the sample flow rate is reduced by about a factor of 25 when flow is switched to the shielded cartridges and Mid and High range radiation detectors. This change happens automatically and no operator action is required. Also, system outputs automatically adjust for the changes in flow rate and detector range.

System control and interfaces are essentially identical to those for the Reactor Building VERMS. The only difference are the automatic changes in sample flow alignment, sample flow rate and radiation detector range as radiation level in the sample increases.

11.5.2.1.3 Standby Gas Treatment System Vent Stack Exhaust Monitor and Sample RMS

General Atomics -ESI Wide Range Gas Monitor system which is almost identical to the Turbine Building VERMS described in 11.5.2.1.2. The only difference is with Bypass Pump Control. Because the Standby Gas Treatment System vent flow is much lower than the Turbine Building Vent flow there are operating conditions where no Bypass Pump flow is needed and both bypass pumps on Bypass Pump Skid Assembly 0C194C are never needed. The automatic Bypass Pump control scheme accounts for these differences. The system is shown on drawing M-165, Sh. 3. The Normal Sample Conditioning Skid on the Refuel Floor is 0C294, the Sample Conditioning Skid on Turbine Building El. 729' is 0C194A and the Sample Detection Skid Assembly is 0C194B.

11.5.2.1.4 Standby Gas Treatment Vent Exhaust Radiation Monitoring System

The system monitors gamma radiation in the exhaust vent of the standby gas treatment system. Two instrument channels constitute this system. Automatic closure of the containment purge isolation valves is actuated upon detection of high radiation in the exhaust vent during containment purge.

(1) The detectors are mounted outside the exhaust vent.

(2) The sensors are Geiger-Muller tubes with converter units. Refer to Table 11.5-1.

(3) Two independent instrument channels are designed each with a detector/converter unit mounted locally and an indicator trip unit in the control structure. The radiation measurement is displayed on the indicator trip unit and both channels are recorded in the main control room on a digital recorder.

The trip circuit detects two upscale trips (high-high and high radiation) and one downscale/inoperative trip.

(4) The following annunciators are located in the control room:

a) Standby Gas Exhaust Vent High-High Radiation

b) Standby Gas Exhaust Vent High Radiation

c) Standby Gas Exhaust Vent Monitor Downscale

5) The power source for instrument channel A is from the reactor protection system 120 V ac supply bus A.

Instrument Channel B is powered from RPS bus B.

6) The trip allowable value and surveillance requirements are defined in the Technical Specifications.

<u>11.5.2.1.5 Refueling Floor Wall Exhaust Duct Radiation Monitoring System</u>

This system monitors the radiation level in the exhaust duct from the refueling floor prior to its discharge to the atmosphere through the reactor building vent. The refueling floor is included as part of reactor building ventilation Zone III.

Refer to Dwg. VC-175, Sh. 2 for system design.

(1) The detection assemblies are located in the exhaust ducting upstream of the inboard isolation damper. The distance from the inboard isolation damper is defined by the ventilation flow transport time at maximum design flow rate from the detector location to the inboard isolation damper, which is greater than the total time to respond to a trip level radiation for complete closure of the inboard isolation damper.

(2) The detector assembly is a Geiger-Muller tube with a converter unit.

(3) Two redundant independent instrument channels are provided. Each channel consists of a local detector and converter unit, which transmits a signal to the control room indicator and trip unit. Two trip circuits monitor the upscale (high-high)/inoperative condition and the downscale condition. The upscale trip indicates high radiation and the downscale trip indicates instrument trouble. The upscale trip initiates closure of the reactor building Zone III ventilation outboard isolation dampers, starts the SGTS and the reactor building recirculation system (see Section 6.5). Refer to Section 7.3 for isolation logic. The radiation level of each channel is recorded on a digital recorder.

(4) Measurement ranges are defined in Table 11.5-1.

(5) Two alarms for high radiation (high and high-high) and one alarm for downscale trip are located in the control room. Actuation of isolation dampers is discussed in Section 7.3.

(6) Reactor protection system power bus A is the power source for one instrument channel. RPS bus B is the power source for the other channel. Refer to Chapter 8.

(7) The monitors are readily accessible for calibration, inspection and maintenance. A portable gamma source may be used for testing the instrumentation.

(8) Reactor building ventilation Zone III is described in Section 9.4.2 and is a common ventilation zone for Units 1 and 2. Both Unit 1 and Unit 2 Refueling Floor Wall Exhaust Duct Radiation Monitors provide monitoring of this common ventilation zone exhaust. As such, both Unit 1 and Unit 2 Refueling Floor Wall Exhaust Duct Radiation Monitors are required during operation of either Unit 1 or Unit 2.

<u>11.5.2.1.6 Refueling Floor Exhaust Duct High Radiation Monitoring System</u>

This system consists of shielded detectors whose purpose is to monitor the radiation level in the refueling floor ventilation exhaust duct adjacent to the intake register. The refueling floor is included as part of reactor building ventilation Zone III.

The system is identical to the refueling floor wall exhaust radiation monitoring system with the same channel trip logic and protective action initiation. Refer to Dwg. VC-175, Sh. 2 and Table 11.5-1 for system configuration.

Reactor building ventilation Zone III is described in Section 9.4.2 and is a common ventilation Zone for Units 1 and 2. Both Unit 1 and Unit 2 Refueling Floor Exhaust Duct High Radiation Monitors provide monitoring of this common ventilation zone exhaust. As such, both Unit 1 and Unit 2 Refueling Floor Exhaust Duct High Radiation Monitors are required during operation of either Unit 1 or Unit 2.

11.5.2.1.7 Railroad Access Exhaust Duct Radiation Monitoring System (Unit 1 only)

This system monitors the radiation level in the railroad access area air exhaust duct prior to the Unit 1 reactor building vent. The railroad access area is located in and is unique to the Unit 1 reactor building. The system design is identical to the refueling floor wall radiation monitoring system. Table 11.5-1 identifies type of detector, location and instrument ranges. Refer to Section 7.3 for reactor building isolation initiation. Dwg. VC-175, Sh. 2 documents the system configuration.

The railroad access shaft ventilation zone is described in Section 9.4.2. The Railroad Access Exhaust Duct Radiation Monitors are required for monitoring of this ventilation area during the movement of Unit 1 or Unit 2 irradiated fuel within the Railroad Access Shaft, and directly above the Railroad Access Shaft with the Railroad Access Shaft Equipment Hatch open.

11.5.2.1.8 Control Structure Outside Air Intake Radiation Monitoring System

The radioactivity of the outside air intake for the control structure is continuously monitored to detect airborne radioactive material which enters the heating, ventilating, and air conditioning system for the control structure. An increase in gamma radiation is detected by the two redundant instrument channels. The system provides a trip signal to initiate the emergency intake air supply system for the control room habitability engineered safety feature. Refer to Section 7.3 for actuation of this safety system.

(1) The two redundant monitors are located in the outside intake air plenum.

(2) The radiation detection system uses a Geiger-Muller tube with a converter unit.

(3) Two redundant, independent instrument channels are provided, each with an indicator and trip unit in the control structure. The radiation measurement is displayed on a four decade logarithmic scale. A high radiation reading initiates the upscale trip circuit and contacts for alarm and protective action are provided. Power failure or component malfunction causes downscale trip initiation.

Each channel measurement is recorded on a digital recorder in the control room.

(4) Instrument ranges and scale information are in Table 11.5-1.

(5) High/high radiation and downscale/inoperative alarms are displayed in the control room. The digital recorder initiates a control room high radiation alarm set at a slightly lower level than the high/high alarm.

At high/high radiation level, the trip circuit initiates the emergency outside air intake system as described in Section 7.3.

(6) Each channel is powered by its separate and independent reactor protection system power supply, channel A from RPS bus A, and channel B from RPS bus B.

Refer to Chapter 8 for electrical power distribution.

(7) The trip allowable value and surveillance requirements are per the Technical Specifications.

(8) The instrumentation is readily accessible for calibration, inspection, and maintenance. A portable gamma source unit may be used for testing and calibration.

11.5.2.1.9 Liquid Radwaste Effluent RMS

This system monitors the gross gamma activity in the discharge line from liquid radwaste prior to discharge into the cooling tower blowdown line.

The system monitors a sample of the discharge effluent by use of a side stream of the discharge. The side stream pipe is located downstream of the last point of waste admission to the discharge, and upstream of the first isolation valve. The sample flow is pumped by the Liquid Radwaste Effluent RMS through a shielded sample chamber and back to the discharge line upstream of the flow control valve (Dwg. M-164, Sh. 1).

The Liquid Radwaste Effluent RMS consist of:

1) a flow element to measure total radwaste discharge flow rate. The flow rate is recorded on a recorder on panel 0C301 in the radwaste control room.

2) a gamma sensitive scintillation detector contained in the shielded sample chamber. The count rate is displayed and recorded on panel 0C301 in the radwaste control room.

The monitoring instrumentation provides three trips, all of which terminate radwaste discharge. The trips are high radiation, downscale and low sample flow. The high radiation and downscale trips initiate alarms in the main control room and the low sample flow trip initiates an alarm in the radwaste control room. A check source is provided for periodic testing of the monitoring system. A fourth trip, cooling tower blowdown flow interlock, exists to terminate radwaste discharge which ensures adequate dilution for effluent releases.

All controls, alarms, setpoint adjustment and indicators are located on 0C336 in the Radwaste Building. The Radwaste Control Room has a monitor which communicates with the local skid for operation status, activity status, alarm status and by receiving status inquiries and function control commands. The local skid can be controlled from the Radwaste Control Room. The Main Control Room Panel 1/2C601 each receives two alarms one for high radiation and one for downscale trip. Two isolation valves installed in series are provided. These valves are air operated and fail closed. All controls and permissive interlocks require contact closures to open the valves, thereby providing fail safe valve control. No emergency power is provided.

The sensitivity of the liquid radwaste effluent monitor is 3.07×10^8 CPM/μCi/cc (Cs^{137}).

Refer to Section 11.2 for a discussion of concentrations, compositions, flows and measurements.

11.5.2.1.10 Service Water Discharge/Supplemental DH Removal Radiation Monitoring System

The objective of this system is to detect radioactive material inleakage to the service water system and to monitor the service water system discharge to the cooling tower basin. The spent fuel pool heat exchangers are the only potential radioactive release path to the service water system. As such, the radiation monitors are located on the service water discharge line from the spent fuel pool heat exchangers.

(1) Two detectors are provided; one in the service water piping and one in the supplemental decay heat removal piping. During normal operation the service water discharge detector is connected to a radiation monitoring unit (See (4)). During unit outages, when supplemental decay heat removal is placed in service, the supplemental decay heat removal detector is connected to a control structure radiation monitoring unit in place of the service water detector.

(2) The service water detector is located on the downstream side of the fuel pool heat exchangers prior to discharge to the cooling tower. The supplemental decay heat removal detector is located on the downstream side of the fuel pool heat exchangers prior to discharge to the supplemental cooling equipment.

(3) Both detectors are scintillation detectors with the same characteristics. (See Table 11.5-1)

(4) Each detector assembly is mounted in the process flow. Shielding is provided as required to ensure adequate sensitivity to the process radiation. A local pulse preamplifier for each detector transmits the signal from the connected detector to a radiation monitoring unit in the control structure (upper relay room). This radiation monitor provides trip points: one upscale (high radiation) and one downscale (low-low radiation). High radiation and downscale trips are alarmed in the control room. The radiation level can be observed in the control room on a digital recorder.

(5) Table 11.5-1 shows instrument ranges.

(6) No emergency power is provided.

(7) Surveillance requirements including calibration and testing are based on the Technical Requirement Manual.

(8) Surveillance requirements including calibration and testing are based on the Technical Requirement Manual.

11.5.2.1.11 Offgas Pretreatment Radiation Monitoring System

This system monitors radioactivity in the condenser offgas discharge after it has passed through the steam jet air ejector (SJAE), see Dwg. M-107, Sh. 4. The monitor detects the radiation level which is attributable to the fission gases produced in the reactor and transported with steam through the turbine to the condenser.

A continuous sample is extracted from the offgas pipe via a stainless steel sample line. It is then passed through a sample chamber and a sample panel before being returned to the condenser. The sample chamber is a steel pipe, which is internally polished to minimize plateout. It can be purged with room air to check detector response to background radiation by using a three-way solenoid operated valve. The valve is controlled by a switch located in the main control room. The sample panel measures and indicates sample line flow.

The sample chamber is monitored by three channels. Each channel has a gamma-sensitive ionization chamber mounted external to the sample chamber. Two channels have logarithmic radiation monitors which provide system alarm output. The third channel has a linear radiation monitor for recording in the control room. The two logarithmic channels are recorded on a separate digital recorder.

Power is supplied from the 125 V nondivisional bus for the logarithmic channels, from 24 V bus A for the linear channel, from the 120 V instrument bus for the recorders, and from a local 120 V bus for the sample and vial sampler panels.

The logarithmic radiation monitors have four trip circuits: two upscale (high-high and high), one downscale (low), and one inoperative.

The trip outputs are used for alarm function only. Each trip actuates a control room annunciator: offgas high-high, offgas high, and offgas downscale/inoperative. High or low sample line flow measured at the sample panel actuates a control room offgas sample high-low flow annunciator.

The radiation level output by the monitor may be correlated to the concentration of the noble gases by using the semiautomatic vial sampler panel to obtain a grab sample. To draw a sample, a serum bottle is inserted into a sample chamber, the sample lines are evacuated from the bottle to a solenoid-operated sample valve. The solenoid-operated sample valve is opened to allow offgas to enter the bottle. The bottle is then removed and the sample is analyzed in the counting room with a multichannel gamma pulse height analyzer to determine the concentration of the various noble gases radionuclides.

11.5.2.1.12 Main Steamline Radiation Monitoring System

This system monitors the gamma radiation level exterior to the main steam lines. The normal radiation level is produced primarily by coolant activation gases plus smaller quantities of fission gases being transported with the steam. In the event of a gross release of fission products from the core the radiation monitor initiates a main control room annunciator and trips the mechanical vacuum pump (MVP).

(1) Four radiation monitors are located near the main steam lines just downstream of the outboard main steam line isolation valves in the space between the primary and secondary containment walls. The detectors are geometrically arranged so that this system is capable of detecting significant increases in radiation level with any number of main steam lines in operation.

(2) Each monitor has a gamma sensitive ion chamber with 3.7×10^{-10} amp/R/hr sensitivity.

(3) The system consists of four instrument channels. Each ion chamber detector provides a signal to a control room log-radiation monitor with meter and auxiliary trip unit. One four channel recorder powered from the 120 V instrument bus allows the output of all four channels to be recorded simultaneously. The channels A and C are physically and electrically independent of channels B and D.

(4) Table 11.5-1 lists the range of the detectors.

(5) Each radiation monitor has four trip circuits: two upscale (high-high and high), one downscale (low), and one inoperative. Each trip is visually displayed on the affected radiation monitor. A high rad count in the radiation monitor initiates a main control room annunciator common to all channels. A high-high or inoperative trip in the radiation monitor results in a trip of the MVP and isolation of its suction valve. A downscale trip actuates a MSL downscale control room annunciator common to all channels. High and low trips do not result in a channel trip. Each channel has a control room display of the measured radiation level.

(6) Power for two channels (A and C) is supplied from the RPS bus A and for the other two channels (B and D) from the RPS bus B. Refer to Chapter 8 for more detail on emergency power supply.

(7) Alarm and trip setpoints and surveillance requirements including calibration and testing are based on the Technical Requirements Manual.

(8) Testing can be performed during full power operation. Calibration can be performed during shutdown.

(9) During the periodic test of any one radiation monitor channel a control room annunciation from the downscale trip output of the monitor will be provided. In order to confirm proper annunciation of a channel, a simulated input must be introduced into the monitor input and increased in magnitude to initiate the annunciator point. Confirmation of the monitor meter indication relative to the other channels must be performed after the simulated input is replaced by a true detector signal.

11.5.2.1.13 RHR Service Water Radiation Monitoring System

This system is designed to detect primary coolant leakage into the RHR service water during operation of the RHR heat exchanger. The two RHR heat exchangers are each rated for 100 percent of reactor shutdown operation. In the event of a leakage in one heat exchanger, the redundant unit could be placed into service by the control room operator.

Two systems are provided, one for each heat exchanger. Each system operates as follows: A sample is drawn from the service water, downstream from the heat exchanger by means of a sample pump. The sample is returned to the same pipe downstream of the sample point. The sample is pumped through a shielded sample chamber and monitored by a radiation detector and electronics. All the radiation monitor components are located in panel 2C212A&B which provides local indication and output signals for recording and alarms in the main control room. Radiation monitor pump automatically starts when RHR Heat exchanger is placed in service. Recording is on panel 1C600/2C600. Alarms are on panel 1C601/2C601. A flow transmitter in the sample loop provides a flow signal to trip the monitor on low sample flow.

11.5.2.1.14 Reactor Building Closed Cooling Water Radiation Monitoring System

The radiation monitor system detects leakage from the reactor water cleanup system into reactor building closed cooling water through the nonregenerative heat exchanger. Any increase of the radiation level above background is an indication of leakage.

The detector is located in the suction header piping of the RBCCW pumps.

Table 11.5-1 identifies the provided instrumentation.

11.5.2.2 Routine Sampling

The requirements of the system design bases for routine continuous and discrete sampling of radioactivity are satisfied by a system of liquid, gaseous, and airborne samplers, laboratory equipment for sensitive radio-chemical analyses, and a program of procedures for obtaining and analyzing representative samples when and where appropriate. This subsection provides a description of system hardware and procedures in general, including the type of sampling equipment used, the procedures to obtain representative samples, and analytical procedures. Table 11.5-2 is a tabulation of basic information describing each of the radioactivity sampling locations, including the basis for selecting the location, expected process flows, sampling frequency, analytical procedure, and expected monitor sensitivities. Table 11.5-3 gives the expected composition and concentration of nuclides in routine effluent samples.

Sampling equipment and procedures are provided to assure that representative samples are obtained. Prior to sampling, large tanks of liquid waste are well-mixed in as short a interval as practicable to assure that any sediments or particulate solids are distributed uniformly in the waste mixture. Sample lines are flushed for a sufficient period of time prior to sample extraction in order to remove sediment deposits and air and gas pockets. A sample is taken before discharge to determine the isotopic mixture and concentration of the tank. Composite sampling of the cooling tower blowdown is performed as part of the Radiation Environmental Monitoring Program for estimating doses to the public.

Effluent ventilation vents are sampled continuously and isokinetically for radioactive gases, particulates, and iodines. Particulate and iodine sampler filters are replaced and removed for analysis periodically for all continuous airborne radiation monitors and samplers. A gas sample will be taken monthly or if the gaseous monitor count rate shows a significant change.

11.5.2.2.1 Analytical Procedures

Techniques available in the laboratory for analyzing samples of process and effluent gases and liquids include:

1) Gross alpha counting (Normal vendor analysis)

2) Gamma spectrometry

3) Liquid scintillation counting

4) Radiochemical separations (Normal vendor analysis)

Instrumentation available in the laboratory for the measurement of radioactivity includes:

1) Liquid scintillation counter

2) Gamma spectrometer

   a) Germanium detector
   b) Multichannel analyzer system

Gamma spectrometry is used for isotopic analysis of liquid, gaseous, and airborne particulate and iodine samples. A high-efficiency, high-resolution Germanium detector is available for resolving complex gamma spectra.

Gaseous tritium samples are collected and counted on the liquid scintillation counter.

11.5.3 EFFLUENT MONITORING AND SAMPLING

General Design Criteria 64, "Monitoring Of Radioactivity Releases," is implemented using the equipment and systems described in Subsection 11.5.2. With respect to the specific areas, discharges and environs mentioned in General Design Criteria 64, the following subsections apply.

11.5.3.1 Containment Atmosphere

Monitoring of containment atmosphere for radioactivity is described in Subsection 5.2.5.1.2.3. Description is given of the systems which can detect leakage of radiation from the vessel and piping to the primary containment. Monitoring is continuous and is applicable to normal operations and occurrences.

Monitoring of Containment Atmosphere for H^2 and O^2 gas concentrations is described in Subsection 6.2.5.2. Description is given of redundant systems which monitor gas concentration within the primary containment drywell or the suppression chamber. Monitoring is continuous during normal plant operations. The PASS (Post Accident Sampling System) is used after a LOCA.

11.5.3.2 Reactor Building

The reactor building contains components and piping which are used for the recirculation of LOCA fluids. Radiation monitoring in this space consists of ventilation duct monitors, (refer to Subsections 11.5.2.1.4 through 11.5.2.1.7) and the area radiation monitors, (refer to Subsection 12.3.4 and Table 12.3-7 channels 1 thru 6, 8 through 16, 25, 26, 35, 36 and 41 through 57). The descriptions for this equipment apply for normal, operating, anticipated occurrences and accident conditions.

11.5.3.3 Effluent Discharge Paths

Monitoring of plant effluent discharge paths is described in Subsection 11.5.2.

Normally non-radioactive systems are considered 80-10 systems in accordance with NRC IE Bulletin 80-10 if they have the potential for radioactive contamination and a release pathway to the environment. The systems that have the potential to be contaminated and conditions for their use if they should become radioactive are controlled by the ODCM.

11.5.3.4 Plant Environs Measurement

Pre-operational Environs measurements are discussed in Chapter 6 of the Susquehanna S.E.S. Environmental Reports. Operational Environs Measurements are discussed in the ODCM and Technical Requirement Manual.

11.5.4 PROCESS MONITORING AND SAMPLING

Systems monitoring gaseous process streams are described in Subsections 11.5.2.1.11 and 11.5.2.1.12.

Systems monitoring liquid process streams are described in Subsections 11.5.2.1.10, 11.5.2.1.13 and 11.5.2.1.14.

11.5.4.1 Process Monitoring and Sampling Systems

These systems implement General Design Criteria 60 with respect to automatic closure of isolation valves as described in the following subsections.

11.5.4.1.1 Plant Radwaste Effluent RMS

This monitoring system will initiate isolation of two effluent discharge valves. Description is provided in Subsection 11.5.2.1.9.

11.5.4.1.2 Service Water Discharge/Supplemental DH Removal RMS

This system does not provide initiation of any isolation function. A description is provided in Subsection 11.5.2.1.10.

11.5.4.1.3 Offgas Pretreatment RMS

There is no provision for the offgas pretreatment monitor system to automatically stop this effluent from reaching the turbine building exhaust vent. A description is provided in Subsection 11.5.2.1.11.

11.5.4.1.4 Main Steamline RMS

Detection of high high radiation by this monitoring system initiates isolation of reactor coolant sample valves.

11.5.4.1.5 RHR Service Water RMS

There is no provision for isolation initiation by this System. A description is provided in Subsection 11.5.2.1.13.

11.5.4.1.6 Reactor Building Closed Cooling Water RMS

There is no provision for isolation initiation by this system. A description is provided in Subsection 11.5.2.1.14.

11.5.4.2 Radioactive Waste Process Monitoring and Sampling Systems

These systems implement General Design Criteria 63, "Monitoring Fuel and Waste Storage," with respect to radiation levels in radioactive waste process systems. Radiation levels are measured only at points in the actual discharge lines in the case of liquids and at the discharge vents in the case of gases (Turbine Building vent). Solid wastes are not measured during the solid waste processing operation.

A sample capability is provided in the Radwaste Solidification System. This allows small grab samples to be taken from the waste mixing tanks OT-307 A&B (see 11.4.2.2).

TABLE 11.5-1

PROCESS AND EFFLUENT RADIATION MONITORING SYSTEMS

MONITORED PROCESS	NO. OF CHANNELS	DETECTOR TYPE	DETECTOR LOCATION	CHANNEL RANGE	WARNING ALARM	TRIP	SCALE
A. SAFETY-RELATED SYSTEMS							
Main Steamline	4	Ionization chamber	Immediately downstream of last main steam	$1\text{-}10^6$ mr/hr	Yes	Technical Requirements Manual	6 dec. log
Refuel Floor Wall Exhaust	2	Geiger-Muller tube	Exhaust duct upstream of ventilation isolation damper	0.01 mr/hr to 100 mr/hr	Yes	Technical Specification	4 dec. log
Refuel Floor High Exhaust	2	Geiger-Muller tube	Exhaust duct upstream of ventilation isolation damper	0.01 mr/hr to 100 mr/hr	Yes	Technical Specification	4 dec. log
Emergency Outside Air Intake	2	Geiger-Muller tube	Outside air intake plenum	0.01 mr/hr to 100 mr/hr	Yes	Technical Specification	4 dec. log
Railroad Access Shaft Exhaust	2	Geiger-Muller tube	Exhaust duct upstream of ventilation isolation damper	0.01 mr/hr to 100 mr/hr	Yes	Technical Specification	4 dec. log
Standby Gas Treatment Vent Exhaust	2	Geiger-Muller tube	Outside Exhaust Vent	0.01 mr/hr to 100 mr/hr	Yes	Technical Specification	4 dec. log
B. SYSTEMS REQUIRED FOR PLANT OPERATION							
Service Water Discharge/Supplemental DH Removal	1	Scintillation	Effluent pipe prior to discharge into other systems	10^1 to 10^6 counts/sec	As determined by methodology of the ODCM	Not applicable	7 dec. log
Reactor Building Closed Cooling Water	1	Scintillation	Suction header to closed cooling water pumps	10^1 to 10^6 counts/sec	Above background	Not applicable	7 dec. log
RHR Service Water A/B	2	Scintillation	Process pipe downstream of heat exchanger	1 to 10^6 counts/min	As determined by methodology of the ODCM	Not applicable	5 dec. log and Digital Readout
Liquid Waste Effluent (Plant)	1	Scintillation	Effluent pipe prior to discharge	1 to 10^6 counts/min	As determined by methodology of the ODCM	As determined by methodology of the ODCM	7 Digital and Recorder 5 dec. log ($10\text{-}10^6$ CPM)
Offgas Pretreatment	3	Ionization chamber	Sample line	1 to 10^6 mr/hr	As determined by methodology of the ODCM	Not applicable	6 dec. log/ 6 dec. linear
Turbine Building Vent Stack Exhaust Monitor, and Standby Gas Treatment Vent Stack Exhaust	1 1 1 1 1	Particulate Filter Iodine Cartridge Noble Gas* Low Range (Beta Scintillation) Mid Range (cadmium telluride) High Range (cadmium telluride)	TB1-1C1108B TB2-2C1108B SBGT-OC194B	3.4×10^{-7} to 3.4×10^{-1} μCi/cc Xe^{133} 10^{-4} to 10^2 μCi/cc Xe^{133} 10^{-1} to 10^5 μCi/cc Xe^{133}	As determined by methodology of the ODCM	Not applicable	Digital Readout and Digital Printout

TABLE 11.5-1

PROCESS AND EFFLUENT RADIATION MONITORING SYSTEMS

MONITORED PROCESS	NO. OF CHANNELS	DETECTOR TYPE	DETECTOR LOCATION	CHANNEL RANGE	WARNING ALARM	TRIP	SCALE
B. SYSTEMS REQUIRED FOR PLANT OPERATION							
Reactor Building Vent Stack Exhaust Monitor	1 1 1	**Particulate Filter** **Iodine Cartridge** **Noble Gas*** Low Range (Beta Scintillation)	RB1-1C299B RB2-2C299B	$3.4x10^{-7}$ to $3.4x10^{-1}$ $\mu Ci/cc$ Xe^{133}	As determined by methodology of the ODCM	Not applicable	Digital Readout and Digital Printout

TABLE 11.5-2

RADIOLOGICAL ANALYSIS SUMMARY OF ROUTINE EFFLUENT SAMPLING

Sample Location	Basis For Location	Process Flow	Sampling Frequency	Analytical Procedure	Expected Sensitivities
Reactor Building Vents (isokinetic probe)	Determination of identity, concentration & quality of radionuclides released	125,000 cfm (Unit 1) 109,000 cfm (Unit 2)	Continuous	Gross Activity	1 x10^{-6} μCi/cc (Xe-133 equivalent)
			Once per month or when there is a change in monitor count rate from an unknown cause.	Analyzed for noble gas gamma emitting nuclides.	1 x 10^{-4} μCi/cc (for each isotope)
Unit 1 Turbine Building Vent (isokinetic probe)	Determination of identity, concentration & quantity of radionuclides released	174,500 cfm	Continuous	Gross Activity	1 x 10^{-6} μCi/cc (Xe-133 equivalent)
			Once per month or when there is a change in monitor count rate from an unknown cause.	Analyzed for noble gas gamma emitting nuclides.	1 x 10^{-4} μCi/cc (for each nuclide)
Unit 2 Turbine Building Vent (isokinetic probe)	Determination of identity, concentration & quantity of radionuclides released	121,300 cfm	Continuous	Gross Activity	1 x 10^{-6} μCi/cc (Xe-133 equivalent)
			Once per month or when there is a change in monitor count rate from an unknown cause.	Analyzed for noble gas gamma emitting nuclides.	1 x 10^{-4} μCi/cc (for each nuclide)

TABLE 11.5-2

RADIOLOGICAL ANALYSIS SUMMARY OF ROUTINE EFFLUENT SAMPLING

Sample Location	Basis For Location	Process Flow	Sampling Frequency	Analytical Procedure	Expected Sensitivities
Standby Gas Treatment Exhaust Vent (isokinetic probe)	Determination of identity, concentration & quantity of radionuclides released	11,000 cfm	Continuous	Gross Activity	1×10^{-6} μCi/cc (Xe-133 equivalent)
			Once per month or when there is a change in monitor count rate from an unknown cause.	Analyzed for noble gas gamma emitting nuclides.	1×10^{-4} μCi/cc (for each nuclide)
Sample Tanks	Determination of identity, concentration & quantity of radionuclides released	100 gpm	Continuous during discharge	Gross activity monitored during discharge	1×10^{-6} μCi/cc
				Grab sample prior to discharge to identify gamma emitting nuclides	As per R.G. 1.21 Rev. 1 June 1974 for grab samples.

TABLE 11.5-3

COMPOSITION & CONCENTRATION OF NUCLIDES IN ROUTINE EFFLUENT SAMPLES

A. Liquid Effluents – Common Station Effluent Pipe

Nuclide	Expected Concentration (µCi/ml)
Corrosion and Activation Products	
Na-24	3.52E-09
P-32	2.76E-10
Cr-51	9.05E-09
Mn-54	1.13E-10
Mn-56	1.08E-09
Fe-55	1.63E-09
Fe-59	4.77E-11
Co-58	3.27E-10
Co-60	6.53E-10
Ni-65	5.03E-12
Cu-64	9.05E-09
Zn-65	3.27E-10
Zn-69m	6.28E-10
Zn-69	6.79E-10
W-187	1.46E-10
Np-239	5.53E-09
Fission Products	
Br-83	6.53E-11
Sr-89	1.58E-10
Sr-90	1.26E-11
Y-90	5.03E-12
Sr-91	9.05E-10
Y-91m	5.78E-10
Y-91	1.03E-10
Sr-92	2.46E-10
Y-92	9.80E-10
Y-93	9.55E-10
Zr-95	1.26E-11
Nb-95	1.26E-11
Nb-98	2.51E-12
Mo-99	1.76E-09
Tc-99m	3.77E-09
Ru-103	3.02E-11
Rh-103m	3.02E-11
Ru-105	1.43E-10
Rh-105m	1.46E-10
Rh-105	1.66E-10
Ru-106	5.03E-12
Rh-106	5.03E-12

TABLE 11.5-3

COMPOSITION & CONCENTRATION OF NUCLIDES IN ROUTINE EFFLUENT SAMPLES

A. Liquid Effluents – Common Station Effluent Pipe

Nuclide	Expected Concentration (µCi/ml)
Rh - 106	5.03E-12
Fission Products	
Te-129m	6.03E-11
Te-129	4.02E-11
Te-131m	5.53E-11
Te-131	1.01E-11
I-131	2.26E-09
Te-132	1.01E-11
I-132	6.03E-10
I-133	1.11E-08
I-134	6.28E-11
Cs-134	1.94E-10
I-135	3.77E-09
Cs-136	4.52E-10
Cs-137	1.28E-10
Ba-137m	1.21E-10
Ba-139	3.77E-11
Ba-140	5.53E-10
La-140	3.27E-10
La-141	5.28E-11
Ce-141	5.28E-11
La-142	3.02E-11
Ce-143	1.76E-11
Pr-143	5.78E-11
Ce-144	5.03E-12
Pr-144	5.03E-12
Nd-147	5.03E-12
Others	1.26E-11
Totals	6.31E-08
H-3	1.48E-05
Total w/H3	1.49.1E-05

TABLE 11.5-3

COMPOSITION & CONCENTRATION OF NUCLIDES IN ROUTINE EFFLUENT SAMPLES

B. Gaseous Effluents

		Expected Concentrations (μCi/CC)	
Nuclide	Reactor Bldg. (each unit)	Unit 1 Turbine Bldg.	Unit 2 Turbine Bldg.
I-131	3.72E-14	2.96E-11	3.86E-11
I-133	5.39E-13	3.22E-10	4.16E-10
Ar-41	6.27E-09	4.44E-09	5.92E-09
Kr-83m	0.00E+00	0.00E+00	0.00E+00
Kr-85m	1.67E-09	3.33E-09	4.44E-09
Kr-85	0.00E+00	5.77E-08	7.69E-08
Kr-87	8.36E-10	2.71E-09	3.61E-09
Kr-88	1.67E-09	4.04E-09	5.38E-09
Kr-89	8.36E-10	3.22E-08	3.43E-08
Xe-131m	0.00E+00	6.21E-09	8.28E-09
Xe-133m	0.00E+00	0.00E+00	0.00E+00
Xe-133	4.60E-08	6.32E-07	7.78E-07
Xe-135m	2.51E-08	1.35E-07	2.37E-08
Xe-135	5.31E-08	1.88E-07	1.67E-07
Xe-137	7.73E-08	6.28E-08	5.92E-08
Xe-138	3.34E-09	4.48E-08	5.92E-08
Cr-51	4.60E-15	2.17E-15	8.28E-16
Mn-54	5.85E-15	9.14E-15	3.55E-16
Co-58	1.25E-15	8.88E-16	5.92E-16
Fe-59	1.63E-15	7.10E-16	5.92E-17
Co-60	2.09E-14	1.61E-14	7.57E-16
Zn-65	2.09E-14	3.40E-15	3.65E-15
Sr-89	2.09E-16	2.66E-15	3.55E-15
Sr-90	4.18E-17	8.88E-18	1.18E-17
Nb-95	4.18E-14	1.15E-17	3.55E-18
Zr-95	4.18E-15	1.79E-15	2.37E-17
Mo-99	2.76E-13	8.94E-16	1.18E-15
Ru-103	1.76E-14	2.44E-17	2.96E-17
Ag-110m	1.00E-17	0.00E+00	0.00E+00
Sb-124	2.09E-16	2.00E-16	5.92E-17
Cs-134	1.96E-14	6.12E-15	1.07E-15
Cs-136	2.09E-15	4.66E-16	6.21E-16
Cs-137	2.51E-14	1.13E-14	3.23E-15
Ba-140	9.19E-14	6.89E-15	9.17E-15
Ce-141	3.76E-15	4.45E-15	5.92E-15
H-3	3.59E-08	1.33E-09	1.78E-09
C-14	0.00E+00	2.11E-09	0.00E+00