7.12 PROCESS RADIATION MONITORING

A number of radiation monitors and monitoring systems are provided on process liquid and gas lines that may serve as discharge routes for radioactive materials. The monitors include the following:

- Main Steam Line Radiation Monitoring System
- Air Ejector Offgas Radiation Monitoring System
- Main Stack Radiation Monitoring System
- Process Liquid Radiation Monitors
- Reactor Building Ventilation Radiation Monitoring System
- Plant Ventilation Exhaust Radiation Monitoring System

These monitors are described individually in this subsection.

7.12.1 Main Steam Line Radiation Monitoring System

7.12.1.1 Safety Objective

The objective of the Main Steam Line Radiation Monitoring System is to monitor for the gross release of fission products from the fuel and, provide indication of such failure such that appropriate actions may be taken to limit fuel damage and contain the released fission products.

7.12.1.2 Safety Design Basis

1. The Main Steam Line Radiation Monitoring System shall be designed to give prompt indication of a gross release of fission products from the fuel.

2. The Main Steam Line Radiation Monitoring System shall be capable of detecting a gross release of fission products from the fuel under any anticipated operating combination of main steam lines.

3. Deleted

4. Deleted

7.12.1.3 Description

Two gamma sensitive instrumentation channels monitor the gross gamma radiation from the main steam lines. The detectors are physically located near the main steam lines just downstream of the outboard main steam isolation valves in the space between the primary containment and secondary containment walls.

The detectors are geometrically arranged so that the system is capable of detecting significant increases in radiation level for a number of main steam lines in operation. Their location along the main steam lines allows the earliest practical detection of a gross fuel failure. This meets safety design bases 1 and 2. The MSLRM channels are powered from independent divisions from one Reactor Protection System bus.

When a significant increase in the main steam line radiation level is detected, non-safety related trip signals are initiated. The main steam high radiation trip signal stops the mechanical vacuum pump and isolates its discharge path only. Closing of the main steam isolation valves, stopping the mechanical vacuum pump, and closing the mechanical vacuum pump line valve effects containment of radioactive materials. Although, the main steam line high radiation trip functions are not required safety related functions, they limit the resulting consequences of gross fuel failures.

The radiation trip setting selected is enough above the background radiation level in the vicinity of the main steam lines that spurious trips are avoided at rated power. Yet, the setting is low enough that the monitors can respond to the fission products released from gross fuel failures.

Each monitoring channel consists of a gamma sensitive ion chamber and a log radiation monitor. Capabilities of the monitoring channel are listed in Table 7.12-1. Each log radiation monitor has two trip circuits. One trip circuit comprises the upscale trip setting that is used to initiate isolation. The other trip circuit is a downscale trip that actuates an instrument trouble alarm in the Main Control Room. The output level from each log radiation monitor is displayed on a six-decade meter in the control room.

The outputs from the two monitoring channels are recorded. The recorder has one upscale alarm circuit. The alarm setting is lower than the log radiation monitor upscale trip setting, so that an alarm is received in the control room before steam line isolation is effected.

The trip circuits for each monitoring channel operate normally energized, so that failures in which power to monitoring components is interrupted result in a trip signal. The environmental capabilities of the components of each monitoring channel are selected in consideration of the locations in which the components are to be placed.

7.12.1.4 Safety Evaluation

The system has been selected and designed with monitoring characteristics sufficient to provide plant personnel with indication of gross fuel failures. Since the system is not essential to any transients or accidents, safety related requirements are not imposed. However, sufficient redundancy, separation, and power requirements are included to provide prompt and accurate signals and indications.

7.12.1.5 Inspection and Testing

A built-in, adjustable current source is provided for test purposes with each log radiation monitor. Routine verification of the operability of each monitoring channel can be made by comparing the outputs of the channels during power operation.

7.12.2 Air Ejector Offgas Radiation Monitoring System

This paragraph describes the Air Ejector Offgas Radiation Monitoring System as it exists following installation of recombiners and charcoal absorbers in the condenser offgas system.

7.12.2.1 Safety Objective

The objectives of the Air Ejector Offgas Radiation Monitoring System are to indicate when limits for the release of radioactive material to the environs are approached and to effect appropriate control of the offgas so that the limits are not exceeded.

7.12.2.2 Safety Design Basis

1. The Air Ejector Offgas Radiation Monitoring System shall provide an alarm to operations personnel whenever the radioactivity level of the air ejector offgas reaches short-term limits.

2. The Air Ejector Offgas Radiation Monitoring System shall provide a continuous record of the radioactivity released via the air ejector offgas line.

3. The Air Ejector Offgas Radiation Monitoring System shall initiate appropriate action in time to prevent exceeding short-term limits on the release of radioactive materials to the environs as a result of releasing the radioactivity contained in the air ejector offgas.

7.12.2.3 Description

The Air Ejector Offgas Radiation Monitoring System is shown in Figures 7.12-2a sheet 1, sheet 2, sheet 5, sheet 6, and Figure 7.12-2b sheet 2.

The system consists of two radiation monitor subsystems. One subsystem is lined up to take a continuous sample from the offgas system just downstream of the charcoal filters. The other takes a continuous reading from the offgas pipe (see Subsection 9.5, "Gaseous Radwaste System (Modified)").

The post-treatment subsystem monitoring the offgas system downstream of the charcoal filters has two instrumentation channels. Each channel consists of a gamma-sensitive detector, a logarithmic radiation monitor with a power supply and a meter, and a recorder point. The monitors and the recorder are located in the control room.

Each logarithmic radiation monitor is powered from a dependable source of power.

The two gamma-sensitive detectors are located in shielded chambers. A sample is drawn from the offgas line through the sample chambers where the radiation level of the gas is measured by two scintillation detectors, one located in each shielded chamber.

Each monitor has three upscale trips and a downscale trip. An upscale trip indicates high radiation. A downscale trip indicates instrument trouble. Any one trip will give an alarm in the control room. Any one upscale, high-radiation trip closes the carbon bed filter bypass valve (if open) and opens the offgas line to the carbon bed (if closed). Two upscale high-high-high radiation trips (one from each channel), or one upscale high-high-high radiation trip and one downscale trip, or two down-scale trips (one from each channel) send an isolation signal to the offgas system outlet valve. The pretreatment subsystem monitoring the offgas pipe upstream of the six-hour holdup pipe has two instrument channels. One channel consists of a gamma-sensitive detector, a logarithmic radiation monitor with a power supply and a meter, and a recorder. The monitor and the recorder are located in the control room. The logarithmic radiation monitor is powered from the instrument bus.

The monitor has two upscale trips and a downscale trip. Each of the upscale trips and the downscale trip sound an alarm in the control room. No control action is performed by this channel.

Small changes in the offgas gross fission-product concentration can be detected by the continuous use of the other radiation channel. This linear radiation monitor is not a process monitor such as the channels described above, but is utilized as an expanded scale device for aiding in locating ruptured or failed fuel elements. The detector is a gamma-sensitive ionization chamber which monitors the same sample as the upstream air ejector offgas detector. The system uses a linear readout with a range switch instead of a logarithmic readout. The output from the monitor is recorded on a recorder. The channel is connected to a dependable source of power.

These gamma-sensitive ion chambers are positioned adjacent to the vertical sample chamber. The chamber is internally polished to minimize plate-out. A sample is drawn from the offgas line through the sample chamber by the main condenser suction.

The environmental and power supply design conditions are given in applicable design output documents for the control room equipment.

7.12.2.4 Safety Evaluation

The Air Ejector Offgas Radiation Monitors have been selected with monitoring characteristics sufficient to provide plant operations personnel with accurate indication of radioactivity in the air ejector offgas. The system thus provides the operator with enough information to easily control the activity release rate. Because the system is not essential to any transients or accidents, no redundancy is required, although sufficient redundancy is provided to allow maintenance on one channel without losing the indications provided by the system.

7.12.2.5 Inspection and Testing

Response may be checked by a known source. These monitors are used primarily for trending.

7.12.3 Main Stack Radiation Monitoring System

7.12.3.1 Safety Objective

The objectives of the Main Stack Radiation Monitoring System are to indicate whenever limits on the release of radioactive noble gases to the environs are reached or exceeded, to obtain representative samples of radioactive iodine and particulates for laboratory analysis, and to indicate the rate of radioactive noble gas release during planned operations and during and following an accident.

7.12.3.2 Safety Design Basis

1. The Main Stack Radiation Monitoring System shall provide a clear indication to operations personnel whenever limits on the release of radioactive material to the environs are reached or exceeded.

2. The Main Stack Radiation Monitoring System shall indicate noble gas release rates from values above noble gas release rate limits and over the range from accident release rates down to release rates encountered during normal plant operation.

3. The Main Stack Radiation Monitoring System shall record the rate of release of radioactive noble gases to the environs and provide means for obtaining representative stack samples of radioactive iodine and particulates for laboratory analysis so that determination of the total amounts of activity released is possible.

7.12.3.3 Description

The Main Stack Radiation Monitoring System consists of two independent monitoring systems; a normal-range system used during planned operations which provides continuous monitoring for noble gases with grab sample capabilities for particulates and iodine, and a wide-range system used during normal and accident conditions which provides continuous monitoring for noble gases in the normal range, continuous monitoring at higher activity levels for noble gases, particulates and iodine in the accident range, and grab sample capabilities for noble gases, particulates and iodine in both the normal and accident ranges.

The normal-range system is shown in Figure 7.12-2a, sheet 3. The system consists of two individual channels. Each channel consists of a gamma-sensitive detector, a log count rate monitor that includes a power supply and a meter, and a recorder. The monitors and the recorder are located in the control room. Both channels are connected to a dependable source of power.

Each monitor has two upscale trips and one downscale trip. Each trip initiates an alarm in the control room, but no control action is provided. The upscale alarms indicate high radiation, and the downscale alarm indicates instrument trouble. To monitor the main stack gas stream, a gas sample is drawn through an isokinetic probe which is located high enough in the vent stream to assure representative sampling. The sample passes through two shielded chambers where the radiation level of the vent gas is measured by two scintillation detectors, one located in each shielded chamber.

As shown in Figures 7.12-2a sheet 3 and sheet 4, the system also provides for monitoring iodine and particulates by the use of filters in the gas sample monitoring stream. The filters are routinely analyzed in a laboratory. The environmental and power supply design conditions are given in applicable design output documents.

A wide-range gaseous effluent radiation monitoring system shown in Figures 7.12-2a, sheet 4, and 7.12-2a, Sheet 7, is installed at the main stack and has the capability to continuously detect and measure concentrations of noble gas, particulate, and iodine effluent during and following an accident. The system consists of a normal-range channel which monitors noble gas drawn through a retrievable iodine and particulate filter canister connected to an isokinetic probe located in the stack. At a preset radiation level sensed by the normal-range noble gas monitor, the accident-range channel automatically starts and draws an isokinetic sample from the normal-range flow stream through shielded iodine and particulate detector chambers (one in operation and one spare) each equipped with retrievable filters and a high-range shielded noble gas detector chamber. Normal-range sample flow is bypassed around the normal-range filter canister and noble gas detector chamber when the accident-range monitors start. Connections are provided to obtain noble gas samples for laboratory analysis on both ranges. The system provides activity release rate indication and recording, upscale high radiation and downscale instrument trouble alarms in the control room. It is powered from a dependable source of power.

7.12.3.4 Safety Evaluation

The Main Stack Radiation Monitoring equipment has been selected with features and characteristics sufficient to provide plant Operations personnel with accurate indication of noble gas release and means for determining radioactive iodine and particulate activity release to the environs via the main stack vent under both normal- and accident-range conditions. The system thus enables Operations personnel to determine when release rate limits are reached or exceeded and determine the total amounts of activity released.

Because the system is not essential to any transients or accidents, no redundancy is required, although sufficient redundancy is provided to allow maintenance on one channel without losing the indication provided by the system.

7.12.3.5 Inspection and Testing

Each individual channel includes a built-in check source and a purge line to purge the vent gas from the sampling chamber. Both the purge valve and the check source are operated from the control room, but the purge valve may also be operated locally.

7.12.4 Process Liquid Radiation Monitors

7.12.4.1 Safety Objective

On process streams that normally discharge to the environs, Process Liquid Radiation Monitors are provided to indicate when operational limits for the normal release of radioactive material to the environs are exceeded. On the Liquid Radwaste System effluent, the monitor also closes valves to prevent release of liquid containing excessive radioactivity.

7.12.4.2 Power Generation Objective

On process streams that do not discharge to the environs, Process Liquid Radiation Monitors are provided to indicate process system malfunctions by detecting the accumulation of radioactive material in a normally uncontaminated system.

7.12.4.3 Safety Design Basis

Process Liquid Radiation Monitors which are used to monitor streams that normally discharge to the environs shall provide a clear indication to operations personnel whenever the radioactivity level in the stream reaches or exceeds preestablished operational limits for the discharge of radioactive material to the environs.

7.12.4.4 Power Generation Design Basis

Process Liquid Radiation Monitors monitoring streams that do not discharge to the environs shall provide a clear indication to operations personnel whenever the radioactivity level in the stream reaches or exceeds a preestablished limit above the normal radiation level of the stream. Unit 1 non-operating systems are exempt from this requirement.

7.12.4.5 Description

The Process Liquid Radiation Monitors are shown in Figures 7.12-2b sheet 4, sheet 5, and sheet 6. Four individual channels with off-line detectors are provided for each unit. One channel monitors the Raw Cooling Water discharge, another channel monitors the Reactor Building Closed Cooling Water Systems, and the third and fourth channels monitor the RHR Service Water Discharge System I and System II RHRS heat exchangers. A separate channel with an in-line detector monitors the discharge from the Liquid Radwaste System which serves all units. All channels are connected to a dependable source of power.

Each of these monitors uses a scintillation detector and a ratemeter chassis. The chassis ratemeters and the recorders are all located in the Main Control Room except for the Radwaste System recorder, which is located on the radwaste control panel in the Radwaste Building.

Each channel has an upscale trip to indicate high radiation level and one downscale trip to indicate instrument trouble.

Raw cooling water is used to cool normally nonradioactive areas such as air compressors, turbine auxiliary systems, and pump bearings. It also cools the Reactor Building Closed Cooling Water System via heat exchangers. An increase in the radiation level of the raw cooling water discharge may indicate that a leak into the system from a contaminated stream has occurred.

The Reactor Building Closed Cooling Water System is utilized to provide cooling for potentially contaminated areas such as the drywell atmosphere cooling coils, nonregenerative heat exchanger, recirculation pumps and various sample coolers. The system normally contains activity due to activation of added corrosion inhibitors and the use of potentially contaminated makeup water. Changes in the normal radiation level could indicate leaks of radioactive water into the system.

The Liquid Radwaste System provides for collection of waste liquids through various drainage systems. Because of high conductivity, not all of the waste liquids can be economically purified by demineralization. Consequently, some liquid containing radioactivity is eventually discharged from the system. The process liquid monitoring channel on the Liquid Radwaste System discharge indicates discharge radiation levels. As described in paragraph 9.2.5, the monitor closes two valves in the waste discharge line before the radioactivity concentration in the discharged waste exceeds the limit determined by Offsite Dose Calculation Manual (ODCM) methodology.

The RHR Service Water System serves as the heat sink for the RHRS in the shutdown cooling mode and the containment cooling mode. The water circulated through the heat exchangers by the RHRS will be primary water or pressure suppression pool water, both of which have a significant activity level. Changes in the normal radiation level in the RHR service water discharge could indicate leakage in the RHR heat exchangers.

The environmental and power supply design conditions are given in applicable design output documents.

7.12.4.6 Safety Evaluation

The Process Liquid Radiation Monitors for the raw cooling water, radwaste and RHR service water discharges possess radiation detection and monitoring sensitivities sufficient to inform plant operations personnel whenever radiation levels in the discharges rise above preset limits.

7.12.4.7 Inspection and Testing

All alarm trip circuits can be tested by using test signals or portable gamma sources.

7.12.5 Reactor Building Ventilation Radiation Monitoring System

7.12.5.1 Safety Objective

The objectives of the Reactor Building Ventilation Radiation Monitoring System are to indicate whenever abnormal amounts of radioactive material exist in the Reactor Building, and to effect appropriate action so that the release of radioactive material to the environs is controlled.

7.12.5.2 Safety Design Bases

1. The Reactor Building Ventilation Radiation Monitoring System shall provide a clear indication to Operations personnel whenever abnormal amounts of radioactivity exist in the Reactor Building by monitoring the intake to the

reactor zone ventilation exhaust fans and the radiation levels at each unit's fuel pool.

2. The Reactor Building Ventilation Radiation Monitoring System shall initiate appropriate action to control the release of radioactive material to the environs when abnormal amounts of radioactive material exist in the Reactor Building.

7.12.5.3 Description

The Reactor Building Ventilation Radiation Monitoring System is shown in Figures 7.12-2a sheet 1, sheet 5, and sheet 6, and specifications are given in Table 7.12-1. The system consists of six sets of Reactor Building Ventilation Monitors (two divisional monitors per unit). Each monitor has one channel of refuel zone logic and one channel reactor zone logic. Each refuel zone channel is comprised of two Geiger-Muller type detectors with a signal splitter located on the refuel floor next to each units fuel pool. Each reactor zone channel is comprised of two Geiger-Muller type detectors with a signal splitter located on the associated units reactor zone ventilation exhaust duct. One channel each of the refuel zone and reactor zone share a combination computer graphics display and trip unit. The refuel and reactor zone inputs are recorded on a single digital paperless recorder. All equipment is located in the control room except for the detectors and the signal splitters.

Power for this system is from the 120VAC Reactor Protection System Busses "A" and "B." Bus A supplies power to one monitor and Bus B supplies power to the other monitor.

There is a Reactor Building Ventilation Radiation Monitor (RBVRM) trip function for the refueling zone and a RBVRM trip function for the reactor zone. Each trip function is composed of two divisional trip systems. Each trip system has one channel for each zone. Each channel contains two sensors. A channel downscale/inoperable trip occurs when either of the sensors are indicating less than the low radiation setpoint or are inoperable. A channel upscale trip occurs when both of the sensors are indicating higher than the high radiation setpoint. Only one channel upscale trip is required for trip function initiation. Two channel downscale trips in a zone are required for trip function initiation. When the trip function occurs, the ventilation system of the affected zone is isolated, the Control Room Emergency Ventilation System (CREVS) is started, the Standby Gas Treatment System is initiated and the Primary Containment System is initiated closing various ventilation supply, purge, and exhaust paths. When any reactor zone is isolated the refuel zone (which is common to all three units) also isolates.

The environmental power supply design conditions are given in applicable design output documents.

7.12.5.4 Safety Evaluation

The physical location and monitoring characteristics of the Reactor Building Ventilation Radiation Monitoring System Channels are adequate to provide detection capability for abnormal amounts of radioactivity in the Reactor Building and initiate isolation. The redundancy and arrangement of channels are sufficient to ensure that no single active component failure can prevent isolation when required.

7.12.5.5 Inspection and Testing

The trip circuits are tested by using test signals or portable gamma sources.

7.12.6 Plant Ventilation Exhaust Radiation Monitoring System

7.12.6.1 Safety Objective

The objectives of the Plant Ventilation Exhaust Radiation Monitoring System are to record the release of radioactive material from the plant buildings to the environs and alarm when preset limits are reached.

7.12.6.2 Safety Design Basis

The Plant Ventilation Exhaust Radiation Monitoring System shall record the rate of release of gaseous and airborne radioactive material to the environs, so that determination of the total amounts of gaseous and airborne activity released is possible.

7.12.6.3 Description

The Plant Ventilation Exhaust Radiation Monitoring System consists of 10 Continuous Air Monitors (CAM), each one their own subsystem. One subsystem separately samples the normal ventilation exhaust of the Turbine Building, reactor zone and refueling zone on each of three units; one subsystem monitors the normal ventilation exhaust from the Radwaste Building; two subsystems monitor the upper atmosphere of the Turbine Building near the Turbine Building roof ventilation exhausts on each of three units. These ventilating systems are described in subsection l0.12, "Heating, Ventilating and Air-Conditioning", and subsection 5.3, "Secondary Containment System".

Each subsystem consists of an assembly for monitoring Noble gases and filter capability for monitoring iodine and particulate activity. High activity or monitor malfunction is alarmed in the main control room. The activity levels are displayed locally and on a touch screen monitor in the main control room of Unit 1 at panel 1-9-2. The specifications for the system are given in applicable design output documents.

7.12.6.4 Safety Evaluation

The plant ventilation exhaust radiation monitors have been selected with monitoring characteristics sufficient to provide plant operations personnel with accurate indication of radioactivity being released to the environs via the plant ventilation exhaust systems.

7.12.6.5 Inspection and Testing

Each individual subsystem is tested and calibrated on a regular basis.

7.12.7 Unit Sharing of Monitoring Systems

Four process radiation monitoring systems are shared among the three nuclear units. These are the Main Stack Radiation Monitoring System, the Reactor Building Ventilation Radiation Monitoring System, the Plant Ventilation Exhaust Radiation Monitoring System and the Liquid Radwaste Effluent Monitor. See Section 7.5 of Appendix F for detailed information.