2.3 Radiation Servicing Equipment

2.3.1 Process Radiation Monitoring System

Design Description

The Process Radiation Monitoring (PRM) System measures and displays radioactivity levels in process and effluent gaseous and liquid streams, initiates protective actions, and activates alarms in the main control room (MCR)on high radiation signals. The PRM System provides radiological monitoring during plant operation and following an accident. PRM System equipment consists of radiation sensors, radiation process monitors, and effluent samplers. The PRM System consists of independent subsystems each of which contains between one and four monitoring channels. Figure 2.3.1 shows the PRM System control interfaces. As shown on Figure 2.3.1, the PRM System safety-related channel trip signals are provided as inputs to the Safety System Logic and Control (SSLC) for generation of protective action signals.

Portions of the PRM System are classified as Class 1E safety-related (items 2 through 5 below); the remainder are classified as non-safety-related.

The PRM System provides the following monitoring functions:

(1) Main Steam Line (MSL) Tunnel Area (4 channels)

The MSL tunnel area is monitored for gamma radioactivity in the steam flow to the turbine. Protective action signals are automatically initiated when any two out of four channels trip.

(2) Reactor Building Heating, Ventilating and Air Condition (HVAC) Exhaust (4 channels)

The air vent exhaust from the secondary containment is monitored for gamma radioactivity. Protective action signals are automatically initiated when any two out of four channels trip.

(3) Fuel Handling Area Ventilation Exhaust (4 channels)

The air vent exhaust from the fuel handling area is monitored for gamma radioactivity. Protective action signals are automatically initiated when any two out of four channels trip.

(4) Control Building Intake Air Supply (4 channels per intake)

The air supply intake to the Control Building is monitored for gamma radioactivity. Protective action signals are automatically initiated when any two out of four channels trip.

(5) Drywell Sump Liquid Discharge (1 channel per sump)

The liquid waste discharged from each of the drywell LCW and HCW sumps to the Radwaste Building is monitored for gamma radioactivity. A protective action signal is automatically initiated when a channel trips.

(6) Off-Gas Post-Treatment Discharge (2 channels)

The off-gas discharge from the charcoal vault to the stack is sampled and monitored for airborne radioactivity. Protective action signals are automatically initiated when both channels trip.

(7) Plant Stack Discharge (2 channels)

The ventilation and the gaseous discharge from the plant stack is sampled and monitored for airborne radioactivity. An alarm is initiated when the detected radiation level exceeds the trip setpoint.

(8) Radwaste Liquid Discharge (1 channel)

The radwaste liquid discharged from the plant is sampled and monitored for gamma radioactivity. A protective action signal is automatically initiated when the channel trips.

(9) Intersystem Radiation Leakage (3 channels)

Reactor coolant leakage into the Reactor Building Cooling Water (RCW) System is monitored for gamma radioactivity. One channel is provided for each RCW System division. An alarm is initiated when the detected radiation level exceeds the trip setpoint.

(10) Turbine Gland Seal Condenser Exhaust (1 channel)

The exhaust discharged from the turbine gland seal condenser is monitored for gamma radioactivity. An alarm is initiated when the detected radiation level exceeds the trip setpoint.

Each safety-related PRM System radiation monitoring channel is powered from its respective divisional Class 1E power source. In the PRM System, independence is provided between Class 1E divisions, and also between the Class 1E divisions and non-Class 1E equipment.

The PRM System radiation sensors and the effluent samplers are installed locally in the plant, while the radiation process monitors are located in the Control Building.

The PRM System has the following alarms and displays in the MCR:

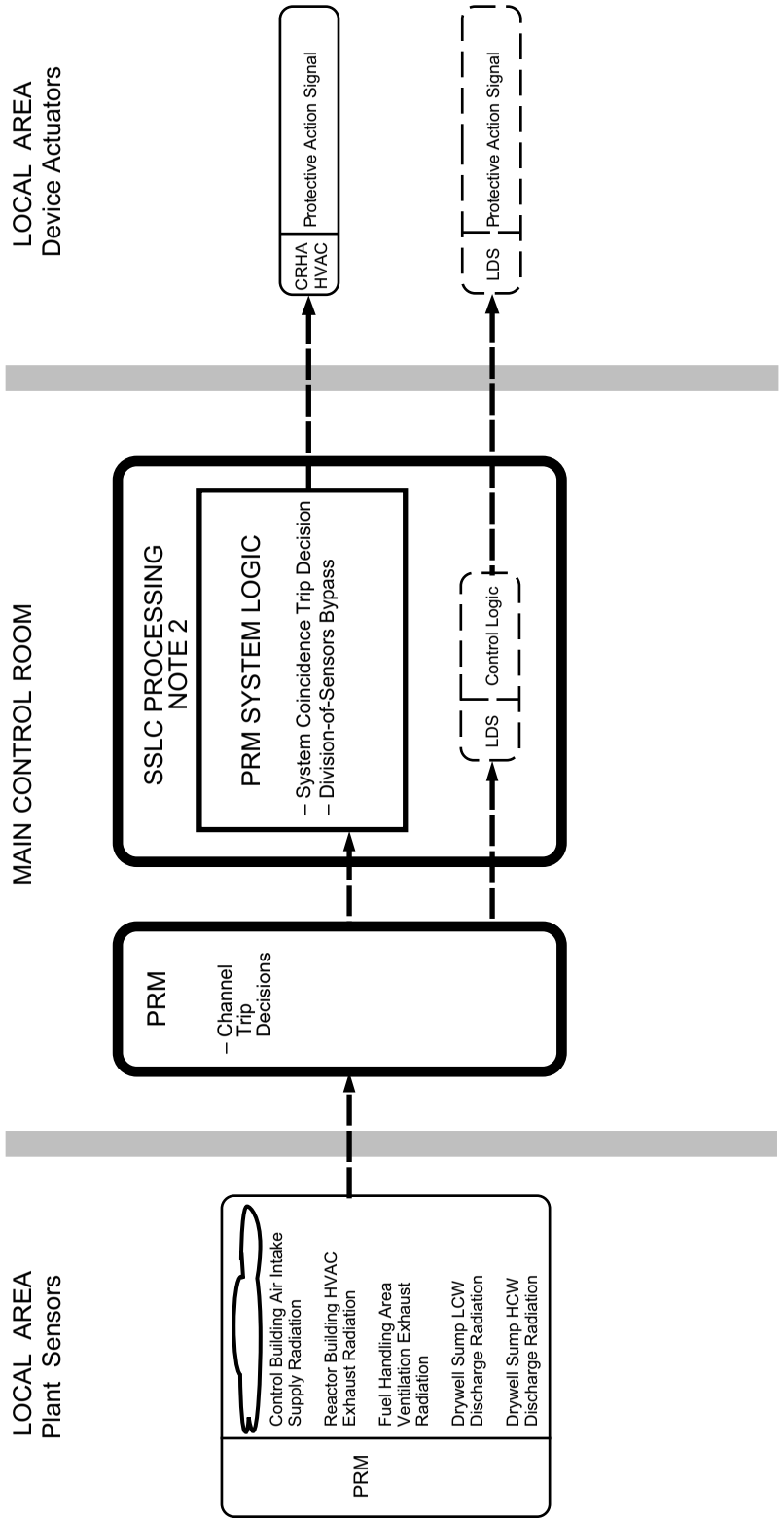
(1) Displays of radiation levels.

(2) Channel trip status.

(3) Plant stack discharge, intersystem leakage, and turbine gland seal condenser exhaust radiation alarms.

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.3.1 provides a definition of the inspections, tests and/or analyses, together with the associated acceptance criteria, which will be undertaken for the Process Radiation Monitoring System.



Notes:
1. Diagram represents one of four PRM System divisions.
2. See Section 3.4, Figure 3.4b for SSLC processing.

Figure 2.3.1 Process Radiation Monitoring System Control Interface Diagram

Table 2.3.1 Process Radiation Monitoring System

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
1. The equipment comprising the PRM System is defined in Section 2.3.1.	1. Inspection of the as-built system will be conducted.	1. The as-built PRM System conforms with the description in Section 2.3.1.
2. The MSL tunnel area is monitored for gamma radioactivity in the steam flow to the turbine. Protective action signals are automatically initiated when any two out of four channels trip.	2. Tests will be conducted using simulated signals to cause trip conditions.	2. Protective action signals are automatically initiated when any two out of four channels trip.
3. The air vent exhaust from the secondary containment is monitored for gamma radioactivity. Protective action signals are automatically initiated when any two out of four channels trip.	3. Tests will be conducted using simulated signals to cause trip conditions.	3. Protective action signals are automatically initiated when any two out of four channels trip.
4. The air vent exhaust from the fuel handling area is monitored for gamma radioactivity. Protective action signals are automatically initiated when any two out of four channels trip.	4. Tests will be conducted using simulated signals to cause trip conditions.	4. Protective action signals are automatically initiated when any two out of four channels trip.
5. The air supply intake to the Control Building is monitored for gamma radioactivity. Protective action signals are automatically initiated when any two out of four channels trip.	5. Tests will be conducted using simulated signals to cause trip conditions.	5. Protective action signals are automatically initiated when any two out of four channels trip.
6. The liquid waste discharged from each of the LCW and HCW drywell sumps to the Radwaste Building is monitored for gamma radioactivity. A protective action signal is automatically initiated when a channel trips.	6. Tests will be conducted on each drywell sump using a simulated signal to cause a trip condition.	6. A protective action signal is automatically initiated when a channel trips.

Table 2.3.1 Process Radiation Monitoring System (Continued)

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
7. The off-gas discharge from the charcoal vault to the stack is sampled and monitored for airborne radioactivity. Protective action signals are automatically initiated when both channels trip.	7. Tests will be conducted using simulated signals to cause trip conditions.	7. Protective action signals are generated when both channels trip.
8. The ventilation and the gaseous discharge from the plant stack is sampled and monitored for airborne radioactivity. An alarm is initiated when the detected radiation level exceeds the trip setpoint.	8. Tests will be conducted using simulated signals to cause trip conditions.	8. An alarm is initiated when the detected radiation level exceeds the trip setpoint.
9. The radwaste liquid discharged from the plant is sampled and monitored for gamma radioactivity. A protective action signal is automatically initiated when the channel trips.	9. Tests will be conducted using simulated signals to cause trip conditions.	9. A protective action signal is automatically initiated when the channel trips.
10. Reactor coolant leakage into the Reactor Building Cooling Water (RCW) System is monitored for gamma radioactivity. One channel is provided for each RCW division. An alarm is initiated when the detected radiation level exceeds the trip setpoint.	10. Tests will be conducted using simulated signals to cause trip conditions.	10. An alarm is initiated when the detected radiation level exceeds the trip setpoint.
11. The exhaust discharged from the turbine gland seal condenser is monitored for gamma radioactivity. An alarm is initiated when the detected radiation level exceeds the trip setpoint.	11. Tests will be conducted using simulated signals to cause trip conditions.	11. An alarm is initiated when the detected radiation level exceeds the trip setpoint.

Table 2.3.1 Process Radiation Monitoring System (Continued)

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
12. Each safety-related PRM System radiation monitoring channel is powered from its respective divisional Class 1E power source. In the PRM System, independence is provided between Class 1E divisions, and between Class 1E divisions and non-Class 1E equipment.	12. a. Tests will be performed on the PRM System by providing a test signal to only one Class 1E division at a time. b. Inspection of the as-built Class 1E divisions in the PRM System will be performed.	12. a. The test signal exists only in the Class 1E division under test in the PRM System. b. In the PRM System, physical separation or electrical isolation exists between Class 1E divisions. Physical separation or electrical isolation exists between these Class 1E divisions and non-Class 1E equipment.
13. Main control room alarms and displays provided for the PRM System are as defined in Section 2.3.1.	13. Inspection will be performed on the main control room PRM System alarms and displays.	13. Alarms and displays exist or can be retrieved in the main control room as defined in Section 2.3.1.

2.3.2 Area Radiation Monitoring System

Design Description

The Area Radiation Monitoring (ARM) System measures the gamma radiation levels at assigned locations within the plant, displays the measurements in the main control room, and activates alarms when the detected radiation levels exceed preset limits.

The ARM System is a multiple channel instrumentation system consisting of radiation monitors, their associated detectors, and local audible alarms. Each ARM channel monitors the radiation level in its assigned area, and initiates a main control room (MCR) alarm and a local alarm (if provided) when the radiation level exceeds a preset limit.

The ARM System is classified as non-safety-related.

The ARM System radiation sensors and the audible warning alarms are installed locally in the plant, while the radiation monitors are located in the Control Building.

The ARM System has the following alarms and displays in the MCR:

(1) Displays of radiation levels.

(2) Channel trip status.

(3) Alarms.

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.3.2 provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the Area Radiation Monitoring System.

Table 2.3.2 Area Radiation Monitoring System

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
1. The equipment comprising the ARM System is defined in Section 2.3.2.	1. Inspection of the as-built system will be conducted.	1. The as-built ARM System conforms with the description in Section 2.3.2.
2. Each ARM channel monitors radiation level in its assigned area, and initiates a MCR alarm and a local audible alarm (if provided) when the radiation level exceeds a preset limit.	2. Tests will be conducted using simulated signals for each channel.	2. The MCR alarm and local audible alarm (if provided) are initiated when the simulated radiation level exceeds a preset limit.
3. MCR alarms and displays provided for the ARM System are as defined in Section 2.3.2.	3. Inspections will be performed on the MCR alarms and displays for the ARM System.	3. Alarms and displays exist or can be retrieved in the MCR as defined in Section 2.3.2.

2.3.3 Containment Atmospheric Monitoring System

Design Description

The Containment Atmospheric Monitoring System (CAMS) is used for post-accident monitoring of the primary containment. The purpose of the CAMS is to:

(1) Provide information on combustible levels of oxygen and hydrogen in the primary containment.

(2) Detect and measure the radiation level within the primary containment during and following an accident.

(3) Detect and measure the hydrogen concentration within the primary containment during and following an accident.

The system monitors the atmospheric conditions in the drywell and in the suppression chamber for radiation levels and for hydrogen and oxygen gas concentration levels, displays the measurements in the main control room (MCR), and activates alarms in the MCR upon detection of high levels of radiation and/or gas concentrations.

The CAMS consists of two independent divisions and each division is composed of two radiation channels and oxygen/hydrogen gas monitoring equipment.

The CAMS is classified as a Class 1E safety-related system, except the oxygen/hydrogen monitoring equipment in CAMS is non-safety-related.

Operation of the oxygen/hydrogen monitoring equipment can be activated manually or automatically during a post-accident condition by a signal indicating a high drywell pressure or a low reactor water level.

One radiation channel of each CAMS division monitors the radiation level in the drywell and the other channel monitors the radiation level in the suppression chamber.

The oxygen/hydrogen monitoring equipment analyzes the hydrogen and oxygen gas concentration levels in the drywell or in the suppression chamber and provides separate gas concentration displays in the MCR.

Each CAMS division of radiation channels is powered from its respective divisional Class 1E power source. In the CAMS, independence is provided between the Class 1E divisions, and also between the Class 1E divisions and non-Class 1E equipment.

CAMS equipment is located in the Reactor Building, except for the radiation and the gas process monitors, which are located in the Control Building.

The CAMS has the following alarms, displays, and controls in the MCR:

(1) Displays of radiation, hydrogen and oxygen levels.

(2) Alarms for radiation levels, and for hydrogen and oxygen gas concentration levels.

(3) Manual or automatic initiation of oxygen/hydrogen monitoring equipment.

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.3.3 provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the Containment Atmospheric Monitoring System.

Table 2.3.3 Containment Atmospheric Monitoring System

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
1. The equipment comprising the CAMS is defined in Section 2.3.3.	1. Inspection of the as-built system will be conducted.	1. The as-built CAMS conforms with the description in Section 2.3.3.
2. Operation of CAMS oxygen/hydrogen monitoring equipment can be activated manually by the operator or automatically.	2. Tests of the as-built CAMS oxygen/hydrogen monitoring equipment will be conducted using manual controls and simulated automatic initiation signals.	2. CAMS oxygen/hydrogen monitoring equipment is activated upon receipt of the test signals.
3.	3.	3.
a. Each CAMS division of radiation channels is powered only from its respective divisional Class 1E power source with electrical independence between divisions.	a. Tests will be performed on each division of the CAMS radiation channels by providing a test signal to only one Class 1E division at a time.	a. The test signal exists only in the Class 1E division under test in the CAMS.
b. In the CAMS, independence is provided between Class 1E divisions, and between Class 1E divisions and non-Class 1E equipment.	b. Inspection of the as-built Class 1E radiation channels will be performed.	b. In the CAMS, physical separation or electrical isolation exists between Class 1E divisions. Physical separation or electrical isolation exists between these Class 1E divisions and non-Class 1E equipment.
4. Main control room alarms, displays and controls provided for the CAMS are as defined in Section 2.3.3.	4. Inspections will be performed on the main control room alarms, displays and controls for the CAMS.	4. Alarms, displays and controls exist or can be retrieved in the main control room as defined in Section 2.3.3.