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Subject: **Response to NRC Request for Additional Information Letter No. 10 for the ESBWR Design Certification Application – Auxiliary Systems – RAI Numbers 9.2-3, 9.2-4, 9.2-5, 9.3-2, 9.4-1, 9.4-2, 9.4-3, 9.4-4**

Enclosure 1 contains GE's responses to the subject NRC RAI transmitted via the Reference 1 letter. In addition to the responses, markups of the related sections of DCD Tier 2 are provided.

If you have any questions about the information provided here, please let me know.

Sincerely,

David H. Hinds
Manager, ESBWR

D068

Reference:

1. MFN 06-077, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 10 Related to ESBWR Design Certification Application,* March 3, 2006

Enclosures:

1. MFN 06-099 – Response to NRC Request for Additional Information Letter No. 10 for the ESBWR Design Certification Application – Auxiliary Systems – RAI Numbers 9.2-3, 9.2-4, 9.2-5, 9.3-2, 9.4-1, 9.4-2, 9.4-3, 9.4-4

| | | |
|---|---|---|
| cc: | WD Beckner | USNRC (w/o enclosures) |
| | AE Cubbage | USNRC (with enclosures) |
| | LA Dudes | USNRC (w/o enclosures) |
| | GB Stramback | GE/San Jose (with enclosures) |
| | eDRF | 0000-0052-6638 |

**ENCLOSURE 1**

**MFN 06-099**

**Response to NRC Request for Additional Information**

**Letter No. 10 for the ESBWR Design Certification Application**

**Auxiliary Systems - RAI Numbers**

**9.2-3, 9.2-4, 9.2-5, 9.3-2, 9.4-1, 9.4-2, 9.4-3, 9.4-4**

NRC RAI 9.2-3

*The RCCWS P&ID does not show the location of radiation monitor No. 15 (RCCW Inter-system Leakage) within this system. Please provide a drawing indicating the location of this radiation monitor. Note that "RE 104" and "RE 105" are shown on the P&ID but are not referenced in DCD Chapter 11. Also, Table 11.5-3 and Figure 11.5-1 of the DCD do not indicate whether radiation monitor No. 15 is located on Train A or B of the RCCWS. Provide updated revisions of Table 11.5-3 and Figure 11.5-1 that include Train A and B of the RCCWS.*

GE Response

The RCCWS contains two detectors, one on the downstream side of each RCCWS heat exchanger. These detectors and their locations are described in DCD Subsection 11.5.3.2.7. DCD Table 11.5-3 and Figure 11.5-1 will be updated to reflect the two detectors as shown in the attached markup.

NRC RAI 9.2-4

*The text notes that a provision for grab sampling from the RCCWS is provided for radiological analysis, but this provision is not included in Table 9.3-1 listing all process sampling systems. Provide an updated revision of Table 9.3-1 that includes the RCCWS.*

GE Response

The RCCWS was intentionally not included in Table 9.3-1. This table lists only those systems designed to have continuous stream sampling and are routed to sampling panels. These panels are used to condition samples to safe handling conditions for plant personnel when grab samples are required. The RCCWS is identified as a system requiring provisions for a local grab sample only and thus not included in Table 9.3-1. Local grab sampling is adequate for RCCWS because the conditions that system operates under are considered safe for operator handling without any conditioning. Radiation monitoring of the RCCWS is done continuously though the use on online monitoring equipment. The radiological analysis of the grab sample would be confirmation of the online monitoring results. The same basis also applies to other systems (TCCWS, Circ Water System, SLCS, CWS and PSWS) noted in the text, which are also not listed in Table 9.3-1.

NRC RAI 9.2-5

*Although references are cited in the text, the full citations are missing in this subsection. Update the list of references to include the applicable Hydraulic Institute Testing standard.*

GE Response

GE assumes that this comment is on DCD Sections 9.2.1.4 and 9.2.7.4. DCD Section 9.2.1.4, second paragraph, second sentence will be revised to read as follows:

"The pumps are tested in accordance with standard of the Hydraulic Institute ANSI/HI 2.6(M108)"

DCD Section 9.2.7.4, third paragraph, last sentence will be revised to read as follows:

"The pumps are tested in accordance with standards of the Hydraulic Institute ANSI/HI 1.6(M104)"

DCD Table 1.9-22 will be updated to include referenced HI Standard with full citation as follows:

ANSI/HI 1.6 (M104) "Centrifugal Tests" 01-Jan-2000;
ANSI/HI 2.6 (M108) "American National Standard for Vertical Pump Tests"; 01-Jan-2000

NRC RAI 9.3-2

*This section describes equipment and floor drainage systems that may become contaminated. A review of this section and Figure 11.2-1 indicates that Drywell HCW/LCW discharges are not included in the descriptions of the listed systems. Revise the text and tables of Sections 9.3.3.2 and 11.2 to include the subsystems identified in Figure 11.2-1 as input to the Liquid Waste Management System. Also, update and provide supporting system flow diagrams, as needed.*

GE Response

GE assumes this comment is on DCD Section 9.3.3. Descriptions for the Drywell HCW and LCW are included in the 3rd and 4th paragraphs of subsection 9.3.3.2. Also the drywell HCW and LCW discharges are shown in Figure 11.2-1.

A description of the RCCWS interface with the Equipment and Floor Drain System will be added to complete the descriptions of systems listed in Subsection 9.3.3. Revision 2 of DCD Subsection 9.3.3.2 will be updated to include the following text:

"Dedicated sumps in the EFDS shall collect vent and drain water from the closed loop RCCWS and shall be directed to the Reactor Building Cooling Water Drain Subsystem. The size of this subsystem shall accommodate the draining of the largest isolable cooling water pipe segment in the Reactor Building. The sump contents shall be evaluated for radioactivity and water quality. If the cooling water is radioactively contaminated, it shall be directed to the LWMS, where it can be processed. If not, the cooling water may be recycled through a line tied back to the cooling water system."

NRC RAI 9.4-1

*The nomenclatures used to designate the Fuel Building HVAC System and Subsystems are not consistent with the corresponding designations used in the text, tables, and figures of Section 11.5. Update text, tables, and figures of both sections for consistency.*

GE Response

GE assumes this comment is on DCD Section 9.4.2 The Fuel Building HVAC subsystem nomenclature used in Section 11.5 will be updated to be more consistent with the naming of the systems in Section 9.4.2. DCD Section 11.5 will be revised as noted in the attached markup.

NRC RAI 9.4-2

*The nomenclatures used to designate the Radwaste Building HVAC System and Subsystems are not consistent with the corresponding designations used in the text, tables, and figures of Section 11.5. The text (p.9.4-16) describing system operations does not discuss what actions are initiated by the system once the exhaust radiation monitor (ID No. 17) detects high radiation levels. Update text, tables, and figures of both sections for consistency.*

GE Response:

GE assumes this comment is on DCD Section 9.4.3 The Radwaste Building HVAC descriptions in Section 9.4.3 do not necessarily match the terms used in Section 11.5 because the location of the radiation monitors is more specific than the name of the HVAC system.

The Radwaste Building ventilation radiation monitors perform a monitoring function only. Table 1 in SRP 11.5 (Draft Rev. 4) does not require or mandate any process radiation monitoring automatic control function on the radwaste ventilation systems.

No changes will be made to the DCD in response to this RAI.

<u>NRC RAI 9.4-3</u>

*The nomenclatures used to designate the Turbine Building HVAC System and Subsystems are not consistent with the corresponding designations used in the text, tables, and figures of Section 11.5. The text (p.9.4-21) describing system operations does not discuss what actions are taken by the system once any of the exhaust radiation monitors (ID No. 5, 6, 7, 8, 9, or 14) detects high radiation levels. Update text, tables, and figures of both sections for consistency. Confirm whether the Turbine Building Decontamination Room Exhaust Subsystem needs to added to the subsystems described in Section 11.5. It is not clear from Figure 9.4-8 (sheet 3) and Figure 11.5-1 as to which radiation monitor (ID No. 5, 6, or 10?) services the discharge side of the Turbine Building Decontamination Room Exhaust Subsystem.*

<u>GE Response</u>

GE assumes this comment is on DCD Section 9.4.4 The HVAC descriptions in Chapter 9 do not necessarily match the terms used in Chapter 11 because the location of the radiation monitors is more specific than the name of the HVAC system.

The Turbine Building ventilation radiation monitors perform a monitoring function only. Table 1 in SRP 11.5 (Draft Rev. 4) does not require or mandate any automatic control function on the turbine building ventilation systems. There are no specific recommendations given in SRP 11.5 regarding the separate monitoring of decontamination rooms. It should be noted that any radioactivity associated with the effluent from these areas will be monitored downstream by the Turbine Building Combined ventilation subsystem.

No changes will be made to the DCD in response to this RAI.

<u>NRC RAI 9.4-4</u>

*The nomenclatures used to designate the Reactor Building HVAC System and Subsystems are not consistent with the corresponding designations used in the text, tables, and figures of Section 11.5. Update text, tables, and figures of both sections for consistency.*

<u>GE Response</u>

GE assumes this comment is on DCD Section 9.4.6. The Reactor Building HVAC subsystem nomenclature used in Section 11.5 will be updated to be more consistent with the naming of the systems in Chapter 9.4.6.

DCD Section 11.5 will be revised as noted in the attached markup.

## Table 1.9-22

## Industrial Codes and Standards[2] Applicable to ESBWR

| Code or Standard Number | Year | Title |
|---|---|---|
| Fluid Controls Institute Inc. (FCI) | | |
| FCI 70-2 | 2003 | Quality Control Standard for Control Valve Seat Leakage |
| Hydraulic Institute (HI) | | |
| ANSI/HI 1.6 (M104) | 2000 | Centrifugal Tests, issued January 1, 2000 |
| ANSI/HI 2.6 (M108) | 2000 | American National Standard for Vertical Pump Tests, issued January 1, 2000 |
| ANSI/HI 9.8 | 1998 | American National Standard for Centrifugal and Vertical Pump Intake Design |
| Various IDs | 2000 | Standards for Centrifugal, Rotary and Reciprocating Pumps |
| Illuminating Engineering Society of North America (IESNA) | | |
| HB-9-00 | 2000 | IESNA Lighting Handbook, 9th Edition – Errata July 29, 2004 |
| RP-1-04 | 2004 | Office Lighting |
| RP-7-01 | 2001 | Lighting Industrial Facilities – ANSI Approved – Errata 2001; Errata July 20, 2004 |
| RP-8-00 | 2000 | Roadway Lighting – ANSI Approved – Errata July 20, 2004 |
| Institute of Electrical and Electronics Engineers (IEEE) | | |
| 1-2000 | 2000 | Recommended Practice – General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation |
| 7-4.3.2-2003 | 2003 | IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Systems |
| 32-1972 | 1972 (R 1997) | Standard Requirements, Terminology, and Test Procedure for Neutral Grounding Devices |
| 67-1972 | 1972 (R 1980) | Guide for Operation and Maintenance of Turbine Generators |
| 80-2000 | 2000 | Guide for Safety in AC Substation Grounding |
| 98-2002 | 2002 | Standard for the Preparation of Test Procedures for Thermal Evaluation of Solid Electrical Insulating Materials |
| 100-2000 | 2000 | The Authoritative Dictionary of IEEE Standards Terms Seventh Edition |
| 101-1987 | 1987 (R 2004) | Guide for the Statistical Analysis of Thermal Life Test Data |
| 112-2004 | 2004 | Standard Test Procedure for Polyphase Induction Motors and Generators |
| 115-1995 | 1995 (R 2002) | Guide: Test Procedures for Synchronous Machines: Part I – Acceptance and Performance Testing, Part II – Test Procedures and Parameter Determination for Dynamic Analysis |

Operation of any two of the four cooling tower makeup or PSWS pumps is sufficient for the design heat load removal in any normal operating mode with the exception of the normal cooldown mode, when three pumps are initially required.

During a LOPP, the running PSWS pumps restart automatically using power supplied by the nonsafety-related standby diesel-generators.

### *9.2.1.3 Safety Evaluation*

The PSWS has no safety-related function. Failure of the system does not compromise any safety-related system or component, nor does it prevent safe shutdown of the plant.

### *9.2.1.4 Testing and Inspection Requirements*

Initial testing of the system includes performance testing of the heat exchangers, cooling towers and pumps for conformance with design heat loads, water flows, and heat transfer capabilities. An integrity test is performed on the system upon completion.

Provision is made for periodic inspection of components to ensure the capability and integrity of the system. The pumps are tested in accordance with standards of the Hydraulic Institute ANSI/HI 2.6(M108). Testing is performed to simulate all normal modes of operation to the greatest extent practical. Transfer between normal and standby power source is included in the periodic tests.

Motor-operated valves are in-service tested and inspected to improve plant availability.

### *9.2.1.5 Instrumentation Requirements*

The PSWS is operated and monitored from the MCR. The PSWS can also be operated from the remote shutdown panels.

When both pumps in a PSWS train are operating, a low-pressure signal in that train automatically starts both pumps in the redundant train. Motor failure of an operating pump automatically starts the pumps in the redundant train.

Automatically starting one or both pumps in a PSWS train opens a flow path to the RCCWS side of the associated RCCWS heat exchangers.

Loss of electric power to an operating PSWS pump automatically starts the redundant pump in the same train.

The pump discharge strainers have remote manual override features for their automatic cleaning cycle. Pressure drop across the strainer is locally indicated and a high-pressure drop is annunciated in the control room. Venturi type flow elements are used in the return headers to minimize pressure losses. These flow elements are used to monitor PSWS flow locally and in the MCR and can be used to assist in leak detection.

Supply and return header temperatures and supply header pressure are indicated in the MCR.

**System Operation**

The CWS remains functional during startup, normal, and shutdown operations. At least one chiller unit is in operation with the others on standby.

The four chiller units come into operation in a staggered manner based on the actual chilled water flow required for the plant as a whole.

The CWS is designed so that failure or malfunction of one loop does not affect system operability. In case of failure the system automatically generates loop isolation signal.

The following actions are required in case of loop isolation signal:

- Closing cross-tie isolation valves
- Startup the chillers and pumps on standby
- Startup air conditioning units of NICWS scope
- Startup the second fans in the Drywell Cooling System

The following events require the automatic loop isolation signal:

- Chilled water leakage exceeding makeup capacity; system leakages are detected by low level signals in surge tanks
- Loss of Preferred Power (LOPP). LOPP signal generates isolation between NICWS loops and BOPCWS loop
- Any other event in the BOPCWS loop that compromises the NICWS loops operability, or vice versa. A loop malfunction is detected by high chilled water flow signal in the other loops

During LOPP, the NICWS is automatically powered from two nonsafety-related on-site diesel generators.

### *9.2.7.3 Safety Evaluation*

The CWS is classified as a nonsafety-related system except for its RCPB and containment isolation functions. Refer to Subsection 6.2.4 for containment isolation valves and to Subsection 7.3.3 for containment isolation instrumentation.

### *9.2.7.4 Testing and Inspection Requirements*

Initial testing of the system includes performance testing of the chillers, pumps and coils for conformance with design heat loads, water flows, and heat transfer capabilities. An integrity test is performed on the system upon completion.

Provision is made for periodic inspection of major components to ensure the capability and integrity of the system. Local display devices are provided to indicate all vital parameters during testing and inspections.

The chillers are tested in accordance with American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard 30 (Methods of Testing for Rating Liquid Chilling

Packages). The pumps are tested in accordance with standards of the Hydraulic Institute ANSI/HI 1.6(M104).

The functional capabilities of the containment isolation valves are testable in-place in accordance with the inservice inspection requirements. Such leak test connections are isolatable by two valves in series. Periodic leak testing of the containment isolation valves is prescribed in the Technical Specifications (refer to DCD Chapter 16) and described in Subsection 6.2.6.

Samples of chilled water may be obtained for chemical analyses. The chilled water is not expected to become radioactive.

#### *9.2.7.5 Instrumentation Requirements*

The CWS status indications, control instrumentation, alarms and annunciators are located in the MCR to provide the operator sufficient data for remote operation of standby units. The plant-wide multiplexing system provides data communication and control.

The chillers and pumps automatically startup and shutdown according to chilled water flow required by the plant. They can also be manually started from the MCR or from the local chiller control panels. The local control panels display the active component operating status and system parameters including flows, temperatures, and pressures.

Chiller package protective controls and monitoring instruments indicate high and low oil pressure, condenser pressure, high and low chilled water temperature and flow, high and low condenser water temperature, and unit diagnostics.

A CWS standby chiller unit starts automatically upon failure of an operating unit. Loss of chilled water or RCCWS/TCCWS cooling water flow automatically stops the chiller unit and associated chilled water recirculating pump.

The chilled water temperature is automatically controlled.

Protective interlocks prevent chiller start if there is no flow through the evaporator or if the RCCWS/TCCWS flow through the NICWS/BOPCWS condenser is out of range. An anti-recycle timer prevents successive compressor starts.

CWS system containment penetration line isolation valves automatically close on a LOCA signal to control the NICWS flow into and out of the containment (refer to Subsection 6.2.4).

The surge tanks are provided with level controlled demineralized water makeup valves and high/low level alarms in the MCR.

### 9.2.8 Turbine Component Cooling Water System

#### *9.2.8.1 Design Bases*

**Safety (10 CFR 50.2) Design Bases**

The Turbine Component Cooling Water System (TCCWS) performs or ensures no safety-related function, and thus, has no safety design basis.

There are no connections between the TCCWS and any safety-related systems.

Redundant sump pumps are included to increase the reliability, availability, and maintainability of the EFDS.

Systems are designed and arranged to minimize flooding of multiple compartments.

### *9.3.3.2 System Description*

**Summary Description**

The EFDS includes sumps, motor-driven pumps, isolation valves, and instrumentation for pump operation, and interconnecting piping. Separate subsystems collect clean (nonradioactive) drains, low conductivity waste (LCW) drains, high conductivity waste (HCW) drains, detergent drains, chemical, and RCCWS drain wastes.

The Clean Drain Subsystem collects and transfers liquid wastes by gravity from the clean nonradioactive equipment and floor drains to sumps and pumps these wastes to an appropriate disposal system.

The LCW Drain Subsystem collects liquid wastes from equipment drains in potentially contaminated systems. These liquids gravity drain to sumps located in the drywell and other areas. The drywell LCW drain, which is monitored for activity, is pumped to the LCW collection tank. The drywell drain line is provided with redundant containment isolation valves. The liquid wastes collected in the LCW sumps are also pumped to the LCW collection tank.

The HCW Drain Subsystem collects liquid wastes from floor drains in potentially contaminated areas. These liquids gravity drain to sumps located in the drywell and other areas. The drywell HCW drain, which is monitored for activity, is pumped to the HCW collection tank. The drywell drain line is provided with redundant containment isolation valves. Liquids collected in the HCW sumps are also pumped to the HCW collection tank.

The Detergent Drain Subsystem collects potentially contaminated wastes from the personnel decontamination stations, laundry, and shower facility drains and transfers them to the detergent drain collection tank.

The Chemical Waste Drain Subsystem collects liquid wastes containing potentially contaminated chemicals and corrosive substances from washdown areas, laboratory drains, hot maintenance shop, and other miscellaneous sources in the plant. These liquid wastes are transferred to the chemical drain collection tank.

Dedicated sumps in the EFDS shall collect vent and drain water from the closed loop RCCWS and shall be directed to the Reactor Building Cooling Water Drain Subsystem. The size of this subsystem shall accommodate the draining of the largest isolable cooling water pipe segment in the Reactor Building. The sump contents shall be evaluated for radioactivity and water quality. If the cooling water is radioactively contaminated, it shall be directed to the LWMS, where it can be processed. If not, the cooling water may be recycled through a line tied back to the cooling water system.

Safety divisions are provided with a separate drain line connecting to the main drainage piping and leading to an appropriate sump in the Reactor Building. Each drain line is provided with a normally open isolation valve, which is automatically closed to prevent flooding of multiple safety divisions due to backflow. Watertight walls, floors, and doors on safety-related compartments also prevent flooding of multiple safety-related compartments.

# 11.5 PROCESS RADIATION MONITORING SYSTEM

The Process Radiation Monitoring System (PRMS) is provided to allow determination of the content of radioactive material in various gaseous and liquid process and effluent streams. The design objective and criteria are based on the following requirements:

- Radiation instrumentation required for safety and protection.
- Radiation instrumentation required for monitoring and plant operation.

All radioactive release points/paths within the plant are identified and monitored by this system. All other release points/paths of the plant are located in clean areas where radiological monitoring is not required.

This system provides continuous monitoring and display of the radiation measurements during normal, abnormal, and accident conditions.

## 11.5.1 Design Bases

### *11.5.1.1 Design Objectives*

#### 11.5.1.1.1 Radiation Monitors Required for Safety and Protection

The main purpose of these radiation monitoring subsystems is to initiate appropriate protective action to limit the potential release of radioactive materials to the environment if predetermined radiation levels are exceeded in major process/effluent streams. Another objective is to provide plant personnel with indication and alarm of the radiation levels in the major process/effluent streams.

The following PRMS subsystems provide signals that initiate automatic safety functions:

- Reactor Building Heating, Ventilating, and Air Conditioning (HVAC) exhaust Radiation Monitoring Subsystem (RMS)
- Refuel Handling Area HVAC exhaust RMS
- Control Building air intake HVAC RMS
- Drywell sumps Low Conductivity Waste/High Conductivity Waste (LCW/HCW) Discharge RMS
- Isolation Condenser Vent Exhaust RMS
- Fuel Building General Area HVAC RMS
- Fuel Building Fuel Pool HVAC RMS
- Containment Purge Exhaust RMS

#### 11.5.1.1.2 Radiation Monitors Required for Plant Operation

The main purpose of these radiation monitoring subsystems is to provide plant personnel with measurements of the content of radioactive material in important gaseous and liquid effluent and process streams. Additional objectives are to initiate discharge valve isolation on the offgas or liquid radwaste systems if predetermined release rates are exceeded, and to provide for sampling at certain radiation monitor locations to allow determination of specific radionuclide content.

The following PRMS subsystems are provided to meet the above design objectives:

- Monitoring Gaseous Effluent Streams
  - Plant Stack RMS
  - Turbine Building Normal Ventilation Air HVAC RMS
  - Turbine Building Compartment Area Air HVAC RMS
  - Radwaste Building Ventilation Exhaust RMS
  - Main Turbine Gland Seal Steam Condenser Exhaust RMS
  - Fuel Building Combined Ventilation Exhaust RMS
  - Turbine Building Combined Ventilation Exhaust RMS
  -
- Monitoring Liquid Effluent Streams
  - Liquid Radwaste Discharge RMS
- Monitoring Gaseous Process Streams
  - Main Steamline RMS
  - Offgas Pre-treatment RMS
  - Offgas Post-treatment RMS
  - Charcoal vault ventilation RMS
  - Drywell Fission Product RMS
- Monitoring Liquid Process Streams
  - Reactor Component Cooling Water Intersystem Leakage RMS
- Monitoring Gaseous Intake Streams
  - Technical Support Center HVAC Air Intake RMS

### 11.5.2 System Design Bases and Criteria

The instrumentation used in the subsystems of the PRMS is designed to be in conformance with the relevant requirements and guidelines of:

- 10 CFR 20.1302, 10 CFR 20 Appendix B, 10 CFR 50.34a, 10 CFR 50.36a
- 10 CFR 50, Appendix A, General Design Criteria (GDC) 19, 60, 63, and 64
- 10 CFR 50 Appendix I
- Regulatory Guides (RG) 1.21, 1.45, 1.97, 4.15
- Standard Review Plan 11.5 (Draft Rev. 4) of NUREG-0800.

- Provide continuous indication of radiation levels in the main control room;
- Annunciate the high radiation levels in the main control room to alert operating personnel to the abnormal conditions;
- Insofar as practical, provide self-diagnosis of the radiation monitors to the extent that power failure or equipment failure causes annunciation in the main control room and isolation of the effluents paths as required;
- Monitor a representative sample of the bulk stream or volume;
- Incorporate provisions for calibration and functional checks;
- Use instrumentation compatible with anticipated radiation levels and ranges expected under normal, abnormal and accident conditions (Regulatory Guide 1.97);
- Register full-scale output if radiation detection exceeds full scale.

## 11.5.3 Subsystem Description

### *11.5.3.1 Radiation Monitors Required for Safety*

The design description of each radiological monitoring and sampling function as identified in Subsection 11.5.1 is provided in this section under its designated name. The types of instrumentation, together with pertinent parameters for each subsystem, are presented in Tables 11.5-1 and 11.5-2.

#### 11.5.3.1.1 Reactor Building HVAC Exhaust Radiation Monitoring Subsystem (RMS)

This subsystem monitors the gross radiation level in the exhaust duct of the Reactor Building. The principal path that this subsystem monitors is exhaust from the contaminated area which is served by Reactor Building Contaminated Area HVAC subsystem (CONAVS). A high activity level in the ductwork could be due to fission gases from a leak or an accident.

The subsystem consists of four redundant instrument channels. Each channel consists of a gamma-sensitive detector and a Main Control Room (MCR) radiation monitor.

The detectors are located adjacent to the exhaust ducting upstream of the ventilating system isolation valves and monitor the RB HVAC exhausts. The detectors are physically located upstream of the ventilation exhaust duct isolation dampers such that closure of the dampers can be accomplished prior to exceeding radioactive effluent limits imposed by 10 CFR 50, Appendix I.

Any two-out-of-four channel trips result in the closure of the Reactor Building ventilating exhaust ventilation dampers and stoppage of the RB HVAC exhaust fans.

Trip circuits initiate their respective alarms in the MCR.

The range of channel measurement and display is as shown in Table 11.5-1 and Table 11.5-2. The range is selected to provide sufficient coverage for radioactivity released during normal operation up to the amount associated with a refueling accident and the subsequent ventilation flow into the Reactor Building Ventilation.

#### 11.5.3.1.2 Refuel Handling Area HVAC Exhaust RMS

This subsystem monitors the gross radiation level in the refuel handling area and pool area HVAC ventilation exhaust duct which is part of the Refueling and Pool Area HVAC subsystem (REPAVS). The system consists of four channels that are physically and electrically independent of each other. Each channel consists of a gamma-sensitive detector and a MCR radiation monitor.

This subsystem performs the same trip functions as those described in Subsection 11.5.3.1.1 for the Reactor Building HVAC exhaust radiation monitoring.

The range of channel measurement and display is shown in Table 11.5-1 and Table 11.5-2. The range is selected to provide sufficient coverage for radioactivity released during normal operation up to the amount associated with a refueling accident and the subsequent flow into the Reactor Building Ventilation system.

#### 11.5.3.1.3 Control Building Air Intake HVAC RMS

The Control Building Air Intake HVAC radiation monitoring subsystem is provided to detect the gross radiation level in the normal outdoor air intake supply and automatically initiates closure of the outdoor air intake and the exhaust dampers, and startup of the emergency air filtration system. The emergency air filtration system fans are started and refuel area exhaust fans stopped on high radiation.

The Control Building Air Intake HVAC consists of two redundant but independent subsystems.

The radiation monitors for each of the Control Building Air Intake HVAC subsystems consist of four redundant channels to monitor the air intake to the building.

The monitors meet the requirements for Class 1E components to provide appropriate reliability. The system warns of the presence of significant air contamination in inlet air and provides isolation of the Control Building intake air ducts.

Each radiation channel consists of a gamma sensitive detector and a radiation monitor that is located in the MCR.

The range of channel measurement and display is shown in Table 11.5-1 and Table 11.5-2. The range is selected to cover normal operation and be sensitive enough to initiate isolation of the MCR prior to exceeding the 10 CFR 50 Appendix A GDC 19 guidelines of 0.05 Sieverts whole body or its equivalent to any part of the body.

#### 11.5.3.1.4 Drywell Sumps LCW/HCW Discharge RMS

This subsystem monitors the gross radiation level in the liquid waste transferred in the drain line from the drywell low conductivity waste (LCW) and high conductivity waste (HCW) sumps to the Radwaste System. One monitoring channel is provided in each sump drain line. Each channel uses a gamma sensitive radiation detector that is located near the drain line from the sump just downstream from the outboard isolation valve. The output from each detector is fed to radiation monitors in the MCR for display and annunciation.

Automatic isolation of the two sump discharge pipes occurs if high radiation levels are detected during liquid waste transfers.

The range of channel measurement and display is shown in Table 11.5-1 and Table 11.5-2. The range is selected to provide sufficient coverage for expected radioactivity concentrations due to accident source terms in these sumps and address the TMI concern about unmonitored transfer of wastes from the containment to the radwaste facility.

#### 11.5.3.1.5 Isolation Condenser Vent Exhaust RMS

This subsystem monitors the gross radiation from the exhaust of the air from the atmospheric pool area above each isolation condenser. The subsystem consists of sixteen channels (four per isolation condenser vent) that are physically and electrically independent of each other. Each channel consists of a gamma-sensitive detector and a MCR radiation monitor.

This subsystem initiates isolation of the affected isolation condenser by closure of isolation valves in the steam line to the condenser and in the condensate return line from the condenser.

The detectors monitor radioactivity in the isolation condenser discharge pool area exhaust that might have resulted from a tubing break or a defective condenser.

The range of channel measurement and display is shown in Table 11.5-1 and Table 11.5-2. The range is selected to provide sufficient coverage from normal operation up to, and several decades beyond, for radioactivity released prior to exceeding limits of 10 CFR 20. Under normal operation, there is no radioactivity expected to be exhausted from this path since there shouldn't be any leakage into the pool area.

#### 11.5.3.1.6 Fuel Building General Area HVAC RMS

This subsystem monitors the gross radiation level in the Fuel Building HVAC exhaust duct for the general area. The system consists of four channels that are physically and electrically independent of each other. Each channel consists of a gamma-sensitive detector and a MCR radiation monitor. The subsystem monitors the radiation levels of the air exiting the Fuel Building general areas as well as the rooms with the fuel pool cooling and cleanup equipment.

This subsystem provides inputs to logic that results in the energization of the Fuel Building General Area HVAC fans and a trip of the Fuel Building General Area HVAC.

The range of channel measurement and display is shown in Table 11.5-1 and Table 11.5-2. The range is selected to provide sufficient coverage for radioactivity released during normal operation up to, and including several decades beyond, the amount associated with a refueling accident and the subsequent air flow into the Fuel Building HVAC.

#### 11.5.3.1.7 Fuel Building Fuel Pool HVAC RMS

The Fuel Building Fuel Pool HVAC RMS consists of a total of four channels that monitor the radiation level of the air exiting the Fuel Building Spent Fuel Storage Pool and equipment areas. Four channels provide the monitoring. Each channel uses a gamma sensitive detector located internal to the monitored exhaust duct. The outputs from the detectors are fed into radiation monitors for display and annunciation.

This subsystem provides inputs to logic that results in the energization of the Fuel Building Area HVAC fans and a trip of the Fuel Building HVAC.

The range of channel measurement and display is shown in Table 11.5-1 and 11.5-2. The range is selected to provide sufficient coverage for radioactivity released during normal operation up to, and including several decades beyond, the amount associated with a refueling accident and the subsequent air flow into the Fuel Building HVAC.

#### 11.5.3.1.8 Containment Purge Exhaust (RMS)

This subsystem monitors the gross radiation level in the exhaust duct leading from the primary containment.

The subsystem consists of four redundant instrument channels. Each channel consists of a gamma-sensitive detector and a MCR radiation monitor.

The detectors are located adjacent to the exhaust ducting upstream of the ventilating system isolation valves. The detectors are physically located upstream of the ventilation exhaust duct isolation dampers such that closure of the dampers can be accomplished prior to exceeding radioactive effluent limits.

Any two-out-of-four channel trips will result in the closure of the Reactor Building HVAC isolation dampers and stoppage of the RB HVAC exhaust fans.

All trip circuits will initiate their respective alarms in the MCR.

The range of channel measurement and display will be as shown in Table 11.5-1 and Table 11.5-2.

### *11.5.3.2 Radiation Monitors Required for Plant Operation*

See Table 11.5-3 and Figure 11.5-1 for diagrammatic information concerning the placement of the PRM subsystems.

Information on these monitors is presented in Table 11.5-2.

#### 11.5.3.2.1 Main Steamline (MSL) RMS

This subsystem monitors the gross gamma radiation level of the steam transported by the Main Steamlines in the MSL tunnel. The normal radiation level is produced primarily by coolant activation gases plus smaller quantities of fission gases being transported with the steam.

The MSL radiation monitors consist of four redundant instrument channels. Each channel consists of a local gamma detector and a radiation monitor located in the main control room.

The detectors are physically located near the Main Steamlines just downstream of the outboard Main Steamline isolation valves (MSIVs) in the steam tunnel. These detectors are arranged so that they are capable of detecting significant increases in radiation level with any number of the Main Steamlines in operation.

The subsystem initiates shutdown of the main turbine condenser mechanical vacuum pump (MVP) and MVP line discharge valve closure upon detection of high radiation. Channel trips are annunciated in the MCR. Although the subsystem is qualified as safety, its function is non-safety.

The range of channel measurement and display is shown in Table 11.5-1 and Table 11.5-2. The range is selected to provide detection from normal background radiation at zero percent reactor

A sample, continuously extracted from the stack, passes through the panel and returns to the stack exhaust. Sampling is done in accordance with ANSI 13.1-1999. Automatic compensation for variation in stack flow is provided to maintain the sample panel flow proportional to the main flow. The subsystem will have provisions for purging the sample panel with room air to check detector response to the background radiation level reading.

Also, abnormal flow, measured at the sample panel, is annunciated in the MCR.

The Plant Stack RMS is non-safety-related. The stack is sampled continuously for the full range of concentrations between normal conditions and those postulated in Regulatory Guide 1.97. The Plant Stack radiation monitor is a post-accident monitor and meets the guidelines of Regulatory Guide 1.97 and NUREG-0737. The plant vent radiation monitor also provides data for plant effluent release reports identified in Regulatory Guide 1.21.

**11.5.3.2.15 Fuel Building Combined Ventilation Exhaust RMS**

The Fuel Building Combined Ventilation exhaust RMS will continuously monitor halogens, particulates and noble gas releases transported from the Fuel Building to the plant stack under both normal and accident conditions.

A sample, continuously extracted from the Fuel Building HVAC duct, passes through a sample panel and is returned to the main exhaust. Sampling is done in accordance with ANSI 13.1-1999. Automatic compensation for variation in HVAC flow is provided in order to maintain the sample panel flow proportional to the main flow. The subsystem will have provision for purging the sample panel with room air to check detector response to the background radiation level reading.

Also, abnormal flow, measured at the sample panel, is annunciated in the MCR.

Provisions for grab sample collection are provided and can be used for isotopic analysis and monitor calibration.

A tritium monitoring device will be associated with this subsystem.

The displayed range is selected to cover normally expected concentrations of radioactivity in Fuel Building HVAC exhaust air, up to and beyond, radionuclide concentrations indicated in 10 CFR 20.

The Fuel Building Combined Ventilation Exhaust RMS is non-safety-related.

## 11.5.4 Regulatory Evaluation

The system design for radiation monitoring is in conformance with the relevant requirements and criteria that are stipulated in the codes and standards that are identified in Subsection 11.5.2. Radiation monitoring is provided during reactor operation and under post-accident conditions. Specifically, the following requirements are evaluated for compliance:

### *11.5.4.1 Basis for Monitor Location Selection*

The detector locations are selected, per RG 1.21 and Standard Review Plan 11.5, to monitor all the major and potentially significant paths for release of radioactive material during normal reactor operation including anticipated operational occurrences. The radioactivity levels in liquid and gaseous effluent releases are monitored, measured, displayed and recorded.

*11.5.4.2 Expected Radiation Levels*

Expected radiation levels are provided in Tables 11.5-1 and 11.5-2.

*11.5.4.3 Instrumentation*

Grab samples are analyzed to identify and quantify the specific radionuclides in effluents. The results from the sample analysis are used to establish relationships between the gross gamma monitor readings and concentrations or release rates of radionuclides in continuous effluent releases. Tables 11.5-4 through 11.5-7 provide summary information concerning the frequency, analysis, sensitivity and purpose for both liquid and gaseous process and effluent extracted samples that are analyzed in the health physics laboratory.

*11.5.4.4 Setpoints*

The trip setpoints for certain safety-related radiation monitors are specified in the Offsite Dose Calculation Manual required by plant Technical Specifications. Trip setpoints for nonsafety-related radiation monitors are specified in the plant Operating Procedures.

### 11.5.5 Process Monitoring and Sampling

*11.5.5.1 Implementation of General Design Criterion 19*

The Main Control Building is provided with detectors that sense radiation in the intake air supply to the control building and provide warning and initiate actions to protect operating personnel for access and occupancy of the control room under accident conditions.

In addition, the Technical Support Center ventilation air intake is provided with radiation detection to initiate actions to protect personnel.

*11.5.5.2 Implementation of General Design Criterion 60*

All potentially significant radioactive discharge paths are equipped with a control system to automatically isolate the effluent on indication of a high radiation level. The subsystems providing these features include:

- Offgas Post-treatment RMS
- Reactor Building HVAC Exhaust RMS
- Refuel Handling Area HVAC Exhaust RMS
- Drywell Sump LCW/HCW Discharge RMS
- Liquid Radwaste Discharge RMS
- Fuel Building General Area HVAC RMS
- Isolation Condenser Vent Exhaust RMS
- Main Steamline RMS

- Containment Purge Exhaust RMS
- Fuel Building Fuel Pool HVAC RMS

### *11.5.5.3 Implementation of General Design Criterion 63*

Fuel storage and radioactive waste systems and their associated handling areas are monitored for excessive radiation levels. The subsystems monitoring these areas include:

- Offgas Pre-treatment RMS
- Offgas Post-treatment RMS
- Radwaste Building Ventilation Exhaust RMS
- Fuel Building Fuel Pool HVAC RMS
- Fuel Building Combined Ventilation Exhaust RMS
- Charcoal Vault Ventilation RMS
- Fuel Building General Area HVAC RMS
- Refuel Handling Area Exhaust RMS
- Reactor Building HVAC Exhaust RMS

### *11.5.5.4 Implementation of General Design Criterion 64*

Radiation levels in the reactor containment atmosphere, spaces containing components for the recirculation of loss-of-coolant accident fluids, effluent discharge paths and important process streams are monitored for radioactivity. The subsystems monitoring these paths and areas include:

- Reactor Building HVAC Exhaust RMS
- Refuel Handling Area HVAC Exhaust RMS
- Drywell Sumps LCW/HCW Discharge RMS
- Isolation Condenser Vent Exhaust RMS
- Fuel Building General Area HVAC RMS
- Main Steamline RMS
- Offgas Pre-treatment and Offgas Post-treatment RMS
- Charcoal Vault Ventilation RMS
- Reactor Component Cooling Water Intersystem Leakage RMS
- Turbine Building Combined Ventilation Exhaust RMS
- Radwaste Building Ventilation Exhaust RMS
- Turbine Building Combined Ventilation Exhaust RMS
- Main Turbine Gland Seal Steam Condenser Exhaust RMS

- Drywell Fission Products RMS
- Fuel Building Combined Ventilation Exhaust RMS
- Fuel Building Fuel Pool HVAC RMS
- Turbine Building Normal Ventilation Air HVAC RMS
- Turbine Building Compartment Area Air HVAC RMS
- Plant Stack RMS
- Containment Purge Exhaust RMS

#### *11.5.5.5 Basis for Monitor Location Selection*

The detector locations are selected to monitor the major and potentially significant paths for release of radioactive material during normal reactor operation including anticipated operational occurrences, thus meeting the intent of RG 1.21 and SRP 11.5. Monitoring of each major path provides measurements that are representative of releases to demonstrate compliance with 10 CFR 20 Appendix B limits.

#### *11.5.5.6 Expected Radiation Levels*

Expected radiation levels are listed in Tables 11.5-1 and 11.5-2.

#### *11.5.5.7 Instrumentation*

Grab samples are analyzed to identify and quantify the specific radionuclides in process streams. The results from the sample analysis are used to establish relationships between the gross gamma monitor readings and concentration and radionuclides in the process streams.

#### *11.5.5.8 Setpoints*

The trip setpoints for the certain safety-related radiation monitors are specified in the Offsite Dose Calculation Manual required by plant Technical Specifications. Trip setpoints for non-safety-related radiation monitors are specified in the plant operating procedures.

### 11.5.6 Calibration and Maintenance

#### *11.5.6.1 Inspection and Tests*

During reactor operation, daily checks of system operability are made by observing channel behavior. At periodic intervals during reactor operation, the detector response of each monitor provided with a remotely positioned check source is verified, together with the instrument background count rate, to ensure proper functioning of the monitors. Any detector whose response cannot be verified by observation during normal operation or by using the remotely positioned check source is response checked with a portable radiation source. A record is maintained showing the background radiation level and the detector response.

The system incorporates self-diagnostics and online calibration for its process radiation monitors that operate continuously to assure maximum availability and minimum down time. Also, each radiation channel is tested and calibrated periodically using a standard radiation source to validate channel operability.

The following monitors have alarm trip circuits that can be tested by using test signals or portable gamma sources:

- Main Steamline
- Reactor Building HVAC Exhaust
- Refuel Handling Area HVAC Exhaust
- Control Building Air Intake HVAC
- Fuel Building General Area HVAC
- Isolation Condenser Vent Exhaust
- Turbine Building Normal Ventilation Air HVAC
- Turbine Building Compartment Area Air HVAC
- Charcoal Vault Ventilation
- Drywell Sump LCW/HCW Discharge
- Technical Support Center HVAC Air Intake
- Offgas Pre-treatment
- Fuel Building Fuel Pool HVAC
- Containment Purge Exhaust HVAC

The following monitors include built-in check sources:

- Offgas Post-treatment
- Liquid Radwaste Discharge
- Radwaste Building Ventilation Exhaust
- Main Turbine Gland Seal Steam Condenser Exhaust
- Turbine Building Combined Ventilation Exhaust
- Drywell Fission Product
- Reactor Component Cooling Water Intersystem Leakage
- Fuel Building CombinedVentilation Exhaust
- Plant Stack

### *11.5.6.2 Calibration*

Calibration of radiation monitors is performed using certified commercial radionuclide sources traceable to the National Institute of Standards and Technology. Each continuous monitor is calibrated during plant operation or during the refueling outage if the detector is not readily accessible. Calibration can also be performed on the applicable instrument by using liquid or

**Table 11.5-1**

**Process and Effluent Radiation Monitoring Systems**

| Monitored Process | No. of Channels | Sample Line or Detector Location | Displayed Channel Range |
|---|---|---|---|
| **A. Safety-Related Monitors** | | | |
| | | | |
| Reactor Building HVAC Exhaust | 4 | Exhaust duct upstream of exhaust ventilation isolation valve | 1E-4 to 1E0 mSv/h |
| Refuel Handling Area HVAC Exhaust | 4 | Exhaust duct upstream of exhaust ventilation isolation valve | 1E-4 to 1E0 mSv/h |
| Control Building Air Intake HVAC | 8 | Intake duct upstream of intake ventilation isolation valve | 1E-4 to 1E0 mSv/h |
| Drywell Sumps LCW/HCW Discharge | 2 | Drain line from LCW & HCW sumps | 1E-2 to 1E4 mSv/h |
| Fuel Building General Area HVAC | 4 | Exhaust duct upstream of exhaust ventilation isolation valve | 1E-4 to 1E0 mSv/h |
| Isolation Condenser Vent Exhaust | 16 | Exhaust of air space surrounding isolation condensers | 1E-4 to 1E0 mSv/h |
| Containment Purge Exhaust | 4 | Exhaust duct upstream of exhaust ventilation isolation valve | 1E-4 to 1E0 mSv/h |
| Fuel Building Fuel Pool HVAC | 4 | On HVAC duct leaving Fuel Pool Area | 1E-4 to 1E0 mSv/h |
| **B. Monitors Required for Plant Operation** | | | |
| Main Steamline | 4 | Immediately downstream of plant Main Steamline isolation valve | 1E-2 to 1E4 mSv/h |
| Plant Stack | 3 | On Stack exhaust | 1E -3 to 1E 10 $MBq/m^3$ (gaseous)<br>1E -6 to 1E 7 $MBq/m^3$ (particulate & halogen) |

## Table 11.5-1

## Process and Effluent Radiation Monitoring Systems

| Monitored Process | No. of Channels | Sample Line or Detector Location | Displayed Channel Range |
|---|---|---|---|
| Charcoal Vault Ventilation | 1 | On charcoal vault HVAC exhaust line | 1E-2 to 1E4 mSv/h |
| Reactor Component Cooling Water Intersystem Leakage | 2 | Each RCCW heat exchanger line exit | 1E-1 to 1E5 MBq/m$^3$ |
| Technical Support Center HVAC Air Intake | 1 | Intake HVAC duct | 1E4 to 1E0 mSv/h |
| Drywell Fission Product (Particulate) | 1 | Sample line from drywell atmosphere | 1E-7 to 1E-1 MBq/m$^3$ |
| Drywell Fission Product (Gaseous) | 1 | Sample line from drywell atmosphere | 1E-1 to 1E4 MBq/m$^3$ |
| Turbine Building Combined Ventilation Exhaust | 3 | Sample line from drywell atmosphere | 1E-3 to 1E3 MBq/m$^3$ (gaseous)<br>1E-7 to 1E-1 MBq/m$^3$ (particulate)<br>1E-7 to 1E-1 MBq/m$^3$ (iodine) |
| | | | |
| Fuel Building Combined Ventilation Exhaust | 3 | Sample Line from HVAC exhaust leaving Fuel Building | 1E-3 to 1E3 MBq/m$^3$ (gaseous)<br>1E-7 to 1E-1 MBq/m$^3$ (particulate)<br>1E-7 to 1E-1 MBq/m$^3$ (iodine) |

MBq/m$^3$ = mega-becquerel per cubic meter; mSv/h = milli-Sieverts per hour

## Table 11.5-2

### Process Radiation Monitoring System (Gaseous and Airborne Monitors)

| Radiation Monitor | Configuration | Dynamic Detection Range * | Principal Radionuclides Measured | Expected Activity ** | Alarms and Trips |
|---|---|---|---|---|---|
| **A. Safety-Related Monitors** | | | | | |
| Main Steamline | Offline (adjacent to Main Steamlines) | ≈ 1.4E 2 to 1.4 E 8 MBq/m3 | N-16, O-19 & Coolant activation gases | ** | DNSC<br>INOP<br>High<br>High-High |
| Reactor Building HVAC Exhaust | Inline (adjacent and external to HVAC duct) | ≈ 1.5E 3 to 1.5E 7 MBq/m3 | Xe-133 | ** | DNSC/INOP<br>High<br>High-High |
| Refuel Handling Area HVAC Exhaust | Inline (adjacent and external to HVAC duct) | ≈ 7.3E2 to 7.3E6 Bq/m3 | Xe-133 | ** | DNSC/INOP<br>High<br>High-High |
| Control Building Air Intake HVAC | Inline (adjacent and external to HVAC air intake duct) | ≈ 8E1 to 8E 5 MBq/m3 | Xe-133 | ** | DNSC/INOP<br>High<br>High-High |
| Fuel Building General Area HVAC | Inline (adjacent and external to HVAC duct) | ≈ 7.4E 1 to 7.4E 5 MBq/m3 | Xe-133 | ** | DNSC/INOP<br>High<br>High-High |
| Isolation Condenser Vent Exhaust | Inline (adjacent to vent duct) | ≈ 1.5E 3 to 1.5E 7 MBq/m3 | Xe-133 | ** | DNSC/INOP<br>High<br>High-High |
| Containment Purge Exhaust | Inline (adjacent and external to HVAC duct) | ≈ 1.5E 3 to 1.5E 7 MBq/m3 | Xe-133 | ** | DNSC/INOP<br>High<br>High-High |
| Fuel Building Fuel Pool HVAC | Inline and internal to HVAC duct | ≈ 5.5E0 to 5.5 E 4 $MBq/m^3$<br>≈ 1E 2 to 1E 6 $MBq/m^3$ | Xe-133<br>Kr-85 | 0**<br>0** | DNSC/INOP<br>High |

## Table 11.5-2

### Process Radiation Monitoring System (Gaseous and Airborne Monitors)

| Radiation Monitor | Configuration | Dynamic Detection Range * | Principal Radionuclides Measured | Expected Activity ** | Alarms and Trips |
|---|---|---|---|---|---|
| Plant Stack | Offline | ≈ 1 E –3 to 1 E 10 MBq/m3<br>≈ 1 E –3 to 1 E 10 MBq/m3<br>≈ 1 E –6 to 1 E 7 MBq/m3<br>≈ 1 E –6 to 1 E 7 MBq/m3 | Xe-133<br>Kr-85<br>Cs-137<br>I-131 | **<br>**<br>**<br>** | Abnormal Flow<br>DNSC/INOP<br>High<br>High-High |
| Drywell Fission Product | Offline | ≈ 8.1E-8 to 8.1E -2 MBq/$m^3$<br>≈ 2.6E -7 to 2.6 E -1 MBq/$m^3$<br>(particulate) | Cs-137<br>Co-60 | **<br>** | Abnormal Flow<br>DNSC/INOP<br>High<br>High-High |
| Drywell Fission Product | Offline | ≈ 8.1E-3 to 8.1E3 MBq/$m^3$<br>≈ 2.6E -3 to 2.6E3 MBq/$m^3$<br>(gaseous) | Xe-133<br>Kr-85 | **<br>** | DNSC/INOP<br>High<br>High-High |
| Radwaste Building Ventilation Exhaust | Offline | ≈ 8 E -3 to 8 E 3 MBq/$m^3$<br>≈ 2.6E -3 to 2.6 E 3 MBq/$m^3$<br>≈ 7.4 E -7 to 7.4 E -1 MBq/$m^3$<br>≈ 7.4 E-7 to 7.4E-1 MBq/$m^3$ | Xe-133<br>Kr-85<br>Cs-137<br>I-131 | **<br>**<br>**<br>** | Abnormal Flow<br>DNSC/INOP<br>High<br>High-High |
| Fuel Building Combined Ventilation Exhaust | Offline | ≈ 8 E -3 to 8 E 3 MBq/$m^3$<br>≈ 2.6 E -3 to 2.6 E 3 MBq/$m^3$<br>≈ 7.4 E -7 to 7.4 E-1 MBq/$m^3$ ≈7.4 E -7 to 7.4 E -1 MBq/$m^3$ | Xe-133<br>Kr-85<br>Cs-137<br>I-131 | **<br>**<br>**<br>** | Abnormal Flow<br>DNSC/INOP<br>High<br>High-High |
| | | | | | |
| Technical Support Center | Inline and internal to | ≈ 8 E0 to 8E4 MBq/$m^3$ | Xe-133 | ** | DNSC/INOP |

## Table 11.5-2

### Process Radiation Monitoring System (Gaseous and Airborne Monitors)

| Radiation Monitor | Configuration | Dynamic Detection Range * | Principal Radionuclides Measured | Expected Activity ** | Alarms and Trips |
|---|---|---|---|---|---|
| HVAC Air Intake | HVAC intake duct | ≈ 1.7E2 to 1.7E 6 $MBq/m^3$ | Kr-85 | ** | High<br>High-High |
| $Bq/m^3$ = Becquerels per cubic meter, $MB/m^3$ = Mega Becquerels per cubic meter; DNSC/INOP = downscale/inoperative; Abnormal Flow = High or Low flow in the sampling system outside system limits | | | | | |

* Dynamic detection ranges are estimated and will be adjusted according to plant unique configurations and radiation background.

** Activity levels are expected to be at the subsystem's lower limit of detection (LLD). The derivation of each LLD is to be determined by the COL applicant based on site specific conditions and operating characteristics of each installed effluent radiation monitoring subsystem. See Section 12.2 for expected activity of various processes and effluents.

## Table 11.5-3

## Key to Radiation Monitors Shown on Figure 11.5-1

| ID on Figure 11.5-1 | Description |
|---|---|
| 1 | Main Steamline |
| 2 | Reactor Building HVAC Exhaust |
| 3 | Refuel Handling Area HVAC Exhaust |
| 4A, 4B | Control Building Air Intake HVAC |
| 5 | Turbine Building Normal Ventilation Air HVAC |
| 6 | Turbine Building Compartment Area Air HVAC |
| 7 | Offgas Pre-treatment |
| 8 | Charcoal Vault Ventilation |
| 9 | Offgas Post-treatment |
| 10 | Turbine Building Combined Ventilation Exhaust |
| 11 | Liquid Radwaste Discharge |
| 12 | Drywell Sump LCW/HCW Discharge |
| 13 | Plant Stack |
| 14 | Main Turbine Gland Seal Steam Condenser Exhaust |
| 15A, 15B | Reactor Component Cooling Water Intersystem Leakage |
| 16 | Drywell Fission Product |
| 17 | Radwaste Building Ventilation Exhaust |
| 18 | Fuel Building Combined Ventilation Exhaust |
| 19 | Isolation Condenser Vent Exhaust |
| 20 | Technical Support Center HVAC Air Intake |
| 21 | Fuel Building General Area HVAC |
| 22 | Fuel Building Fuel Pool HVAC |
| 23 | Containment Purge Exhaust |

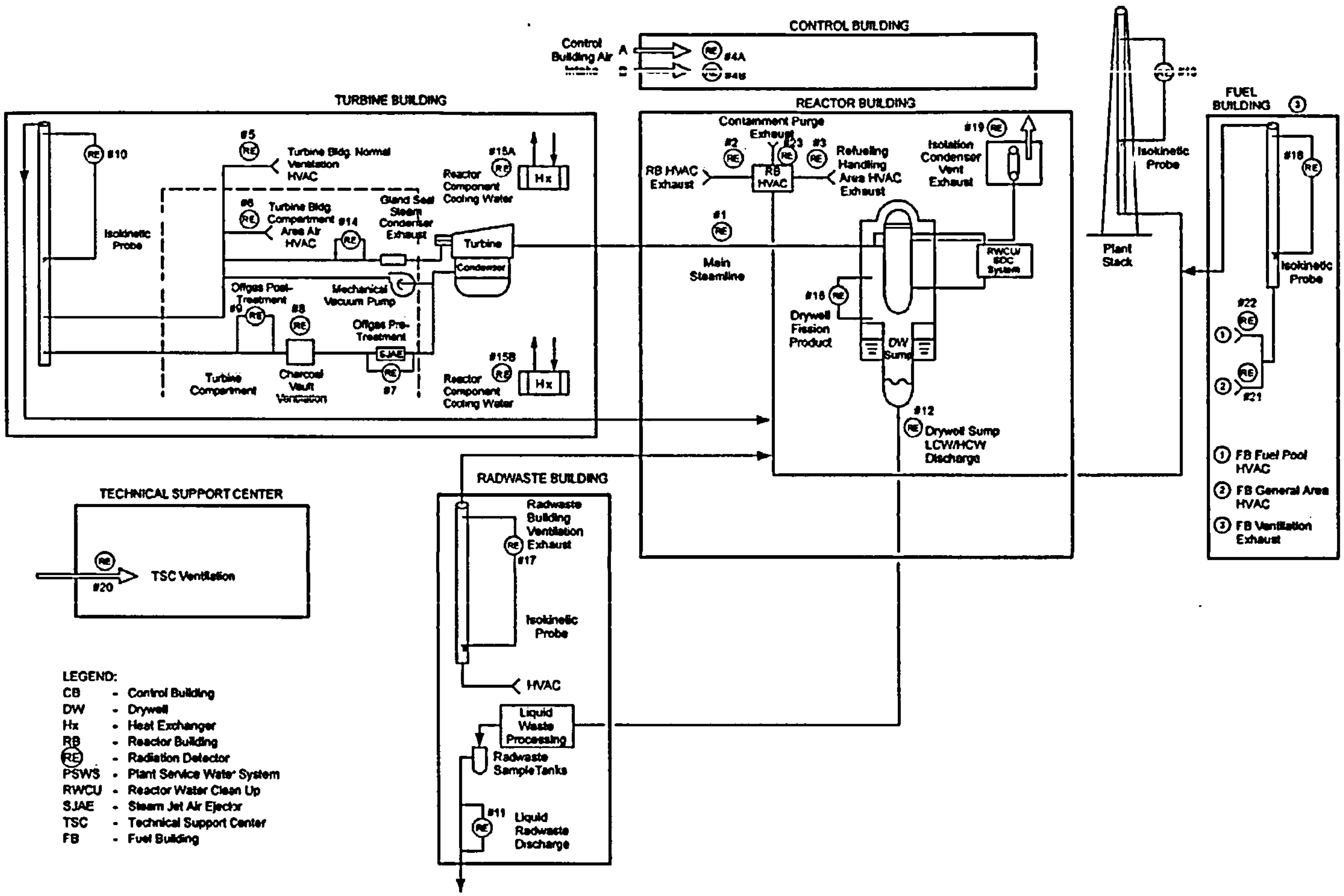


**Figure 11.5-1. Location of Radiation Monitors**