

2.5 Instrumentation and Control Systems

2.5.1 Diverse Actuation System

Design Description

The diverse actuation system (DAS) initiates reactor trip, actuates selected functions, and provides plant information to the operator.

The component locations of the DAS are as shown in Table 2.5.1-5.

1. The functional arrangement of the DAS is as described in the Design Description of this Section 2.5.1.
2. The DAS provides the following nonsafety-related functions:
 - a) The DAS provides an automatic reactor trip on low wide-range steam generator water level, or on low pressurizer water level, or on high hot leg temperature, separate from the PMS.
 - b) The DAS provides automatic actuation of selected functions, as identified in Table 2.5.1-1, separate from the PMS.
 - c) The DAS provides manual initiation of reactor trip and selected functions, as identified in Table 2.5.1-2, separate from the PMS. These manual initiation functions are implemented in a manner that bypasses the control room multiplexers, if any; the PMS cabinets; and the signal processing equipment of the DAS.
 - d) The DAS provides main control room (MCR) displays of selected plant parameters, as identified in Table 2.5.1-3, separate from the PMS.
3. The DAS has the following features:
 - a) The signal processing hardware of the DAS uses input modules, output modules, and microprocessor or special purpose logic processor boards that are different than those used in the PMS.
 - b) The display hardware of the DAS uses a different display device than that used in the PMS.
 - c) Software diversity between DAS and PMS will be achieved through the use of different algorithms, logic, program architecture, executable operating system, and executable software/logic.
 - d) The DAS has electrical surge withstand capability (SWC), and can withstand the electromagnetic interference (EMI), radio frequency (RFI), and electrostatic discharge (ESD) conditions that exist where the DAS equipment is located in the plant.
 - e) The sensors identified on Table 2.5.1-3 are used for DAS input and are separate from those being used by the PMS and plant control system.

- f) The DAS is powered by non-Class 1E uninterruptible power supplies that are independent and separate from the power supplies which power the PMS.
 - g) The DAS signal processing cabinets are provided with the capability for channel testing without actuating the controlled components.
 - h) The DAS equipment can withstand the room ambient temperature and humidity conditions that will exist at the plant locations in which the DAS equipment is installed at the times for which the DAS is designed to be operational.
4. The DAS hardware and any software are developed using a planned design process which provides for specific design documentation and reviews during the following life cycle stages:
- a) Development phase for hardware and any software
 - b) System test phase
 - c) Installation phase

The planned design process also provides for the use of commercial off-the-shelf hardware and software.

5. The DAS manual actuation of ADS, IRWST injection, and containment recirculation can be executed correctly and reliably.

Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.5.1-4 specifies the inspections, tests, analyses, and associated acceptance criteria for the DAS.

Table 2.5.1-1
Functions Automatically Actuated by the DAS

1. Reactor and Turbine Trip on Low Wide-range Steam Generator Water Level or Low Pressurizer Water Level or High Hot Leg Temperature
2. Passive Residual Heat Removal (PRHR) Actuation and In-containment Refueling Water Storage Tank (IRWST) Gutter Isolation on Low Wide-range Steam Generator Water Level or on High Hot Leg Temperature
3. Core Makeup Tank (CMT) Actuation and Trip All Reactor Coolant Pumps on Low Wide-Range Steam Generator Water Level or Low Pressurizer Water Level
4. Isolation of Selected Containment Penetrations and Initiation of Passive Containment Cooling System (PCS) on High Containment Temperature

Table 2.5.1-2
Functions Manually Actuated by the DAS

1. Reactor and Turbine Trip
2. PRHR Actuation and IRWST Gutter Isolation
3. CMT Actuation and Trip All Reactor Coolant Pumps
4. First-stage Automatic Depressurization System (ADS) Valve Actuation
5. Second-stage ADS Valve Actuation
6. Third-stage ADS Valve Actuation
7. Fourth-stage ADS Valve Actuation
8. PCS Actuation
9. Isolation of Selected Containment Penetrations
10. Containment Hydrogen Ignitor Actuation
11. IRWST Injection Actuation
12. Containment Recirculation Actuation
13. Actuate IRWST Drain to Containment

| Table 2.5.1-3 DAS Sensors and Displays | |
|---|-------------------|
| Equipment Name | Tag Number |
| Reactor Coolant System (RCS) Hot Leg Temperature | RCS-300A |
| RCS Hot Leg Temperature | RCS-300B |
| Steam Generator 1 Wide-range Level | SGS-044 |
| Steam Generator 1 Wide-range Level | SGS-045 |
| Steam Generator 2 Wide-range Level | SGS-046 |
| Steam Generator 2 Wide-range Level | SGS-047 |
| Pressurizer Water Level | RCS-305A |
| Pressurizer Water Level | RCS-305B |
| Containment Temperature | VCS-053A |
| Containment Temperature | VCS-053B |
| Core Exit Temperature | IIS-009 |
| Core Exit Temperature | IIS-013 |
| Core Exit Temperature | IIS-030 |
| Core Exit Temperature | IIS-034 |
| Rod Control Motor Generator Voltage | PLS-ET001 |
| Rod Control Motor Generator Voltage | PLS-ET002 |

| Table 2.5.1-4 Inspections, Tests, Analyses, and Acceptance Criteria | | |
|--|---|---|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| 1. The functional arrangement of the DAS is as described in the Design Description of this Section 2.5.1. | Inspection of the as-built system will be performed. | The as-built DAS conforms with the functional arrangement as described in the Design Description of this Section 2.5.1. |
| 2.a) The DAS provides an automatic reactor trip on low wide-range steam generator water level, or on low pressurizer water level, or on high hot leg temperature, separate from the PMS. | Electrical power to the PMS equipment will be disconnected and an operational test of the as-built DAS will be performed using real or simulated test signals. | The field breakers of the control rod motor-generator sets open after the test signal reaches the specified limit. |
| 2.b) The DAS provides automatic actuation of selected functions, as identified in Table 2.5.1-1, separate from the PMS. | Electrical power to the PMS equipment will be disconnected and an operational test of the as-built DAS will be performed using real or simulated test signals. | Appropriate DAS output signals are generated after the test signal reaches the specified limit. |
| 2.c) The DAS provides manual initiation of reactor trip, and selected functions, as identified in Table 2.5.1-2, separate from the PMS. These manual initiation functions are implemented in a manner that bypasses the control room multiplexers, if any; the PMS cabinets; and the signal processing equipment of the DAS. | Electrical power to the control room multiplexers, if any, and PMS equipment will be disconnected and the outputs from the DAS signal processing equipment will be disabled. While in this configuration, an operational test of the as-built system will be performed using the DAS manual actuation controls. | i) The field breakers of the control rod motor-generator sets open after reactor and turbine trip manual initiation controls are actuated. ii) DAS output signals are generated for the selected functions, as identified in Table 2.5.1-2, after manual initiation controls are actuated. |
| 2.d) The DAS provides MCR displays of selected plant parameters, as identified in Table 2.5.1-3, separate from the PMS. | Electrical power to the PMS equipment will be disconnected and inspection will be performed for retrievability of the selected plant parameters in the MCR. | The selected plant parameters can be retrieved in the MCR. |

| Table 2.5.1-4 (cont.) Inspections, Tests, Analyses, and Acceptance Criteria | | |
|---|---|---|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| 3.a) The signal processing hardware of the DAS uses input modules, output modules, and microprocessor or special purpose logic processor boards that are different than those used in the PMS. | Inspection of the as-built DAS and PMS signal processing hardware will be performed. | The DAS signal processing equipment uses input modules, output modules, and microprocessor or special purpose logic processor boards that are different than those used in the PMS. The difference may be a different design, use of different component types, or different manufacturers. |
| 3.b) The display hardware of the DAS uses a different display device than that used in the PMS. | Inspection of the as-built DAS and PMS display hardware will be performed. | The DAS display hardware is different than the display hardware used in the PMS. The difference may be a different design, use of different component types, or different manufacturers. |
| 3.c) Software diversity between the DAS and PMS will be achieved through the use of different algorithms, logic, program architecture, executable operating system, and executable software/logic. | Inspection of the DAS and PMS design documentation will be performed. | Any DAS algorithms, logic, program architecture, executable operating systems, and executable software/logic are different than those used in the PMS. |
| 3.d) The DAS has electrical surge withstand capability (SWC), and can withstand the electromagnetic interference (EMI), radio frequency (RFI), and electrostatic discharge (ESD) conditions that exist where the DAS equipment is located in the plant. | Type tests, analyses, or a combination of type tests and analyses will be performed on the equipment. | A report exists and concludes that the DAS equipment can withstand the SWC, EMI, RFI and ESD conditions that exist where the DAS equipment is located in the plant. |
| 3.e) The sensors identified on Table 2.5.1-3 are used for DAS input and are separate from those being used by the PMS and plant control system. | Inspection of the as-built system will be performed. | The sensors identified on Table 2.5.1-3 are used by DAS and are separate from those being used by the PMS and plant control system. |
| 3.f) The DAS is powered by non-Class 1E uninterruptible power supplies that are independent and separate from the power supplies which power the PMS. | Electrical power to the PMS equipment will be disconnected. While in this configuration, a test will be performed by providing simulated test signals in the non-Class 1E uninterruptible power supplies. | A simulated test signal exists at the DAS equipment when the assigned non-Class 1E uninterruptible power supply is provided the test signal. |

| Table 2.5.1-4 (cont.) Inspections, Tests, Analyses, and Acceptance Criteria | | |
|---|--|---|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| 3.g) The DAS signal processing cabinets are provided with the capability for channel testing without actuating the controlled components. | Channel tests will be performed on the as built system. | The capability exists for testing individual DAS channels without propagating an actuation signal to a DAS controlled component. |
| 3.h) The DAS equipment can withstand the room ambient temperature and humidity conditions that will exist at the plant locations in which the DAS equipment is installed at the times for which the DAS is designed to be operational. | Type tests, analyses, or a combination of type tests and analyses will be performed on the equipment. | A report exists and concludes that the DAS equipment can withstand the room ambient temperature and humidity conditions that will exist at the plant locations in which the DAS equipment is installed at the times for which the DAS is designed to be operational. |
| <p>4. The DAS hardware and any software are developed using a planned design process which provides for specific design documentation and reviews during the following life cycle stages:</p> <p>a) Development phase for hardware and any software</p> <p>b) System test phase</p> <p>c) Installation phase</p> <p>The planned design process also provides for the use of commercial off-the-shelf hardware and software.</p> | Inspection will be performed of the process used to design the hardware and any software. | <p>A report exists and concludes that the process defines the organizational responsibilities, activities, and configuration management controls for the following:</p> <p>a) Documentation and review of hardware and any software.</p> <p>b) Performance of tests and the documentation of test results during the system test phase.</p> <p>c) Performance of tests and inspections during the installation phase.</p> <p>The process also defines requirements for the use of commercial off-the-shelf hardware and software.</p> |
| 5. The DAS manual actuation of ADS, IRWST injection, and containment recirculation can be executed correctly and reliably. | An evaluation will be made to confirm that the operator actions can be performed within the specified times. | A report exists and concludes that DAS manual operator action verification was conducted. |

| Table 2.5.1-5 | | |
|---------------------------------|----------------|---------------------------|
| Component Name | Tag No. | Component Location |
| DAS Processor Cabinet 1 | DAS-JD-001 | Annex Building |
| DAS Processor Cabinet 2 | DAS-JD-002 | Annex Building |
| DAS Squib Valve Control Cabinet | DAS-JD-003 | Auxiliary Building |
| DAS Instrument Cabinet | DAS-JD-004 | Auxiliary Building |

2.5.2 Protection and Safety Monitoring System

Design Description

The protection and safety monitoring system (PMS) initiates reactor trip and actuation of engineered safety features in response to plant conditions monitored by process instrumentation and provides safety-related displays. The PMS has the equipment identified in Table 2.5.2-1. The PMS has four divisions of Reactor Trip and Engineered Safety Features Actuation, and two divisions of safety-related post-accident parameter displays. The functional arrangement of the PMS is depicted in Figure 2.5.2-1 and the component locations of the PMS are as shown in Table 2.5.2-9.

1. The functional arrangement of the PMS is as described in the Design Description of this Section 2.5.2.
2. The seismic Category I equipment, identified in Table 2.5.2-1, can withstand seismic design basis loads without loss of safety function.
3. The Class 1E equipment, identified in Table 2.5.2-1, has electrical surge withstand capability (SWC), and can withstand the electromagnetic interference (EMI), radio frequency interference (RFI), and electrostatic discharge (ESD) conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function.
4. The Class 1E equipment, identified in Table 2.5.2-1, can withstand the room ambient temperature, humidity, pressure, and mechanical vibration conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function.
5.
 - a) The Class 1E equipment, identified in Table 2.5.2-1, is powered from its respective Class 1E division.
 - b) Separation is provided between PMS Class 1E divisions, and between Class 1E divisions and non-Class 1E cable.
6. The PMS provides the following safety-related functions:
 - a) The PMS initiates an automatic reactor trip, as identified in Table 2.5.2-2, when plant process signals reach specified limits.
 - b) The PMS initiates automatic actuation of engineered safety features, as identified in Table 2.5.2-3, when plant process signals reach specified limits.
 - c) The PMS provides manual initiation of reactor trip and selected engineered safety features as identified in Table 2.5.2-4.
7. The PMS provides the following nonsafety-related functions:
 - a) The PMS provides process signals to the plant control system (PLS) through isolation devices.

- b) The PMS provides process signals to the data display and processing system (DDS) through isolation devices.
 - c) Data communication between safety and nonsafety systems does not inhibit the performance of the safety function.
 - d) The PMS ensures that the automatic safety function and the Class 1E manual controls both have priority over the non-Class 1E soft controls.
 - e) The PMS receives signals from non-safety equipment that provides interlocks for PMS test functions through isolation devices.
8. The PMS, in conjunction with the operator workstations, provides the following functions:
- a) The PMS provides for the minimum inventory of displays, visual alerts, and fixed position controls, as identified in Table 2.5.2-5. The plant parameters listed with a "Yes" in the "Display" column and visual alerts listed with a "Yes" in the "Alert" column can be retrieved in the main control room (MCR). The fixed position controls listed with a "Yes" in the "Control" column are provided in the MCR.
 - b) The PMS provides for the transfer of control capability from the MCR to the remote shutdown workstation (RSW) using multiple transfer switches. Each individual transfer switch is associated with only a single safety-related group or with nonsafety-related control capability.
 - c) Displays of the open/closed status of the reactor trip breakers can be retrieved in the MCR.
9. a) The PMS automatically removes blocks of reactor trip and engineered safety features actuation when the plant approaches conditions for which the associated function is designed to provide protection. These blocks are identified in Table 2.5.2-6.
- b) The PMS two-out-of-four initiation logic reverts to a two-out-of-three coincidence logic if one of the four channels is bypassed. All bypassed channels are alarmed in the MCR.
 - c) The PMS does not allow simultaneous bypass of two redundant channels.
 - d) The PMS provides the interlock functions identified in Table 2.5.2-7.
10. Setpoints are determined using a methodology which accounts for loop inaccuracies, response testing, and maintenance or replacement of instrumentation.
11. The PMS hardware and software is developed using a planned design process which provides for specific design documentation and reviews during the following life cycle stages:
- a) Design requirements phase, may be referred to as conceptual or project definition phase (Complete)
 - b) System definition phase (Complete)

- c) Hardware and software development phase, consisting of hardware and software design and implementation
 - d) System integration and test phase
 - e) Installation phase
12. The PMS software is designed, tested, installed, and maintained using a process which incorporates a graded approach according to the relative importance of the software to safety and specifies requirements for:
- a) Software management including documentation requirements, standards, review requirements, and procedures for problem reporting and corrective action.
 - b) Software configuration management including historical records of software and control of software changes.
 - c) Verification and validation including requirements for reviewer independence.
13. The use of commercial grade hardware and software items in the PMS is accomplished through a process that specifies requirements for:
- a) Review of supplier design control, configuration management, problem reporting, and change control.
 - b) Review of product performance.
 - c) Receipt acceptance of the commercial grade item.
 - d) Final acceptance based on equipment qualification and software validation in the integrated system.
14. The Component Interface Module (CIM) is developed using a planned design process which provides for specific design documentation and reviews.

Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.5.2-8 specifies the inspections, tests, analyses, and associated acceptance criteria for the PMS.

| Table 2.5.2-1 PMS Equipment Name and Classification | | | |
|--|-----------------------|-----------------|-------------------------------|
| Equipment Name | Seismic Cat. I | Class 1E | Qual. for Harsh Envir. |
| PMS Cabinets, Division A | Yes | Yes | No |
| PMS Cabinets, Division B | Yes | Yes | No |
| PMS Cabinets, Division C | Yes | Yes | No |
| PMS Cabinets, Division D | Yes | Yes | No |
| Reactor Trip Switchgear, Division A | Yes | Yes | No |
| Reactor Trip Switchgear, Division B | Yes | Yes | No |
| Reactor Trip Switchgear, Division C | Yes | Yes | No |
| Reactor Trip Switchgear, Division D | Yes | Yes | No |
| MCR/RSW Transfer Panels | Yes | Yes | No |
| MCR Safety-related Display, Division B | Yes | Yes | No |
| MCR Safety-related Display, Division C | Yes | Yes | No |
| MCR Safety-related Controls | Yes | Yes | No |

Table 2.5.2-2
PMS Automatic Reactor Trips

Source Range High Neutron Flux Reactor Trip
Intermediate Range High Neutron Flux Reactor Trip
Power Range High Neutron Flux (Low Setpoint) Trip
Power Range High Neutron Flux (High Setpoint) Trip
Power Range High Positive Flux Rate Trip
Reactor Coolant Pump High Bearing Water Temperature Trip
Overtemperature Delta-T Trip
Overpower Delta-T Trip
Pressurizer Low Pressure Trip
Pressurizer High Pressure Trip
Pressurizer High Water Level Trip
Low Reactor Coolant Flow Trip
Low Reactor Coolant Pump Speed Trip
Low Steam Generator Water Level Trip
High-2 Steam Generator Water Level Trip
Automatic or Manual Safeguards Actuation Trip
Automatic or Manual Depressurization System Actuation Trip
Automatic or Manual Core Makeup Tank (CMT) Injection Trip
Passive Residual Heat Removal (PRHR) Actuation Reactor Trip

| Table 2.5.2-3 PMS Automatically Actuated Engineered Safety Features |
|--|
| Safeguards Actuation |
| Containment Isolation |
| Automatic Depressurization System (ADS) Actuation |
| Main Feedwater Isolation |
| Reactor Coolant Pump Trip |
| CMT Injection |
| Turbine Trip (Isolated signal to nonsafety equipment) |
| Steam Line Isolation |
| Steam Generator Relief Isolation |
| Steam Generator Blowdown Isolation |
| Passive Containment Cooling Actuation |
| Startup Feedwater Isolation |
| Passive Residual Heat Removal (PRHR) Heat Exchanger Alignment |
| Block of Boron Dilution |
| Chemical and Volume Control System (CVS) Makeup Line Isolation |
| Steam Dump Block (Isolated signal to nonsafety equipment) |
| MCR Isolation and Air Supply Initiation |
| Auxiliary Spray and Letdown Purification Line Isolation |
| Containment Air Filtration System Isolation |
| Normal Residual Heat Removal Isolation |
| Refueling Cavity Isolation |
| In-Containment Refueling Water Storage Tank (IRWST) Injection |
| IRWST Containment Recirculation |
| CVS Letdown Isolation |
| Pressurizer Heater Block (Isolated signal to nonsafety equipment) |
| Containment Vacuum Relief |

Table 2.5.2-4
PMS Manually Actuated Functions

| |
|--|
| Reactor Trip |
| Safeguards Actuation |
| Containment Isolation |
| Depressurization System Stages 1, 2, and 3 Actuation |
| Depressurization System Stage 4 Actuation |
| Feedwater Isolation |
| Core Makeup Tank Injection Actuation |
| Steam Line Isolation |
| Passive Containment Cooling Actuation |
| Passive Residual Heat Removal Heat Exchanger Alignment |
| IRWST Injection |
| Containment Recirculation Actuation |
| Control Room Isolation and Air Supply Initiation |
| Steam Generator Relief Isolation |
| Chemical and Volume Control System Isolation |
| Normal Residual Heat Removal System Isolation |
| Containment Vacuum Relief |

| Table 2.5.2-5 Minimum Inventory of Displays, Alerts, and Fixed Position Controls in the MCR | | | |
|--|----------------|----------------|----------------------------|
| Description | Control | Display | Alert⁽¹⁾ |
| Neutron Flux | - | Yes | Yes |
| Neutron Flux Doubling ⁽²⁾ | - | No | Yes |
| Startup Rate | - | Yes | Yes |
| Reactor Coolant System (RCS) Pressure | - | Yes | Yes |
| Wide-range Hot Leg Temperature | - | Yes | No |
| Wide-range Cold Leg Temperature | - | Yes | Yes |
| RCS Cooldown Rate Compared to the Limit Based on RCS Pressure | - | Yes | Yes |
| Wide-range Cold Leg Temperature Compared to the Limit Based on RCS Pressure | - | Yes | Yes |
| Change of RCS Temperature by more than 5°F in the last 10 minutes | - | No | Yes |
| Containment Water Level | - | Yes | Yes |
| Containment Pressure | - | Yes | Yes |
| Pressurizer Water Level | - | Yes | Yes |
| Pressurizer Water Level Trend | - | Yes | No |
| Pressurizer Reference Leg Temperature | - | Yes | No |
| Reactor Vessel-Hot Leg Water Level | - | Yes | Yes |
| Pressurizer Pressure | - | Yes | No |
| Core Exit Temperature | - | Yes | Yes |
| RCS Subcooling | - | Yes | Yes |
| RCS Cold Overpressure Limit | - | Yes | Yes |
| IRWST Water Level | - | Yes | Yes |
| PRHR Flow | - | Yes | Yes |
| PRHR Outlet Temperature | - | Yes | Yes |

Note: Dash (-) indicates not applicable.

1. These parameters are used to generate visual alerts that identify challenges to the critical safety functions. For the main control room, the visual alerts are embedded in the safety-related displays as visual signals.

| Table 2.5.2-5 (cont.) Minimum Inventory of Displays, Alerts, and Fixed Position Controls in the MCR | | | |
|--|----------------|----------------|----------------------------|
| Description | Control | Display | Alert⁽¹⁾ |
| Passive Containment Cooling System (PCS) Storage Tank Water Level | - | Yes | No |
| PCS Cooling Flow | - | Yes | No |
| IRWST to Normal Residual Heat Removal System (RNS) Suction Valve Status ⁽²⁾ | - | Yes | Yes |
| Remotely Operated Containment Isolation Valve Status ⁽²⁾ | - | Yes | No |
| Containment Area High-range Radiation Level | - | Yes | Yes |
| Containment Pressure (Extended Range) | - | Yes | No |
| CMT Level | - | Yes | No |
| Manual Reactor Trip (also initiates turbine trip) | Yes | - | - |
| Manual Safeguards Actuation | Yes | - | - |
| Manual CMT Actuation | Yes | - | - |
| Manual MCR Emergency Habitability System Actuation | Yes | - | - |
| Manual ADS Stages 1, 2, and 3 Actuation | Yes | - | - |
| Manual ADS Stage 4 Actuation | Yes | - | - |
| Manual PRHR Actuation | Yes | - | - |
| Manual Containment Cooling Actuation | Yes | - | - |
| Manual IRWST Injection Actuation | Yes | - | - |
| Manual Containment Recirculation Actuation | Yes | - | - |
| Manual Containment Isolation | Yes | - | - |
| Manual Main Steam Line Isolation | Yes | - | - |
| Manual Feedwater Isolation | Yes | - | - |
| Manual Containment Hydrogen Igniter (Nonsafety-related) | Yes | - | - |
| Manual Containment Vacuum Relief | Yes | | |

Note: Dash (-) indicates not applicable.

2. These instruments are not required after 24 hours.

| Table 2.5.2-6 PMS Blocks |
|---|
| <p>Reactor Trip Functions:</p> <ul style="list-style-type: none"> Source Range High Neutron Flux Reactor Trip Intermediate Range High Neutron Flux Reactor Trip Power Range High Neutron Flux (Low Setpoint) Trip Pressurizer Low Pressure Trip Pressurizer High Water Level Trip Low Reactor Coolant Flow Trip Low Reactor Coolant Pump Speed Trip High Steam Generator Water Level Trip <p>Engineered Safety Features:</p> <ul style="list-style-type: none"> Automatic Safeguards Containment Isolation Main Feedwater Isolation Reactor Coolant Pump Trip Core Makeup Tank Injection Steam Line Isolation Startup Feedwater Isolation Block of Boron Dilution Chemical and Volume Control System Isolation Chemical and Volume Control System Letdown Isolation Steam Dump Block Auxiliary Spray and Letdown Purification Line Isolation Passive Residual Heat Removal Heat Exchanger Alignment Normal Residual Heat Removal System Isolation |

| Table 2.5.2-7 PMS Interlocks |
|---|
| <ul style="list-style-type: none"> RNS Suction Valves PRHR Heat Exchanger Inlet Isolation Valve CMT Cold Leg Balance Line Isolation Valves Containment Vacuum Relief Isolation Valves |

| Table 2.5.2-8 Inspections, Tests, Analyses, and Acceptance Criteria | | |
|--|---|---|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| 1. The functional arrangement of the PMS is as described in the Design Description of this Section 2.5.2. | Inspection of the as-built system will be performed. | The as-built PMS conforms with the functional arrangement as described in the Design Description of this Section 2.5.2. |
| 2. The seismic Category I equipment, identified in Table 2.5.2-1, can withstand seismic design basis loads without loss of safety function. | i) Inspection will be performed to verify that the seismic Category I equipment identified in Table 2.5.2-1 is located on the Nuclear Island. ii) Type tests, analyses, or a combination of type tests and analyses of seismic Category I equipment will be performed. iii) Inspection will be performed for the existence of a report verifying that the as-built equipment including anchorage is seismically bounded by the tested or analyzed conditions. | i) The seismic Category I equipment identified in Table 2.5.2-1 is located on the Nuclear Island. ii) A report exists and concludes that the seismic Category I equipment can withstand seismic design basis loads without loss of safety function. iii) A report exists and concludes that the as-built equipment including anchorage is seismically bounded by the tested or analyzed conditions. |
| 3. The Class 1E equipment, identified in Table 2.5.2-1, has electrical surge withstand capability (SWC), and can withstand the electromagnetic interference (EMI), radio frequency interference (RFI), and electrostatic discharge (ESD) conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function. | Type tests, analyses, or a combination of type tests and analyses will be performed on the equipment. | A report exists and concludes that the Class 1E equipment identified in Table 2.5.2-1 can withstand the SWC, EMI, RFI, and ESD conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function. |

| Table 2.5.2-8 (cont.) Inspections, Tests, Analyses, and Acceptance Criteria | | |
|--|--|--|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| 4. The Class 1E equipment, identified in Table 2.5.2-1, can withstand the room ambient temperature, humidity, pressure, and mechanical vibration conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function. | Type tests, analyses, or a combination of type tests and analyses will be performed on the Class 1E equipment identified in Table 2.5.2-1. | A report exists and concludes that the Class 1E equipment identified in Table 2.5.2-1 can withstand the room ambient temperature, humidity, pressure, and mechanical vibration conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function. |
| 5.a) The Class 1E equipment, identified in Table 2.5.2-1, is powered from its respective Class 1E division. | Tests will be performed by providing a simulated test signal in each Class 1E division. | A simulated test signal exists at the Class 1E equipment identified in Table 2.5.2-1 when the assigned Class 1E division is provided the test signal. |
| 5.b) Separation is provided between PMS Class 1E divisions, and between Class 1E divisions and non-Class 1E cable. | See Tier 1 Material, Table 3.3-6, items 7.d and 7.e. | See Tier 1 Material, Table 3.3-6, items 7.d and 7.e. |
| 6.a) The PMS initiates an automatic reactor trip, as identified in Table 2.5.2-2, when plant process signals reach specified limits. | An operational test of the as-built PMS will be performed using real or simulated test signals. | <p>i) The reactor trip switchgear opens after the test signal reaches the specified limit. This only needs to be verified for one automatic reactor trip function.</p> <p>ii) PMS output signals to the reactor trip switchgear are generated after the test signal reaches the specified limit. This needs to be verified for each automatic reactor trip function.</p> |
| 6.b) The PMS initiates automatic actuation of engineered safety features, as identified in Table 2.5.2-3, when plant process signals reach specified limits. | An operational test of the as-built PMS will be performed using real or simulated test signals. | Appropriate PMS output signals are generated after the test signal reaches the specified limit. These output signals remain following removal of the test signal. Tests from the actuation signal to the actuated device(s) are performed as part of the system-related inspection, test, analysis, and acceptance criteria. |

| Table 2.5.2-8 (cont.) Inspections, Tests, Analyses, and Acceptance Criteria | | |
|--|--|--|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| 6.c) The PMS provides manual initiation of reactor trip and selected engineered safety features as identified in Table 2.5.2-4. | An operational test of the as-built PMS will be performed using the PMS manual actuation controls. | i) The reactor trip switchgear opens after manual reactor trip controls are actuated. ii) PMS output signals are generated for reactor trip and selected engineered safety features as identified in Table 2.5.2-4 after the manual initiation controls are actuated. |
| 7.a) The PMS provides process signals to the PLS through isolation devices. | Type tests, analyses, or a combination of type tests and analyses of the isolation devices will be performed. | A report exists and concludes that the isolation devices prevent credible faults from propagating into the PMS. |
| 7.b) The PMS provides process signals to the DDS through isolation devices. | Type tests, analyses, or a combination of type tests and analyses of the isolation devices will be performed. | A report exists and concludes that the isolation devices prevent credible faults from propagating into the PMS. |
| 7.c) Data communication between safety and nonsafety systems does not inhibit the performance of the safety function. | Type tests, analyses, or a combination of type tests and analyses of the PMS gateways will be performed. | A report exists and concludes that data communication between safety and nonsafety systems does not inhibit the performance of the safety function. |
| 7.d) The PMS ensures that the automatic safety function and the Class 1E manual controls both have priority over the non-Class 1E soft controls. | Type tests, analyses, or a combination of type tests and analyses of the PMS manual control circuits and algorithms will be performed. | A report exists and concludes that the automatic safety function and the Class 1E manual controls both have priority over the non-Class 1E soft controls. |
| 7.e) The PMS receives signals from non-safety equipment that provides interlocks for PMS test functions through isolation devices. | Type tests, analyses, or a combination of type tests and analyses of the isolation devices will be performed. | A report exists and concludes that the isolation devices prevent credible faults from propagating into the PMS. |

| Table 2.5.2-8 (cont.) Inspections, Tests, Analyses, and Acceptance Criteria | | |
|--|--|---|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| <p>8.a) The PMS provides for the minimum inventory of displays, visual alerts, and fixed position controls, as identified in Table 2.5.2-5. The plant parameters listed with a "Yes" in the "Display" column and visual alerts listed with a "Yes" in the "Alert" column can be retrieved in the MCR. The fixed position controls listed with a "Yes" in the "Control" column are provided in the MCR.</p> | <p>i) An inspection will be performed for retrievability of plant parameters in the MCR.</p> <p>ii) An inspection and test will be performed to verify that the plant parameters are used to generate visual alerts that identify challenges to critical safety functions.</p> <p>iii) An operational test of the as-built system will be performed using each MCR fixed position control.</p> | <p>i) The plant parameters listed in Table 2.5.2-5 with a "Yes" in the "Display" column, can be retrieved in the MCR.</p> <p>ii) The plant parameters listed in Table 2.5.2-5 with a "Yes" in the "Alert" column are used to generate visual alerts that identify challenges to critical safety functions. The visual alerts actuate in accordance with their correct logic and values.</p> <p>iii) For each test of an as-built fixed position control listed in Table 2.5.2-5 with a "Yes" in the "Control" column, an actuation signal is generated. Tests from the actuation signal to the actuated device(s) are performed as part of the system-related inspection, test, analysis and acceptance criteria.</p> |
| <p>8.b) The PMS provides for the transfer of control capability from the MCR to the RSW using multiple transfer switches. Each individual transfer switch is associated with only a single safety-related group or with nonsafety-related control capability.</p> | <p>i) An inspection will be performed to verify that a transfer switch exists for each safety-related division and the nonsafety-related control capability.</p> <p>ii) An operational test of the as-built system will be performed to demonstrate the transfer of control capability from the MCR to the RSW.</p> | <p>i) A transfer switch exists for each safety-related division and the nonsafety-related control capability.</p> <p>ii) Actuation of each transfer switch results in an alarm in the MCR and RSW, the activation of operator control capability from the RSW, and the deactivation of operator control capability from the MCR for the associated safety-related division and nonsafety-related control capability.</p> |
| <p>8.c) Displays of the open/closed status of the reactor trip breakers can be retrieved in the MCR.</p> | <p>Inspection will be performed for retrievability of displays of the open/closed status of the reactor trip breakers in the MCR.</p> | <p>Displays of the open/closed status of the reactor trip breakers can be retrieved in the MCR.</p> |

| Table 2.5.2-8 (cont.) Inspections, Tests, Analyses, and Acceptance Criteria | | |
|--|--|--|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| 9.a) The PMS automatically removes blocks of reactor trip and engineered safety features actuation when the plant approaches conditions for which the associated function is designed to provide protection. These blocks are identified in Table 2.5.2-6. | An operational test of the as-built PMS will be performed using real or simulated test signals. | The PMS blocks are automatically removed when the test signal reaches the specified limit. |
| 9.b) The PMS two-out-of-four initiation logic reverts to a two-out-of-three coincidence logic if one of the four channels is bypassed. All bypassed channels are alarmed in the MCR. | An operational test of the as-built PMS will be performed. | The PMS two-out-of-four initiation logic reverts to a two-out-of-three coincidence logic if one of the four channels is bypassed. All bypassed channels are alarmed in the MCR. |
| 9.c) The PMS does not allow simultaneous bypass of two redundant channels. | An operational test of the as-built PMS will be performed. With one channel in bypass, an attempt will be made to place a redundant channel in bypass. | The redundant channel cannot be placed in bypass. |
| 9.d) The PMS provides the interlock functions identified in Table 2.5.2-7. | An operational test of the as-built PMS will be performed using real or simulated test signals. | Appropriate PMS output signals are generated as the interlock conditions are changed. |
| 10. Setpoints are determined using a methodology which accounts for loop inaccuracies, response testing, and maintenance or replacement of instrumentation. | Inspection will be performed for a document that describes the methodology and input parameters used to determine the PMS setpoints. | A report exists and concludes that the PMS setpoints are determined using a methodology which accounts for loop inaccuracies, response testing, and maintenance or replacement of instrumentation. |

| Table 2.5.2-8 (cont.) Inspections, Tests, Analyses, and Acceptance Criteria | | |
|--|--|---|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| <p>11. The PMS hardware and software is developed using a planned design process which provides for specific design documentation and reviews during the following life cycle stages:</p> <ul style="list-style-type: none"> a) Hardware and software development phase, consisting of hardware and software design and implementation b) System integration and test phase c) Installation phase | <p>Inspection will be performed of the process used to design the hardware and software.</p> | <p>A report exists and concludes that the process defines the organizational responsibilities, activities, and configuration management controls for the following:</p> <ul style="list-style-type: none"> a) Documentation and review of hardware and software. b) Performance of system tests and the documentation of system test results, including a response time test performed under maximum CPU loading to demonstrate that the PMS can fulfill its response time criteria. c) Performance of installation tests and inspections. |

| Table 2.5.2-8 (cont.) Inspections, Tests, Analyses, and Acceptance Criteria | | |
|---|--|--|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| <p>12. The PMS software is designed, tested, installed, and maintained using a process which incorporates a graded approach according to the relative importance of the software to safety and specifies requirements for:</p> <ul style="list-style-type: none"> a) Software management including documentation requirements, standards, review requirements, and procedures for problem reporting and corrective action. b) Software configuration management including historical records of software and control of software changes. c) Verification and validation including requirements for reviewer independence. | <p>Inspection will be performed of the process used to design, test, install, and maintain the PMS software.</p> | <p>A report exists and concludes that the process establishes a method for classifying the PMS software elements according to their relative importance to safety and specifies requirements for software assigned to each safety classification. The report also concludes that requirements are provided for the following software development functions:</p> <ul style="list-style-type: none"> a) Software management including documentation requirements, standards, review requirements, and procedures for problem reporting and corrective action. Software management requirements may be documented in the software quality assurance plan, software management plan, software development plan, software safety plan, and software operation and maintenance plan; or these requirements may be combined into a single software management plan. b) Software configuration management including historical records of software and control of software changes. Software configuration management requirements are provided in the software configuration management plan. c) Verification and validation including requirements for reviewer independence. Verification and validation requirements are provided in the verification and validation plan. |

| Table 2.5.2-8 (cont.) Inspections, Tests, Analyses, and Acceptance Criteria | | |
|--|---|--|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| <p>13. The use of commercial grade computer hardware and software items in the PMS is accomplished through a process that specifies requirements for:</p> <ul style="list-style-type: none"> a) Review of supplier design control, configuration management, problem reporting, and change control. b) Review of product performance. c) Receipt acceptance of the commercial grade item. d) Acceptance based on equipment qualification and software validation in the integrated system. | <p>Inspection will be performed of the process defined to use commercial grade components in the application.</p> | <p>A report exists and concludes that the process has requirements for:</p> <ul style="list-style-type: none"> a) Review of supplier design control, configuration management, problem reporting, and change control. b) Review of product performance. c) Receipt acceptance of the commercial grade item. d) Acceptance based on equipment qualification and software validation in the integrated system. |
| <p>14. The Component Interface Module (CIM) is developed using a planned design process which provides for specific design documentation and reviews.</p> <p>{Design Acceptance Criteria}</p> | <p>An inspection and or an audit will be performed of the processes used to design the hardware, development software, qualification and testing.</p> | <p>A report exists and concludes that CIM meets the below listed life cycle stages.</p> <p>Life cycle stages:</p> <ul style="list-style-type: none"> a. Design requirements phase, may be referred to as conceptual or project definition phase b. System definition phase c. Hardware and software development phase, consisting of hardware and software design and implementation d. System integration and test phase e. Installation phase |

| Table 2.5.2-9 | |
|-------------------------------------|---------------------------|
| Component Name | Component Location |
| PMS Cabinets, Division A | Auxiliary Building |
| PMS Cabinets, Division B | Auxiliary Building |
| PMS Cabinets, Division C | Auxiliary Building |
| PMS Cabinets, Division D | Auxiliary Building |
| Reactor Trip Switchgear, Division A | Auxiliary Building |
| Reactor Trip Switchgear, Division B | Auxiliary Building |
| Reactor Trip Switchgear, Division C | Auxiliary Building |
| Reactor Trip Switchgear, Division D | Auxiliary Building |
| MCR/RSW Transfer Panels | Auxiliary Building |
| MCR Safety-related Displays | Auxiliary Building |
| MCR Safety-related Controls | Auxiliary Building |

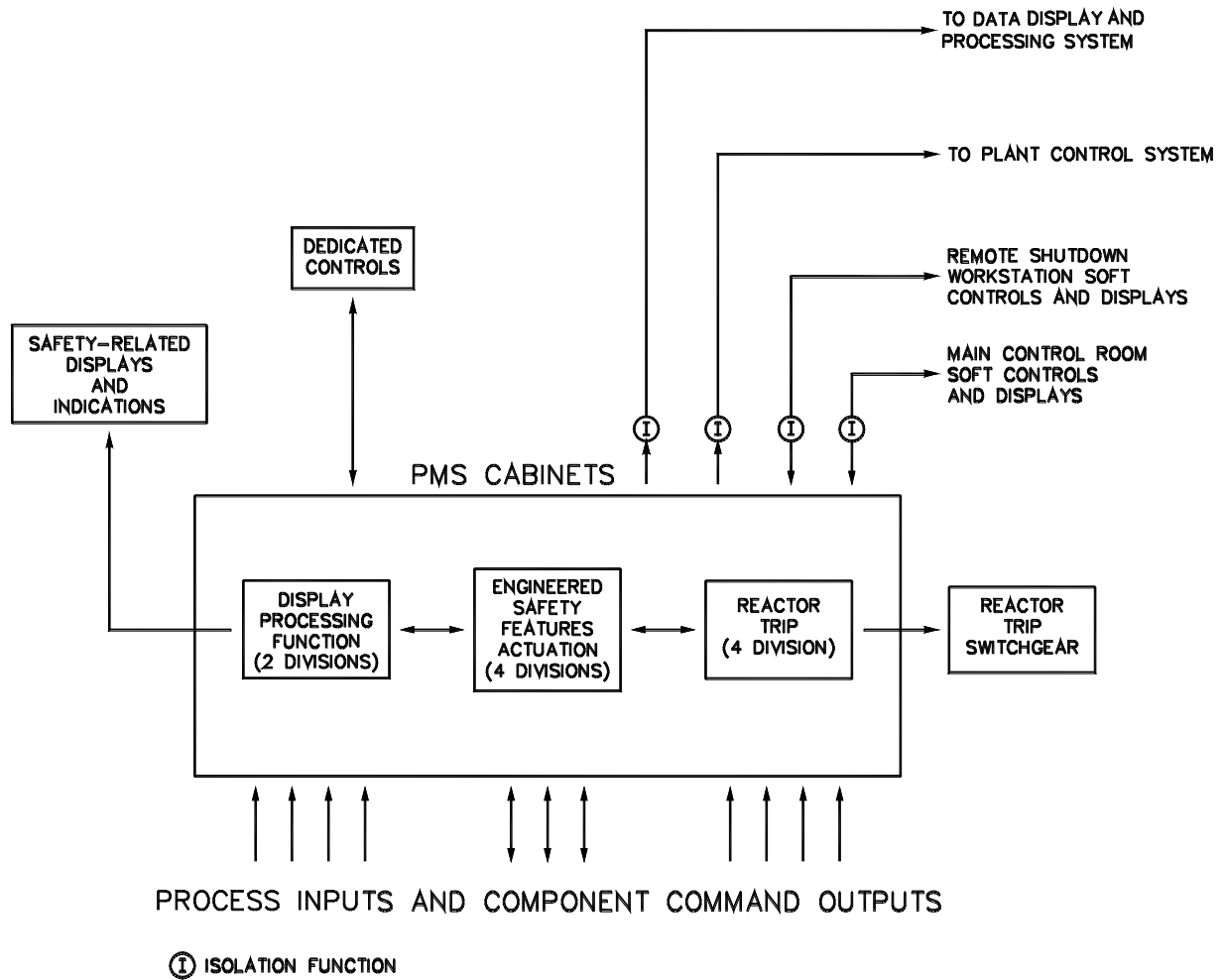


Figure 2.5.2-1
Protection and Safety Monitoring System

2.5.3 Plant Control System**Design Description**

The plant control system (PLS) provides for automatic and manual control of nonsafety-related plant components during normal and emergency plant operations. The PLS has distributed controllers and operator controls interconnected by computer data links or data highways.

1. The functional arrangement of the PLS is as described in the Design Description of this Section 2.5.3.
2. The PLS provides control interfaces for the control functions listed in Table 2.5.3-1.

Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.5.3-2 specifies the inspections, tests, analyses, and associated acceptance criteria for the PLS.

| Table 2.5.3-1 Control Functions Supported by the PLS | |
|---|------------------------------|
| 1. Reactor Power | 5. Steam Generator Feedwater |
| 2. Reactor Rod Position | 6. Steam Dump |
| 3. Pressurizer Pressure | 7. Rapid Power Reduction |
| 4. Pressurizer Water Level | |

| Table 2.5.3-2 Inspections, Tests, Analyses, and Acceptance Criteria | | |
|---|--|---|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| 1. The functional arrangement of the PLS is as described in the Design Description of this Section 2.5.3. | Inspection of the as-built system will be performed. | The as-built PLS conforms with the functional arrangement as described in the Design Description of this Section 2.5.3. |
| 2. The PLS provides control interfaces for the control functions listed in Table 2.5.3-1. | An operational test of the system will be performed using simulated input signals. System outputs or component operations will be monitored to determine the operability of the control functions. | The PLS provides control interfaces for the control functions listed in Table 2.5.3-1. |

2.5.4 Data Display and Processing System**Design Description**

The data display and processing system (DDS) provides nonsafety-related alarms and displays, analysis of plant data, plant data logging and historical storage and retrieval, and operational support for plant personnel. The DDS has distributed computer processors and video display units to support the data processing and display functions.

1. The functional arrangement of the DDS is as described in the Design Description of this Section 2.5.4.
2. The DDS, in conjunction with the operator workstations, provides the following function:

The DDS provides for the minimum inventory of displays, visual alerts, and fixed position controls, as identified in Table 2.5.4-1. The plant parameters listed with a "Yes" in the "Display" column and visual alerts listed with a "Yes" in the "Alert" column can be retrieved at the remote shutdown workstation (RSW). The controls listed with a "Yes" in the "Control" column are provided at the RSW.

3. The DDS provides information pertinent to the status of the protection and safety monitoring system.

Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.5.4-2 specifies the inspections, tests, analyses, and associated acceptance criteria for the DDS.

| Description | Control | Display | Alert⁽¹⁾ |
|---|----------------|----------------|----------------------------|
| Neutron Flux | - | Yes | Yes |
| Neutron Flux Doubling | - | No | Yes |
| Startup Rate | - | Yes | Yes |
| Reactor Coolant System (RCS) Pressure | - | Yes | Yes |
| Wide-range Hot Leg Temperature | - | Yes | No |
| Wide-range Cold Leg Temperature | - | Yes | Yes |
| RCS Cooldown Rate Compared to the Limit Based on RCS Pressure | - | Yes | Yes |
| Wide-range Cold Leg Temperature Compared to the Limit Based on RCS Pressure | - | Yes | Yes |
| Change of RCS Temperature by more than 5°F in the last 10 minutes | - | No | Yes |
| Containment Water Level | - | Yes | Yes |
| Containment Pressure | - | Yes | Yes |
| Pressurizer Water Level | - | Yes | Yes |
| Pressurizer Water Level Trend | - | Yes | No |
| Pressurizer Reference Leg Temperature | - | Yes | No |
| Reactor Vessel-Hot Leg Water Level | - | Yes | Yes |
| Pressurizer Pressure | - | Yes | No |
| Core Exit Temperature | - | Yes | Yes |
| RCS Subcooling | - | Yes | Yes |
| RCS Cold Overpressure Limit | - | Yes | Yes |
| In-containment Refueling Water Storage Tank (IRWST) Water Level | - | Yes | Yes |
| Passive Residual Heat Removal (PRHR) Flow | - | Yes | Yes |

Note: Dash (-) indicates not applicable.

1. These parameters are used to generate visual alerts that identify challenges to the critical safety functions. For the RSW, the visual alerts are embedded in the nonsafety-related displays as visual signals.

| Table 2.5.4-1 (cont.) Minimum Inventory of Controls, Displays, and Alerts at the RSW | | | |
|---|----------------|----------------|----------------------------|
| Description | Control | Display | Alert⁽¹⁾ |
| PRHR Outlet Temperature | - | Yes | Yes |
| Passive Containment Cooling System (PCS) Storage Tank Water Level | - | Yes | No |
| PCS Cooling Flow | - | Yes | No |
| IRWST to Normal Residual Heat Removal System (RNS) Suction Valve Status | - | Yes | Yes |
| Remotely Operated Containment Isolation Valve Status | - | Yes | No |
| Containment Area High-range Radiation Level | - | Yes | Yes |
| Containment Pressure (Extended Range) | - | Yes | No |
| Core Makeup Tank (CMT) Level | - | Yes | No |
| Manual Reactor Trip (also initiates turbine trip) | Yes | - | - |
| Manual Safeguards Actuation | Yes | - | - |
| Manual CMT Actuation | Yes | - | - |
| Manual Automatic Depressurization System (ADS) Stages 1, 2, and 3 Actuation | Yes | - | - |
| Manual ADS Stage 4 Actuation | Yes | - | - |
| Manual PRHR Actuation | Yes | - | - |
| Manual Containment Cooling Actuation | Yes | - | - |
| Manual IRWST Injection Actuation | Yes | - | - |
| Manual Containment Recirculation Actuation | Yes | - | - |
| Manual Containment Isolation | Yes | - | - |
| Manual Main Steam Line Isolation | Yes | - | - |
| Manual Feedwater Isolation | Yes | - | - |
| Manual Containment Hydrogen Igniter (Nonsafety-related) | Yes | - | - |

Note: Dash (-) indicates not applicable.

1. These parameters are used to generate visual alerts that identify challenges to the critical safety functions. For the RSW, the visual alerts are embedded in the nonsafety-related displays as visual signals.

| Table 2.5.4-2 Inspections, Tests, Analyses, and Acceptance Criteria | | |
|--|--|--|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| 1. The functional arrangement of the DDS is as described in the Design Description of this Section 2.5.4. | Inspection of the as-built system will be performed. | The as-built DDS conforms with the functional arrangement as described in the Design Description of this Section 2.5.4. |
| 2. The DDS provides for the minimum inventory of displays, visual alerts, and fixed position controls, as identified in Table 2.5.4-1. The plant parameters listed with a "Yes" in the "Display" column and visual alerts listed with a "Yes" in the "Alert" column can be retrieved at the RSW. The controls listed with a "Yes" in the "Control" column are provided at the RSW. | i) An inspection will be performed for retrievability of plant parameters at the RSW. ii) An inspection and test will be performed to verify that the plant parameters are used to generate visual alerts that identify challenges to critical safety functions. iii) An operational test of the as-built system will be performed using each RSW control. | i) The plant parameters listed in Table 2.5.4-1 with a "Yes" in the "Display" column can be retrieved at the RSW. ii) The plant parameters listed in Table 2.5.4-1 with a "Yes" in the "Alert" column are used to generate visual alerts that identify challenges to critical safety functions. The visual alerts actuate in accordance with their logic and values. iii) For each test of a control listed in Table 2.5.4-1 with a "Yes" in the "Control" column, an actuation signal is generated. Tests from the actuation signal to the actuated device(s) are performed as part of the system-related inspection, test, analysis and acceptance criteria. |
| 3. The DDS provides information pertinent to the status of the protection and safety monitoring system. | Tests of the as-built system will be performed. | The as-built system provides displays of the bypassed and operable status of the protection and safety monitoring system. |

2.5.5 In-Core Instrumentation System**Design Description**

The in-core instrumentation system (IIS) provides safety-related core exit thermocouple signals to the protection and safety monitoring system (PMS). The IIS also provides nonsafety-related core exit thermocouple signals to the diverse actuation system (DAS). The core exit thermocouples are housed in the core instrument assemblies. Multiple core instrument assemblies are used to provide radial coverage of the core. At least three core instrument assemblies are provided in each core quadrant.

1. The functional arrangement of the IIS is as described in the Design Description of this Section 2.5.5.
2. The seismic Category I equipment identified in Table 2.5.5-1 can withstand seismic design basis loads without loss of safety function.
3.
 - a) The Class 1E equipment identified in Table 2.5.5-1 as being qualified for a harsh environment can withstand environmental conditions that would exist before, during, and following a design basis accident without loss of safety function, for the time required to perform the safety function.
 - b) The Class 1E cables between the Incore Thermocouple elements and the connector boxes located on the integrated head package have sheaths.
 - c) For cables other than those covered by 3.b, separation is provided between IIS Class 1E divisions, and between Class 1E divisions and non-Class 1E cable.
4. Safety-related displays of the parameters identified in Table 2.5.5-1 can be retrieved in the main control room (MCR).

Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.5.5-2 specifies the inspections, tests, analyses, and associated acceptance criteria for the IIS.

| Table 2.5.5-1 | | | | | |
|---|----------------|--------------------------|--------------------|------------------------|--------------------------------------|
| Equipment Name | Seismic Cat. I | ASME Code Classification | Class 1E | Qual. for Harsh Envir. | Safety-Related Display |
| Incore Thimble Assemblies (at least three assemblies in each core quadrant) | Yes | – | Yes ⁽¹⁾ | Yes ⁽¹⁾ | Core Exit Temperature ⁽¹⁾ |

Note: Dash (-) indicates not applicable.

1. Only applies to the safety-related assemblies. There are at least two safety-related assemblies in each core quadrant.

| Table 2.5.5-2 Inspections, Tests, Analyses, and Acceptance Criteria | | |
|---|--|---|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| 1. The functional arrangement of the IIS is as described in the Design Description of this Section 2.5.5. | Inspection of the as-built system will be performed. | The as-built IIS conforms with the functional arrangement as described in the Design Description of this Section 2.5.5. |
| 2. The seismic Category I equipment identified in Table 2.5.5-1 can withstand seismic design basis dynamic loads without loss of safety function. | <p>i) Inspection will be performed to verify that the seismic Category I equipment identified in Table 2.5.5-1 is located on the Nuclear Island.</p> <p>ii) Type tests, analyses, or a combination of type tests and analyses of seismic Category I equipment will be performed.</p> <p>iii) Inspection will be performed for the existence of a report verifying that the as-built equipment including anchorage is seismically bounded by the tested or analyzed conditions.</p> | <p>i) The seismic Category I equipment identified in Table 2.5.5-1 is located on the Nuclear Island.</p> <p>ii) A report exists and concludes that the seismic Category I equipment can withstand seismic design basis dynamic loads without loss of safety function.</p> <p>iii) A report exists and concludes that the as-built equipment including anchorage is seismically bounded by the tested or analyzed conditions.</p> |
| 3.a) The Class 1E equipment identified in Table 2.5.5-1 as being qualified for a harsh environment can withstand the environmental conditions that would exist before, during, and following a design basis accident without loss of safety function, for the time required to perform the safety function. | <p>i) Type tests, analysis, or a combination of type tests and analysis will be performed on Class 1E equipment located in a harsh environment.</p> <p>ii) Inspection will be performed of the as-built Class 1E equipment and the associated wiring, cables, and terminations located in a harsh environment.</p> | <p>i) A report exists and concludes that the Class 1E equipment identified in Table 2.5.5-1 as being qualified for a harsh environment. This equipment can withstand the environmental conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function.</p> <p>ii) A report exists and concludes that the as-built Class 1E equipment and the associated wiring, cables, and terminations identified in Table 2.5.5-1 as being qualified for a harsh environment are bounded by type tests, analyses, or a combination of type tests and analyses.</p> |

| Table 2.5.5-2 (cont.) Inspections, Tests, Analyses, and Acceptance Criteria | | |
|--|--|--|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| 3.b) The Class 1E cables between the Incore Thermocouple elements and the connector boxes located on the integrated head package have sheaths. | Inspection of the as-built system will be performed. | The as-built Class 1E cables between the Incore Thermocouple elements and the connector boxes located on the integrated head package have sheaths. |
| 3.c) For cables other than those covered by 3.b, separation is provided between IIS Class 1E divisions, and between Class 1E divisions and non-Class 1E cable. | See Tier 1 Material, Table 3.3-6, item 7.d. | See Tier 1 Material, Table 3.3-6, item 7.d. |
| 4. Safety-related displays of the parameters identified in Table 2.5.5-1 can be retrieved in the MCR. | Inspection will be performed for retrievability of the safety-related displays in the MCR. | Safety-related displays identified in Table 2.5.5-1 can be retrieved in the MCR. |

2.5.6 Special Monitoring System

Design Description

The special monitoring system (SMS) monitors the reactor coolant system (RCS) for the occurrence of impacts characteristic of metallic loose parts. Metal impact monitoring sensors are provided to monitor the RCS at the upper and lower head region of the reactor pressure vessel, and at the reactor coolant inlet region of each steam generator.

1. The functional arrangement of the SMS is as described in the Design Description of this Section 2.5.6.
2. Data obtained from the metal impact monitoring sensors can be retrieved in the main control room (MCR).

Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.5.6-1 specifies the inspections, tests, analyses, and associated acceptance criteria for the SMS.

| Table 2.5.6-1 Inspections, Tests, Analyses, and Acceptance Criteria | | |
|---|--|---|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| 1. The functional arrangement of the SMS is as described in the Design Description of this Section 2.5.6. | Inspection of the as-built system will be performed. | The as-built SMS conforms with the functional arrangement as described in the Design Description of this Section 2.5.6. |
| 2. Data obtained from the metal impact monitoring sensors can be retrieved in the MCR. | Inspection will be performed for retrievability of data from the metal impact monitoring sensors in the MCR. | Data obtained from the metal impact monitoring sensors can be retrieved in the MCR. |

2.5.7 Operation and Control Centers System**Design Description**

The operation and control centers system (OCS) is developed and implemented based upon a human factors engineering (HFE) program. The human system interface (HSI) scope includes the design of the OCS and each of the HSI resources. For the purposes of the HFE program, the OCS includes the main control room, remote shutdown workstation, the local control stations, and the associated workstations for each of these centers. Implementation of the HFE program involves the completion of the human factors engineering analyses and plans described in Tier 1 Material Section 3.2, Human Factors Engineering.

Inspections, Tests, Analyses, and Acceptance Criteria

The inspections, tests, analyses, and associated acceptance criteria for the OCS are provided in Table 3.2-1.

2.5.8 Radiation Monitoring System

No entry. Radiation monitoring function covered in Section 3.5, Radiation Monitoring.

2.5.9 Seismic Monitoring System**Design Description**

The seismic monitoring system (SJS) provides for the collection of seismic data in digital format, analysis of seismic data, notification of the operator if the ground motion exceeds a threshold value, and notification of the operator (after analysis of data) that a predetermined cumulative absolute velocity (CAV) has been exceeded. The SJS has at least four triaxial acceleration sensor units and a time-history analyzer and recording system. The time-history analyzer and recording system are located in the auxiliary building.

1. The functional arrangement of the SJS is as described in the Design Description of this Section 2.5.9.
2. The SJS can compute CAV and the 5 percent of critical damping response spectrum for frequencies between 1 and 10 Hertz.
3. The SJS has a dynamic range of 0.001g to 1.0g and a frequency range of 0.2 to 50 Hertz.

Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.5.9-1 specifies the inspections, tests, analyses, and associated acceptance criteria for SJS.

| Table 2.5.9-1 Inspections, Tests, Analyses, and Acceptance Criteria | | |
|---|---|--|
| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
| 1. The functional arrangement of the SJS is as described in the Design Description of this Section 2.5.9. | Inspection of the as-built system will be performed. | The as-built SJS conforms with the functional arrangement as described in the Design Description of this Section 2.5.9. |
| 2. The SJS can compute CAV and the 5 percent of critical damping response spectrum for frequencies between 1 and 10 Hz. | Type tests using simulated input signals, analyses, or a combination of type tests and analyses, of the SJS time-history analyzer and recording system will be performed. | A report exists and concludes that the SJS time-history analyzer and recording system can record data at a sampling rate of at least 200 samples per second, that the pre-event recording time is adjustable from less than or equal to 1.2 seconds to greater than or equal to 15.0 seconds, and that the initiation value is adjustable from less than or equal to 0.002g to greater than or equal to 0.02g. |
| 3. The SJS has a dynamic range of 0.001g to 1.0g and a frequency range of 0.2 to 50 Hertz. | Type tests, analyses, or a combination of type tests and analyses, of the SJS triaxial acceleration sensors will be performed. | A report exists and concludes that the SJS triaxial acceleration sensors have a dynamic range of at least 0.001g to 1.0g and a frequency range of at least 0.2 to 50 Hertz. |

2.5.10 Main Turbine Control and Diagnostic System

No entry. Covered in Section 2.4.2, Main Turbine System.