2.5 INSTRUMENTATION AND CONTROLS

2.5.1 Reactor Trip System and Engineered Safety Feature Systems

2.5.1.1 Design Description

The reactor trip (RT) system and the engineered safety feature (ESF) system ~~consist of the protection and safety monitoring system (PSMS)~~ and the associated field equipment are part of the protection and safety monitoring system (PSMS). The PSMS includes the reactor protection system (RPS), the engineered safety features actuation system (ESFAS), the safety logic system (SLS) and the safety grade human system interface system (HSIS). The PSMS consists of four safety divisions. A

The purpose of the PSMS is to provide protection against unsafe reactor operation during steady-state and transient power operation by automatically tripping the reactor and actuating necessary engineered safety features. These trip and actuation functions are ~~referred to as~~ implemented by the RT system and the ESF system, respectively. A
The safety grade HSIS includes conventional switches for manual actuation of reactor trip and ESF actuation. Table 2.5.1-1 shows equipment names and classifications of the PSMS and the field equipment for the RT system and the ESF system. ~~ESF systems are automatically initiated from signals that originate in the RPS. Manual actuation of ESF systems is carried out through a diverse signal path that bypasses the RPS.~~ B

The safety VDUs and the safety VDU processors, which are part of the PSMS, provide monitoring and control for the safety-related plant components and instrumentation, including monitoring and control for the credited manual operator actions. The operational VDUs, which are part of the PCMS, also provide monitoring and control for the safety-related plant components and instrumentation, including the monitoring and control for the credited manual operator actions and monitoring of automatic ESF actuations. Y

~~Figures 2.5.1-1 and 2.5.1-2 show the configuration of the RPS, ESFAS, and SLS for implementation of the RT system and the ESF system, respectively. Figure 2.5.1-3 shows the configuration of the ESFAS, SLS, HSIS and diverse actuation system (DAS) for implementation of the safety grade component control system. Figure 2.5.1-4 shows the configuration of the reactor trip breakers (RTBs).~~ C D

~~The PSMS is located in areas that provide protection from accident related hazards such as missiles, pipe breaks, and flooding. The redundant divisions of the PSMS are isolated from each other and isolated from non-safety systems. Each division of the PSMS is electrically independent, and by placement in different equipment rooms is physically separated from other safety divisions. The redundant divisions of the PSMS are configured for the RT system and the ESF system functions, as shown in Figures 2.5.1-1 and 2.5.1-2. The redundancy in combination with safety division independence, separation, and isolation provided for each PSMS division, ensure protection from a single failure preventing actuation of a safety function. Isolation is provided between the PSMS and the plant control and monitoring system (PCMS) to ensure failures in the PCMS cannot adversely affect the PSMS.~~ E F G H I

~~The PSMS initiates automatic reactor trips and ESF actuations, identified in Table 2.5.1-2 and 2.5.1-3, when the plant process signals reach a predetermined limit (setpoint). The PSMS signals are derived from direct measurements. Automatically or manually initiated PSMS protection functions are sealed-in to ensure that the protective actions go to completion. A deliberate operator action is required to reset the seal-in feature. There are no interlocks that prevent manual PSMS actuations. The PSMS can perform its protective functions in the presence of a maintenance bypass. The PSMS automatically removes operating bypasses when permissive conditions are not met.~~

~~The PSMS is designed to facilitate the timely recognition, location, replacement, repair and adjustment of malfunctioning components or modules. The built-in diagnostics, along with operational VDU alarms and engineering tool provide a mechanism for rapidly identifying and locating malfunctioning assemblies. A single channel or division can be bypassed to allow on-line testing, maintenance or repair during the plant operation and this capability does not prevent the PSMS from performing its safety function. For many measurement channels and many division level functions, the PSMS can perform its safety function with a single failure and with one channel or division bypassed, or with two channels or divisions bypassed (but without an additional single failure). The technical specifications distinguish the functions for which these capabilities are applicable.~~

~~Input sensors from each PSMS are compared continuously in the PCMS to detect abnormal deviations for checking the operational availability of each PSMS input sensor that may be required for a safety function during reactor operation.~~

~~Spatially dependent sensors that are required for protective actions are identified in Table 2.5.1-2 and Table 2.5.1-3, and have the minimum number of sensors and locations to perform the protective action.~~

~~The RT logic of the PSMS is designed to fail to a safe state such that loss of electrical power to a division of PSMS results in a trip condition for that division.~~

~~The RT and ESF actuation setpoints of the PSMS are determined using a proven nuclear industry standard methodology. This methodology accounts for uncertainties in determination of device setpoints to maintain adequate margin between analytical limits and device setpoints.~~

~~The PSMS and the field equipment listed in Table 2.5.1-1 are qualified to meet environmental, seismic and EMI/RFI (electromagnetic interference and radio frequency interference) condition without loss of the function for the analyzed design basis events. The equipment is designed and manufactured under a quality program that ensures highly reliable and safe operation.~~

~~The safety VDUs and the safety VDU processors, which are part of the PSMS, provide monitoring and control for the safety-related plant components and instrumentation, including monitoring and control for the credited manual operator actions. The operational VDUs, which are part of the PCMS, also provide monitoring and control for the safety-related plant components and instrumentation, including the monitoring and control for the credited manual operator actions. In addition, the operational VDUs~~

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~~provide monitoring for the critical safety functions, monitoring of automatic ESF actuations, and automatic indications whenever a protective function is either bypassed or inoperable. Isolation is provided between the PSMS and the operational VDU to ensure that credible failures of the operational VDU do not degrade the performance of the PSMS. Figure 2.5.1-3 shows the configuration of the ESFAS, SLS, safety VDU and operational VDU.~~ Z AA BB

~~The signal selector algorithm (SSA) of the PCMS ensures that the PCMS does not take an erroneous control action based on a single instrument channel failure or a single RPS train failure that results in a condition which requires RT or ESF action. The SSAs are provided in the PCMS to the monitored variables which are commonly used in the PSMS and PCMS as listed in Table 2.5.1-5.~~ CC

~~Manual controls from the operational VDU can be blocked and disabled manually from the safety VDU. The logic in the SLS blocks non-safety signals from the PCMS when any safety function signal is present, such as a safety interlock or ESF actuation signal.~~ DD

~~The PSMS cabinets are located in a secure area with key locks and alarms. The PSMS equipment is provided with a clear means of identification. Identification shall not require frequent use of reference material.~~ EE FF

~~Each division of the PSMS is supplied from two safety-related Class 1E power sources to ensure reliability.~~ GG

~~The PSMS and the field equipment provide the safety-related interlocks important to safety. These interlocks are listed in Table 2.5.1-4. The PSMS provides the operator with automatic indications whenever an interlock function is either bypassed or inoperable.~~ HH II

~~The PSMS hardware and software are developed in accordance with a design process, qualification program and quality assurance (QA) program that conform to the U.S. regulatory requirements for the Class 1E safety systems. These programs encompass the entire product life cycle including software verification and validation (V&V), configuration management, and cyber security.~~ JJ

1. The functional arrangement of the RPS is as described in the Design Description of Subsection 2.5.1 and in Table 2.5.1-2, and as shown in Figures 2.5.1-1 and 2.5.1-2. KK

2. The functional arrangements of the ESFAS, SLS, HSIS and DAS are as described in the Design Description of Subsection 2.5.1 and in Table 2.5.1-3, and as shown in Figures 2.5.1-2 and 2.5.1-3. LL

3. The functional arrangement of the RTBs is as described in the Design Description of Subsection 2.5.1 and as shown in Figure 2.5.1-4. MM

4. Conventional PSMS switches in the MCR can be used to provide manual initiation for reactor trip and ESF Manual Actuations identified in Tables 2.5.1-2 and 2.5.1-3. NN

5. The seismic Category I equipment identified in Table 2.5.1-1 can withstand seismic design basis loads without loss of safety function. OO

6. The Class 1E equipment identified in Table 2.5.1-1 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. PP

7. The RPS, ESFAS, SLS, safety VDU processor, and safety VDU are qualified to meet the electromagnetic conditions that would exist based on the equipment location in the facility, without loss of safety function. QQ

8. The Class 1E equipment listed in Table 2.5.1-1 is located in a facility area that provides protection from accident related hazards such as missiles, pipe breaks and flooding. RR

9. The Class 1E PSMS equipment listed in Table 2.5.1-1 is powered from two safety-related power sources: the first source is its respective Class 1E division and the second source is from another division to ensure reliable power to each division of the PSMS. SS

10.a The redundant divisions of PSMS and field equipment listed in Table 2.5.1-1 are physically separated and electrically independent of each other and physically separated and electrically independent of any non-safety systems. TT

10.b Deleted. UU

11. The PSMS, via PCMS, provides the operator with: (1) non-safety HSIS indications of the bypassed or inoperable status indication (BISI) for protective actions; and (2) the ability to manually actuate BISI for protective actions. VV

12. The PSMS cabinets have key locks and door position alarms, and are located in a vital area of the facility. WW

13. Redundant safety equipment of the PSMS and field equipment listed in Table 2.5.1-1 are provided with a clear means of identification. XX

14.a The PSMS initiates automatic reactor trips and ESF actuations, identified in Tables 2.5.1-2 and 2.5.1-3, when the plant process signals reach a predetermined limit. YY

14.b Once initiated (automatically or manually), the intended sequences of safety-related functions as identified in Tables 2.5.1-2 and 2.5.1-3 of the PSMS continue until completion, and, after completion, deliberate operator action is required to return the safety related systems to normal. ZZ

15. Deleted. AAA

16. The PSMS signals are derived from direct measurements described in Table 2.5.1-2 and Table 2.5.1-3. BBB

17.a The PSMS is designed to facilitate the timely recognition, location, replacement, repair and adjustment of malfunctioning components or modules. CCC

17.b A single channel or division of the PSMS can be bypassed to allow on-line testing, maintenance or repair and this capability does not prevent the PSMS from performing its safety function. DDD

18. The PSMS automatically removes the operating bypasses listed in Table 2.5.1-7 when permissive conditions are not met. EEE

19. Deleted. FFF

20. Deleted. WWW

21. The RT logic of the PSMS is designed to fail to a safe state such that loss of electrical power to a division of PSMS results in a trip condition for that division. Loss of electrical power to a division of the PSMS ESF logic does not result in ESF actuation. GGG

22. The RT and ESF actuation instrumentation that is required to function during normal operation, anticipated operational occurrence (AOO) and postulated accident (PA) conditions is provided with adequate range to monitor normal operating, AOO and PA events. The monitored variables are listed in Tables 2.5.1-2 and 2.5.1-3. HHH

23. The PSMS provides the interlocks important to safety identified in Table 2.5.1-4. III

24. The PSMS hardware and software are developed and managed by the Basic and Application Software Program Manuals that meet the regulatory requirements for Class 1E safety systems, and which encompasses the entire product life cycle including software V&V, configuration management and cyber security. JJJ

25.a Manual controls from the operational VDU are blocked from the safety VDU and can be disabled manually from the safety VDU. The logic in the SLS blocks non-safety signals from the PCMS when any safety function signal is present, such as a safety interlock or ESF actuation signal. KKK

25.b Automatic ESFAS actuation signals identified in Table 2.5.1-3 and the interlocks important to safety identified in Table 2.5.1-4 override PCMS control signals. XXX

26. A signal selection algorithm (SSA) is provided in the PCMS for the monitoring variables as listed in Table 2.5.1-5 to ensure the PCMS does not take control action that results in a condition which requires RT or ESF action based on a single instrument channel failure or a single RPS division failure. LLL

27. Input sensors from each division of the PSMS as identified in Table 2.5.1-2 and Table 2.5.1-3 are compared continuously in the PCMS to allow detection of out-of-tolerance sensors. LLL

28. Deleted.

29a. ESF systems are automatically initiated from signals that originate in the RPS as described in Table 2.5.1-3.

29b. Manual actuation of ESF systems is carried out through a diverse signal path that bypasses the RPS.

30a. Deleted.

30b. Deleted.

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2.5.1.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.5.1-6 describes the ITAAC for the RT system and the ESF system.

Table 2.5.1-1 Equipment Names and Classifications of PSMS and Field Equipment for RT System and ESF System

Equipment Name	Seismic Category I	Class 1E	Qualification for Harsh Environment
PSMS			
RPS Division A/B/C/D	Yes	Yes	No
ESFAS Division A/B/C/D	Yes	Yes	No
SLS Division A/B/C/D	Yes	Yes	No
MCR*[1] Safety VDU Division A/B/C/D	Yes	Yes	No
RSR*[2] Safety VDU Division A/B/C/D	Yes	Yes	No
Safety VDU Processor Division A/B/C/D	Yes	Yes	No
MCR Division Level Switches A/B/C/D	Yes	Yes	No
MCR/RSR Transfer Panels*[3]	Yes	Yes	No
Field Equipment			
RTB Division A/B/C/D	Yes	Yes	No
RT and ESF Measurement Instrumentation	Yes	Yes	Yes*[4]/No

Note1: Main Control Room
Note2: Remote Shutdown Room
Note3: Transfer function is described in Subsection 2.5.2.
Note4: Field equipment~~s~~ which ~~are~~ is located in the harsh environment

RRR

Table 2.5.1-2 Reactor Trip and Monitored Variables

Actuation Signal	Monitored Variables
High Source Range Neutron Flux	Neutron Flux
High Intermediate Range Neutron Flux	Neutron Flux
High Power Range Neutron Flux (Low Setpoint)	Neutron Flux(1)
High Power Range Neutron Flux (High Setpoint)	Neutron Flux(1)
High Power Range Neutron Flux Positive Rate	Neutron Flux(1)
High Power Range Neutron Flux Negative Rate	Neutron Flux(1)
Over Temperature ΔT	Reactor Coolant Temperature(2)
	Pressurizer Pressure
	Neutron Flux(1)
Over Power ΔT	Reactor Coolant Temperature(2)
	Neutron Flux(1)
Low Reactor Coolant Flow	Reactor Coolant Flow
Low Reactor Coolant Pump Speed	Reactor Coolant Pump Speed
Low Pressurizer Pressure	Pressurizer Pressure
High Pressurizer Pressure	Pressurizer Pressure
High Pressurizer Water Level	Pressurizer Water Level
Low Steam Generator Water Level	Steam Generator Water Level
High-High Steam Generator Water Level	Steam Generator Water Level
ECCS Actuation	Refer to ECCS Actuations in Table 2.5.1-3.
Manual Actuation	Manual Switch Position (Reactor Trip Switch)

Notes:
1: Power Range Neutron flux is a spatially dependent variable due to axial variations.
2. Reactor Coolant System hot leg (3 sensors) ~~are~~ is spatially dependent ~~variables~~.

SSS

Table 2.5.1-3 ESF Actuations and Monitored Variables (Sheet 1 of 3)

ESF Function	Actuation Signal	Monitored Variables
ECCS Actuation	Low Pressurizer Pressure	Pressurizer Pressure
	Low Main Steam Line Pressure	Main Steam Line Pressure
	High Containment Pressure	Containment Pressure
	Manual Actuation	Manual Switch Position (ECCS Actuation Switch)
Main Steam Line Isolation	High-High Containment Pressure	Containment Pressure
	Low Main Steam Line Pressure	Main Steam Line Pressure
	High Main Steam Line Pressure Negative Rate	Main Steam Line Pressure
	Manual Actuation	Manual Switch Position (Main Steam Line Isolation Switch)
Containment Isolation Phase A	ECCS Actuation	ECCS Actuation Signal
	Manual Actuation	Manual Switch Position (Containment Isolation Switch)
Containment Isolation Phase B	High-3 Containment Pressure	Containment Pressure
	Manual Actuation	Manual Switch Position (Containment Spray Switch)
Containment Purge Isolation	ECCS Actuation	ECCS Actuation Signal
	High Containment Area Radiation	Containment Area Radiation
	Manual Actuation	Manual Switch Position (Containment Isolation Switch) (Containment Spray Switch)
Containment Spray	High-3 Containment Pressure	Containment Pressure
	Manual Actuation	Manual Switch Position (Containment Spray Switch)

Table 2.5.1-3 ESF Actuations and Monitored Parameters (Sheet 2 of 3)

ESF Function	Actuation Signal	Monitored Variables
Emergency Feedwater Actuation	ECCS Actuation	ECCS Actuation Signal
	Low Steam Generator Water Level	Steam Generator Water Level
	Loss of Offsite Power	Class 1E 6.9kV Bus Voltage
	Manual Actuation	Manual Switch Position (Emergency Feedwater Actuation Switch)
Emergency Feedwater Isolation Loop A (Loop B, C, D) *[1]	Low Main Steam Line Pressure	Main Steam Line Pressure
	High Steam Generator Water level	Steam Generator Water Level
	Manual Actuation	Manual Switch Position (Emergency Feedwater Isolation Switch)
Main Control Room Isolation	ECCS Actuation	ECCS Actuation Signal
	High Main Control Room Outside Air Intake Radiation	Main Control Room Outside Air Intake Gas Radiation
		Main Control Room Outside Air Intake Iodine Radiation
		Main Control Room Outside Air Intake Particulate Radiation
	Manual Actuation	Manual Switch Position (Main Control Room Isolation Switch)
Main Feedwater Regulation Valve Closure	Low T_{avg} coincident with RT (P-4)	Reactor Coolant Temperature(2)
		Reactor Trip (RTB Open)
Main Feedwater Isolation	High-High Steam Generator Water Level	Steam Generator Water Level
	ECCS Actuation	ECCS Actuation Signal
	Manual Actuation	Manual Switch Position (Main Feedwater Isolation Switch)

Note1: Loop A isolation is initiated by steam generator water level signal and main steam line pressure signal from loop A. All loops are identical (e.g., loop B isolation is initiated by the signal from loop B).
Note 2: Reactor Coolant System hot leg (3 sensors) ~~are~~ is spatially dependent ~~variables~~.

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Table 2.5.1-3 ESF Actuations and Monitored Parameters (Sheet 3 of 3)

ESF Function	Actuation Signal	Monitored Variables
CVCS Isolation	High Pressurizer Water Level	Pressurizer Water Level
	Manual Actuation	Manual Switch Position (CVCS Isolation Switch)
Block Turbine Bypass and Cooldown Turbine Bypass Valves	Low-Low T_{avg}	Reactor Coolant Temperature(2)
	Manual Actuation	Manual Switch Position (Turbine Bypass Block Switch)

Note 2: Reactor Coolant System hot leg (3 sensors) ~~are~~ is spatially dependent ~~variables~~.

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Table 2.5.1-4 Interlocks Important to Safety

Containment Spray/Residual Heat Removal Pump Hot Leg Isolation Valve Open Permissive Interlock
Simultaneous-Open Block Interlock with Residual Heat Removal Discharge Line Containment Isolation Valve and Containment Spray Header Containment Isolation Valve
Simultaneous-Open Block Interlock with Containment Spray/Residual Heat Removal Pump Hot Leg Isolation Valve and Containment Spray Header Containment Isolation Valve
Reactor Makeup Water Line Isolation Interlock
Accumulator Discharge Valve Open Interlock
Component Cooling Water Supply and Return Header Tie Line Isolation Interlock
RCP Thermal Barrier Heat Exchanger Component Cooling Water Return Line Isolation Interlock

Table 2.5.1-5 Monitored Variables Using Signal Selection Algorithms (SSA)

Power Range Neutron Flux
Reactor Coolant Temperature
Pressurizer Pressure
Pressurizer Water Level
Steam Generator Water Level
Main Steam Line Pressure
Turbine Inlet Pressure

Table 2.5.1-6 RT System and ESF System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 1 of 8)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The functional arrangement of the RPS is as described in the ~~d~~Design ~~d~~Description of Subsection 2.5.1 and in Table 2.5.1-2, and as shown in Figures 2.5.1-1 and 2.5.1-2.	1. ~~An i~~Inspection of the as-built RPS will be performed.	1. The as-built RPS conforms to the functional arrangement as described in the ~~d~~Design ~~d~~Description of Subsection 2.5.1 and in Table 2.5.1-2, and as shown in Figures 2.5.1-1 and 2.5.1-2.
2. The functional arrangements of the ESFAS, SLS, HSIS and DAS are as described in the ~~d~~Design ~~d~~Description of Subsection 2.5.1 and in Table 2.5.1-3, and as shown in Figures 2.5.1-2 and 2.5.1-3.	2. ~~An i~~Inspection of the as-built ESFAS, SLS, HSIS and DAS will be performed.	2. The as-built ESFAS, SLS, HSIS and DAS conform to the functional arrangement as described in the ~~d~~Design ~~d~~Description of Subsection 2.5.1 and in Table 2.5.1-3, and as shown in Figures 2.5.1-2 and 2.5.1-3.
3. The functional arrangement of the RTBs is as described in the ~~d~~Design ~~d~~Description of Subsection 2.5.1 and as shown in Figure 2.5.1-4.	3. ~~An i~~Inspection of the as-built RTBs will be performed.	3. The as-built RTBs conform~~s~~ to the functional arrangement as described in the ~~d~~Design ~~d~~Description of Subsection 2.5.1 and as shown in Figure 2.5.1-4.
4. Conventional PSMS switches in the MCR can be used to provide manual initiation for reactor trip and ESF Manual ~~a~~Actuations identified in Tables 2.5.1-2 and 2.5.1-3.	4. A test of the as-built conventional ~~equipment~~ PSMS manual actuation switches for RT and ESF functions will be performed.	4. As-built conventional PSMS switches in the MCR can be used to provide manual initiation for the reactor trip Manual Actuation ~~reactor trip~~ identified in Table 2.5.1-2 and the ESF Manual Actuations ~~actuations~~ identified in Table~~s 2.5.1-2 and~~ 2.5.1-3.

5. The seismic Category I equipment~~,~~ identified in Table 2.5.1-1~~,~~ can withstand seismic design basis loads without loss of safety function.	5.i Inspections will be performed to verify that the as-built seismic Category I ~~as-built~~ equipment identified in Table 2.5.1-1 ~~are~~ is located in a seismic Category I structure~~the containment and reactor building~~.	5.i The as-built seismic Category I ~~as-built~~ equipment identified in Table 2.5.1-1 is located in a seismic Category I structure~~the containment and reactor building~~.
	5.ii Type tests, ~~and/or~~ analyses, or a combination of type tests and analyses, of seismic Category I equipment identified in Table 2.5.1-1 will be performed using analytical assumptions, or will be performed under conditions which bound the seismic design basis requirements.	5.ii ~~The result of the type tests and/or analyses~~ A report exists and concludes that the seismic Category I equipment identified in Table 2.5.1-1 can withstand seismic design basis loads without loss of safety function.
	5.iii Inspections and analyses will be performed ~~on~~ to verify the as-built seismic Category I equipment identified in Table 2.5.1-1, including anchorages, is seismically bounded by the tested or analyzed conditions.	5.iii A report exists and concludes that ~~T~~the as-built seismic Category I equipment identified in Table 2.5.1-1, including anchorages, is seismically bounded by the tested or analyzed conditions.

Table 2.5.1-6 RT System and ESF System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 2 of 8)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
6. The Class 1E equipment identified in Table 2.5.1-1 as being qualified for a harsh environment can ~~is designed to~~ withstand the environmental conditions that would exist before, during, and following a design basis ~~event~~ accident without loss of safety function for the time required to perform the safety function.	6.i Type tests ~~and/or analyses,~~ or a combination of type tests and analyses using the design environmental conditions, or under conditions which bound the design environmental conditions, will be performed on Class 1E equipment identified in Table 2.5.1-1 ~~located in a~~ as being qualified for a harsh environment.	6.i A report exists and ~~The results of the type tests, and/or analyses~~concludes that the Class 1E equipment identified in Table 2.5.1-1 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 its safety function.
	6.ii Inspection~~s~~ will be performed ~~on~~ of the as-built Class 1E equipment identified in Table 2.5.1-1 as being qualified for a harsh environment and the associated wiring, cables, and terminations located in a harsh environment.	6.ii The as-built Class 1E equipment and the associated wiring, cables, and terminations identified in Table 2.5.1-1 as being qualified for a harsh environment are bounded by type tests ~~and/or analyses~~ or a combination of type tests and analyses.
7. The RPS, ESFAS, SLS, safety VDU processor, and safety VDU are qualified to meet the electromagnetic conditions that would exist ~~before, during, and following a design basis accident, with respect to~~ based on ~~its~~ the equipment location in the facility, without loss of safety function ~~for the time required to perform the safety function~~.	7. Type tests~~, and/or analyses~~, or a combination of type tests and analyses, will be performed on the equipment.	7. A report exists and concludes that the RPS, ESFAS, SLS, safety VDU processor, and safety VDU are qualified to meet the electromagnetic conditions that would exist ~~before, during, and following a design basis accident, with respect to~~ based on ~~its~~ the equipment location in the facility, without loss of safety function ~~for the time required to perform the safety function~~.
8. The Class 1E equipment listed in Table 2.5.1-1 is located in a facility area that provides protection from ~~natural phenomena hazards such as tornadoes, and~~ accident related	8. An inspection of the as-built equipment location will be performed.	8. The as-built equipment listed in Table 2.5.1-1 is located in a plant area that provides protection from ~~natural phenomena hazards such as tornadoes, and~~ accident related

hazards such as missiles, pipe breaks and flooding.		hazards such as missiles, pipe breaks and flooding.
9. The Class 1E PSMS equipment listed in Table 2.5.1-1 is powered from two safety-~~-~~related power sources: the first source is its respective Class 1E division and the second source is from another division to ensure reliable power to each division of the PSMS.	9. Inspection of the as-built PSMS equipment will be performed.	9. The Class 1E as-built PSMS equipment listed in Table 2.5.1-1 is powered from two safety-related power sources: the first source is its respective Class 1E division and the second source is from another division ~~to ensure reliable power to each~~ of the PSMS.

Table 2.5.1-6 RT System and ESF System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 3 of 8)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
10.a The redundant divisions of PSMS and field equipment listed in Table 2.5.1-1 ~~redundant divisions~~ are physically separated and electrically independent of each other and physically separated and electrically independent of any non-safety ~~divisions~~systems. ~~Physical independence is provided by distance or barriers, which prevent propagation of fire or electrical faults. Electrical independence is achieved by using independent power sources and electrical circuits for each safety division and by using qualified electrical fault isolation devices at interfaces between redundant divisions and interfaces between safety and non-safety divisions.~~	10.a.i 1) An inspection of the as-built PSMS and field equipment will be performed to verify physical separation. 2) Analyses, tests or a combination of analyses and tests of the as-built PSMS and field equipment will be performed to verify its electrical independence.	10.a.i ~~The results of the inspection conclude that:~~ 1) The as-built PSMS and field equipment redundant divisions' physical ~~independence~~ separation is provided by distance or barriers in accordance with RG 1.75~~, which prevent propagation of fire or electrical faults~~. 2) A report exists and concludes that ~~The~~ as-built PSMS and field equipment redundant divisions' electrical independence is achieved by ~~maintaining separate~~ independent power sources and electrical circuits for each division, and by fiber optic cable interfaces, conventional isolators, or other proven isolation methods or devices at interfaces between redundant divisions, and at interfaces between safety and non-safety ~~divisions~~systems.
	10.a.ii Type tests ~~and/~~or analyses, or a combination of type tests and analyses of the isolation devices will be performed.	10.a.ii ~~The results of the type tests and/or analyses~~ A report exists and concludes that the isolation devices prevent credible faults.
10.b ~~Digital communication independence is achieved between redundant divisions of the PSMS and field equipment listed in Table 2.5.1-1 or between non-safety divisions and the PSMS and field~~	10.b.i ~~An inspection of the as-built equipment will be performed.~~Deleted.	10.b.i ~~The as-built communication independence is achieved by communication processing functions that are independent of trip and actuation processing functions.~~Deleted.

~~equipment listed in Table 2.5.1-1, by communication processing functions that are independent of trip and actuation processing functions.~~Deleted.	10.b.ii ~~Type tests and/or analyses of the communication processing devices will be performed.~~Deleted.	10.b.ii ~~The results of the type tests and/or analyses conclude that the isolation devices prevent credible faults.~~Deleted.
11. The PSMS, via PCMS, provides the operator with: (1) ~~automatic~~ non-safety HSIS indications of the bypassed or inoperable status indication (BISI) for protective actions; and (2) the ability to manually actuate BISI for protective actions.	11. A test of the as-built equipment will be performed.	11. The as-built PSMS, via the as-built PCMS, provides the operator with: (1) automatic non-safety HSIS BISI for protective actions and (2) the ability to manually actuate BISI for these protective actions.

Table 2.5.1-6 RT System and ESF System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 4 of 8)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
12. The PSMS cabinets have key locks and door position alarms, and are located in a ~~secure~~ vital area of the facility.	12.i A test of the as-built PSMS cabinets ~~will be performed~~ for key lock capability, and a test of door position alarms, will be performed.	12.i Each cabinet of the as-built PSMS has ~~a~~ key locking capability, and ~~appropriate~~ alarms are received in the as-built MCR~~measures~~ when cabinet doors are opened.
	12.ii An inspection of the as-built PSMS cabinets will be performed for the installed location.	12.ii Each cabinet of the as-built PSMS is located in a vital ~~the secure~~ area of the facility.
13. Redundant safety equipment of the PSMS and field equipment listed in Table 2.5.1-1 are provided with a clear means of identification. ~~Identification shall not require frequent use of reference material.~~	13. An inspection of the as-built equipment for conformance with equipment color coding requirements will be performed.	13. ~~Documentation exists that describes distinct color coding for each redundant division.~~ The as-built equipment listed in Table 2.5.1-1 complies with the color coding ~~documentation~~requirements. ~~Identification shall not require frequent use of reference material.~~
14.a The PSMS initiates automatic reactor trips and ESF actuations, identified in Tables 2.5.1-2 and 2.5.1-3, when the plant process signals reach a predetermined limit.	14.~~-~~a~~.~~ A test of the as-built PSMS will be performed.	14.~~-~~a~~.~~ The as-built PSMS initiates automatic reactor trips and ESF actuations, identified in Tables 2.5.1-2 and 2.5.1-3, when the plant process signals reach a predetermined limit.
14.b~~.~~ Once initiated (automatically or manually), the intended sequences of safety-related functions as identified in Tables 2.5.1-2 and 2.5.1-3 of the PSMS continue until completion, and, after completion, deliberate operator action is required to return the safety related systems to normal.	14.b~~.~~ A test of the as-built PSMS will be performed.	14.b~~.~~ Once initiated (automatically or manually), the intended sequences of safety-related functions as identified in Tables 2.5.1-2 and 2.5.1-3 of the as-built PSMS continue until completion, and, after completion, deliberate operator action is required to return the safety related systems to normal.
15. Deleted.	15. Deleted.	15. Deleted.
16. The PSMS signals are derived from direct measurements described in Table 2.5.1-2 and Table 2.5.1-3.	16. An inspection of the as-built PSMS will be performed to verify that input signals are from direct measurement	16. The input signals to the as-built PSMS ~~signals~~ are derived from direct measurements described in Table 2.5.1-2 and Table 2.5.1-3.

	of sensor output described in Table 2.5.1-2 and Table 2.5.1-3.	

Table 2.5.1-6 RT System and ESF System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 5 of 8)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
17.a The PSMS is designed to facilitate the timely recognition, location, replacement, repair and adjustment of malfunctioning components or modules.	17.a ~~An inspection~~ Tests and analyses of the as-built PSMS will be performed.	17.a~~.~~ A report exists and concludes that t~~T~~he as-built PSMS is designed to facilitate ~~the timely~~ recognition~~,~~ and location~~, replacement, repair and adjustment~~ of malfunctioning components or modules.
17.b A single channel or division of the PSMS can be bypassed to allow on-line testing, maintenance or repair and this capability does not prevent the PSMS from performing its ~~without impeding the~~ safety function.	17.b Tests will be performed to confirm the as-built channel or division bypass capabilities and to confirm the function of the bypass interlock logic.	17.b A single channel or division of the as-built PSMS can be bypassed to allow on-line testing, maintenance or repair and this capability does not prevent the PSMS from performing its safety function.
18. The PSMS automatically removes the operating bypasses listed in Table 2.5.1-7 when permissive conditions are not met.	18. A test of the as-built PSMS will be performed.	18. The as-built PSMS automatically removes the operating bypasses listed in Table 2.5.1-7 when permissive conditions are not met.
19. ~~The PSMS setpoints are determined using a methodology based on proven nuclear industry standards. This methodology provides allowance for uncertainties between analytical limits and device setpoints.~~ Deleted.	19. Deleted.~~An inspection will be performed to define the as-built PSMS setpoints in accordance with the acceptable methodology.~~	19. Deleted.~~The as-built PSMS setpoints are determined using the acceptable methodology, which provides allowance for uncertainties between analytical limits and device setpoints and that is based on proven nuclear industry standards.~~
20. ~~Each division of the PSMS and field equipment listed in Table 2.5.1-1 is supplied from two safety related Class 1E power sources. Either power source is sufficient to power each division of the PSMS.~~ Deleted.	20. ~~A test of the as-built equipment will be performed.~~ Deleted.	20. ~~Each division of the as-built PSMS and field equipment listed in Table 2.5.1-1 is supplied from two safety related Class 1E power sources. Either power source is sufficient to power each division of the as-built PSMS.~~ Deleted.
21. The ~~PSMS~~ RT logic of the PSMS is designed to fail to a safe state such that loss of electrical power to a division of PSMS results in a ~~reactor~~ trip condition for that division. Loss of electrical power to a division of the PSMS ESF logic does not result in ESF actuation.	21. A test will be performed by disconnecting the electrical power to each division of the as-built PSMS.	21. Each division of the as-built ~~PSMS~~ RT logic of the as-built PSMS ~~will~~ fails to a safe state upon loss of electrical power to the division (i.e., results in a ~~reactor~~ trip condition for that division), and loss of electric power to a division of the as-built PSMS ESF logic does not

		result in ESF actuation.

Table 2.5.1-6 RT System and ESF System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 6 of 8)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
22. The RT and ESF actuation instrumentation that is required to function during normal operation, anticipated operational occurrence (AOO) and postulated accident (PA) conditions is provided with adequate range to monitor normal operating, AOO and PA events. The monitored variables are listed in Tables 2.5.1-2 and 2.5.1-3.	22. An inspection of the as-built RT and ESF actuation instrumentation ranges will be performed.	22. The ranges of the as-built PSMS RT and ESF actuation instrumentation that is required to function during normal operation, anticipated operational occurrences (AOO) and postulated accident (PA) conditions, and that is listed in Tables 2.5.1-2 and 2.5.1-3, meet design requirements~~is provided with adequate range to monitor operating events~~.
23. The PSMS provides the interlocks important to safety identified in Table 2.5.1-4.	23. A test of the as-built PSMS will be performed.	23. The as-built PSMS provides the interlocks important to safety identified in Table 2.5.1-4 when the simulated plant process signals reach a predetermined limit.
24. The PSMS hardware and software are developed and managed by the Basic and Application Software Program Manuals~~a life cycle process~~ that meet~~s~~ the regulatory requirements for Class 1E safety systems, and which encompasses the entire product life cycle including software V&V, configuration management and cyber security.	24. Inspections of the as-built hardware and software life cycle documentation of the PSMS will be performed.	24. The as-built PSMS hardware and software are developed and managed by the Basic and Application Software Program Manuals ~~a life cycle process~~ that meet~~s~~ the regulatory requirements for Class 1E safety systems, and which encompasses the entire product life cycle including software V&V, configuration management and cyber security.
25.a~~-~~ Manual controls from the operational VDU ~~can be~~are blocked from the safety VDU and can be disabled manually from the safety VDU. The logic in the SLS blocks non-safety signals from the PCMS when any safety function signal is present, such as a safety interlock or ESF actuation signal.	25.~~-~~a ~~An inspection~~ Tests of the as-built PSMS ~~functions~~ will be performed.	25.a~~-~~ Manual controls from the operational VDU ~~can be~~ are blocked from the as-built safety VDU and can be disabled manually from the as-built safety VDU. The logic in the as-built SLS blocks non-safety signals from the PCMS when any safety function signal is present, such as a safety interlock or ESF actuation signal.

Table 2.5.1-6 RT System and ESF System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 7 of 8)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
25.b Automatic ESFAS actuation signals identified in Table 2.5.1-3 and the interlocks important to safety identified in Table 2.5.1-4 override PCMS control signals.	25.b A test of the as-built PSMS will be performed to confirm that simulated ESFAS actuation signals identified in Table 2.5.1-3 and the interlocks important to safety identified in Table 2.5.1-4 override PCMS control signals.	25.b PCMS control signals are overridden by simulated automatic ESFAS actuation signals identified in Table 2.5.1-3 and the interlocks important to safety identified in Table 2.5.1-4 in the as-built PSMS.
26. A signal selectionor algorithm (SSA) is provided in the PCMS for the monitoring variables as listed in Table 2.5.1-5 to ensure the PCMS does not take an erroneous control action that results in a condition which requires RT or ESF action based on to consider a single instrument channel failure or a single RPS train division failure.	26. A test inspection of the as-built PCMS SSA functions functional arrangement will be performed using simulated signals.`	26. The as-built PSMS and PCMS conform to the functional arrangement of the SSA functions to ensure the PCMS does not take control action that results in a condition which requires RT or ESF action based on a single instrument channel failure or a single RPS division failure, as described in the design description for the monitored variables listed in and Table 2.5.1-5.
27. Input sensors from each division of the PSMS as identified in Table 2.5.1-2 and Table 2.5.1-3 are compared continuously in the PCMS to allow detection of abnormal deviations out-of-tolerance sensors. for checking the operational availability of each division of the PSMS input sensor that may be required for a safety function during reactor operation.	27. A test n inspection of the as-built PSMS and PCMS functions will be performed utilizing simulated signals.	27. The iInput sensors as identified in Table 2.5.1-2 and Table 2.5.1-3 from each division of the as-built PSMS that are out-of-tolerance can be detected by the PCMSare compared continuously in the as-built PCMS to detect abnormal deviations.
28. The spatially dependent sensors that are required for protective actions are identified in Table 2.5.1-2 and Table 2.5.1-3Deleted.	28. An inspection of the as-built spatially dependent sensors required for protective actions will be performedDeleted.	28. The as-built PSMS includes the minimum number and locations of spatially dependent sensors that are required for protective actions as identified in Table 2.5.1-2 and Table 2.5.1-3Deleted.
29.a. ESF systems are automatically initiated from signals that originate in the RPS as described in Table	29.a. A test of the as-built PSMS will be performed.	29.a. As-built ESF systems are automatically initiated from signals that originate in the as-built RPS as described

2.5.1-3.		in Table 2.5.1-3.
29.b. Manual actuation of ESF systems is carried out through a diverse signal path that bypasses the RPS.	29.b. A test of the as-built PSMS will be performed.	29.b. Manual actuation of the as-built ESF systems is carried out through a diverse signal path that bypasses the as-built RPS.

Table 2.5.1-6 RT System and ESF System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 8 of 8)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
30.a. Deleted. ~~The PSMS digital platform is developed by a design process that has been determined to be equivalent to the regulatory requirements for Class 1E safety systems, including V&V of programmable functions and devices, configuration management and cyber security. Equivalence has been determined through an evaluation conducted by persons independent of the platform developers and under a quality program that meets the requirements of 10CFR50 Appendix B. The equivalence evaluation determines that the digital platform contains the critical characteristics and built-in quality necessary for Class 1E safety systems, in accordance with the commercial grade dedication requirements of 10CFR21.~~	30.a. Deleted. ~~Inspections of the commercial grade dedication report for the PSMS digital platform will be performed.~~	30.a. Deleted. ~~The report exists and concludes that the PSMS digital platform contains the critical characteristics and built-in quality necessary for Class 1E safety systems.~~
30.b. Deleted. ~~After commercial grade dedication, the PSMS digital platform is managed by a life cycle process that meets the regulatory requirements for Class 1E safety systems. The Class 1E product life cycle management encompasses manufacturing, configuration management, design change management, error reporting and corrective actions, and cyber security.~~	30.b. Deleted. ~~Inspections of the post-development life cycle documentation of the PSMS digital platform will be performed.~~	30.b. Deleted. ~~The PSMS digital platform is managed by a life cycle process that meets the regulatory requirements for Class 1E safety systems.~~

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Table 2.5.1-7 Operating Bypasses

Designation		RT and/or ESF	Function
P-6	Intermediate Range Neutron Flux Above or Below Setpoint	RT	Below setpoint • Remove manual operating bypass for high source range neutron flux reactor trip.
P-7	Turbine Inlet Pressure (P-13) or Power Range Neutron Flux (P-10) Above Setpoint or Turbine Inlet Pressure (P-13) and Power Range Neutron Flux (P-10) Below Setpoint	RT	Above setpoint • Remove operating bypass for low pressurizer pressure reactor trip. • Remove operating bypass for low reactor coolant flow reactor trip. • Remove operating bypass for low RCP speed reactor trip. • Remove operating bypass for high pressurizer water level reactor trip. • Remove operating bypass for high-high SG water level reactor trip. • Remove operating bypass for reactor trip by turbine trip.
P-10	Power Range Neutron Flux Above or Below Setpoint	RT	Below setpoint • Remove manual operating bypass for high intermediate range neutron flux reactor trip. • Remove manual operating bypass for high power range neutron flux (low setpoint) reactor trip.
P-11	Pressurizer Pressure Above or Below Setpoint	ESF	Above setpoint • Remove manual operating bypass for low pressurizer pressure ECCS actuation. • Remove manual operating bypass for high-high SG water level MFW isolation function for all MFW pumps, all MFW isolation valves, and all SG water filling control valves. • Remove manual operating bypass for high pressurizer water level CVCS. • Remove manual operating bypass for EFW isolation. • Remove manual operating bypass for low main steam line pressure ECCS actuation. • Remove manual operating bypass for low main steam line pressure main steam line isolation.

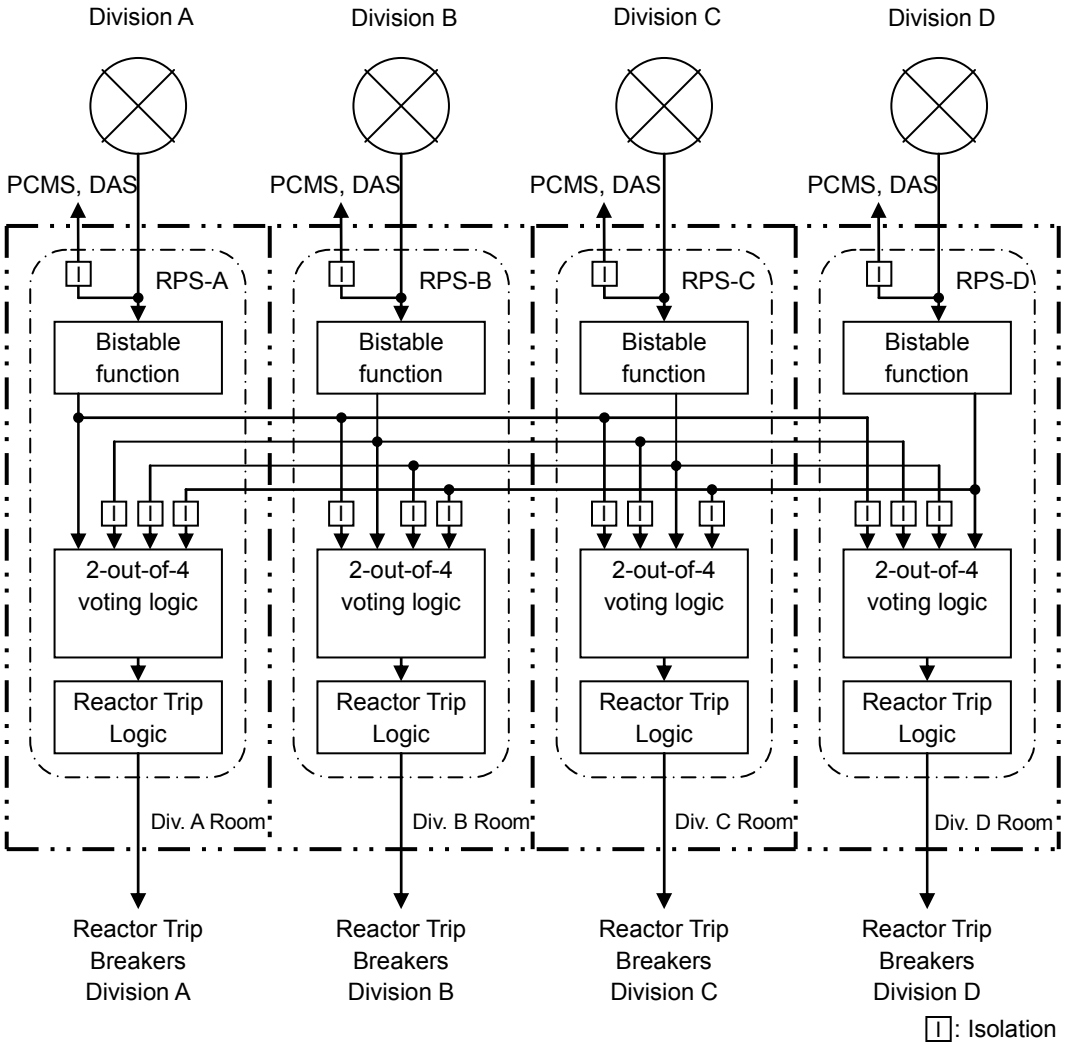


Figure 2.5.1-1 Configuration of the Reactor Trip System

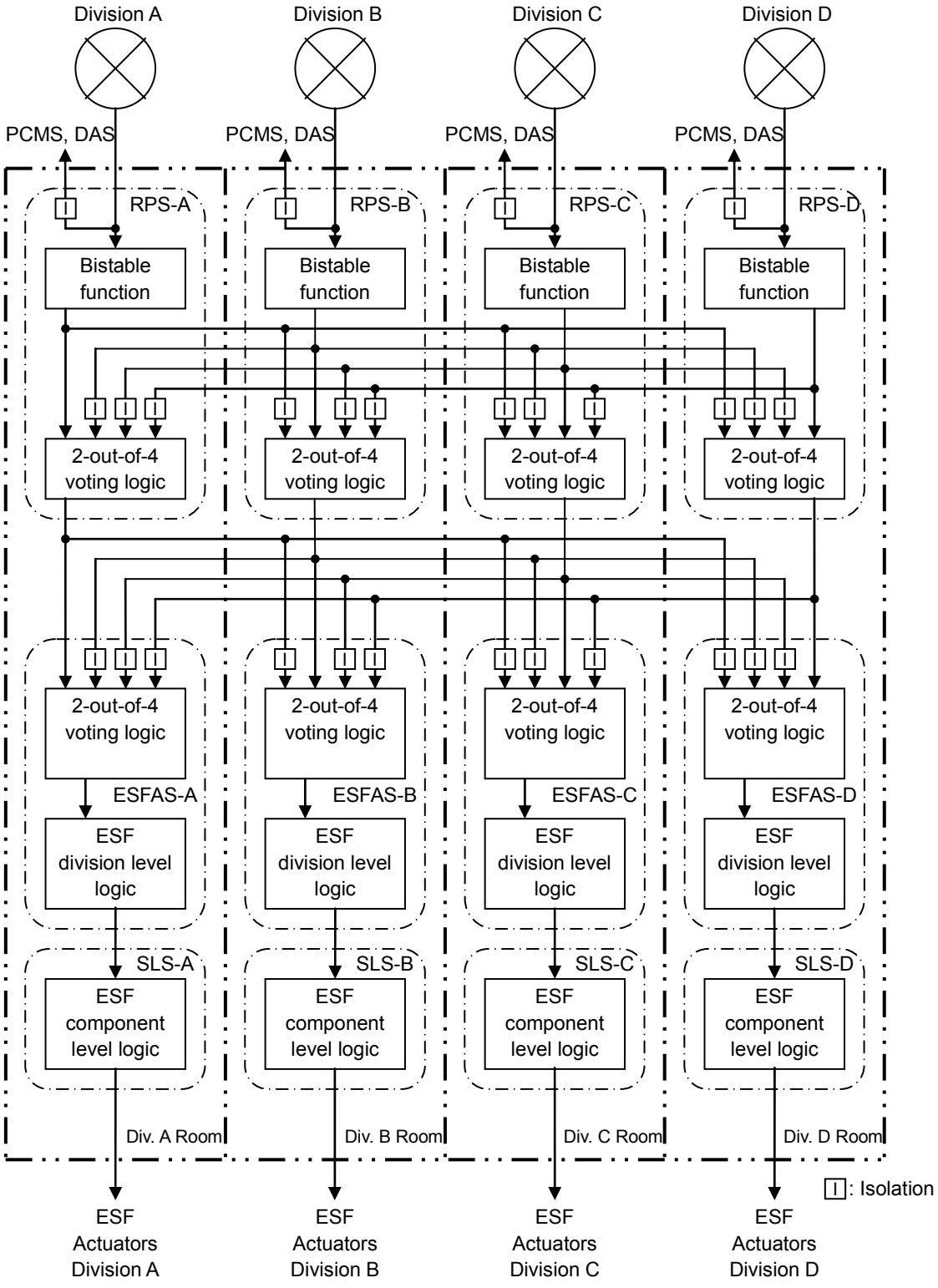
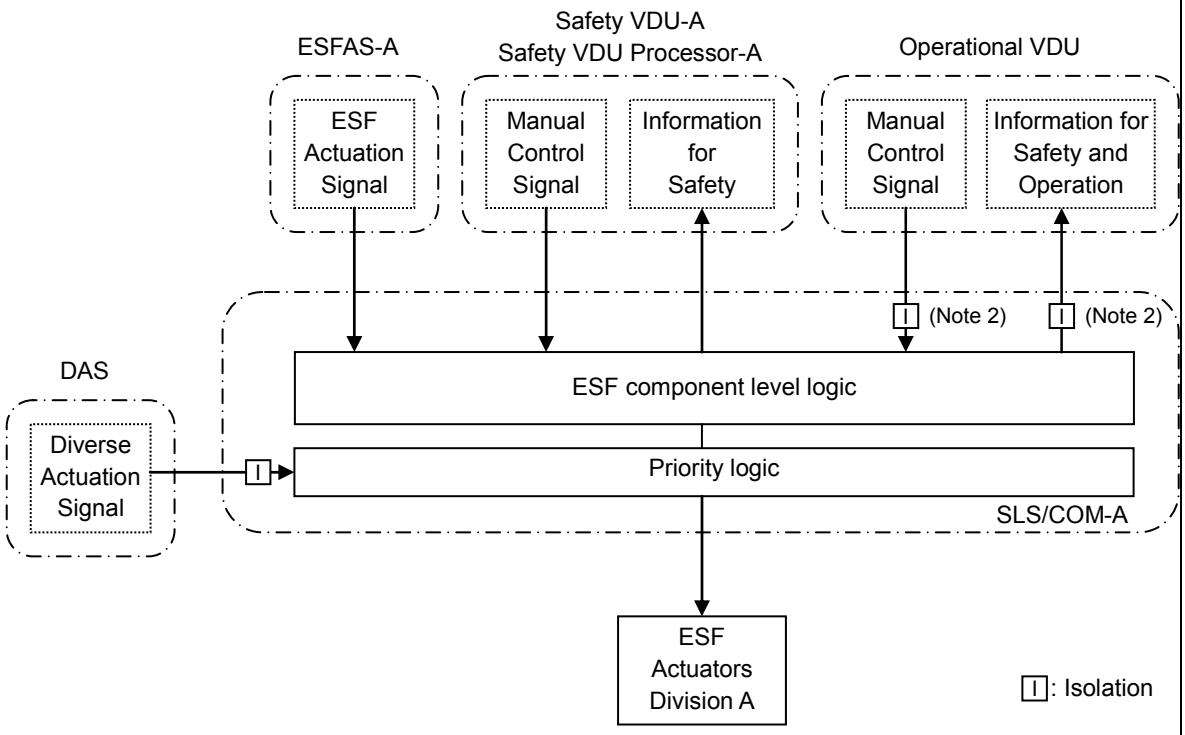


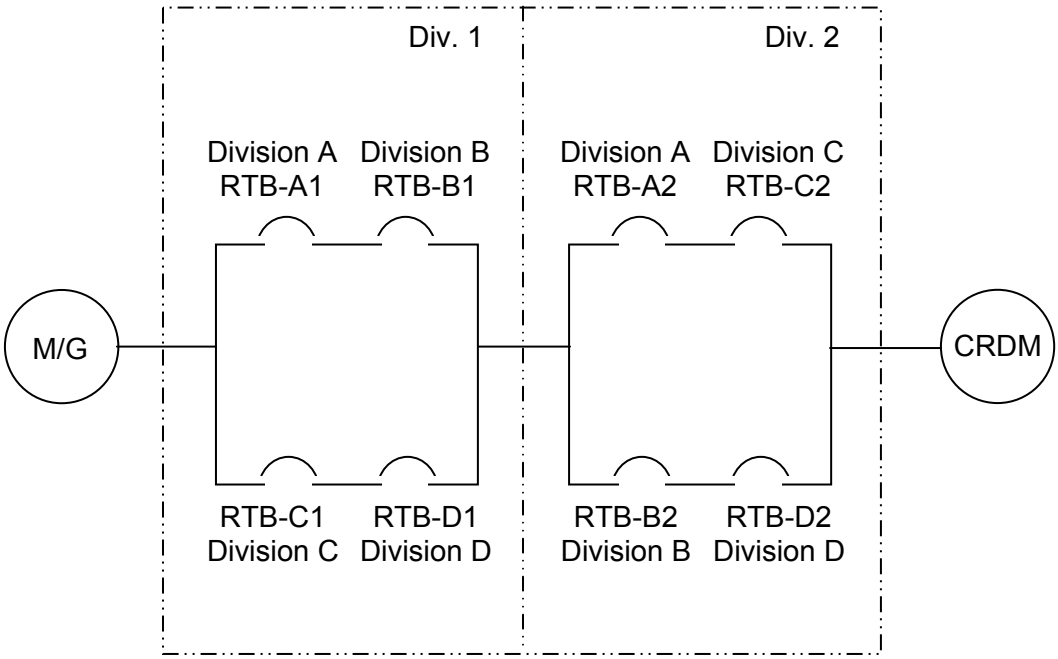
Figure 2.5.1-2 Configuration of the Engineered Safety Feature System



Note 1: Division A system is shown for the representative configuration.
Note 2: Isolation is performed in communication system.

VVV

Figure 2.5.1-3 Configuration of the Safety Grade Component Control System



M/G: Motor-Generator Set

CRDM: Control Rod Drive Mechanism

Note: Div. 1 and Div. 2 show the separate fire area.

Figure 2.5.1-4 Configuration of the Reactor Trip Breakers