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Westinghouse Electric Corporation

Energy Systems

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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTENTION: DR. THOMAS MURLEY

SUBJECT: INSPECTION TEST ANALYSES AND ACCEPTANCE CRITERIA

Dear Dr. Murley:

A set of ITAAC for the AP600 design is enclosed for staff review. This ITAAC submittal consists of the following seven systems:

- Class 1E DC and UPS System
- Containment System
- Onsite Standby Power System
- Passive Core Cooling System
- Protection and Safety Monitoring System
- Service Water System
- Steam Generator System

The Westinghouse Electric Corporation copyright notice is also attached.

These seven systems ITAAC contain preliminary values depicted in brackets, and will be finalized during the review process with the staff.

A process for determining the complete set of system ITAAC is underway. The results of this review will be submitted to the staff by September 18, 1992.

The next submittal for AP600 system ITAAC is scheduled for October 23, 1992 and the final submittal is scheduled for December 15, 1992.

Westinghouse continues to support the industry ITAAC activities and will participate in the industry review of the General Electric ABWR ITAAC scheduled throughout September.

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Please contact Mr. Brian A. McIntyre on (412) 374-4334 if you have any questions concerning this transmittal.

N. J. Liparulo, Manager
Nuclear Safety & Regulatory Activities

/lmr

Attachment

cc: F. Hasselberg NRC
B. McIntyre Westinghouse

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AP600

X.X CLASS 1E DC AND UPS SYSTEM

Design Description

The Class 1E dc and UPS System (IDS) provides power for the safety-related equipment required for safe shutdown.

There are four independent Class 1E 125 vdc divisions, A, B, C, and D. Divisions A and D are each comprised of one battery bank, one switchboard, and one battery charger. Divisions B and C are each comprised of two battery banks, two switchboards, and two battery chargers.

One battery bank in each division, designated as the 24 hour battery bank, provides power to the loads required for the first 24 hours following an event of loss of all ac power sources. The second battery bank in divisions B and C, designated as 72 hour battery bank, is used for those loads requiring power for 72 hours following the same event.

The Class 1E UPS provides power to four independent divisions of Class 1E instrument and control buses and emergency lighting. Divisions A and D each consist of one Class 1E inverter associated with an instrument and control distribution panel and a backup regulating transformer. The inverter is powered from the respective 24 hour battery bank switchboard. Divisions B and C, each consists of two inverters, two instrument and control distribution panels, and a backup regulating transformer with a distribution panel. One inverter in Division B and C is powered by the 24 hour battery bank switchboard and the other by the 72 hour battery bank switchboard.

During normal operation, the Class 1E inverters receive power from the associated dc bus. If an inverter is not available, the Class 1E regulating transformer provides a backup power to Class 1E UPS loads from the non-Class 1E 480 vac bus.

The Class 1E dc and UPS system is designed so that no single failure of any component results in loss of more than one Division.

The safety-related functions of the battery banks, battery chargers, UPS inverters, and the regulating transformers are:

- The battery banks provide dc power to the safe shutdown loads for 24 hours (Divisions A and D) and for 24 and 72 hours (Divisions B and C) respectively, as required, without the support of battery chargers during a loss of all ac power sources.
- The battery chargers provide electrical isolation between non-Class 1E 480 vac and Class 1E 125 vdc circuits.
- The UPS inverters provide ac power to the instrument and control devices, and the emergency lighting.
- The regulating transformers provide electrical isolation between the non-Class 1E 480 vac and Class 1E UPS circuits.

In addition to the above safety-related functions, the battery chargers and the regulating transformers perform the following defense-in-depth functions:

- The battery chargers supply the continuous load demand while maintaining the associated batteries in charged condition.
- The regulating transformer in each division provides backup power to the Class 1E UPS loads if one of the inverters in that division is not available.

Table IDS-1 - Class 1E DC and UPS System Inspections, Tests, Analyses and Acceptance Criteria		
Certified Design Commitment	**Inspections, Tests, Analysis**	**Acceptance Criteria**
1. Each battery bank in a Class 1E Division is sized to meet its design load requirements without the support of battery chargers for 24 or 72 hours, as required.	An 8 hour constant current capacity test at [500] amperes shall be performed on each 24 hour and 72 hour battery bank to demonstrate that the battery bank is capable of meeting its design load requirement.	At the end of the test, battery terminal voltage is greater than or equal to [105] volts.
2. Each Class 1E battery charger is capable of meeting the continuous load demand while maintaining the associated battery bank charged.	Load test shall be performed to demonstrate that each battery charger is capable of meeting the continuous load demand while maintaining the associated battery bank charged.	Each battery charger capacity is at least [240] amperes.
3. Each Class 1E inverter is sized to provide power to the Class 1E instrument and control loads of its safety Division.	Load test shall be performed to demonstrate that each inverter is capable of meeting the Class 1E instrument and control loads of its safety division.	Each inverter capacity is at least [16] kva.
4. Each Class 1E regulating transformer is sized to provide power to the Class 1E instrument and control loads of any inverter in its safety Division.	Load test should be performed to demonstrate that each regulating transformer is capable of meeting the Class 1E instrument and control loads of the inverter in its safety Division.	Each regulating transformer capacity is at least [20] kva.

X.X CONTAINMENT SYSTEM

Design Description

The Containment System (CNS) is a safety-related system and is the third barrier in preventing the release of fission products to the atmosphere, with the fuel cladding and the reactor coolant system boundary being the first two barriers.

The CNS is formed by the steel containment shell, electrical and mechanical penetrations, fuel transfer channel penetration, equipment hatches, personnel airlocks, steam generator shells, and the steam, feedwater and blowdown lines within the containment structure. Although the containment isolation valves are not a part of the CNS, they perform an essential CNS function and are verified as part of the CNS.

To perform its function, the CNS provides sufficient volume and is designed to withstand the highest internal pressure and temperatures resulting from a postulated loss-of-coolant accident (LOCA), main stream line break or feedwater line break. The design pressure of the CNS is 45 psig. The system is also designed to withstand transient conditions from other postulated events including discharge of the passive containment cooling system (PCS) water or loss of ac power.

The CNS and the containment isolation valves provide the isolation function by establishing a barrier between the containment environment and the outside environment. Containment isolation provisions are designed to isolate fluid lines which penetrate the primary containment boundary so as to mitigate the release of radioactivity to the environment. The system design incorporates the following features:

- Automatic containment isolation valves are actuated by Class 1E dc power.
- Remotely operated non-motor-operated valves fail in the closed position upon loss of support system, such as instrument air or electric power.
- Normally closed manual containment isolation valves have provisions for locking the valve closed.
- Isolation valves are designed to close with the prevailing conditions that may exist during events requiring containment isolation.
- The division assignment for valves and controls is such that the loss of any single class 1E power division will not prevent containment isolation.
- No single failure prevents containment isolation.

Normally open mechanical penetrations are isolated by the appropriate isolation signal. The actuation signal may be generated:

- automatically or manually within the protection and safety monitoring system at a system level
- automatically or manually within the diverse actuation system at a system level
- manually at an individual valve level.

The manual protection and safety monitoring system isolation signals can be initiated from either the main control room or the remote shutdown workstation.

With the passive containment cooling system , the CNS performs the function of heat removal from the containment . See the passive containment cooling system, Section PCS.

Table CNS-1 - Containment System Inspections, Tests, Analyses and Acceptance Criteria		
Certified Design Commitment	**Inspections, Tests, Analysis**	**Acceptance Criteria**
1. The containment system is constructed with a design pressure of 45 psig.	A containment pressurization test shall be conducted with a minimum pressure of 45 psig.	The "N" stamp for the containment vessel is confirmed.
2. The remote operated containment isolation valves close upon receipt of automatic or manual closure signals from the protection and safety monitoring system or diverse actuation system.	Valve functional tests shall be conducted demonstrating proper valve operation in the presence of each actuation signal.	Valves close consistent with isolation criteria of Table 1.
3. The division assignment for valves and controls is such that the loss of any single 1E division will not prevent containment isolation.	A review of the test results of Design Commitment 2 shall confirm isolation of each mechanical penetration with the loss of any single Class 1E power/protection division.	No penetration depends on a single electrical power division for the successful isolation.
4. The CNS and the isolation valves are an effective leak-tight barrier against an uncontrolled release of radioactivity to the environment.	A test program shall be conducted to determine the containment system overall integrated leakage rate at a containment pressure of 45 psig.	The overall integrated leakage rate as determined and confirmed is less than design leakage rate of [.12] weight percent of contained air mass at test pressure per 24 hours.

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Table CNS-2 - PRINCIPAL CONTAINMENT PENETRATIONS

System	Penetration Sleeve No.	Line Description	Device Location	Device Function	Division Assignm't (1)	Isolation Signal (2)	Maximum Closure Time
CAS	P01	Breathing Air In	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation	N/A	None	N/A
	P02	Service Air In	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation		PMS	[60] sec.
CCS	P03	CCW IRC Loads In	IRC	Containment Isolation		PMS	[60] sec.
			ORC	Containment Isolation		PMS	[60] sec.
	P04	CCW IRC Loads Out	IRC	Thermal Relief	N/A	None	N/A
			IRC	Containment Isolation		PMS	[60] sec.
			ORC	Containment Isolation		PMS	[60] sec.
CVS	P05	Spent Resin Flush Out	IRC	Thermal Relief	N/A	None	N/A
			IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation	N/A	None	N/A
	P06	Letdown	IRC	Thermal Relief	N/A	None	N/A
			IRC	Containment Isolation		PMS	[60] sec.
			ORC	Containment Isolation		PMS	[60] sec.
	P07	Charging	IRC	Containment Isolation		PMS	[60] sec.

Table CNS-2 - PRINCIPAL CONTAINMENT PENETRATIONS							
System	Penetration Sleeve No.	Line Description	Device Location	Device Function	Division Assignm't (1)	Isolation Signal (2)	Maximum Closure Time
			ORC	Containment Isolation		PMS	[60] sec.
	P08	H_2 Injection to RCS	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation		PMS	[60] sec.
	P09	Water to CMT & Accumulators	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation		PMS	[60] sec.
DWS	P10	Demineralized Water System	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation		PMS	[60] sec.
FHS	P11	Fuel Transfer	IRC	Containment Isolation	N/A	None	N/A
FPS	P12	Fire Protection Standpipe	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation	N/A	None	N/A
PCS	P13	Containment Pressure	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation	N/A	None	N/A
	P14	Containment Pressure	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation	N/A	None	N/A
	P15	Containment Pressure	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation	N/A	None	N/A

Table CNS-2 - PRINCIPAL CONTAINMENT PENETRATIONS							
System	Penetration Sleeve No.	Line Description	Device Location	Device Function	Division Assignm't (1)	Isolation Signal (2)	Maximum Closure Time
	P16	Containment Pressure	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation	N/A	None	N/A
PSS	P17	RCS/PXS/CVS Samples Out	IRC	Containment Isolation		PMS	[60] sec.
			IRC	Containment Isolation		PMS	[60] sec.
			ORC	Containment Isolation		PMS	[60] sec.
		Containment Air Samples Out	IRC	Containment Isolation		PMS	[60] sec.
			IRC	Containment Isolation		PMS	[60] sec.
			ORC	Containment Isolation		PMS	[60] sec.
		RCS/Cont. Air Sample Return	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation		PMS	[60] sec.
		Spare	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation	N/A	None	N/A
PXS	P18	N_2 to Accumulators	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation		PMS	[60] sec.
RNS	P19	RCS/IRWST to RHR Pump	IRC	RCS Hot Leg Isolation		None	N/A
			IRC	RCS Hot Leg Isolation		None	N/A

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Table CNS-2 - PRINCIPAL CONTAINMENT PENETRATIONS							
System	Penetration Sleeve No.	Line Description	Device Location	Device Function	Division Assignm't (1)	Isolation Signal (2)	Maximum Closure Time
			IRC	IRWST Line Isolation		PMS	[60] sec.
			IRC	PXS Line Isolation	N/A	None	N/A
			IRC	CVS Line Isolation	N/A	None	N/A
			IRC	Relief to IRWST	N/A	None	N/A
			ORC	Containment Isolation		None	N/A
	P20	RHR Pump to RCS	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation		None	N/A
SFS	P21	SF Pump to IRWST/Ref. Cavity	IRC	Containment isolation	N/A	None	N/A
			ORC	Containment Isolation		PMS	[60] sec.
	P22	IRWST/Ref. Cavity Purif. Out	IRC	Thermal Relief	N/A	None	N/A
			IRC	Containment Isolation		PMS	[60] sec.
			ORC	Containment Isolation		PMS	[60] sec.
SGS	P23	Main Steamline #1	ORC	Main Steam Isolation		PMS	[5] sec.
			ORC	Main Steam Bypass Iso.		PMS	[10] sec.
			ORC	SG PORV Isolation		PMS	[10] sec.
			ORC	Condensate Drain Isol.		PMS	[10] sec.

Table CNS-2 - PRINCIPAL CONTAINMENT PENETRATIONS							
System	Penetration Sleeve No.	Line Description	Device Location	Device Function	Division Assignm't (1)	Isolation Signal (2)	Maximum Closure Time
			ORC	MS Safety Valve	N/A	None	N/A
			ORC	MS Safety Valve	N/A	None	N/A
			ORC	MS Safety Valve	N/A	None	N/A
	P24	Main Steamline #2	ORC	Main Steam Isolation		PMS	[5] sec.
			ORC	Main Steam Bypass Iso.		PMS	[10] sec.
			ORC	SG PORV Isolation		PMS	[10] sec.
			ORC	Condensate Drain Isol		PMS	[10] sec.
			ORC	MS Safety Valve	N/A	None	N/A
			ORC	MS Safety Valve	N/A	None	N/A
			ORC	MS Safety Valve	N/A	None	N/A
	P25	Main and Startup Feedwater #1	ORC	Main Feed Isolation		PMS	[5] sec.
			ORC	Startup Feed Isolation		PMS	[10] sec.
	P26	Main and Startup Feedwater #2	ORC	Main Feed Isolation		PMS	[5] sec.
			ORC	Startup Feed Isolation		PMS	[10] sec.
	P27	SG Blowdown #1	ORC	Containment Isolation		PMS	[10] sec.
	P28	SG Blowdown #2	ORC	Containment Isolation		PMS	[10] sec.

Table CNS-2 - PRINCIPAL CONTAINMENT PENETRATIONS							
System	Penetration Sleeve No.	Line Description	Device Location	Device Function	Division Assignm't (1)	Isolation Signal (2)	Maximum Closure Time
	P29	SG Blowdown Recirculation	ORC	Containment Isolation	N/A	None	N/A
VFS	P30	Containm'nt Air Filter Supply A	IRC	Containment Isolation		PMS,DAS	[5] sec.
			ORC	Containment Isolation		PMS,DAS	[5] sec.
	P31	Containm'nt Air Filter Supply B	IRC	Containment Isolation		PMS,DAS	[5] sec.
			ORC	Containment Isolation		PMS,DAS	[5] sec.
	P32	Containm't Air Filter Exhaust A	IRC	Containment Isolation		PMS,DAS	[5] sec.
			ORC	Containment Isolation		PMS,DAS	[5] sec.
	P33	Containm't Air Filter Exhaust B	IRC	Containment Isolation		PMS,DAS	[5] sec.
			ORC	Containment Isolation		PMS,DAS	[5] sec.
VWS	P34	Chilled Water from Fan Coolers	IRC	Containment Isolation		PMS	[60] sec.
			ORC	Containment Isolation		PMS	[60] sec.
	P35	Chilled Water to Fan Coolers	IRC	Containment Isolation		PMS	[60] sec.
			ORC	Containment Isolation		PMS	[60] sec.
WLS	P36	Reactor Coolant Drain Tank Out	IRC	Containment Isolation		PMS,DAS	[60] sec.
			ORC	Containment Isolation		PMS,DAS	[60] sec.

Table CNS-2 - PRINCIPAL CONTAINMENT PENETRATIONS							
System	Penetration Sleeve No.	Line Description	Device Location	Device Function	Division Assignm't (1)	Isolation Signal (2)	Maximum Closure Time
	P37	Reactor Coolant Drain Tank Gas	IRC	Containment Isolation		PMS	[60] sec.
			ORC	Containment Isolation		PMS	[60] sec.
	P38	Normal Containment Sump	IRC	Containment Isolation		PMS,DAS	[60] sec.
			ORC	Containment Isolation		PMS,DAS	[60] sec.
SPARE	P39 (typical)	Spare	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation	N/A	None	N/A
CNS	H01	Main Equipment Hatch	IRC	Containment Isolation	N/A	None	N/A
	H02	Maintenance Hatch	IRC	Containment Isolation	N/A	None	N/A
	H03	Personnel Hatch	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation	N/A	None	N/A
	H04	Personnel Hatch	IRC	Containment Isolation	N/A	None	N/A
			ORC	Containment Isolation	N/A	None	N/A
	EO1 (typical)	Electrical Penetrations		Containment Isolation	N/A	None	N/A

Table CNS-2 - PRINCIPAL CONTAINMENT PENETRATIONS							
System	Penetration Sleeve No.	Line Description	Device Location	Device Function	Division Assignm't (1)	Isolation Signal (2)	Maximum Closure Time

NOTES:

1) Electrical power division assignment recorded for remotely operated valves during testing to confirm containment isolation capability with single failure of class 1E power supplies (Design Commitment 3). Isolation is confirmed for each penetration if either inside barriers or outside barriers or both are closed.

2) Penetration signal applies to automatic remote isolation valves for the penetration.
PMS: Protection and Safety Monitoring System Signal
DAS: Diverse Actuation System Signal

X.X PASSIVE CORE COOLING SYSTEM

Design Description

The passive core cooling system (PXS) performs the following safety-related functions:

- Emergency Core Decay Heat Removal

  Provide core decay heat removal whenever the normal heat removal paths are disabled.

- Emergency Reactor Coolant System Makeup and Boration

  Provide reactor coolant system makeup and boration when the normal reactor coolant system makeup supply from the chemical and volume control system is unavailable or is insufficient.

- Safety Injection

  Provide safety injection to the reactor coolant system to provide core cooling for the complete range of loss-of-coolant accidents, up to and including the double-ended rupture of the largest primary loop reactor coolant system piping.

- Containment pH Control

  Provide for chemical addition to the containment during post-accident conditions to establish floodup chemistry conditions that support radionuclide retention in the event of high radioactivity in containment.

The passive core cooling system depends upon passive components and processes such as gravity injection and expansion of compressed gases. The passive core cooling system requires a one-time alignment of valves upon actuation of the specific components.

The subsystems that provide the passive core cooling functions are:

- Passive residual heat removal heat exchangers
- Core makeup tanks
- Accumulators
- In-containment refueling water storage tank and containment recirculation
- pH adjustment tank.

The passive core cooling system design description is divided into sections, based on the individual subsystems that comprise the passive core cooling system. Each subsystem has a separate design description and associated ITAAC.

X.X.1 Passive Residual Heat Removal Heat Exchangers

The passive residual heat removal heat exchangers provide safety-related core decay heat removal whenever normal reactor coolant system heat removal paths are not available.

The passive residual heat removal heat exchanger subsystem consists of two passive residual heat removal heat exchangers, located inside the in-containment refueling water storage tank, and the associated valves and piping that connect the heat exchangers to the reactor coolant system.

The passive residual heat removal heat exchanger subsystem has a common inlet line from one of the reactor coolant system hot legs with remotely-operated isolation capability. The common inlet line is connected to two parallel heat exchangers, each with inlet and outlet isolation valves. A common outlet line connects to the steam generator cold leg channel head on the same reactor coolant system loop as the heat exchanger inlet piping. The outlet line contains two parallel isolation valves.

The passive residual heat removal heat exchangers actuate on receipt of a signal from the protection and safety monitoring system or from the diverse actuation system. Either automatic actuation signal opens the outlet isolation valves for the passive residual heat removal heat exchangers. The protection and safety monitoring also provides a open signal to the common inlet line isolation valve.

The passive residual heat removal heat exchangers can also be manually actuated in the main control room or at the remote shutdown workstation via the protection and safety monitoring system or by dedicated switches in the main control room via the diverse actuation system. The protection and safety monitoring system can be used to manually operate the inlet and outlet isolation valves, either individually or via a system level actuation. The diverse actuation system provides a system level actuation signal for the outlet isolation valves.

The valves that initiate passive residual heat removal heat exchanger injection receive power from Class 1E dc power sources. The outlet valves de-energize to actuate their safety-related functions. The common inlet isolation valve is normally open, and it receives an actuation signal to open from the protection and safety monitoring system.

X.X.2 Core Makeup Tanks

The core makeup tanks provide safety-related emergency makeup to the reactor coolant system when the normal makeup systems are not available. The core makeup tanks are also one of the sources of passive safety injection available during loss of coolant accidents, with the other sources being the accumulators, the in-containment refueling water storage tank, and the containment recirculation .

The core makeup tank subsystem consists of two core makeup tanks and the associated valves and piping that connect the core makeup tanks to the reactor coolant system.

Each CMT has an inlet pressure balance line from the pressurizer with a remotely-operated isolation valve and two series check valves, and a inlet pressure balance line from a reactor coolant system cold leg. Each cold leg line has two parallel, remotely-operated isolation valves. Each CMT has an outlet discharge line that connects to a direct vessel injection line, which injects into the reactor vessel downcomer. Each core makeup tank discharge line contains two parallel remotely-operated isolation valves, two series check valves, and a flow tuning orifice.

The core makeup tanks actuate on receipt of a signal from the protection and safety monitoring system or from the diverse actuation system. Either automatic actuation signal opens the inlet and outlet isolation valves for each core makeup tank. The protection and safety monitoring system also provides a open signal to the isolation valve in each pressurizer pressure balance line.

The core makeup tanks can also be manually actuated in the main control room or at the remote shutdown workstation via the protection and safety monitoring system or by dedicated switches in the main control room via the diverse actuation system. The protection and safety monitoring system can be used to manually operate the cold leg inlet line, the pressurizer inlet line, and the outlet line isolation valves, either individually or via a system level actuation. The diverse actuation system provides a system level actuation signal for the cold leg inlet line and the outlet line isolation valves.

The valves that initiate core makeup tank injection receive power from Class 1E dc power sources. The inlet and outlet valves de-energize to actuate their safety-related functions.

When the core makeup tanks actuate, the inlet line from the pressurizer supplies steam to allow core makeup tank injection to mitigate non-LOCA events. The large inlet line from the cold leg is sized for loss of coolant accidents, where higher core makeup tank injection flows are required.

X.X.3 Accumulators

The accumulators are one of the safety-related sources of passive safety injection available during loss of coolant accidents.

The accumulator subsystem consists of two accumulators and the associated valves and piping that connect the accumulators to the reactor coolant system.

Each accumulator has a discharge line that connects to a direct vessel injection line, which injects into the reactor vessel downcomer. Each accumulator discharge line contains a discharge isolation valve, two series check valves, and a flow tuning orifice.

The accumulators automatically provide injection to the reactor coolant system when system pressure falls below the static pressure in the accumulator and the discharge check valves open. The remotely-operated discharge isolation valve for each accumulator is normally open, but it receives an actuation signal from the protection and safety monitoring system.

The accumulator discharge isolation valves can also be manually actuated in the main control room or at the remote shutdown workstation, either individually or via a system level actuation by the protection and safety monitoring system.

The accumulator discharge valves receive power from Class 1E dc power sources. They are normally open and are not required to reposition to initiate accumulator injection flow.

X.X.4 In-Containment Refueling Water Storage Tank and Containment Recirculation

The in-containment refueling water storage tank (IRWST) and containment recirculation are two of the safety-related sources of passive safety injection available during loss of coolant accidents. These sources provide injection and recirculation following reactor coolant system depressurization during loss of coolant accidents. After containment floodup, long term core cooling is provided by containment recirculation.

The in-containment refueling water storage tank and containment recirculation subsystem consists of the in-containment refueling water storage tank, two containment recirculation screens, and the associated valves and piping that connect the tank and the screen to the reactor coolant system.

The IRWST has two injection lines, each of which connects to a direct vessel injection line, which inject into the reactor vessel downcomer. Each IRWST injection line contains an isolation valve, a flow tuning orifice, and four check valves (two parallel paths of two series check valves).

Each containment recirculation screen has two lines which join together before they connect to an IRWST injection line, upstream of its isolation valves. One of the two parallel recirculation lines from each screen contains two series check valves and the other line contains two series isolation valves.

The in-containment refueling water storage tank automatically provides flow through each injection line after the reactor coolant system has been depressurized sufficiently, so that the head of water in the tank can open the IRWST injection line check valves. Each IRWST injection line has a normally open, remotely-operated isolation valve which receives an open actuation signal from the protection and safety monitoring system and the diverse actuation system.

Containment recirculation initiates automatically through either the check valve or the remotely operated valve paths. The check valve paths open when the containment floodup elevation exceeds the IRWST level. The remotely operated valve recirculation flow path opens automatically on a signal from the protection and safety monitoring system.

The injection line and the recirculation line remote isolation valves can be manually actuated in the main control room or at the remote shutdown workstation via the protection and safety monitoring system, either individually or via system level actuations.

The valves that remotely actuate to initiate injection and recirculation flow receive power from Class 1E dc power sources.

X.X.5 pH Adjustment Tank

The pH adjustment tank provides the safety-related addition of a pH control agent to the containment in certain accident floodup conditions where core damage has occurred and core radioactivity has been released from the reactor coolant system into containment.

The pH adjustment tank subsystem consists of the pH adjustment tank and the associated valves and piping that allow the pH adjustment tank to drain to the containment.

The pH adjustment tank inlet line contains two parallel vacuum breakers. The pH adjustment tank discharge flow path contains two parallel isolation valves. The discharge flow path is cross connected downstream of the isolation valves. The path then divides into two lines providing flow to both containment screen areas.

The pH adjustment tank actuates on receipt of a signal from the protection and safety monitoring system. The actuation signal automatically opens the discharge isolation valves. When the pH adjustment tank actuates, the vacuum breakers on the tank inlet line provide air flow into the tank allowing it to drain to the containment.

The pH adjustment tank can also be manually actuated in the main control room or at the remote shutdown workstation via the protection and safety monitoring system by actuating the discharge isolation valves, either individually or via a system level actuation.

The valves that initiate pH adjustment tank flow receive power from Class 1E dc power sources.

Table PXS-1.1 - Passive Core Cooling System (PRHR Heat Exchangers) Inspections, Tests, Analyses and Acceptance Criteria		
Certified Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
1. The primary flow paths required to perform the safety-related functions, are included in the as-built configuration for the passive residual heat removal heat exchanger subsystem.	Visual inspections shall be conducted for the as-built passive residual heat removal heat exchanger subsystem.	1a. Verify that the as-built configuration of the primary flow paths for the passive residual heat removal heat exchanger subsystem are as follows: (1) A common inlet line from one of the reactor coolant system hot legs with remotely-operated isolation valve. (2) Two parallel heat exchangers, with individual isolation valves. (3) A common outlet line that connects to the steam generator cold leg channel head of the same reactor coolant system loop as the heat exchanger inlet piping. The outlet line contains two parallel isolation valves.
		1b. Verify that the elevation of the passive residual heat removal heat exchanger upper channel head centerline is higher than the hot leg piping top (outside surface) by: [$\geq$ 26.3] feet

Table PXS-1.1 - Passive Core Cooling System (PRHR Heat Exchangers)
Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
		1c. Verify that the elevation of the passive residual heat removal heat exchanger upper channel head centerline is higher than the lower channel head by: [≥ 17.5] feet
2. The passive residual heat removal heat exchanger inlet and outlet isolation valves open upon receipt of an actuation signal from the protection and safety monitoring system and the diverse actuation system.	Valve functional tests shall be conducted demonstrating proper valve operation in the presence of an actuation signal.	Verify that the following PRHR valves reposition as follows upon receipt of an actuation signal: PMS DAS Inlet isolation valve: Open N/A Outlet isolation valves: Open Open
3. The division assignment for valves and controls is such that the loss of any single 1E division will not prevent system safety function.	Tests shall be conducted to confirm actuation of the redundant outlet isolation valves is from different divisions.	Verify that the redundant outlet isolation valves actuate from different divisions.

Table PXS-1.1 - Passive Core Cooling System (PRHR Heat Exchangers)
Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
4. Each passive residual heat removal heat exchanger provides the required reactor coolant system heat removal.	A high pressure heat removal performance test for each passive residual heat removal heat exchanger shall be conducted to determine the heat transfer from the heat exchangers. The reactor coolant system shall be at hot standby conditions with the hot leg temperature between [550] and [560] F with the reactor coolant pumps stopped. The in-containment refueling water storage tank (IRWST) water level shall be at least [28 feet] above the tank bottom and the water temperature between [40] and [70] F.	Verify that the total heat transfer from each heat exchanger operating individually is: [≥ 1.3 E 8] BTU/hr [≤ 1.8 E 8] BTU/hr

Table PXS-1.2 - Passive Core Cooling System (Core Makeup Tanks)
Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The primary flow paths required to perform the safety-related functions are included in the as-built configuration for the core makeup tank subsystem.	Visual inspections shall be conducted for the as-built core makeup tank subsystem.	1a. Verify that the as-built configuration of the primary flow paths for the core makeup tank subsystem is as follows: (1) An inlet pressure balance line from the pressurizer with a remotely-operated isolation valve and two series check valves. (2) An inlet pressure balance line from one of the reactor coolant system cold legs with two parallel, remotely-operated inlet isolation valves. (3) An outlet discharge line that connects to one of the direct vessel injection lines, which injects into the reactor vessel downcomer. Each core makeup tank discharge line contains two parallel remotely-operated isolation valves, two series check valves, and a flow tuning orifice.
		1b. Verify that the elevation of the core makeup tank top (outside surface) is higher than the direct vessel injection nozzle centerline by: [≥ 28.5] feet

Table PXS-1.2 - Passive Core Cooling System (Core Makeup Tanks)
Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
2. The core makeup tank inlet and outlet isolation valves and the pressurizer pressure balance line isolation valves open upon receipt of an actuation signal from the protection and safety monitoring system and the diverse actuation system.	Valve functional tests shall be conducted demonstrating proper valve operation in the presence of an actuation signal.	Verify that the following CMT valves reposition as follows upon receipt of an actuation signal: PMS DAS Pzr line valves: Open N/A Cold leg line valves: Open Open Outlet line valves: Open Open
3. The division assignment for valves and controls is such that the loss of any single 1E division will not prevent system safety function.	Tests shall be conducted to confirm actuation of the redundant cold leg inlet line and outlet line isolation valves is from different divisions.	Verify that the redundant cold leg inlet and outlet line isolation valves actuate from different divisions.
4. Each core makeup tank provides the required injection flow to the reactor coolant system.	4a. A low pressure injection test for each core makeup tank shall be conducted to determine the CMT injection with air-compensated injection. The reactor vessel head and internals shall be removed, the reactor coolant system shall be empty, and the pressurizer and cold leg pressure balance lines isolation valves shall be open. Each core makeup tank shall be filled with water and the tank level change shall be used to determine the injection flow rate.	4a. Verify that the water injection from each core makeup tank with the tank water level [23] feet above the reactor vessel connection, is: [≥ 740] gpm [≤ 835] gpm

Table PXS-1.2 - Passive Core Cooling System (Core Makeup Tanks) Inspections, Tests, Analyses and Acceptance Criteria		
Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
	4b. A low pressure test shall be conducted for each CMT to determine the pressurizer balance line piping flow resistance. The reactor coolant system shall be at cold conditions with pressurizer full of water and with the RCPs stopped. The RCS pressure shall be between [30] and [50] psig. The CMT outlet isolation valves and the cold leg pressure balance lines isolation valves shall be closed. The pressurizer pressure balance line isolation valve shall be open. Each CMT shall be drained and vented to the containment.	4b. Verify that the piping flow resistance of the core makeup tank subsystem pressurizer pressure balance line piping for each core makeup tank is: [$\geq$ 5.8 E -4] ft/gpm^2 [$\leq$ 1.2 E -3] ft/gpm^2

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Table PXS-1.2 - Passive Core Cooling System (Core Makeup Tanks)
Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
	4c. A low pressure test shall be conducted for each CMT to determine the cold leg balance line piping flow resistance. The reactor coolant system shall at cold conditions with the pressurizer level between [40] and [50] percent and with the RCPs stopped. The RCS pressure shall be between [30] and [50] psig. The CMT outlet isolation valves and pressurizer pressure balance lines isolation valve shall be closed. The cold leg pressure balance line isolation valves shall be open. Each CMT shall be drained and vented to the containment.	4c. Verify that the piping flow resistance of the core makeup tank subsystem cold leg pressure balance line piping for each core makeup tank is: [≥ 6.9 E -6] ft/gpm² [≤ 9.3 E -6] ft/gpm²
5. The core makeup tank volume shall be sufficient to provide the required injection.	Visual inspections shall be conducted of each core makeup.	Verify that the volume of each core makeup tank is [≥ 2000] cubic feet.

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**Table PXS 1.3 - Passive Core Cooling System (Accumulators)
Inspections, Tests, Analyses and Acceptance Criteria**

Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The primary flow paths required to perform the safety-related functions are included in the as-built configuration for the accumulator tank subsystem.	Visual inspections shall be conducted for the as-built accumulator tank subsystem.	Verify that the as-built configuration of the primary flow paths for the accumulator subsystem is as follows: a. An outlet discharge line that connects to one of the direct vessel injection lines which injects into the reactor vessel downcomer. b. Each accumulator discharge line contains a discharge isolation valve, two series check valves, and a flow tuning orifice.
2. The accumulator discharge isolation valves open upon receipt of an actuation signal from the protection and safety monitoring system.	Valve functional tests shall be conducted demonstrating proper valve operation in the presence of an actuation signal.	Verify that the following accumulator valves reposition as follows upon receipt of an actuation signal: PMS DAS Discharge isolation valves: Open N/A
3. The division assignment for valves and controls is such that the loss of any single 1E division will not prevent system safety function.	Tests shall be conducted to confirm actuation of the discharge line isolation valve is from different 1E divisions.	Verify that the accumulator discharge line isolation valves operate from different 1E divisions.

Table PXS 1.3 - Passive Core Cooling System (Accumulators) Inspections, Tests, Analyses and Acceptance Criteria		
Certified Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
4. Each accumulator provides the required injection flow to the reactor coolant system.	A low pressure injection test for each accumulator shall be conducted to determine the accumulator injection flow capability. The reactor vessel head and internals shall be removed and the reactor coolant system shall be empty. Each accumulator shall be filled with water to between [1000] and [1100] ft^3 and pressurized with nitrogen to between [270] and [300] psig.	Verify that the accumulator discharge flow from each accumulator at a pressure of [200] psig is: [≥ 4300] gpm [≤ 4900] gpm
5. The accumulator volume shall be sufficient to provide the required injection.	Visual inspections shall be conducted of each accumulator tank.	Verify that the volume of each accumulator is [≥ 2000] cubic feet.

Table PXS-1.4 - Passive Core Cooling System (IRWST and Containment Recirculation) Inspections, Tests, Analyses and Acceptance Criteria		
Certified Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
1. The primary flow paths required to perform the safety-related functions are included in the as-built configuration for the IRWST and containment recirculstion subsystem.	Visual inspections shall be conducted for the as-built IRWST and containment recirculation subsystem.	1a. Verify that the as-built configuration of the primary flow paths for the IRWST and containment recirculation subsystem is as follows: (1) Two injection lines from the IRWST, one to each of the two direct vessel injection lines which inject into the reactor vessel downcomer. Each injection line contains an isolation valve, a flow tuning orifice, and four check valves (two parallel paths of two series check valves). (2) Two recirculation lines from each containment recirculation screen to one IRWST injection line, upstream of its isolation valves. One of the two parallel recirculation lines from each screen contains two series check valves and the other line contains two series isolation valves.
		1b. Verify that the elevation of the overflow level in the IRWST is higher than the direct vessel injection nozzle centerline by: [$\geq$ 32] feet

Table PXS-1.4 - Passive Core Cooling System (IRWST and Containment Recirculation) Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
2. The IRWST injection line discharge isolation valves open upon receipt of an actuation signal from the protection and safety monitoring system and the diverse actuation system.	Valve functional tests shall be conducted demonstrating proper valve operation in the presence of an actuation signal.	Verify that the following IRWST valves reposition as follows upon receipt of the actuation signal: PMS DAS IRWST injection line valves: Open Open
3. The containment recirculation line isolation valves open upon receipt of an actuation signal from the protection and safety monitoring system.	Valve functional tests shall be conducted demonstrating proper valve operation in the presence of an actuation signal.	Verify that the following recirculation valves reposition as follows upon receipt of the actuation signal: PMS DAS Containment recirc line valves: Open N/A
4. The division assignment for valves and controls is such that the loss of any single 1E division will not prevent system safety function.	Tests shall be conducted to confirm actuation of the redundant injection line and recirculation line isolation valves is from different divisions.	Verify that the redundant injection line isolation valve and the redundant recirculation line isolation valves actuate on different divisions.
5. The IRWST provides the required injection flow to the reactor coolant system.	A test for each injection line shall be conducted to determine the injection flow capability. The reactor head and internals shall be removed and the reactor coolant system shall be empty. The IRWST shall be partially filled with water, with a water level at least [18] feet above the reactor vessel connection.	Verify that the IRWST flow from each injection line into the reactor vessel injection connection, with the IRWST water level [16] feet above the reactor vessel connection, is: [≥ 345] gpm [≤ 1000] gpm

Table PXS-1.4 - Passive Core Cooling System (IRWST and Containment Recirculation) Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
6. The containment recirculation lines provides the required recirculation flow to the reactor coolant system.	A test for each containment recirculation screen line shall be conducted to determine the flow capability. The reactor head shall be removed and the reactor coolant system shall be empty. A temporary water supply shall be connected to the recirculation line with a water level of at least [10] feet above the reactor vessel injection connection.	Verify that the containment recirculation flow for each recirculation line into the reactor vessel injection connection, with the injection water level [8] feet above the reactor vessel injection connection, is: [≥ 100] gpm [≤ 455] gpm
7. The IRWST volume is sufficient to provide the required injection.	Visual inspections shall be conducted of the IRWST.	Verify that the volume of the IRWST below the tank overflow elevation is [≥ 73000] cubic feet.
8. The containment flooded volume and elevation head shall be sufficient to provide the required recirculation.	Visual inspections shall be conducted of the floodable containment volume.	Verify that the total floodable volume in the containment for all compartments, with the exception of the chemical and volume control system equipment areas, at an elevation that is [8] feet above the direct vessel injection nozzle centerline is: [≤ TBD] cubic feet

Table PXS-1.5 - Passive Core Cooling System (pH Adjustment Tank) Inspections, Tests, Analyses and Acceptance Criteria		
Certified Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
1. The primary flow paths required to perform the safety-related functions are included in the as-built configuration for the pH adjustment tank subsystem.	Visual inspections shall be conducted for the as-built pH adjustment tank subsystem.	1a. Verify that the as-built configuration of the primary flow paths for the pH adjustment tank subsystem is as follows: (1) The tank inlet line contains two parallel vacuum breakers. (2) A discharge line connects to the tank bottom and drains to both containment recirculation screen areas. The pH adjustment tank discharge flow path contains two parallel isolation valves. The discharge flow path divides into two cross-connected lines, downstream of the isolation valves, to provide flow to both containment screen areas.
		1b. Verify that the tank bottom (outside surface) is located [≥ 12] feet above the reactor vessel injection connection.

Table PXS-1.5 - Passive Core Cooling System (pH Adjustment Tank) Inspections, Tests, Analyses and Acceptance Criteria		
Certified Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
2. The pH adjustment tank vacuum breakers self-actuate open and the discharge isolation valves open upon receipt of an actuation signal from the protection and safety monitoring system.	Valve functional tests shall be conducted demonstrating proper valve operation in the presence of an actuation signal. The pH adjustment tank shall be partially filled with water, at atmospheric pressure, without nitrogen makeup to the tank. A separate test will be conducted for each discharge isolation valve. One vacuum breaker valve shall be gagged for each test.	Verify vacuum breaker operation and discharge valve actuation by observing pH adjustment tank flow through the discharge lines to both containment sumps. Verify that the tank empties in less than [100] minutes. Verify that the volume of water that drains to each screen area is [≥ 40] percent of the initial tank test volume.
3. The division assignment for valves and controls is such that the loss of any single 1E division will not prevent system safety function.	Tests shall be conducted to confirm actuation of the redundant discharge line isolation valves is from different divisions.	Verify that the redundant discharge line isolation valve actuates from different divisions.
4. The pH adjustment tank volume is sufficient to provide the required containment pH.	Visual inspection of the pH adjustment tank shall be conducted.	Verify that the total pH adjustment tank volume is [≥ 160] cubic feet.

X.X ONSITE STANDBY POWER SYSTEM

Design Description

The Onsite Standby Power System (ZOS) serves no safety-related function, and therefore, has no nuclear safety design basis. ZOS supplies ac power to the following systems loads that are automatically connected to the diesel buses in a predetermined time sequence:

a. the Class 1E Direct Current and UPS System,

b. the selected electrical components of the plant defense-in-depth non safety-related systems listed below:

- Component Cooling Water System
- Chemical and Volume Control System
- Standby Diesel Fuel Oil subsystem
- Non-Class 1E DC and UPS System
- Startup Feedwater subsystem
- Pressurizer Heaters
- Normal Residual Heat Removal System
- Spent Fuel Pit Cooling System
- Service Water System
- Normal Residual Heat Removal Pump Room Ventilation subsystem
- Chemical and Volume Control Pump Room Ventilation subsystem
- Nuclear Island Nonradioactive Ventilation System
- Containment Hydrogen Control System
- Central Chilled Water System
- Diesel Generator Building Ventilation System
- Onsite Standby Power System.

These systems loads are divided into two functionally redundant load groups each supplied by a separate diesel generator. See Table ZOS-2.

ZOS includes two onsite standby diesel generator units that supply power to the associated ac power distribution system buses. Each diesel generator unit is complete with its own support subsystems that include:

- Diesel Engine Starting Subsystem
- Combustion Air Intake and Engine Exhaust Subsystem
- Engine Cooling Subsystem
- Engine Lubricating Oil Subsystem
- Engine Speed Control Subsystem
- Static exciter, generator protection, monitoring instruments and control subsystems.

Each diesel-generator unit has minimum rated output of [2736] kw necessary to power the selected system components as listed in Table ZOS-2.

Each diesel-generator unit is capable of automatically starting and connecting to its associated bus within [20] seconds in the event of a loss of voltage on these buses.

Each diesel generator supplies power at the nominal voltage and frequency ratings of the plant medium voltage bus.

Table ZOS-1 - Onsite Standby Power System
Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analysis	Acceptance Criteria
1. In the event of loss of voltage on the diesel generator backed buses, each diesel generator automatically starts and connects to its associated bus.	Verify that each diesel generator automatically starts and connects to its associated bus in the event of loss of voltage on that bus. Measure the time from the instant of loss of bus voltage signal to the instant rated voltage reappears on the bus.	On receipt of loss of D/G backed bus voltage signal, each of the diesel generator starts and powers the associated bus - at the rated [60 ±TBD] hz frequency and [4160 ±TBD] volts voltage - within [20] seconds.
2. The selected systems loads are automatically connected to the diesel backed buses per predetermined loading sequence as shown in Table ZOS-2.	A test shall be performed to verify that each automatic load sequencer connects the selected systems loads to the associated bus in a predetermined time sequence. This test can be performed by verifying the individual load breaker operating in TEST position.	The test results verify that the selected systems load breakers close in a predetermined time sequence as identified in Table ZOS-2.
3. Each diesel-generator shall be able to operate at the rated load capacity, required to supply the selected defense-in-depth systems loads, as listed in Table ZOS-2 simultaneously.	Operate the diesel generator at minimum [TBD: 2736] kw capacity for a time required to reach engine temperature equilibrium plus one hour. Measure the fuel consumption. (Note: The fuel consumption measurements is for the use in DOS system ITAAC.)	The test results verify that each diesel generator can support the plant defense-in-depth loads continuously without exceeding the design temperature limits. Test readings verify that the fuel consumption was measured.

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Table ZOS-1 - Onsite Standby Power System
Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analysis	Acceptance Criteria
4. The diesel generator governor and excitation/voltage regulator can provide ac power to the defense-in-depth loads at the rated [4160 ±TBD] volts voltage and rated [60 ±TBD] hz frequency during automatic load sequencing as stated in Table ZOS-2.	A test shall be performed either in the vendor shop or in the field to measure the voltage and frequency readings when: a) the D/G is operating at no load and is subject to a stepload of [TBD:] kw, b) the D/G is operating at [TBD:] percent capacity and is subjected to a stepload of [TBD:] at [TBD:] seconds, c) Repeat the steps as necessary to simulate the largest incremental loading at time interval [TBD:] seconds. Analyze the shop/field tests to ensure that the test conditions envelop the automatic load sequence profile identified in Table ZOS-2.	The test results and the associated analysis verify that the defense-in-depth loads receive ac power at the voltage and frequency values within design limits during and on completion of the load sequencing.

TABLE ZOS-2
ONSITE STANDBY POWER SYSTEM
LIST OF DEFENSE-IN-DEPTH SYSTEM COMPONENTS
SUPPLIED FROM DIESEL GENERATOR NO. 2

S. NO.	LOAD DESCRIPTION	LOADING METHOD	TIME SEQ.(SEC.)
1.	Start-up Feed Water Pump B	AUTO	[5]
2.	Component Cooling Water Pump B	AUTO	[30]
3.	Residual Heat Removal Pump B	AUTO *	[700]
4.	Pressurizer Heaters	AUTO *	[800]
5.	Spent Fuel Cooling Pump B	AUTO *	[700]
6.	Make-Up Pump B	AUTO *	[900]
7.	Service Water Pump 2	AUTO	[60]
8.	D/G Radiator Fans	AUTO	[0]
9.	D/G Building Vent Fans	AUTO	[60]
10.	D/G Primary AHU B	AUTO	[60]
11.	D/G Day Tank Vault Exhaust Fan B	AUTO	[120]
12.	D/G Fuel Oil Transfer Pump B	AUTO	[0]
13.	N-1E Battery Charger 2	AUTO	[0]
14.	N-1E Battery Charger 2	AUTO	[0]
15.	N-1E Regulating XFMR 2	AUTO	[0]
16.	N-1E Regulating XFMR 4	AUTO	[0]
17.	Main Control Room/TSC Supply Fan B	AUTO	[120]
18.	Main Control Room/TSC Recirc. Fan B	AUTO	[120]

TABLE ZOS-2
ONSITE STANDBY POWER SYSTEM
LIST OF DEFENSE-IN-DEPTH SYSTEM COMPONENTS
SUPPLIED FROM DIESEL GENERATOR NO. 1

SL. NO.	LOAD DESCRIPTION	LOADING METHOD	TIME SEQ. (SEC.)
1.	Start-up Feedwater Pump A	AUTO	[5]
2.	Component Cooling Water Pump A	AUTO	[30]
3.	Residual Heat Removal Pump A	AUTO *	[700]
4.	Pressurizer Heaters	AUTO *	[800]
5.	Spent Fuel Cooling Pump A	AUTO *	[700]
6.	Make-Up Pump A	AUTO *	[900]
7.	Service Water Pump 1	AUTO	[60]
8.	D/G Radiator Fans	AUTO	[0]
9.	D/G Building Vent Fans	AUTO	[60]
10.	D/G Primary AHU A	AUTO	[60]
11.	D/G Day Tank Vault Exhaust Fan A	AUTO	[120]
12.	D/G Fuel Oil Transfer Pump A	AUTO	[0]
13.	N-1E Battery Charger 1	AUTO	[0]
14.	N-1E Battery Charger 3	AUTO	[0]
15.	N-1E Regulating XFMR 1	AUTO	[0]
16.	N-1E Regulating XFMR 3	AUTO	[0]
17.	Main Control Room/TSC Supply Fan A	AUTO	[120]
18.	Main Control Room/TSC Recirc. Fan A	AUTO	[120]

NOTES:
1. Loads identified as 'AUTO *' will be energized in response to the process system automatic sensor controls after the set time sequence delay.
2. Loads identified as 'AUTO' energized after the set time sequence delay.
3. All values in the 'Time Sequence' column are nominal and include ± tolerance [TBD]. The time sequence delay, in seconds, is counted from the instant the diesel generator is connected to its associated bus.

TABLE ZOS-2
ONSITE STANDBY POWER SYSTEM
LIST OF DEFENSE-IN-DEPTH SYSTEM COMPONENTS
SUPPLIED FROM DIESEL GENERATOR NO. 1

SL. NO.	LOAD DESCRIPTION	LOADING METHOD	TIME SEQ.(SEC.)
19.	CL 1E DC SWGR. Room Supply Fan A	AUTO	[120]
20.	CL 1E DC SWGR. Room Exhaust Fan A	AUTO	[120]
21.	CL 1E Div A/C Battery Room Exhaust Fan A	AUTO	[300]
22.	RHR Compartment Unit Cooler A	AUTO *	[700]
23.	Make-Up Pump Compartment Unit Cooler A	AUTO *	[700]
24.	Main Control Room & SWGR Rooms Air-Cooled Chiller 2	AUTO	[300]
25.	Chilled Water Low Cap. Pump 2	AUTO	[600]
26.	Supplemental Air Filtration System Fan A	AUTO	[120]
27.	Supplemental Air Filtration System Electric Heater A	AUTO	[120]
28.	CL-1E Div. A Battery Charger 1	AUTO	[0]
29.	CL-1E Div. C Battery Charger 1	AUTO	[0]
30.	CL-1E Div. C Battery Charger 2	AUTO	[0]
31.	CL-1E Div. A Regulating XFMR 1	AUTO	[0]
32.	CL-1E Div. C Regulating XFMR 1	AUTO	[0]
33.	Hydrogen Ignitors	AUTO *	[700]

X.X PROTECTION AND SAFETY MONITORING SYSTEM

Design Description

The Protection and Safety Monitoring System (PMS) for the AP600 provides the following safety-related functions:

- Tripping the reactor by opening the reactor trip breakers.

- Actuation of the engineered safety features equipment.

- Safety-related plant parameter monitoring prior to, during, and after an accident or plant transient.

For this design description, the PMS consists of the sensors, detectors, signal conditioning, data acquisition, data processors, datalinks and data highways, operator interfaces, displays, and other equipment necessary for the execution of the functions of the system. The PMS for the AP600 implements its functions by software logic installed in programmable digital devices (data processors). Plant data and other signals are exchanged between data processors by means of isolated datalinks and data highways.

The necessary sensors and logic for generating the reactor trips, engineered safety features actuations, and safety-related plant parameter monitoring are discussed within this design description. PMS components and equipment are electrically isolated from nonsafety-related plant instrumentation and electrical equipment. Signals from the PMS to other plant instrumentation and control systems, such as the plant control system and the data display and processing system, are transmitted through isolation devices. Certain sensor signals originating in the PMS are shared with the diverse actuation system through isolation devices.

The PMS is a four division system which automatically or manually initiates a reactor trip or engineered safety features actuation coincident with a single failure in the PMS. Additionally, the PMS protects against unnecessary reactor trips or engineered safety features actuations resulting from single failures in the PMS. Loss of power or input signals, or disconnection of portions of the system results in a trip or actuation initiating state.

Reactor Trip Function

The reactor trip function of the PMS is implemented by plant sensors, the reactor trip processors, and the reactor trip switchgear. The reactor is tripped by opening the circuit breakers in the reactor trip switchgear, thereby removing electrical power to the control rod drive mechanisms, causing the control rods to drop into the reactor core due to gravity. The reactor trip breakers are arranged so that tripping any two out of four divisions results in interruption of power to the control rod drive mechanisms. Tripping any single division will not interrupt power to the control rod drive mechanisms. Once a reactor trip has been initiated, the reactor trip breakers in the reactor trip switchgear latch open, and must be manually reset before the control rods can be withdrawn.

The reactor trip function utilizes the four independent PMS divisions, using 2-out-of-4 logic for automatic trips based on plant sensor inputs. The manual reactor trip function uses 1-out-of-2 logic.

The sensors monitor plant conditions and send signals to the reactor trip processors where these signals are compared to setpoints. When two or more unbypassed signals monitoring the same plant parameter in different divisions exceed the setpoint, and permissive or interlock logic is satisfied, a reactor trip is initiated. Plant parameters that are monitored to produce a reactor trip include:

- Neutron flux

- Reactor coolant pump speed
- Reactor coolant flow
- Overtemperature ΔT
- Overpower ΔT
- Pressurizer level
- Pressurizer pressure
- Steam generator level
- Reactor trip on safeguards actuation.

A manual reactor trip and a reactor trip on manual safeguards actuation are implemented by directly opening the reactor trip switchgear.

Engineered Safety Features Functions

The engineered safety features functions of the PMS are implemented by plant sensors, the engineered safety features processors, the engineered safety features actuation processors, the protection logic, the logic buses, and manual actuation devices. The protection logic provides actuating signals to operate the plant components. Several engineered safety features sensors are shared with the reactor trip function.

The engineered safety features functions utilize the four independent PMS divisions, using 2-out-of-4 logic for automatic actuations based on sensor inputs. An exception is the startup feedwater signal, which utilizes two divisions and 1-out-of-2 logic. Manual, systems level actuations are provided for individual functions.

The sensors monitor plant conditions and send signals to the engineered safety features processors, where these signals are compared to setpoints. When two or more unbypassed signals monitoring the same plant parameter in different divisions exceed the setpoint, and permissive or interlock logic is satisfied, a system level actuation signal is produced in the engineered safety features actuation processors. This system level signal is transmitted to the associated protection logic in the same division by the logic bus data highway. The protection logic then provides actuation signals to the component if the component interlock logic is satisfied. Plant parameters that are monitored to produce engineered safety features functions include:

- Neutron flux
- Pressurizer pressure
- Pressurizer level
- Steam generator level
- Steam line pressure
- Cold leg temperature
- Startup feedwater flow
- Containment pressure
- Core makeup tank level.

The engineered safety features actuation signals include:

- Safeguards actuation
- Passive residual heat removal
- Core makeup tank injection
- Reactor coolant pump trip
- Containment cooling
- Containment isolation
- Main feedwater line isolation
- Steam line isolation
- Reactor coolant system depressurization
- Startup feedwater isolation
- Chemical volume control system isolation.
- Turbine trip
- Steam generator blowdown system isolation
- Block of boron dilution
- Block steam dump
- Letdown line isolation
- Containment sump pH control
- Normal residual heat removal system isolation

Safety-Related Plant Parameter Monitoring Function

The safety-related plant parameter monitoring function is implemented by plant sensors, communications processors or data acquisition processors, qualified display processors, and qualified operator displays. Plant sensors may be shared with the reactor trip and engineered safety features functions. For plant sensors shared with either of these functions, data acquisition takes place at the communications processors, for sensors which are not shared, data acquisition is performed by the qualified display data acquisition processors. The plant data is then transmitted to the qualified display processors, where it is prepared for display on the qualified operator displays.

The safety-related plant parameter monitoring function utilizes two of the four independent PMS divisions. A minimum of two operator display devices, one per division, are provided at each location. Operator display devices are provided in the main control room and at the remote shutdown workstation.

The sensors monitor plant conditions and send signals to either the communications processors, or the qualified display data acquisition processors. This data is transmitted to the qualified display processors, where it is collected, organized, and prepared for display. The final data is displayed on the qualified operator displays. The plant parameters that are collected and displayed by the safety-related plant parameter monitoring function include:

- Reactor coolant system pressure
- Reactor coolant system temperature
- Pressurizer level
- Neutron flux
- Containment water level
- Core exit temperature
- Passive residual heat removal heat exchanger outlet temperature
- Passive residual heat removal flow
- Incontainment refueling water storage tank water level
- Passive containment cooling flow
- Passive containment cooling storage tank level
- Containment pressure
- Containment radiation
- Containment hydrogen concentration
- Pressurizer safety valve status
- Automatic depressurization system first stage valve status
- Automatic depressurization system second stage valve status
- Automatic depressurization system third stage valve status
- Automatic depressurization system fourth stage valve status.

Table PMS-1 - Protection and Safety Monitoring System Inspections, Tests, Analyses and Acceptance Criteria		
Certified Design Commitment	**Inspections, Tests, Analysis**	**Acceptance Criteria**
1. The protection and safety monitoring system performs the safety-related reactor trip, engineered safety features actuation, and plant parameter monitoring functions.	1(a). System functional tests shall be conducted to verify that reactor trip breakers open when system logic has been satisfied.	1(a). Reactor trip breakers open when trip logic is satisfied from the following plant parameters: • Neutron flux • Reactor coolant pump speed • Reactor coolant flow • Overtemperature ΔT • Overpower ΔT • Pressurizer level • Pressurizer pressure • Steam generator level
1. (continued)	1(b). System functional tests shall be conducted to verify that engineered safety features actuation signals are initiated when system logic has been satisfied.	1(b). Component actuation signals are generated when engineered safety features actuation logic is satisfied from the following plant parameters: • Neutron flux • Pressurizer pressure • Pressurizer level • Steam generator level • Steam line pressure • Cold leg temperature • Startup feedwater flow • Containment pressure • Core makeup tank level

Table PMS-1 - Protection and Safety Monitoring System
Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analysis	Acceptance Criteria
1. (continued)	1(c). An inspection shall be performed to verify that the designated plant parameters are displayed.	1(c). The Protection and Safety Monitoring System displays the following plant parameters in the main control room and at the remote shutdown workstation: • Reactor coolant system pressure • Reactor coolant system temperature • Pressurizer level • Neutron flux • Containment water level • Core exit temperature • Passive residual heat removal system heat exchanger outlet temperature • Passive residual heat removal flow • Incontainment refueling water storage tank water level • Passive containment cooling flow • Passive containment cooling storage tank level • Containment pressure • Containment radiation • Containment hydrogen concentration • Pressurizer safety valve status • ADS system first stage valve status • ADS second stage valve status • ADS third stage valve status • ADS fourth stage valve status

Table PMS-1 - Protection and Safety Monitoring System
Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analysis	Acceptance Criteria
1. (continued)	1(d). System functional tests shall be conducted to verify that operational permissives and interlocks are generated and removed when system logic has been satisfied.	1(d). Operational permissives and interlocks are generated and removed when reactor trip and engineered safety features actuation logic is satisfied from the following plant parameters: • Neutron flux • Pressurizer pressure

Table PMS-1 - Protection and Safety Monitoring System
Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analysis	Acceptance Criteria
2. The Protection and Safety Monitoring System design provides timely initiation of safety-related reactor trip and engineered safety features actuations.	2(a). Tests shall be conducted to measure the response times to initiate reactor trip when trip setpoints have been exceeded. Time response is defined as the maximum allowable time for the reactor trip breakers to open following a step change by a simulated sensor from 5% below the setpoint to 5% above the setpoint with each externally adjustable time delay set to OFF.	2(a). The time to satisfy trip logic, the trip signal to reach the reactor trip breakers, and the reactor trip breakers to open is less than or equal to the time response requirement listed for the following channels: • Power range neutron flux $\leq$ [TBD sec] • Reactor coolant pump speed $\leq$ [TBD sec] • Reactor coolant flow $\leq$ [TBD sec] • Overtemperature $\Delta T \leq$ [TBD sec] • Overpressure $\Delta T \leq$ [TBD sec] • Pressurizer level $\leq$ [TBD sec] • Pressurizer pressure $\leq$ [TBD sec] • Steam generator narrow range level $\leq$ [TBD sec]

Table PMS-1 - Protection and Safety Monitoring System Inspections, Tests, Analyses and Acceptance Criteria		
Certified Design Commitment	**Inspections, Tests, Analysis**	**Acceptance Criteria**
2. (continued)	2(b). Tests shall be conducted to measure the response times to initiate engineered safety features actuation signals when trip setpoints have been exceeded. Time response is defined as the maximum allowable time for component actuation signals to be produced following a step change by a simulated sensor from 5% below the setpoint to 5% above the setpoint with each externally adjustable time delay set to OFF. Time response shall not include the engineered safety features components.	2(b). The time to satisfy engineered safety features actuation logic and the component actuation signal to be produced is less than or equal to the time response requirement listed for the following channels: • Source range neutron flux (rate) ≤ [TBD sec] • Pressurizer pressure ≤ [TBD sec] • Pressurizer level ≤ [TBD sec] • Steam generator narrow range level ≤ [TBD sec] • Steam generator wide range level ≤ [TBD sec] • Steam line pressure ≤ [TBD sec] • Cold leg temperature ≤ [TBD sec] • Startup feedwater flow ≤ [TBD sec] • Containment pressure ≤ [TBD sec] • Core makeup tank level ≤ [TBD sec]

Table PMS-1 - Protection and Safety Monitoring System
Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analysis	Acceptance Criteria
3(a). The Protection and Safety Monitoring System provides a manual reactor trip capability.	3(a). The manual reactor trip switches shall be tested.	3(a). The reactor trip breakers open when the manual reactor trip switches are operated.
3(b). The Protection and Safety Monitoring System initiates a reactor trip coincident with manual safeguards actuation.	3(b). The manual safeguards actuation switches shall be tested.	3(b). The reactor trip breakers open when the manual safeguards actuation switches are operated.
3(c). The Protection and Safety Monitoring System provides manual engineered safety features actuation capability.	3(c). The following manual engineered safety features actuation switches shall be tested: • Manual safeguards actuation • Manual passive residual heat removal actuation • Manual steam line isolation • Manual steam/feedwater isolation • Manual feedwater isolation • Manual containment coolong actuation • Manual containment isolation actuation • Manual depressurization system actuation	3(c). Component actuation signals are generated in accordance with engineered safety features actuation logic when manual engineered safety features actuation switches are operated.

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Table PMS-1 - Protection and Safety Monitoring System Inspections, Tests, Analyses and Acceptance Criteria		
Certified Design Commitment	**Inspections, Tests, Analysis**	**Acceptance Criteria**
4. The four redundant divisions of Protection and Safety Monitoring System equipment are independent from each other except for isolated data communications required for voting logic. The four redundant divisions of Protection and Safety Monitoring System equipment are powered from independent power sources.	4. One Protection and Safety Monitoring System division shall be selected and deenergized. The tests of ITAACs 1(a), 1(b), 1(c), and 1(d) shall be repeated.	4. The acceptance criteria is the same as the acceptance criteria for ITAACs 1(a), 1(b), 1(c), and 1(d) except for the division that is deenergized.

X.X SERVICE WATER SYSTEM

Design Description

The service water system (SWS) serves no safety-related function and therefore has no nuclear safety design basis.

The service water system supplies cooling water to remove heat from nonsafety-related heat exchangers in the turbine building. This is achieved by pumping water through heat exchangers where heat is removed from the component cooling water system.

The service water system provides the defense-in-depth function of removing heat from the component cooling water system for all modes of operation. It removes heat from the spent fuel pool via the spent fuel cooling and component cooling water systems. During plant shutdown, the service water system provides an additional defense-in-depth function of decay heat removal through the normal residual heat removal system and the component cooling water system. The system is available during loss of offsite power conditions. The system consists of redundant pumps together with associated piping, valves, and controls.

Table SWS-1 - Service Water System Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analysis**	**Acceptance Criteria**
1. The service water system shall provide sufficient flow to the component cooling water system (CCS) to provide the defense-in-depth functions of decay heat removal and spent fuel cooling.	The service water system performance shall be validated by a service water system test. The test will be performed with one of the redundant pumps operating, the pump suction source at its minimum operating level, and with one component cooling water heat exchanger and one turbine building closed cooling water heat exchanger in service. This test will be repeated for the other pump.	The flow delivered to one of the component cooling water system heat exchangers shall be at least [TBD] gpm.
2. Flowpaths exist to both of the component cooling water heat exchangers with the turbine building closed cooling water system heat exchangers isolated on loss of air or loss of electrical power.	The test shall be conducted to verify on loss of air or power that a flow path exists to both component cooling water heat exchangers and that a flow path is isolated for both turbine building closed cooling water heat exchangers.	Inspection of the valves shall confirm that the valves are in the open position for each of the component cooling water heat exchanger remote operated isolation valves and that the remote operated isolation valves for the turbine building closed cooling water heat exchangers are in a closed position on both loss of air and loss of power.
3. The service water system shall provide sufficient cooling to the component cooling water system to perform the defense-in-depth functions of normal residual heat removal and spent fuel pool cooling.	A test shall be conducted to verify that the service water system provides sufficient heat transfer capability at site-limiting environmental conditions. The test can be conducted at any environmental conditions and the results extrapolated to the limiting condition.	The calculated minimum heat rejection capability of the service water system for defense-in-depth cooling is at least [TBD] Btu/hr after extrapolating the measured value.

X.X STEAM GENERATOR SYSTEM

Design Description

The Steam Generator System (SGS) is safety-related system and is made up of the safety-related portions of the main steam, main feedwater, startup feedwater and blowdown lines connected to the steam generator. The safety-related portions of the steam generator system include:

- That portion of each main steam line from the steam generator outlet nozzle up to and including the piping anchors at the auxiliary building/turbine building wall. Within this safety-related portion of the main steam line are the main steam and bypass isolation valves and connected upstream of these valves, the power operated relief and block valves, the two series condensate drain isolation valves and the three safety valves.

- That portion of each main feedwater line from the steam generator feedwater nozzle up to and including the feedwater control valve. Within this portion of the feedwater line are the main feedwater isolation valve and the downstream feedwater check valve.

- That portion of each startup feedwater line from the connection to feedwater line out to the restraint at the auxiliary building/turbine building wall. The line includes the startup feedwater control valve and a downstream startup feedwater isolation valve.

- That portion of each steam generator blowdown line from the steam generator blowdown outlet nozzle up and including the second steam generator isolation valve. Within this safety-related portion of the line are the two remotely operated isolation valves in series.

The SGS performs the following safety and defense in depth functions.

Safety Functions:

- The SGS provides overpressure protection for the steam generator secondary side, as well as portions of the main steam line, feedwater lines and blowdown lines by means of the safety relief valves for events that result in steam generator pressure transients. Three safety valves are provided on each main steam line.

- During design basis accidents, the SGS in conjunction with the main steam system prevents excessive steam generator blowdown and excessive feedwater flow from the main and startup feedwater system. This function is accomplished via isolation of the main feedwater, startup feedwater, blowdown and main steam lines.

- In the event of feedwater unavailability, the SGS removes decay heat from the reactor coolant by releasing the steam generated from the steam generator inventory to the atmosphere via the safety valves.

- The portion of the SGS inside containment is an integral part of the containment isolation boundary and limits radioactive releases to the environment. The inside containment isolation function (isolating the reactor coolant system and containment atmosphere from the environment) is provided by the steam generator, tubes, and SGS lines inside containment, while isolation outside containment is provided by manual and automatic valves. See the containment system ITAACs, Section X.X.

- The SGS system, in conjunction with passive core cooling and chemical and volume control system safety features is designed to avoid steam line flooding after a steam generator tube rupture accident and thus serves to limit t' releases to the environment. The SGS features include provisions for steamline, feedline, and blowdown line isolation.

Defense-in-Depth:

- During shutdown operations, the SGS removes decay heat by delivery of feedwater from the startup feedwater system to the steam generator and venting of steam from the steam generators to the atmosphere via the power operated relief valves.

The valves and controls necessary for system actuation and control are powered from the Class 1E dc power system. The division assignment for valves and controls is such that the loss of any single Class 1E power division will not prevent system safety functions

The steam generator system in combination with other safety-related systems is designed such that no single failure in the SGS will prevent the systems from accomplishing identified safety functions.

In order to provide accident mitigation functions, the SGS valves close on the appropriate isolation signal. The isolation signal may be generated automatically or manually at a system level and manually at the valve level within the protection and safety monitoring system. The manual and protection and safety monitoring system signals can be initiated from either the main control room or the remote shutdown workstation.

Table SGS-1 - Steam Generator System
Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analysis	Acceptance Criteria
1. The SGS provides overpressure protection for the secondary side of the steam generator and the SGS piping by means of the safety relief valves.	Inspections shall be conducted to confirm valve vendor code plate rating is greater than or equal to system relief requirements.	The sum of the rated capacities of the three valves in each main steam line shall exceed [TBD] lb/hr as recorded on the valve vendor code plates.
	Tests shall be conducted to confirm the safety valve provides overpressure protection.	The set pressures of the three safety valves are: [1085] psig ± [TBD] psig [1113] psig ± [TBD] psig [1140] psig ± [TBD] psig
2. The SGS isolates the main feedwater, startup feedwater, blowdown and main steam lines. The isolation valves close upon receipt of manual or automatic actuation signals from the protection and safety monitoring system.	Valve functional tests shall be conducted demonstrating proper valve operation in the presence of an actuation signal.	The main steam isolation, feedwater isolation and feedwater control valves shall close within [5] seconds upon receipt of an actuation signal. The startup feedwater isolation and control valves, blowdown isolation valves, MSIV bypass valve and condensate drain valves shall close within [10] seconds upon receipt of an actuation signal. The power operated relief valve and PORV block valve shall close upon reciept of an actuation signal.

Table SGS-1 - Steam Generator System
Inspections, Tests, Analyses and Acceptance Criteria

Certified Design Commitment	Inspections, Tests, Analysis	Acceptance Criteria
3. The division assignment for isolation valves and controls is such that the loss of any single 1E division shall not prevent system safety function.	With the loss of any single Class 1E power/protection division, tests shall be conducted to confirm remote automatic isolation of main steam, main and startup feedwater, and steam generator blowdown lines.	Signals for isolation valves within the main steamlines, main and startup feedwater lines, and blowdown lines are generated to provide for isolation of each line.
4. The SGS removes decay heat by delivery of feedwater from the startup feedwater system to the steam generator and steam from the steam generators to the atmosphere.	Valve functional tests shall be conducted demonstrating proper valve operation in the presence of actuation signals from the plant control system or the protection and safety monitoring system.	The startup feedwater isolation valve and control valve and the power operated relief valve and block valve shall open upon receipt of an actuation signal.