Appendix 7A. Tables

Table 7-1. List of Reactor Trips

Reactor Trip	Coincident Logic	Interlocks	Comments
High neutron flux (Power Range)	2/4	Manual block of low setting permitted by P-10	High and low settings; manual block and automatic reset of low setting by P-10
Intermediate range neutron flux	1/2	Manual block permitted by P-10	Manual block and automatic reset
Source range neutron flux	1/2	Manual block permitted by P-6, interlocked with P-10	Manual block and automatic reset. Automatic block above P-10
Power range high positive neutron flux rate	2/4	No interlocks	
Overtemperature ΔT	2/4	No interlocks	
Overpower ΔT	2/4	No interlocks	
Pressurizer low pressure	2/4	Interlocked with P-7	Blocked below P-7
Pressurizer high pressure	2/4	No interlocks	
Pressurizer high water level	2/3	Interlocked with P-7	Blocked below P-7
Low reactor coolant flow	2/3	Interlocked with P-7 and P-8	Low flow in one loop will cause a reactor trip when above P-8 and a low flow in two loops will cause a reactor trip when above P-7. Blocked below P-7
Reactor coolant pump under voltage	2/4	Interlocked with P-7	Low voltage to RCP motors permitted below P-7; Reactor trip blocked below P-7.
Reactor coolant pump bus under-frequency	2/4	Interlocked with P-7	Under frequency on 2 buses will trip all reactor coolant pump breakers and cause reactor trip; reactor trip blocked below P-7
Low-Low steam generator water level	2/4 in any loop	No interlocks	

Reactor Trip	Coincident Logic	Interlocks	Comments
Safety injection signal	Coincident with actuation of safety injection	No interlocks	(See Section 7.3 for Engineered Safety Features actuation conditions)
Manual	1/2	No interlocks	
Turbine-Generator Trip			
1. Low Auto Stop Oil Pressure	2/3	Interlocked with P-8	Blocked below P-8
2. Turbine Stop Valve Closed	4/4	Interlocked with P-8	Blocked below P-8

Table 7-2. Protection System Interlocks

Designation	Derivation	Function
I	POWER ESCALATION PERMISSIVES	
P-6	1/2 Neutron flux (intermediate- range) above setpoint	Allows manual block of source range reactor trip
	2/2 Neutron flux (intermediate- range) below setpoint	Defeats the block of source range reactor trip
P-10	2/4 Neutron flux (power-range) above setpoint	Allows manual block of power range (low setpoint) reactor trip
		Allows manual block of intermediate range reactor trip and intermediate range rod stops (C-1)
		Blocks source range reactor trip
	3/4 Neutron flux (power-range below setpoint	Defeats the block of power range (low setpoint) reactor trip
		Defeats the block of intermediate range reactor trip and intermediate range rod stops (C-1)
		Input to P-7
II	BLOCKS OF REACTOR TRIPS	
P-7	3/4 Neutron flux (power-range) below setpoint (from P-10) and 2/2 Turbine inlet pressure below setpoint (from P-13)	Signal blocks reactor trip on: Low flow in more than one loop, under voltage, underfrequency, pressurizer low pressure, and pressurizer high level
P-8	2/4 Neutron flux (power-range) above setpoint	Signal unblocks reactor trip on low reactor coolant flow or turbine trip
P-13	2/2 Turbine inlet pressure below setpoint	Input to P-7

Table 7-3. Reactor Protection System Instrument Accuracies

Reactor Trip Signal	System Accuracy	See Note
Power-range high neutron flux	±1 percent of full power	
Intermediate-range high neutron flux	±1.5 percent of full scale	(a)
	Deleted per 2015 update	
Source-range high neutron flux	± 2 percent of full scale	(a)
Power-range high positive neutron flux rate	±5 percent	(a)
Overtemperature ΔT	±3.2°F	
Overpower ΔT	±2.7°F	
Pressurizer low pressure	±18 psi	
Pressurizer high pressure	±14 psi	
Pressurizer high water level	±2.3 percent of full range Δp between taps at design temperature and pressure	
Low reactor coolant flow	±2.5 percent of full range within range of 70 percent to 100 percent of full flow	(a)
Reactor coolant pump under voltage	±5 percent of rated voltage	
Reactor coolant pump bus underfrequency	±0.1 Hz	
Low-Low steam generator water level	±2.3 percent of Δp signal over pressure range of 700 to 1200 psig	

Note:

1. (a): Reproducibility

Table 7-4. Reactor Trip Correlation

Trip (1)	Accident (2)	Tech. Spec. (3)
Power-Range High Neutron Flux Trip (Low Setpoint)	1. Uncontrolled Rod Cluster Control Assembly Bank Withdrawal From A Subcritical Condition (15.4.1) 2. Excessive Heat Removal Due to Feedwater System Malfunctions (15.1.1 & 15.1.2) 3. Rupture of a Control Rod Drive Mechanism Housing (15.4.8)	3.3.1
Power-Range High Neutron Flux Trip (High Setpoint)	1. Uncontrolled Rod Cluster Control Assembly Bank Withdrawal From A Subcritical Condition (15.4.1) 2. Uncontrolled Rod Cluster Control Assembly Bank Withdrawal at Power (15.4.2) 3. Startup of an Inactive Reactor Coolant Loop (15.4.4) 4. Excessive Heat Removal Due to Feedwater System Malfunctions (15.1.1 & 15.1.2) 5. Excessive Load Increase Incident (15.1.3) 6. Accidental Depressurization of the Main Steam System (15.1.4) 7. Major Secondary System Pipe Rupture (15.1.5) 8. Rupture of a Control Rod Drive Mechanism Housing (Rod Cluster Control Assembly Ejection) (15.4.8)	3.3.1
Intermediate-Range High Neutron Flux Trip	Uncontrolled Rod Cluster Control Assembly Bank Withdrawal From A Subcritical Condition (15.4.1)	see note 4
Source-Range High Neutron Flux Trip	Uncontrolled Rod Cluster Control Assembly Bank Withdrawal From A Subcritical Condition (15.4.1)	see note 4
Power-Range High Positive Neutron Flux Rate Trip	Rupture of a Control Rod Drive Mechanism Housing (Rod Cluster Control Assembly Ejection) (15.4.8)	3.3.1

Trip (1)	Accident (2)	Tech. Spec. (3)
Overtemperature ΔT Trip	1. Uncontrolled Rod Cluster Control Assembly Bank Withdrawal At Power (15.4.2) 2. Uncontrolled Boron Dilution (15.4.6) 3. Loss of External Electrical Load and/or Turbine Trip (15.2.2) (15.2.3) 4. Excessive Heat Removal Due to Feedwater System Malfunctions (15.1.1 & 15.1.2) 5. Excessive Load Increase Incident (15.1.3) 6. Accidental Depressurization of the Reactor Coolant System (15.6.1) 7. Accidental Depressurization of the Main Steam System (15.1.4) 8. Loss of Reactor Coolant From Small Ruptured Pipes or From Cracks in large Pipes Which Actuates ECCS (15.6.5)	3.3.1
Overpower ΔT Trip	1. Uncontrolled Rod Cluster Control Assembly Bank Withdrawal at Power (15.4.2) 2. Excessive Heat Removal Due to Feedwater System Malfunctions (15.1.1 & 15.1.2) 3. Excessive Load Increase Incident (15.1.3) 4. Accidental Depressurization of The Main Steam System (15.1.4) 5. Major Secondary System Pipe Rupture (15.1.5)	3.3.1

Trip (1)	Accident (2)	Tech. Spec. (3)
Pressurizer Low Pressure	1. Accidental Depressurization of the Reactor Coolant System (15.6.1) 2. Loss of Reactor Coolant From Small Ruptured Pipes or From Cracks in Large Pipes Which Actuates ECCS (15.6.3) 3. Major Reactor Coolant System Pipe Ruptures (LOCA) (15.6.5) 4. Steam Generator Tube Rupture (15.6.3)	3.3.1
Pressurizer High Pressure Trip	1. Uncontrolled Rod Cluster Control Assembly Bank Withdrawal At Power (15.4.2) 2. Loss of External Electrical Load and/or Turbine Trip (15.2.2) (15.2.3)	3.3.1
Pressurizer High Water Level Trip	1. Uncontrolled Rod Cluster Control Assembly Bank at Power (15.4.2) 2. Loss of External Electrical Load and/or Turbine Trip (15.2.2) (15.2.3)	3.3.1
Low Reactor Coolant Flow	1. Partial Loss of Forced Reactor Coolant Fow (15.3.1) 2. Loss of Off-Site Power to the Station Auxiliaries (Station Blackout) (15.2.6) 3. Complete Loss of Forced Reactor Coolant Flow (15.3.2)	3.3.1
Reactor Coolant Pump Under Voltage Trip	Complete Loss of Forced Reactor Coolant Flow (15.3.2)	3.3.1
Reactor Coolant Pump Bus Underfrequency Trip	Complete Loss of Forced Reactor Coolant Flow (15.3.2)	3.3.1
Low-low Steam Generator Water Level Trip	Loss of Normal Feedwater (15.2.7)	3.3.1

Trip (1)	Accident (2)	Tech. Spec. (3)
Reactor Trip on Turbine Trip	1. Loss of external electrical load and/or Turbine Trip (15.2.2) (15.2.3) 2. Loss of Off-Site Power to the Station Auxiliaries (Station Blackout) (15.2.6)	3.3.1
Safety Injection Signal Actuation Trip	Accidental Depressurization of the Main Steam System (15.1.4)	see note 5
Manual Trip	Available for all Accidents (15.0)	see note 4

Note:

1. Trips are listed in order of discussion of Section 7.2.
2. References refer to accident analyses presented in 15.0.
3. References refer to Technical Specifications.
4. A technical specification is not required because this trip is not assumed to function in the accident analyses
5. Accident assumes that the reactor is tripped at end of life (EOL) which is the worst initial condition for this case. Pressurizer low pressure is the first out trip of safety injection.

Table 7-5. Instrument Operating Condition for Engineered Safety Features

No.	Functional Unit	No. of Channels	No. of Channels to Trip
1.	SAFETY INJECTION		
	a. Manual	2	1
	b. High Containment Pressure	3	2
	c. Pressurizer Low Pressure[1]	4	2
	Deleted Per 2012 Update		

Note:

1. Permissible bypass if reactor coolant pressure less than 1955 psig.

Table 7-6. Instrument Operating Conditions for Isolation Functions

No.	Functional Unit	No. of Channels	No. of Channels To Trip
1	CONTAINMENT ISOLATION		
	a. Automatic Safety Injection (Phase A)	See Item 1b through 1c of Table 7-5	
	b. Containment Pressure (Phase B)	See Item 2b of Table 7-5	
	c. Manual	2	1
	1) Phase A		
	2) Phase B	See Item No. 2a of Table 7-5	
2.	STEAM LINE ISOLATION		
	a. Low Steam Line Pressure	3/steam line	2/steam line in any system line
	b. Containment Pressure High-High	See Item 2b of Table 7-5	
	c. Manual	1/loop	1/loop
	d. High Negative Steam Line Pressure Rate	3/Steam line in any steam line	2/Steam line
3.	FEEDWATER LINE ISOLATION		
	a. Safety Injection	See Item 1 of Table 7-5	

Table 7-7. Interlocks for Engineered Safety Features Actuation System

Designation	Input	Function Performed
P-4	Reactor trip	Actuates turbine trip
		Closes main feedwater valves on T_{avg} below setpoint. Prevents opening of main feedwater valves which were closed by safety injection or high steam generator water level.
		Allows manual reset/block of the automatic reactuation of safety injection.
		Blocks steam dump control via load rejection T_{avg} controller.
		Makes steam dump valves available for either tripping or modulation.
	Reactor not tripped	Defeats the manual reset/block preventing automatic reactuation of safety injection.
		Blocks steam dump control via plant trip $T_{avg.}$ controller.
P-11	2/3 Pressurizer pressure below setpoint	Allows manual block of safety injection actuation on low pressurizer pressure signal.
		Allows manual block of steam line isolation on low compensated steam line pressure signal and allows steam line isolation on high steam line negative pressure rate.
	2/3 Pressurizer pressure above setpoint	Defeats manual block of steam line isolation on low steam line pressure and defeats steam line isolation on high steamline negative pressure rate. Defeats manual block of safety injection actuation on low Pressurizer Pressure.
P-12	3/4 T_{avg} above setpoint	Defeats the manual bypass of steam dump block.
P-14	2/3 Steam generator water level above setpoint on any steam generator.	Closes all feedwater control valves.
		Trips all main feedwater pumps which closes the pump discharge valves.
		Actuates turbine trip.

Table 7-8. Auxiliary Shutdown Control Panel Controls and Indicators Available for Hot Standby

Indicators

- Pressurizer Level
- Pressurizer Pressure
- Reactor Coolant Loop D Hot Leg Temperature
- NC Cold Leg Wide Range Temperature
- Neutron Flux
- Letdown Temperature
- Letdown Pressure
- Letdown Flow
- ND Pump Discharge Temp, A&B
- ND to NC Cold Leg Temp, A&B
- ND to NC Cold Leg Temp, C&D
- NC Wide Range Pressure

Controls

- Reciprocating Charging Pump
- Nuclear Service Water Pump 1A
- Nuclear Service Water Pump 1B
- Component Cooling Water Pump 1A1
- Component Cooling Water Pump 1A2
- Component Cooling Water Pump 1B1
- Component Cooling Water Pump 1B2
- Pressurizer Heater Backup Group '1A'
- Pressurizer Heater Backup Group '1B'
- Boric Acid Transfer Pump 1A
- Boric Acid Transfer Pump 1B
- Letdown Orifice Isolation Valve - 1NV457A
- Letdown Orifice Isolation Valve - 1NV458A
- Letdown Orifice Isolation Valve - 1NV35A
- Centrifugal Charging Pump 1A
- Centrifugal Charging Pump 1B
- Boric Acid Charging Pumps Valve - 1NV265B
- Auxiliary Spray Supply to Pressurizer Isolation Valve - 1NV21A
- NV Supply to NC Loop 4 Isolation Valve - 1NV16A
- NV Supply to NC Loop 1 Isolation Valve - 1NV13B
- Pressurizer #1 Power Operated Safety Relief Valve - 1NC34A
- Pressurizer #1 Power Operated Safety Relief Valve - 1NC32B
- Pressurizer #1 Power Operated Safety Relief Valve - 1NC36B
- NC Loop 3 Supply to Excess Letdown Hx. #1 Isolation Valve - 1NV24B
- NC Loop 3 Supply to Excess Letdown Hx. #1 Isolation Valve - 1NV25B
- NC Letdown Isolation to Regenerative Hx. #1 Valve - 1NV1A
- NC Letdown Isolation to Regenerative Hx. #1 Valve - 1NV2A
- BA to BA Blender Control Valve - 1NV267A
- Excess Letdown Hx. #1 Tube Outlet Control Valve - 1NV26B
- Regenerative Hx. #1 Tube Inlet Control Valve - 1NV241
- Charging Line Flow Control Valve - 1NV238

Note:

1. While not used for hot standby, RHR controls as described in Section 7.4.1.5.1.6, have been provided on this panel for the operators convenience.

Table 7-9. Auxiliary Feedwater Pump Motor 1A Control Panel Controls and Indicators Available for Hot Standby

Indicators
Steam Generator 1A Level
Steam Generator 1B Level
Steam Generator 1A Pressure
Steam Generator 1B Pressure
Flow to Steam Generator 1A
Flow to Steam Generator 1B
Controls
Motor 1A Control
Motor 1A Control Selector
Hotwell Supply Valves - 1/CA/2, 1/CM/265
Pump 1A AFW to SG 1A Valve Position Selector Station
Pump 1A AFW to SG 1B Valve Position Selector Station

Table 7-10. Auxiliary Feedwater Pump Motor 1B Control Panel Controls and Indicators Available for Hot Standby

Indicators
Steam Generator 1C Level
Steam Generator 1D Level
Steam Generator 1C Pressure
Steam Generator 1D Pressure
Flow to Steam Generator 1C
Flow to Steam Generator 1D
Controls
Motor 1B Control
Motor 1B Control Selector
Pump 1B AFW to SG 1C Valve Position Selector Station
Pump 1B AFW to SG 1D Valve Position Selector Station

Table 7-11. Auxiliary Feedwater Pump Turbine Control Panel Controls and Indicators Available for Hot Standby

Indicators
Steam Generator 1A Level
Steam Generator 1B Level
Steam Generator 1C Level
Steam Generator 1D Level
Steam Generator 1A Pressure
Steam Generator 1B Pressure
Steam Generator 1C Pressure
Steam Generator 1D Pressure
Flow to Steam Generator 1A
Flow to Steam Generator 1B
Flow to Steam Generator 1C
Flow to Steam Generator 1D
Controls
Hotwell Supply Valve - 1/CM/265
Hotwell Supply Valve - 1/CA/2
AFWPT Control
AFWPT Control Selector
AFWPT Stop Valve - 1/SA/48
AFWPT Stop Valve - 1/SA/49

Table 7-12. Main Control Board Indicators and/or Recorders Available to the Operator. Condition II and III Events

	Parameter	No. of Channels		Range	Available Indicated Accuracy(1)	Indicator/ Recorder	Purpose
		Avail.	Req.				
1.	T_{cold} or T_{hot} (measured, wide range)	1 T_{hot}, 1 T_{cold} per loop	2 T_{hot} and 2 T_{cold}	0-700°F	± 4% of full range	All channels are recorded	Ensure maintenance of proper cooldown rate and to ensure maintenance of proper relationship between system pressure and temperature for NDTT considerations.
2.	Pressurizer Water Level	3	2	Entire distance between taps	± 5% of ΔP at 2250 psia	All 3 channels indicated; one channel is recorded	Ensure maintenance of proper reactor coolant inventory.
3.	System Pressure (wide range)	2	2	0-3000 psig	± 3% of full range	Both channels indicated; one channel is recorded.	Ensure maintenance of proper relationship between system pressure and temperature for NDTT considerations.

	Parameter	No. of Channels		Range	Available Indicated Accuracy(1)	Indicator/ Recorder	Purpose
		Avail.	Req.				
4.	Containment Pressure	4 (2 IR, 2 WR)	2 (WR)	-5 to 20 PSIG (IR) -5 to 60 PSIG (WR)	± 2.4% of span	All 4 are indicated, 2 are recorded (1 IR, 1 WR).	Monitor containment conditions to indicate need for potential safeguards actuation.
5.	Steam Line Pressure	2/Steamline	2/Steamline	0-1300 psig	± 4% of full scale	All required channels are indicated, one is recorded	Monitor steam generator temperature conditions during hot shutdown and cooldown, and for use in recovery steam generator ruptures.
6.	Steam Generator Water Level (wide range)	1/Steam Generator	2/Plant	+5 to -45 feet from nominal full load water level	± 5% of level span (cold)	All channels recorded	Ensure maintenance of reactor heat sink.
7.	Steam Generator Water Level (narrow range)	4/Steam Generator	2/Steam Generator	+5 to -10 feet from nominal full load water level	± 4% of ΔP span (hot)	All channels indicated	Ensure maintenance of reactor heat sink.

(1) Includes accuracy and environmental effects.

Table 7-13. Main Control Board Indicators and/or Recorders Available to the Operator. Condition IV Events

	Parameter	No. of Channels Avail.	No. of Channels Req.	Range	Available Indicated Accuracy(1)	Indicator/ Recorder	Purpose
1.	Containment Pressure	4 (2 IR, 2 WR)	2 (WR)	-5 to 20 PSIG (IR) -5 to 60 PSIG (WR)	± 2.4% of span	All 4 are indicated, 2 are recorded (1 IR, 1 WR).	Monitor post-LOCA Containment conditions.
2.	Refueling Water Storage Tank Water Level	3	2	0-100% of span	≤ 4% of level span	All are indicated and alarmed, one is recorded	Ensure that water is flowing to the safety injection system after a LOCA and determine when to shift from injection to recirculation mode.
3.	Steam Generator Water Level (narrow range)	4/Steam Generator	2/Steam Generator	+5 to -10 feet from nominal full load level	± 18.6% of ΔP span[(a)]	All channels indicated, one channel recorded	Detect steam generator tube rupture; monitor steam generator water level following a steam line break.
4.	Steam line Pressure	2/Steam line	2/Steam line	0-1300 psig	± 12.5% of full scale	All channels are indicated, one is recorded	Monitor steam line pressures following steam generator tube rupture or steam line break.

Parameter	No. of Channels Avail.	No. of Channels Req.	Range	Available Indicated Accuracy(1)	Indicator/ Recorder	Purpose
5. Pressurizer Water Level	3	2	Entire distance between taps	±29% of span	All 3 are indicated and one is recorded	Indicate that water has returned to pressurizer following cooldown after steam generator rupture or steam line break.

(1) Includes accuracy and environmental effects.

(2) For the steam break, when the water level channel is exposed to a hostile environment, the accuracy required can be relaxed. The indication need only convey to the operator that water level in the steam generator is somewhere between the narrow range steam generator water level taps.

Table 7-14. Control Room Indicators and/or Recorders Available to the Operator to Monitor Significant Unit Parameters During Normal Operation

Parameter	No. of Channels Available	Range	Indicated Accuracy(1)	Indicator/ Recorder	Location	Notes
NUCLEAR INSTRUMENTATION						
1. Source Range						
a. Count rate (NIS)	2	0.1 to 10^6 counts/sec	± 10% of the linear full scale	Both channels indicated.	Control Board	Deleted Per 2015 Update
b. Count rate (Gamma-metrics)	2	0.1 to 10^5 counts/sec.	± 2% of full scale or of equivalent full scale	Both channels indicated	Control board	Provided for Cat-1 PAM per Table 1-6, and to supplement S/R NIS during modes 3-6 operations
c. Startup rate (NIS)	2	-0.5 to 5.0 decades/min.	±10% of the linear full scale analog voltage	Both channels indicated.	Control Board	
2. Intermediate Range						
a. Flux level	2	10 decades of neutron flux (corresponds to 0 to full scale analog voltage) overlapping the source range by 4 decades	9% of the log arithmic of the full scale.	Both channels indicated.	Control Board	

Parameter	No. of Channels Available	Range	Indicated Accuracy(1)	Indicator/ Recorder	Location	Notes
b. Startup rate	2	-0.5 to 5.0 decades/min.	±9 % of the linear full scale analog voltage	Both channels indicated.	Control Board	
3. Power Range						
a. Uncalibrated ion chamber current (top and bottom uncompensated ion chambers)	4	0 to 120% of full power current	± 1% of full span	All 8 current signals indicated.	NIS Racks in control room	Meters NI301(302) provide a 0 to 5 mA DC current indication of the full power level of the reactor section monitored.

Parameter	No. of Channels Available	Range	Indicated Accuracy(1)	Indicator/ Recorder	Location	Notes
b. Calibrated ion chamber current	4	0-120% of full power	± 2% of full span	All 8 current signals recorded (four 2 pen recorders). Recorder 1 - upper currents for two diagonally opposed detectors. Recorder 2 - upper currents for remaining detectors. Recorder 3 - lower currents for two diagonally opposed detectors. Recorder 4 - lower currents for remaining detectors.	Control Board	
Deleted Per 2015 Update						
c. Average flux of the top and bottom ion chamber	4	0 to 120% of full power	±3% of full power for indication, ± 2% for recording	All 4 channels indicated. Any 2 of the four channels may be recorded.	Control Board	

Parameter	No. of Channels Available	Range	Indicated Accuracy(1)	Indicator/ Recorder	Location	Notes
d. Average flux of the top and bottom ion chambers	4	0 to 120% of full power, 0 to 200% full power	± 2% of full power to 120%, ± 6% of full power to 200%.	All 4 channels recorded.	Control Board	
e. Flux difference of the top and bottom ion chambers	4	-30 to +30%	±4%	All 4 channels indicated.	Control Board	
REACTOR COOLANT SYSTEM						
1. $T_{average}$ (measured)	1/Loop	530° - 630°F	± 4°F	All channels indicated.	Control Board	
2. ΔT (measured)	1/Loop	0 to 150% of full power ΔT	± 4% of full power ΔT	All channels indicated. One channel is available on Ovation PCS.	Control Board	
a. T_{cold} or T_{hot} (measured, wide range)	1-T_{hot} and 1-T_{cold} per loop	0-700°	± 4% of span	Both channels recorded.	Control Board	
3. Overpower ΔT Setpoint	1/Loop	0 to 150% of full power ΔT	± 3% of full power ΔT	All channels indicated. One channel is selected for recording.	Control Board	

Parameter	No. of Channels Available	Range	Indicated Accuracy(1)	Indicator/ Recorder	Location	Notes
4. Overtemperature ΔT Setpoint	1/Loop	0 to 150% of full power ΔT	± 4% of full power ΔT	All channels indicated. One channel is selected for recording.	Control Board	
5. Pressurizer Pressure	4	1700 to 2500 psig	± 28 psi	All channels indicated. One channel is recorded.	Control Board	
6. Pressurizer Level	3	Entire distance between taps	± 5% of ΔP signal at 2250 psia	All channels indicated. One channel is recorded.	Control Board	Two pen recorder used, second pen records reference level signal.
7. Primary Coolant Flow	3/Loop	0 to 120% of rated flow	Repeatability of 4.5% of full flow	All channels indicated.	Control Board	
8. Reactor Coolant pump motor amperes	1/Loop	0 to 800 amperes	± 4%	All channels indicated.	Control Board	One channel for each bus.
9. System Pressure Wide Range	2	0-3000 psig	± 3% of full range	Both channels indicated; one is recorded.	Control Board	
REACTOR CONTROL SYSTEM						
1. Demanded Rod Speed	1	0 to 100% of rated speed	± 5%	The one channel is indicated.	Control Board	

Parameter	No. of Channels Available	Range	Indicated Accuracy(1)	Indicator/ Recorder	Location	Notes
2. Auctioneered $T_{average}$	1	530° to 630°F	± 3°F	The one channel is recorded.	Control Board	The highest of the four T_{avg} channels into the auctioneer will be passed to the recorder
3. $T_{reference}$	1	530 to 630°F	±4°F	The one channel is recorded.	Control Board	
4. Control Rod Position						If system not available, borate and sample accordingly.
a. Number of steps of demanded rod withdrawal	1/group	0 to 230 steps	± 1 step	Each group is indicated during rod motion.	Control Board	These signals are used in conjunction with the measured position signals (4b) to detect deviation of any individual rod from the demanded position. A deviation will actuate an alarm and annunciator.

Parameter	No. of Channels Available	Range	Indicated Accuracy(1)	Indicator/ Recorder	Location	Notes
b. Full length rod measured position	1 for each rod	0 to 228 steps	± 3 steps at full accuracy, ± 12 steps at 1/2 accuracy	Each rod position is indicated.	Control Board	
CONTAINMENT SYSTEM						
Containment Pressure	4	-5 to 20 PSIG	± 2.4% of full scale	All 4 channels indicated, one is recorded	Control Board	
FEEDWATER AND STEAM SYSTEMS						
1. Auxiliary Feedwater Flow	1/Feed line	0 to 600 gpm	8.8%	All channels indicated.	Control Board	One channel to measure the flow to each steam generator.
2. Steam Generator level (narrow range)	4/Steam generator	+5 to -10 feet from nominal full load level	± 4% of ΔP (hot)	All channels indicated. One channel per Steam Generator is recorded.	Control Board	
3. Steam generator level (wide range)	1/Steam generator	+5 to -45 ft from nominal full load level	± 5% of level (cold)	All channels recorded.	Control Board	
4. Programmed steam generator level signal	1/Steam generator	38.9% to 65% of span	± 4%	All channels recorded.	Control Board	

Parameter	No. of Channels Available	Range	Indicated Accuracy(1)	Indicator/ Recorder	Location	Notes
5. Main feedwater flow	2/Steam generator	0 to 120% of maximum calculated flow	± 5%	2 channels per Steam Generator is indicated. One channel per Steam Generator is recorded.	Control Board	
6. Magnitude of signal controlling main and bypass control valves	1/Main	0 to 100% of valve opening	± 3%	All channels indicated.	Control Board	1. One channel for each main feedwater control valve. 2. OPEN/SHUT indication is provided in the control room for each main and bypass feedwater control valve.

Parameter	No. of Channels Available	Range	Indicated Accuracy(1)	Indicator/ Recorder	Location	Notes
7. Steam flow	2/Steam generator	0 to 117% of max. calculated flow	± 5.5%	All channels indicated. One channel is are recorded.	Control Board	Accuracy is equipment capability; however, absolute accuracy depends on calibration against feedwater flow.
8. Steam line pressure	3/loop	0 to 1300 psig	± 4% of full scale	All channels indicated, one is recorded	Control Board	
9. Steam dump modulate signal	1	0-100% max. steam dump capacity	± 3%	The one channel is indicated.	Control Board	OPEN/SHUT indication is provided in the control room for each steam dump valve.
10. Turbine inlet pressure	3	0 to 1000 PSI	± 3.5%	Two channels indicated.	Control Board	OPEN/SHUT indication is provided in the control room for each turbine stop valve.

(1) Includes channel accuracy and environmental effects.

Table 7-15. Single Failure Analysis on Containment Pressure Control System Air Return Fans and Discharge Dampers

Component	Malfunction	Resulting Consequences	
		Containment Pressure Control	Engineered Safety Features
One Pressure Switch (Air Return Fan)	Fails High	None - Signal to discharge damper will prevent air flow before blowdown event and redundant signal to Air Return Fan will prevent air flow after blowdown event.	None - ESF signal is not inhibited
One Pressure Switch (Air Return Fan)	Fails Low	None - This is the fail-safe position of the CPCS.	None - Redundant train will operate and provide air flow
One Pressure Switch (Discharge Damper)	Fails High	None - Signal to air return fan will prevent air flow	None - ESF signal is not inhibited
One Pressure Switch (Discharge Damper)	Fails Low	None - This is the fail-safe position of the CPCS	None - Redundant train will operate and provide air flow
Motor Starter	Fails Open	None - The fan fails to start	None - The redundant train will operate and provide air flow
Motor Starter	Fails Closed	None - Signal to discharge damper will prevent air flow	None - Fan will operate
Discharge Damper	Fails Open	None - Signal to fan will prevent air flow	None - This is fail safe condition of ESF System
Discharge Damper	Fails Closed	None - This is safe condition of CPCS	None - The redundant train will operate and provide air flow
Air Return Fan	Fails to Start	None - This is safe condition of CPCS	None - The redundant train will operate and provide air flow
One Power Supply	Loss	None - This is safe condition of CPCS	None - The redundant train will operate and provide air flow
One Pressure Switch (Spray Pump)	Fails High	None - Signal to discharge valve will prevent spray	None - EST signal is not inhibited

Component	Malfunction	Resulting Consequences	
		Containment Pressure Control	Engineered Safety Features
One Pressure Switch (Spray Pump)	Fails Low	None - This is safe condition for CPCS	None - Redundant train will provide spray
One Pressure Switch (Discharge Valve)	Fails High	None - Signal to spray pump will prevent spray	None - ESF signal is not inhibited
One Pressure Switch (Discharge Valve)	Fails Low	None - This is safe condition for CPCS	None - Redundant train will provide spray
Valve	Fails Open	None - Signal to spray pump will prevent spray	None - This is safe condition for ESF
Valve	Fails Closed	None - This is safe condition for CPCS	None - Redundant train will provide spray
Pump Breaker	Fails Open	None - This is safe condition for CPCS	None - The redundant train will provide spray
Pump Breaker	Fails Closed	None - Signal to spray valve will prevent spray	None - Redundant train will provide spray
Feeder Cable for 4KV Switchgear	Fails Open	None - This is safe condition for CPCS	None - Redundant train will provide spray
One Pressure Switch (H_2 Skimmer Fan & Air Return Fan)	Fails High	None - Fan operates continuously after initiation	None - ESF Signal is not inhibited
One Pressure Switch (H_2 Skimmer Fan & Air Return Fan)	Fails Low	None - This is the fail safe position of the CPCS	None - Redundant train will operate and provide air flow
Motor Starter	Fails Open	None - The fan fails to start	None - The redundant train will operate and provide air flow
Motor Starter	Fails Closed	None - Signal to inlet valve will prevent air flow	None - Fan will operate
Inlet Valve	Fails Closed	None - This is the safe condition of CPCS	None - The redundant train will operate and provide air flow

Component	Malfunction	Resulting Consequences	
		Containment Pressure Control	Engineered Safety Features
H_2 Skimmer Fan	Fails to Start	None - This is the safe condition of CPCS	None - The redundant train will operate and provide air flow
One Power Supply	Loss	None - This is the safe condition of CPCS	None - The redundant train will operate and provide air flow

Table 7-16. Ice Condenser RTD's

	Bay No.	Radial Loc.	Elev. Above Wear Slab	Detail		Bay No.	Radial Loc.	Elev. Above Wear Slab	Detail
ICE BED RTD's:									
1	24	3	55 FT	(2)	25	13	3	55 FT	(2)
2	24	3	30 FT 9	(2)	26	13	3	30 FT 9	(2)
3	24	3	0 FT 0	(2)	27	13	3	0 FT 0	(2)
4	21	2	55 FT	(1)	28	10	2	55 FT	(1)
5	21	2	30 FT 9	(1)	29	10	2	30 FT 9	(1)
6	21	2	10 FT 6	(1)	30	10	2	10 FT 6	(1)
7	18	1	55 FT	(1)	31	7	1	55 FT	(1)
8	18	1	30 FT 9	(1)	32	7	1	30 FT 9	(1)
9	18	1	10 FT 6	(1)	33	7	1	10 FT 6	(1)
10	18	2	55 FT	(1)	34	7	2	55 FT	(1)
11	18	2	30 FT 9	(1)	35	7	2	30 FT 9	(1)
12	18	2	10 FT 6	(1)	36	7	2	10 FT 6	(1)
13	18	3	55 FT	(1)	37	7	3	55 FT	(1)
14	18	3	30 FT 9	(1)	38	7	3	30 FT 9	(1)
15	18	3	10 FT 6	(1)	39	7	3	10 FT 6	(1)
16	15	2	55 FT	(1)	40	4	2	55 FT	(1)
17	15	2	30 FT 9	(1)	41	4	2	30 FT 9	(1)
18	15	2	10 FT 6	(1)	42	4	2	10 FT 6	(1)
19	13	1	55 FT	(6)	43	1	3	55 FT	(2)
20	13	1	30 FT 9	(6)	44	1	3	30 FT 9	(2)
21	13	1	1 FT 6	(6)	45	1	3	0 FT 0	(2)
22	13	2	55 FT	(1)	46	13	See Dwg.	58 FT 6	(3)
23	13	2	30 FT 9	(1)	47	13	See Dwg.	58 FT 6	(4)
24	13	2	10 FT 6	(1)	48	13	Spare		(5)
FLOOR COOLING RTD's:									
					13	13	2	0 FT 0	(7)
2	2	2	0 FT 0	(7)	14	14	2	0 FT 0	(7)
3	3	2	0 FT 0	(7)					

	Bay No.	Radial Loc.	Elev. Above Wear Slab	Detail		Bay No.	Radial Loc.	Elev. Above Wear Slab	Detail
					16	16	2	0 FT 0	(7)
5	5	2	0 FT 0	(7)	17	17	2	0 FT 0	(7)
6	6	2	0 FT 0	(7)					
					19	19	2	0 FT 0	(7)
8	8	2	0 FT 0	(7)	20	20	2	0 FT 0	(7)
9	9	2	0 FT 0	(7)					
10	10	2	0 FT 0	(7)	22	22	2	0 FT 0	(7)
					23	23	2	0 FT 0	(7)
12	12	2	0 FT 0	(7)					
FLOOR COOLING GLYCOL RTD's:									
34	1		2 FT 0						
35	1		8 FT 0						
36	1		51 FT 0						
37	1		5 FT 0						

	Bay No.	Radial Loc.	Elev. Above Wear Slab	Detail
TEMPERATURE SWITCHES:				
1	1	2	57 FT	(T)
2	4	2	57 FT	(T)
3	7	2	57 FT	(T)
4	18	2	57 FT	(T)
5	21	2	57 FT	(T)
6	24	2	57 FT	(T)
WALL PANEL RTD's:				
25	1		10 FT 6	(8)
26	8		10 FT 6	(8)
27	8		1 FT 0	(8)
28	13		10 FT 6	(8)
29	13		1 FT 0	(8)
30	18		10 FT 6	(8)
31	18		1 FT 0	(8)
32	24		10 FT 6	(8)

	Bay No.	Radial Loc.	Elev. Above Wear Slab	Detail		Bay No.	Radial Loc.	Elev. Above Wear Slab	Detail
WEAR SLAB RTD's:									
41	1	1	0FT0	(7)	44	8	1	0FT0	(7)
42	17	1	0FT0	(7)	45	8	2	0FT0	(7)
43	17	2	0FT0	(7)	46	24	1	0FT0	(7)
Deleted Per 2005 Update									
FLOOR THAW RTD's									
NPRD9840	1-2	2	0FT0	(7)	NPRD9880	15-16	2	0FT0	(7)
NPRD9850	4-5	2	0FT0	(7)	NPRD9890	18-19	2	0FT0	(7)
NPRD9860	7-8	2	0FT0	(7)	NPRD9900	21-22	2	0FT0	(7)
NPRD9870	11-12	2	0FT0	(7)	NPRD9910	24	2	0FT0	(7)

DETAIL NO:	
(1) (2) (6)	- LATTICE-FRAME MTD. ICE BED. TEMP. RTD
(3) (4)	- PLENUM-PANEL MTD. RTD
(5)	- NOT USED
(7)	- WEAR SLAB (FLOOR) MTD. RTD
(8)	- WALL PANEL MTD. RTD
(T)	- TEMPERATURE SWITCH

Table 7-17. Devices Actuated on ESFAS and LOOP

Equipment	Train A	Train B
CRA-P-1	X	
CRA-C-1	X	
CR-AHU-1[1]	X	
CRA-AHU-1[1]	X	
SGR-AHU-1A[1]	X	
SGR-AHU-2A[1]	X	
SGR-AHU-1C[1]	X	
SGR-AHU-2C[1]	X	
BR-XF-1[1]	X	
CRA-P-2		X
CRA-C-2		X
CR-AHU-2[1]		X
CRA-AHU-2[1]		X
SGR-AHU-1B[1]		X
SGR-AHU-2B[1]		X
SGR-AHU-1D[1]		X
SGR-AHU-2D[1]		X
BR-XF-2[1]		X
CRA-OAPFT-1	X	
CRA-OAPFT-2		X

Note:

1. Includes associated dampers.
2. X Denotes operational equipment.

Table 7-18. Unit Control System Interlocks

Designation	Derivation	Function
C-1	1/2 Neutron flux (intermediate range)above setpoint	Blocks automatic and manual control rod withdrawal
C-2	1/4 Neutron flux (power range) above setpoint	Blocks automatic and manual control rod withdrawal
C-3	2/4 Overtemperature ΔT above setpoint	Blocks automatic and manual control rod withdrawal Actuates turbine runback via load reference Defeats remote load dispatching
C-4	2/4 Overpower ΔT above setpoint	Blocks automatic and manual control rod withdrawal Actuates turbine runback via load reference Defeats remote load dispatching
C-5	1/1 Turbine inlet pressure below setpoint	Defeats remote load dispatching Blocks automatic control rod withdrawal
C-7A	1/1 Time derivative (absolute value) of turbine inlet pressure (decrease only) above setpoint	Makes steam dump valves available for either tripping or modulation
C-9	Any condenser pressure above setpoint, or any 3 out of 4 circulation water pump breakers open	Blocks steam dump to condenser
C-11	1/1 Bank D control rod position above setpoint	Blocks automatic rod withdrawal

Table 7-19. Reactor Trip System Instrumentation Response Times

Functional Unit	Response Time
1. Manual Reactor Trip	N.A.
2. Power Range, Neutron Flux	≤ 0.5 second
3. Power Range, Neutron Flux, High Positive Rate	N.A.
4. Intermediate Range, Neutron Flux	N.A.
5. Source Range, Neutron Flux	N.A.
6. Overtemperature DT (Note 1)	

Narrow Range RTD time constant	Filter Time Constant	Thot and Tcold input to DT	Tavg input to setpoint	Pressurizer pressure input to set point	Flux imbalance input to set point
a. ≤ 3.5 sec	≤ 4.7 sec	≤ 2.606 sec	≤ 1.863 sec	≤ 1.500 sec	≤ 1.500 sec
b. ≤ 4.0 sec	≤ 4.25 sec	≤ 2.488 sec	≤ 1.827 sec		
c. ≤ 4.5 sec	≤ 3.8 sec	≤ 2.372 sec	≤ 1.791 sec		
d. ≤ 5.0 sec	≤ 3.35 sec	≤ 2.259 sec	≤ 1.755 sec		
e. ≤ 5.5 sec	≤ 2.9 sec	≤ 2.149 sec	≤ 1.720 sec		
f. ≤ 6.0 sec	≤ 2.45 sec	≤ 2.042 sec	≤ 1.685 sec		
g. ≤ 6.5 sec	≤ 2.0 sec	≤ 1.937 sec	≤ 1.650 sec		
h. ≤ 7.0 sec	≤ 1.55 sec	≤ 1.835 sec	≤ 1.616 sec		
i. ≤ 7.5 sec	≤ 1.1 sec	≤ 1.734 sec	≤ 1.582 sec		

Deleted Per 2014 Update.

7. Overpower DT (Note 1)

Narrow Range RTD time constant	Filter time Constant	Thot and Tcold input to DT	Tavg input to setpoint	Flux imbalance input to set point
a. ≤ 3.5 sec	≤ 4.7 sec	≤ 2.606 sec	≤ 1.500 sec (Note 2)	≤ 1.500 sec
b. ≤ 4.0 sec	≤ 4.25 sec	≤ 2.488 sec		
c. ≤ 4.5 sec	≤ 3.8 sec	≤ 2.372 sec		
d. ≤ 5.0 sec	≤ 3.35 sec	≤ 2.259 sec		
e. ≤ 5.5 sec	≤ 2.9 sec	≤ 2.149 sec		
f. ≤ 6.0 sec	≤ 2.45 sec	≤ 2.042 sec		
g. ≤ 6.5 sec	≤ 2.0 sec	≤ 1.937 sec		
h. ≤ 7.0 sec	≤1.55 sec	≤ 1.835 sec		
i. ≤ 7.5 sec	≤ 1.1 sec	≤ 1.734 sec		

Deleted Per 2014 Update.

Functional Unit	Response Time
8. Pressurizer Pressure—Low	≤ 2.0 seconds
9. Pressurizer Pressure – High	≤ 2.0 seconds
10. Pressurizer Water Level—High	N.A
11. Low Reactor Coolant flow	
a. Single Loop (Above P-8)	≤ 1.0 second
b. Two Loops (Above P-7 and below P-8)	≤ 1.0 second
12. Steam Generator Water Level--Low-Low	≤ 3.039 seconds
13. Undervoltage-Reactor Coolant Pumps	< 1.5 seconds
14. Underfrequency-Reactor Coolant Pumps	< 0.6 second
15. Turbine Trip	
a. Low Fluid Oil Pressure	N.A
b. Turbine Stop Valve Closure	N.A
16. Safety Injection Input from ESF	N.A.
17. Reactor Trip System Interlocks	N.A.
18. Reactor Trip Breakers	N.A.
19. Automatic Trip and Interlock Logic	N.A.

Note(s):

1. The RTD and filter time constant combinations for Overtemperature DT and Overpower DT are provided to allow adjustments to reduce spurious DT runback alarms resulting from hot leg streaming.
2. The response time requirement for Tave input to set point for Overpower DT is the same for all combinations of RTD time constants and filter time constants.

Table 7-20. Engineered Safety Features Response Times

Initiating signal and Function	Response Time In Seconds
1. Manual	
a. Safety Injection (ECCS)	N.A.
Deleted Per 2012 Update	
b. Containment Isolation	
1) Phase “A” Isolation	N.A.
2) Phase “B” Isolation	N.A.
3) Purge and Exhaust Isolation	N.A.
c. Steam Line Isolation	N.A.
d. Feedwater Isolation	N.A.
e. Auxiliary Feedwater	N.A.
f. Nuclear Service Water	N.A.
g. Component Cooling Water	N.A.
h. Reactor Trip (from SI)	N.A.
i. Start Diesel Generators	N.A.
2. Containment Pressure-High	
a. Safety Injection (ECCS)	≤ 27(1)
b. Reactor Trip (from SI)	≤ 2
c. Feedwater Isolation	≤ 12
d. Containment Isolation-Phase “A”(2)	≤ 18(3)/28(4)
e. Containment Purge and Exhaust Isolation	N.A.
f. Auxiliary Feedwater(5)	N.A.
g. Nuclear Service Water	≤ 65(3)/76(4)
h. Component Cooling Water	≤ 65(3) /76(4)
i. Start Diesel Generators	≤ 11
3. Pressurizer Pressure-Low-Low	
a. Safety Injection (ECCS)	≤ 27(1)/12(3)
b. Reactor Trip (from SI)	≤ 2
c. Feedwater Isolation	≤ 12
d. Containment Isolation-Phase “A”(2)	≤ 18(3) /28(4)
e. Containment Purge and Exhaust Isolation	N.A.
f. Auxiliary Feedwater5	N.A.

Initiating signal and Function	Response Time In Seconds
g. Nuclear Service Water System	≤ 76[(1)]/65[(3)]
h. Component Cooling Water	≤ 76[(1)]/65[(3)]
i. Start Diesel Generators	≤ 11
4. Steam Line Pressure-Low	
Steam Line Isolation	≤ 10
5. Containment Pressure-High-High	
Deleted Per 2012 Update	
a. Containment Isolation-Phase “B”	N.A.
b. Steam Line Isolation	≤ 10
6. Steam Generator Water Level-High-High	
a. Turbine Trip	N.A.
b. Feedwater Isolation	≤ 12
7. Steam Generator Water Level Low-Low	
a. Motor-driven Auxiliary	≤ 60
b. Turbine-driven Auxiliary Feedwater Pump	≤ 60
8. Negative Steam Line Pressure Rate – High	
Steam Line Isolation	≤ 10
9. Start Permissive	
Containment Pressure Control System	N.A.
10. Termination	
Containment Pressure Control System	N.A.
11. Auxiliary Feedwater Suction Pressure – Low	
Auxiliary Feedwater Pumps (Suction Supply Automatic Realignment	≤ 19
12. RWST Level	
Automatic Switchover to Recirculation	≤ 100
13. Blackout	
a. Start Motor-Driven Auxiliary Feedwater Pumps	≤ 60
b. Start Turbine-Driven Auxiliary Feedwater Pump[(6)]	≤ 60
14. Trip of Main Feedwater Pumps	
Start Motor-Driven Auxiliary Feedwater	≤ 60

Initiating signal and Function	Response Time In Seconds
Pumps	
15. Loss of Power	
a. 4 kV Loss of Voltage	≤ 11
b. 4 kV Degraded Voltage	≤ 11 with SI, and ≤ 600 without SI

Note:

TABLE NOTATION

1. Diesel generator starting and sequence loading delays included. Response time limit includes opening of valves to establish Safety Injection path and attainment of discharge pressure for contrifugal charging pumps, Safety Injection and RHR pumps.
2. Valves 1KC305B and 1KC315B are exceptions to the response times listed in the table. The following response times in seconds are the required values for those valves for the initiating signal and function indicated:
   2.d ≤ 30 (3)/40(4)
   3.d ≤ 30 (3)
   4.d ≤ 30 (3)/40(4)
3. Diesel generator starting and sequence loading delays not included. Off-site power available. Response time limit includes opening of valves to establish Safety Injection path and attainment of discharge pressure for centrifugal charging pumps and Safety Injection pumps.
4. Diesel generator starting and sequence loading delays included. Response time limit includes opening of valves to establish Safety Injection path and attainment of discharge pressure for centrifugal charging pumps and Safety Injection pumps.
5. Response time for motor-driven auxiliary feedwater pumps on all Safety Injection signal shall be less than or equal to 60 seconds. Response time limit includes opening of valves to establish Safety Injection path and attainment of discharge pressure for auxiliary feedwater pumps.
6. The turbine driven pump does not start on a blackout signal coincident with a safety injection signal.
7. Deleted Per 2012 Update.