Appendix 7A. Tables

Table 7-1. List of Reactor Trips

	Reactor Trip	Coincidence Logic	Interlocks	Comments
1.	High neutron flux (Power Range)	2/4	Manual block of low setting permitted by P-10	High and low setting; manual block and automatic reset of low setting by P-10
2.	Intermediate range neutron flux	1/2	Manual block permitted by P-10	Manual block and automatic reset
3.	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
4.	Power range high positive neutron flux rate	2/4	No interlocks	
5.	Overtemperature ΔT	2/4	No interlocks	
6.	Overpower ΔT	2/4	No interlocks	
7.	Pressurizer low pressure	2/4	Interlocked with P-7	Blocked below P-7
8.	Pressurizer high pressure	2/4	No interlocks	
9.	Pressurizer high water level	2/3	Interlocked with P-7	Blocked below P-7
10.	Low reactor coolant flow	2/3 in any loop	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.
		1/4	Interlocked with P-8	Blocked below P-8.
11.	Reactor coolant pump undervoltage	2/4	Interlocked with P-7	Low voltage to RCP motors permitted below P-7.
12.	Reactor coolant pump underfrequency	2/4	Interlocked with P-7	Underfrequency on 2 motors will trip all reactor coolant pump breakers and cause reactor trip; reactor trip blocked below P-7

	Reactor Trip	Coincidence Logic	Interlocks	Comments
13.	Low-low steam generator water level	2/4 in any loop	No interlocks	
14.	Safety injection signal	Coincident with actuation of safety injection	No interlocks	(See Section 7.3 for Engineered Safety Features actuation conditions)
15.	Turbine (anticipatory) trip			
	a) Low stop valve EH pressure	2/4	Interlocked with P-9	Blocked below P-9
	b) Turbine stop valve closed	4/4	Interlocked with P-9	Blocked below P-9
16.	Manual	1/2	No interlocks	

Table 7-2. Protection System Interlocks

Designation	Derivation	Function
	I POWER ESCALATION PERMISSIVES	
P-6	Presence of P-6: 1/2 neutron flux (intermediate range) above setpoint	Allows manual block of source range reactor trip
	Absence of P-6: 2/2 neutron flux (intermediate range) below setpoint	Defeats the block of source range reactor trip
P-10	Presence of 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 (back-up for P-6)
	Absence of P-10: 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	Absence of P-7: 3/4 neutron flux (power range) below setpoint (from P-10)	Blocks reactor trip on: Low reactor coolant flow in more than one loop, RCP undervoltage, RCP underfrequency, pressurizer low pressure, and pressurizer high level
P-8	Absence of P-8: 3/4 neutron flux (power range) below setpoint	Blocks reactor trip on low reactor coolant flow in a single loop
P-9	Absence of P-9: 3/4 neutron flux (power range) below setpoint	Blocks reactor trip on turbine trip
P-13	2/2 turbine impulse chamber pressure below setpoint	Input to P-7

Table 7-3. Reactor Trip System Instrumentation

	Reactor Trip Signal	Typical Range	Typical Trip Accuracy	Maximum Time Response (sec)
1.	Power range high neutron flux	0 to 120% full power	1% of full power	0.5(3)
2.	Intermediate range high neutron flux	10 decades of neutron flux overlapping source range by 5 decades	8% of span (From CNC-1552.08-00-0360, Rev. 1)	N.A.
3.	Source range high neutron flux	7 decades of neutron flux (0.1 to 10^6 counts/sec)	9.5% of span (From CNC-1552.08-00-0359, Rev. 1)	N.A.
4.	Power range high positive neutron flux rate	Neutron flux (0-120% full power)	±5 percent [1]	N.A.
5.	Overtemperature ΔT:	T_H 530 to 650°F T_C 510 to 630°F T_{AV} 530 to 630°F P_{PRZR}1700 to 2500 psig F (Δϕ) ±60 ΔT Setpoint 0 to 100°F (0-150%)	±7.9°F	
	a. Narrow Range RTD time constants b. Thot and Tcold input to ΔT c. Tavg input to setpoint d. Pressurizer pressure input to setpoint e. Flux imbalance input to setpoint			a. ≤8.0 seconds (Unit 1) ≤8.0 seconds (Unit 2) b. ≤1.5 seconds c. ≤1.5 seconds d. ≤1.5 seconds e. ≤1.5 seconds[3]

	Reactor Trip Signal	Typical Range	Typical Trip Accuracy	Maximum Time Response (sec)
6.	Overpower ΔT	T_H 530 to 650°F T_C 510 to 630°F T_{AV} 530 to 630°F ΔT Setpoint 0 to 100°F (0-150%)	±4.4°F	
	a. Narrow Range RTD time constants b. Thot and Tcold input to ΔT c. Tavg input to setpoint d. Flux imbalance input to setpoint			a. ≤8.0 seconds (Unit 1) ≤8.0 seconds (Unit 2) b. ≤1.5 seconds c. ≤1.5 seconds d. ≤1.5 seconds[3]
7.	Pressurizer low pressure	1700 to 2500 psig	±18 psi (Compensated signal)	2.0
8.	Pressurizer high pressure	1700 to 2500 psig	±18 psi (non-compensate signal)	2.0
9.	Pressurizer high water level	Entire cylindrical portion of pressurizer (distance between taps)	±2.3 percent of full range Δρ between taps at design temperature and pressure.	N.A.
10.	Low reactor coolant flow	0 to 120% of rated flow	±2.5 percent of full flow within range of 70 percent to 100 percent of full flow [1]	1.0
11.	Reactor Coolant pump undervoltage	0 to 100% rated voltage	±1%	1.5
12.	Reactor coolant pump underfrequency	50 to 65 Hz	±0.1 Hz	0.6

	Reactor Trip Signal	Typical Range	Typical Trip Accuracy	Maximum Time Response (sec)
13.	Low-low steam generator water level	±~ 6 ft. (unit 2), ±~ 8 ft. (unit 1) from nominal full load water level	±2.3 percent of $\Delta\rho$ signal over pressure range of 700 to 1200 psig	2.0
14.	Turbine trip			N.A.
15.	Manual Reactor Trip			N.A.
16.	Safety Injection Input from ESF			N.A.

Notes:

1. Reproducibility (see definitions in 7.0).
2. Accuracy of steam flow signal is ±3 percent of maximum calculated flow over the pressure range of 700 to 1200 psig.
3. Does not include neutron detector.

Table 7-4. Reactor Trip Correlation

	Trip[1]		Accident[2]	Tech Spec.[3]/ UFSAR[3]
1.	Power Range High Neutron Flux Trip (Low Setpoint)	1.	Uncontrolled Rod Cluster Control Assembly Bank Withdrawal From a Subcritical Condition or Low Power Startup Condition (15.4.1)	Table 3.3.1-1/- 3.3.1 / Table 7-3 3.3.2 / Table 7-15
		2.	Feedwater System Malfunctions that result in a Reduction in Feedwater Temperature (15.1.1)	
		3.	Spectrum of Rod Cluster Control Assembly Ejection Accidents (15.4.8)	
		4.	Chemical and Volume Control System Malfunction That Results In A Decrease In Boron Concentration In The Reactor Coolant (15.4.6)	
2.	Power Range High Neutron Flux Trip (High Setpoint)	1.	Uncontrolled Rod Cluster Control Assembly Bank Withdrawal From a Subcritical or Low Power Startup Condition (15.4.1)	Table 3.3.1-1/- 3.3.1 / Table 7-3 3.3.2 / Table 7-15
		2.	Uncontrolled Rod Cluster Control Assembly Bank Withdrawal at Power (15.4.2)	
		3.	Startup of an Inactive Reactor Coolant Pump At An Incorrect Temperature (15.4.4)	
		4.	Feedwater System Malfunctions That Result in a reduction In Feedwater Temperature (15.1.1)	
		5.	Excessive Increase In Secondary Steam Flow (15.1.3)	
		6.	Inadvertent Opening of A Steam Generator Relief or Safety Valve (15.1.4)	
		7.	Steam System Piping Failure (15.1.5)	
		8.	Spectrum of Rod Cluster Control Assembly Ejection Accidents (15.4.8)	
		9.	Rod Cluster Control Assembly Misoperation (15.4.3)	
3.	Intermediate Range High Neutron Flux Trip	1.	Uncontrolled Rod Cluster Control Assembly Bank Withdrawal From a Subcritical or Low Power Startup Condition (15.4.1)	See Note 4 Table 3.3.1-1/- 3.3.1 / Table 7-3 3.3.2 / Table 7-15

	Trip[1]		Accident[2]	Tech Spec.[3]/ UFSAR[3]
4.	Source Range High Neutron Flux Trip	1.	Uncontrolled Rod Cluster Control Assembly Bank Withdrawal From a Subcritical or Low Power Startup Condition (15.4.1)	See Note 4 Table 3.3.1-1/- 3.3.1 / Table 7-3 3.3.2 / Table 7-15
		2.	Chemical and Volume Control System Malfunction That Results In A Decrease In Boron Concentration In the Reactor Coolant (15.4.6)	
5.	Power Range High Positive Neutron Flux Rate Trip	1.	Spectrum of Rod Cluster Control Assembly Ejection Accidents (15.4.8)	Table 3.3.1-1/- See Note 4 3.3.1 / Table 7-3 3.3.2 / Table 7-15
		2.	Uncontrolled Rod Cluster Control Assembly Bank Withdrawal From A Subcritical Or Low Power Startup Condition (15.4.1)	
6.	Overtemperature ΔT Trip	1.	Uncontrolled Rod Cluster Control Assembly Bank Withdrawal at Power (15.4.2)	Table 3.3.1-1/- 3.3.1 / Table 7-3 3.3.2 / Table 7-15
		2.	Chemical and Volume Control System Malfunction that Results in a Decrease in Boron Concentration in the Reactor Coolant (15.4.6)	
		3.	Loss of External Load and/or Turbine Trip (15.2.2/ 15.2.3)	
		4.	Feedwater System Malfunctions That Result in a Reduction in Feedwater Temperature (15.1.1)	
		5.	Excessive Increase In Secondary Steam Flow (15.1.3)	
		6.	Inadvertent Opening Of A Pressurizer Safety or Reliefs Valve (15.6.1)	
		7.	Inadvertent Opening Of A Steam Generator Relief or Safety Valve (15.1.4)	
		8.	Loss-Of-Coolant Accidents (15.6.5)	
		9.	Feedwater System Pipe Break (15.2.8)	
		10.	Rod Cluster Control Assembly Misoperation (15.4.3)	
		11.	Steam Generator Tube Failure (15.6.3)	

	Trip[1]		Accident[2]	Tech Spec.[3]/ UFSAR[3]
7.	Overpower ΔT Trip	1.	Uncontrolled Rod Cluster Control Assembly Bank Withdrawal at Power (15.4.2)	Table 3.3.1-1/- 3.3.1 / Table 7-3 3.3.2 / Table 7-15
		2.	Feedwater System Malfunctions That Result in a Reduction In Feedwater Temperature (15.1.1)	
		3.	Excessive Increase In Secondary Steam Flow (15.1.3)	
		4.	Inadvertent Opening Of A Steam Generator Relief Of Safety Valve (15.1.4)	
		5.	Steam System Piping Failure (15.1.5)	
8.	Pressurizer Low Pressure Trip	1.	Inadvertent Opening Of A Pressurizer Safety Or Relief Valve (15.6.1)	Table 3.3.1-1/- 3.3.1 / Table 7-3 3.3.2 / Table 7-15
		2.	Loss-Of-Coolant Accidents (15.6.5)	
		3.	Deleted Per 2001 Update.	
		4.	Steam Generator Tube Failure (15.6.3)	
9.	Pressurizer High Pressure Trip	1.	Uncontrolled Rod Cluster Control Assembly Bank Withdrawal at Power (15.4.2)	Table 3.3.1-1/- 3.3.1 / Table 7-3 3.3.2 / Table 7-15
		2.	Loss of External Load and/or Turbine Trip (15.2.2/ 15.2.3)	
		3.	Feedwater Sysem Pipe Break (15.2.8)	
10.	Pressurizer High Water Level Trip	1.	Uncontrolled Rod Cluster Control Assembly Bank Withdrawal at Power (15.4.2)	Table 3.3.1-1/- See Note 4 3.3.1 / Table 7-3 3.3.2 / Table 7-15
		2.	Loss of External Load and/or Turbine Trip (15.2.2/ 15.2.3)	
11.	Low Reactor Coolant Flow	1.	Partial Loss of Forced Reactor Coolant Flow (15.3.1)	Table 3.3.1-1/- 3.3.1 / Table 7-3 3.3.2 / Table 7-15
		2.	Loss of Non-Emergency AC Power to the Station Auxiliaries (15.2.6)	
		3.	Complete Loss of Forced Reactor Coolant Flow (15.3.1)	
		4.	Startup Of An Inactive Reactor Coolant Pump At An Incorrect Temperature (15.4.4)	

	Trip[1]		Accident[2]	Tech Spec.[3]/ UFSAR[3]
12.	Reactor Coolant Pump Under-voltage Trip	1.	Complete Loss of Forced Reactor Coolant Flow (15.2.1)	Table 3.3.1-1/- 3.3.1 / Table 7-3 3.3.2 / Table 7-15
		2.	Partial Loss Of Forced Reactor Coolant Flow (15.3.1)	
13.	Reactor Coolant Pump Under-frequency Trip	1.	Complete Loss of Forced Reactor Coolant Flow (15.3.2)	Table 3.3.1-1/- 3.3.1 / Table 7-3 3.3.2 / Table 7-15
14.	Low-low Steam Generator Water Level Trip	1.	Loss of Normal Feedwater Flow (15.2.7)	Table 3.3.1-1/- 3.3.1 / Table 7-3 3.3.2 / Table 7-15
		2.	Turbine Trip (15.2.3)	
		3.	Feedwater System Pipe Break (15.2.8)	
15.	Safety Injection Signal Actuation Trip	1.	Inadvertent Opening Of A Steam Generator Relief Or Safety Valve (15.1.4)	See Note 5 3.3.1 / Table 7-3 3.3.2 / Table 7-15
		2.	Steam System Piping Failure (15.1.5)	
		3.	Feedwater System Pipe Break (15.2.8)	
16.	Reactor Trip on Turbine Trip	1.	Loss of External Load and/or Turbine Trip (15.2.2/ 15.2.3)	See Note 4 Table 3.3.1-1/- 3.3.1 / Table 7-3 3.3.2 / Table 7-15
		2.	Loss of Non-Emergency AC Power to the Station Auxiliaries (15.2.6)	See Note 4 Table 3.3.1-1/- 3.3.1 / Table 7-3 3.3.2 / Table 7-15
17.	Manual Trip		Available for all Accidents (15.0)	See note 4 3.3.1 / Table 7-3 3.3.2 /Table 7-15

Notes:

1. Trips are listed in order of discussion in 7.2.
2. References refer to accident analyses presented in Chapter 15.
3. References refer to Technical Specifications and UFSAR Sections.
4. A response time Technical Specification is not required because this trip is not assumed to function in the accident analyses, or it is not a time critical action.
5. Reactor trip occurs in conjunction with safety injection on setpoints in Technical Specifications, Table 3.3.2-1, item 1.

Table 7-5. Instrumentation 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	4	2
2.	Containment Spray		
	a. Manual	2	1
	Deleted Per 2012 Update.	4	2

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 No. 1 (b) and (c) of Table 7-5	
b.	Containment Pressure (Phase B)	4	2
c.	Manual Phase A Phase B	 2 2	 1 1
2.	Steam Line Isolation		
a.	High Steam Negative Pressure Rate	12 (3/steam line)	2/steam line in any steam line.
b.	Containment Pressure (High-High)	4	2
c.	Low steam line pressure	12 (3/steam line)	2/steam line
d.	Manual	1/loop[1]	1/loop[1]
3.	Feedwater Line Isolation		
a.	Safety Injection	See Item No. 1 of Table 7-5	
b.	Steam Generator High-High level 2/4 on any Steam Generator	4/loop	2/loop
c.	Low $T_{avg'}$ interlocked with P4	See P4 on Table 7-7	

Note:

1. Additionally, there will be two switches (one for train A and one for train B) that will actuate all four main steam line isolation and bypass valves at the system level.

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

Designation	Input		Function Performed
P-4	Reactor trip	(a)	Actuates turbine trip
		(b)	Closes main feedwater valves on T_{avg} below setpoint
		(c)	Prevents opening of main feedwater valves which were closed by safety injection or High-High steam generator water level
		(d)	Allows manual block of the automatic reactuation of safety injection
		(e)	Blocks steam dump control via load rejection T_{avg} controller
		(f)	Makes steam dump valves available for either tripping or modulation
		(g)	Runback of Main Feedwater Pump Turbines (non-safety function)
	Reactor not tripped	(a)	Defeats the block preventing automatic reactuation of safety injection
		(b)	Block steam dump control via plant trip T_{avg} controller
P-11	2/3 Pressurizer pressure below setpoint	(a)	Allows manual block of safety injection actuation on low pressurizer pressure signal
		(b)	Allows manual block of steamline isolation on low compensated steamline pressure signal and allows steamline isolation on high steamline negative pressure rate
P-11	2/3 Pressurizer pressure above setpoint	(a)	Reinstates automatically steamline isolation on low steamline pressure. Reinstates automatically safety injection on low pressurizer pressure. Automatically blocks steamline isolation on high steamline negative pressure rate.
		(b)	Defeats manual block of steamline isolation on low steamline pressure. Defeats manual block of safety injection on low pressurizer pressure. Defeats steamline isolation on high steamline negative pressure rate.

Designation	Input		Function Performed
		(c)	Defeats manual block of motor driven auxiliary feedwater pumps automatic starting on 2/4 low-low steam generator level and loss of both main feedwater pumps as described in Section 7.4.1.1.
		(d)	Defeats manual block of Turbine Trip and Feedwater Isolation on 2/4 Hi-Hi Steam Generator Level.
P-12	2/4 T_{avg} below setpoint	(a)	Blocks steam dump
		(b)	Allows manual bypass of steam dump block for the cooldown valves only
	3/4 T_{avg} above setpoint	(a)	Defeats the manual bypass of steam dump block
P-14	2/4 Steam generator water level above setpoint on any steam generator	(a)	Closes all feedwater control valves
		(b)	Trips all main feedwater pumps which closes the pump discharge valves
		(c)	Actuates turbine trip

Table 7-8. Auxiliary Shutdown Panel A Instrumentation And Controls Available For Hot Shutdown

INDICATORS:
Steam Generator A Level
Steam Generator B Level
Steam Generator A Pressure
Steam Generator B Pressure
Auxiliary Feedwater Flow to Steam Generator A
Auxiliary Feedwater Flow to Steam Generator B
Auxiliary Feedwater Condensate Storage Tank Level Low
Condenser Hotwell Level Low
Upper Surge Tank Level Low
Auxiliary Feedwater Pumps Train A Loss of Normal Suction
Nuclear Service Water System Flow
Component Cooling Water System Flow
Centrifugal Charging Flow
Letdown Flow
Pressurizer Level
Pressurizer Pressure
Reactor Coolant Cold Leg Temperature & Hot Leg Temperature
Seal Injection Flow
Volume Control Tank Level
Boric Acid Flow
Boric Acid Tank Level
LOCA Sequencer Activated Status Light
B/O Sequencer Activated Status Light
Diesel Generator A Status Light
Auxiliary Shutdown Panel Relay Status
AC Low Pressure Mode Light
NC Loop B Wide Range Pressure
NC Loop C Wide Range Pressure
CONTROLS:

Auxiliary Shutdown Panel A Transfer Switch
Auxiliary Feedwater Motor A Start/Stop
Auxiliary Feedwater Pump A Normal Suction Valve CA11A
Auxiliary Feedwater Pump A RN Suction Valve CA15A
Nuclear Service Water Supply Valve RN250A
Auxiliary Feedwater Pump A Discharge to Steam Generator A Isolation Valve 1CA62A
Auxiliary Feedwater Pump A Discharge to Steam Generator B Isolation Valve 1CA58A
Auxiliary Feedwater Pump A Auxiliary Feedwater to SG A Valve Position Selector Station (CA60)
Auxiliary Feedwater Pump A Auxiliary Feedwater to SG 1B Valve Position Selector Station (CA56)
Nuclear Service Water Pump A
Component Cooling Water Pump A1
Component Cooling Water Pump A2
Boric Acid Transfer Pump A
Centrifugal Charging Pump A
Component Cooling System Valves – KC1A, KC3A, KC50A, KC230A, KCC37A
Chemical & Volume Control Systems Valves – NV1A, NV2A, NV13A, NV37A, NV11A, NV186A, NV172A, NV238A, NV148, NV309, NV294, NV39A
Pressure #1 Power Operated Safety Relief Valves – NC33A, NC34A
Pressurizer Heater
Cold Leg Accumulator C discharge isolation – NI76A
Cold Leg Accumulator A discharge isolation – NI54A
Sequencer Reset
Residual Heat Removal Pump A Suction – ND002
Residual Heat Removal Pump B Suction – ND037
Resideual Heat Removal Pump A

Table 7-9. Auxiliary Shutdown Panel B Instrumentation And Controls Available For Hot Shutdown

INDICATORS:
Steam Generator C Level
Steam Generator D Level
Steam Generator C Pressure
Steam Generator D Pressure
Auxiliary Feedwater Flow to Steam Generator C
Auxiliary Feedwater Flow to Steam Generator D
Auxiliary Feedwater Condensate Storage Tank Level Low
Condenser Hotwell Level Low
Upper Surge Tank Level Low
Auxiliary Feedwater Pumps Train B Loss of Normal Suction
Pressurizer Level
Pressurizer Pressure
Reactor Coolant Cold Leg Temperature & Hot Leg Temperature
Nuclear Service Water System Flow
Component Cooling Water System Flow
Centrifugal Charging Flow
Seal Injection Flow
Volume Control Tank Level
Boric Acid Flow
Boric Acid Tank Level
LOCA sequencer activated status light
B/O sequencer activated status light
Diesel Generator B status light
Auxiliary Shutdown Panel Relay Status
NC Loop C Wide Range Pressure
Low Pressure Mode Status Light
CONTROLS:

Auxiliary Shutdown Panel B Transfer Switch
Auxiliary Feedwater Motor B Start/Stop
Auxiliary Feedwater Pump B Normal Suction Valve CA9B
Auxiliary Feedwater Pump B RN Suction Valve CA18B
Nuclear Service Water Supply Valve RN310B
Auxiliary Feedwater Pump B Discharge to Steam Generator C Isolation Valve CA46B
Auxiliary Feedwater Pump B Discharge to Steam Generator D Isolation Valve CA42B
Auxiliary Feedwater Pump B Auxiliary Feedwater to SG C Valve Position Selector Station (CA44)
Auxiliary Feedwater Pump B Auxiliary Feedwater to SG ID Valve Position Selector Station (CA40)
Nuclear Service Water Pump B
Component Cooling Water Pump B1
Component Cooling Water Pump B2
Boric Acid Transfer Pump B
Centrifugal Charging Pump B
Auxiliary Shutdown Panel B
Instrumentation And Controls Available For Hot Shutdown
Component Cooling System Valves - KC2B, KC18B, KC53B, KC228B, KCC40B
Chemical & Volume Control Systems Valves - NV122B, NV123B, NV124B, NV125B, NV236B, NV309, NV32B
Pressurizer #1 Power Operated Safety Relief Valves NC31B, NC32B, NC35B, NC36B
Pressurizer Heater

Cold Leg Accumulator D discharge isolation - NI88B
Cold Leg Accumulator B discharge isolation - NI65B
Sequencer Reset
Residual Heat Removal Pump A Suction - ND001B
Residual Heat Removal Pump B Suction - ND36B
Residual Heat Removal Pump B
Train B Auxiliary Feedwater Pumps Discharge Valves
Auto-Start Alignment Reset Switch

Table 7-10. Auxiliary Feedwater Pump Turbine Control Panel Instrumentation And Controls Available For Hot Shutdown

INDICATORS:
Steam Generator A Level
Steam Generator B Level
Steam Generator C Level
Steam Generator D Level
Steam Generator A Pressure
Steam Generator B Pressure
Steam Generator C Pressure
Steam Generator D Pressure
Auxiliary Feedwater Flow to Steam Generator A
Auxiliary Feedwater Flow to Steam Generator B
Auxiliary Feedwater Flow to Steam Generator C
Auxiliary Feedwater Flow to Steam Generator D
Steam Supply Press to CA Pump Turbine
INDICATING LIGHTS:
Steam Supply Valve SA2 Open-Close
Steam Supply Valve SA5 Open-Close
Condenser Hotwell Level
Upper Surge Tank Level
Auxiliary Feedwater Condensate Storage Tank Level Auxiliary Feedwater Pumps Loss of Normal Suction
CONTROLS:
Auxiliary Feedwater Turbine Driven Pump Steam Drain Isolation TE33A
Auxiliary Feedwater Turbine Driven Pump Discharge to SG A Isolation Valve CA54B
Auxiliary Feedwater Turbine Driven Pump Discharge to SG B Isolation Valve CA66B
Auxiliary Feedwater Turbine Driven Pump Discharge to SG C Isolation Valve CA50A
Auxiliary Feedwater Turbine Driven Pump Discharge to SG D Isolation Valve CA38A

Auxiliary Feedwater Turbine Driven Pump Normal Suction Valve CA7A
Nuclear Service Water Supply Valve CA116A
Nuclear Service Water Supply Valve CA85B
Auxiliary Feedwater Pump Turbine Start/Stop
Auxiliary Feedwater Pumps Suction From Hotwell Isolation Valve CA2
Auxiliary Feedwater Pumps Suction From Upper Suirge Tank Isolation Valve CA4
Auxiliary Feedwater Pumps Suction From CA Condensate Storage Tank Isolation Valve CA6
Steam Generator 1A Power Operated Relief Valve SV19
Steam Generator 1B Power Operated Relief Valve SV13
Steam Generator 1C Power Opeated Relief Valve SV7
Steam Generator 1D Power Opeated Relief Valve SV1
Steam Generators Power Operated Relief Valves Transfer Switch (Unit 1 Only)
Train A Auxiliary Feedwater Pumps Discharge Valves Auto-Start Alignment Reset Switch

Table 7-11. Control Room Indicators and/or Recorders Available to the Operator to Monitor Significant Plant Parameters During Normal Operation

Parameter	No. of Channels Available	Typical Range	Indicated Accuracy(p)	Indicator/ Recorder	Location	Notes
Nuclear Instrumentation						
1. Source Range						
a. Count rate	2	10^{-1} to 10^{6} counts/sec	10% of span (From CNC-1552.08-00-0359, Rev. 1)	Both channels indicated. Both channels are recorded.	Control board	One recorder is used to record all 8 nuclear channels (2 source range, 2 intermediate range, and 4 power range)
b. Startup rate	2	-0.5 to 5.0 decades/ min	±7% of the linear full scale analog voltage	Both channels indicated	Control Board	
2. Intermediate Range						
a. Flux level	2	10 decades, 10^{-8} to 200% FP, of neutron flux (corresponds to 0 to full scale analog voltage) overlapping source range by 5 decades	8.4% of span (From CNC-1552.08-00-0360, Rev. 1)	Both channels indicated. Both channels are recorded using recorder in Item 1 above.	Control Board	
b. Startup rate	2	-0.5 to 5.0 decades/ min	±7% of the linear full scale analog voltage	Both channels indicated	Control Board	

Parameter	No. of Channels Available	Typical Range	Indicated Accuracy(p)	Indicator/ Recorder	Location	Notes
3. Power Range						
a. Uncalibrated ion chamber current (top and bottom uncompensated ion chambers)	4	0-5 mA	±1% of full power current	All 8 current signals indicated.	NIS racks in control room	
b. Calibrated ion chamber current (top and bottom uncompensated ion chambers)	4	0 to 120% of full power current	±2% full power current	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	
c. Upper and lower ion chamber current difference	4	-60 to +60%	±3% of full	Diagonally opposed channels are recorded using recorder in Item 1.	Control board	

Parameter	No. of Channels Available	Typical Range	Indicated Accuracy(p)	Indicator/ Recorder	Location	Notes
d. Average flux of the top and bottom ion chambers	4	0 to 120% of full power	±3% of full power for indication ±2% for recording	All 4 channels indicated. All 4 channels are recorded using recorder in Item 1.	Control board	
e. Average flux of the top and bottom ion chambers	4	0 to 200% of full power	±2% of full power to 120%, ±6% of full power to 200%	All 4 channels recorded.	Control board	
f. 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 selected for recording.	Control board	
a. T_{cold} or T_{hot} (measured, wide range)	1-T_{hot}, 1-T_{cold} per loop	0 to 700°	±4%	All T_{hot} channels are recorded on 1 multipoint recorder. All T_{cold} channels are recorded on another multipoint recorder.	Control board	

Parameter	No. of Channels Available	Typical Range	Indicated Accuracy(p)	Indicator/ Recorder	Location	Notes
3. Overpower ΔT Setpoint	1/loop	0 to 150% of full power ΔT	±4% of full power ΔT	All channels indicated One channel selected for recording.	Control board	
4. Overtemperature T 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.	Control board	
6. Pressurizer Level	3	Entire distance between taps	±3.5%ΔP level at 2250 psia	All channels indicated. Two channels recorded.	Control board	
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 Current	1/loop	0-800 Amps	±2%	All channels indicated.	Control board	One channel for each pump
9. System Pressure Wide Range	2	0 to 3000 psig	±4.%	All channels indicated and recorded.	Control board	
Reactor Control System						
1. Demanded Rod Speed	1	0 to 100% of rated speed	±2%	The one channel is indicated.	Control board	
2. Selected T_{avg}	1	530° to 630°F	±4°F	Value is displayed and can be trended on control room display.	Control board	Any one of the T_{avg} channels into the auctioneer may be bypassed

Parameter	No. of Channels Available	Typical Range	Indicated Accuracy(p)	Indicator/ Recorder	Location	Notes
3. Selected T_{ref}	1	530° to 630°F	±4°F	Value is displayed and can be trended on control room display.	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.
b. Full length rod measured position	1 for each rod	0 to 228 steps	±4 steps	Each rod position is indicated.	Control board	

Parameter	No. of Channels Available	Typical Range	Indicated Accuracy(p)	Indicator/ Recorder	Location	Notes
5. Control Rod Bank Demanded Position	4	0 to 230 steps	±2.5% of total bank travel	Value is displayed and can be trended on control room display along with the low-low limit alarm for each bank.	Control board	1. One channel for each control bank. 2. An alarm and annunciator are actuated when the last rod control bank to be withdrawn reaches the withdrawal limit, when any rod control bank reaches the low insertion limit and when any rod control bank reaches the low-low insertion limit.
Containment System						
1. Containment Pressure	4	-5 to 5 psig	±3%	All 4 channels indicated and 2 are recorded.	Control board	
Feedwater and Steam Systems						
1. Auxiliary Feedwater Flow	1/feed	50 to 800 gpm	±2.5%	All channels indicated	Control board	One channel to measure the flow to each steam generator
2. Steam Generator Level (narrow range)	4/steam generator	+7 to -5 feet (unit 2), +5 to -10 feet (unit 1) from nominal full load level	±4% of ΔP level (hot)	All channels indicated. The channels used for control are recorded.	Control board.	

Parameter	No. of Channels Available	Typical Range	Indicated Accuracy(p)	Indicator/ Recorder	Location	Notes
3. Steam Generator Level (wide range)	1/steam generator	+7 to -41 ft (unit 2), +5 to -45 feet (unit 1) from nominal full load level	+5% of level (cold)	All channels recorded.	Control board.	
4. Programmed Steam Generator Level Signal	1/steam generator	+7 to -5 feet (unit 2) +5 to -10 feet (unit 1)	±4%	All channels recorded.	Control board	
5. Main Feedwater Flow	2/steam generator	0 to 120% of maximum±5% mum calculated flow	All Values are displayed and can be trended on control room display. The selected channels used for control are recorded	Control board		
6. Magnitude of Signal Controlling Main and Bypass Feedwater Control Valves	1/main 1/bypass	0 to 100% of valve opening	±1.5%	All channels indicated	Control board	1. One channel for each main and bypass feedwater control valve 2. OPEN/SHUT indi-cation is provided in the control room for each main and bypass feedwater control valve

Parameter	No. of Channels Available	Typical Range	Indicated Accuracy(p)	Indicator/ Recorder	Location	Notes
7. Steam Flow	2/steam generator	0 to 120% of maximum calculated flow	±5.5%	All Values are displayed and can be trended on control room display. The selected channels used for control are recorded.	Control board	Accuracy is equip-ment capability; however, absolute accuracy depends on calibration against feedwater flow.
8. Steam Line Pressure	3/loop	0 to 1300 psig	±4%	All channels indicated and 1 is recorded.	Control board	
9. Steam Dump Modulate Signal	1	0-100% of steam dump valves open	±1.5%	The one channel is indicated.	Control board	OPEN/SHUT indication is provided in the control room for each steam dump valve
10. Turbine Impulse Chamber Pressure	2	0 to 120 percent of maximum calculated turbine load	±3.5%	Additional channel available on control room display.	Control board	OPEN/SHUT indication is provided in the control room for each turbine stop valve

Note:

1. Includes channel accuracy and environmental effects

Table 7-12. Plant 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
C-4	2/4 Overpower ΔT above setpoint	Blocks automatic and manual control rod withdrawal
		Actuates turbine runback via load reference
C-5	Selected Turbine impulse chamber pressure below setpoint	Block automatic control rod withdrawal
C-7	2/3 Time derivative (absolute value) of turbine impulse chamber pressure (decrease only) above setpoint	Makes steam dump valves available for either tripping or modulation
C-9	Any condenser pressure above setpoint, or All 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
C-16	Reduced limit in coolant temperature above normal setpoint.	Stops automatic turbine loading until condition clears.

Table 7-13. Deleted Per 1990 Update

Table 7-14. ESF Bypass Indication

Bypass indication is provided for each train of the following safety-related functions:
Annulus ventilation
Auxiliary building ventilation
Auxiliary feedwater (motor driven)
Auxiliary feedwater (turbine driven)
Chemical and volume control system (charging/injection)
Component cooling
Containment air return and hydrogen skimmer Containment isolation
Containment penetration valve injection water Containment pressure control
Containment spray
Control room ventilation and chilled water Diesel building ventilation
Diesel generator
Diesel generator room sump drainage
Groundwater drainage
Nuclear service water
Nuclear service water pump structure ventilation
Reactor trip
Residual heat removal (injection)
Residual heat removal (spray)
Safety injection
Safety injection (accumulator)
Spent fuel pool cooling

Table 7-15. ESF Response Times

Initiation Signal and Function	Maximum Response Time (sec)
1. Manual Initiation	
a. Safety Injection (ECCS)	N.A.
b. Containment Spray	N.A.
c. Phase "A" Isolation	N.A.
d. Phase "B" Isolation	N.A.
e. Containment Air Release and Addition	N.A.
f. Steam Line Isolation	N.A.
g. Diesel Building Ventilation Operation	N.A.
h. Nuclear Service Water Operation	N.A.
i. Turbine Trip	N.A.
j. Component Cooling Water	N.A.
k. Annulus Ventilation Operation	N.A.
l. Auxiliary Building Filtered Exhaust Operation	N.A.
m. Reactor Trip	N.A.
n. Emergency Diesel Generator Operation	N.A.
o. Containment Air Return and Hydrogen Skimmer Operation	N.A.
p. Auxiliary Feedwater	N.A.
2. Containment Pressure-High	
a. Safety Injection (ECCS)	27(1)/12(3)
1) Reactor Trip	2
2) Feedwater Isolation	12
3) Phase "A" Isolation[2,8]	18(3)/28(4)
4) Deleted	
5) Auxiliary Feedwater[5]	N.A.
6) Nuclear Service Water Operation	65(3)/76(4)
7) Turbine Trip	N.A.
8) Component Cooling Water	65(3)/76(4)
9) Emergency Diesel Generator Operation	11
10) Control Room Area Ventilation Operation	N.A.

Initiation Signal and Function	**Maximum Response Time (sec)**
11) Annulus Ventilation Opeation	23
12) Auxiliary Building Filtered Exhaust Operation	N.A.
13) Containment Sump Recirculation	N.A.
3. Pressurizer Pressure-Low	
a. Safety Injection (ECCS)	27(1)/12(3)
1) Reactor Trip	2
2) Feedwater Isolation	12
3) Phase "A" Isolation[2,8]	18(3)/28(4)
4) Deleted	
5) Auxiliary Feedwater[5]	N.A.
6) Nuclear Service Water Operation	65(3)/76(4)
7) Turbine Trip	N.A.
8) Component Cooling Water	65(3)/76(4)
9) Emergency Diesel Generator Operation	11
10) Control Room Area Ventilation Operation	N.A.
11) Annulus Ventilation Operation	23
12) Auxiliary Building Filtered Exhaust Operation	N.A.
13) Containment Sump Recirculation	N.A.
4. Steam Line Pressure-Low	
Steam Line Isolation	10
5. Containment Pressure-High-High	
Deleted Per 2012 Update.	
a. Phase "B" Isolation	≤ 65(3)/76(4)
Nuclear Service Water Operation	N.A.
b. Steam Line Isolation	10
c. Containment Air Return and Hydrogen Skimmer Fan Operation	600(9)
6. Steam Line Pressure – Negative Rate-High	
Steam Line Isolation	10
7. Steam Generator Water Level-High-High	
a. Turbine Trip	3

Initiation Signal and Function	**Maximum Response Time (sec)**
b. Feedwater Isolation	12
8. T_{avg}-Low	
Feedwater Isolation	N.A.
9. Doghouse Water Level-High High	
Feedwater Isolation	N.A.
10. Start Permissive	
Containment Pressure Control System	N.A.
11. Termination	
Containment Pressure Control System	N.A.
12. Steam Generator Water Level-Low-Low	
a. Motor-Driven Auxiliary Feedwater Pumps	60
b. Turbine-Driven Auxiliary Feedwater Pump	60
13. Loss-of-Offsite Power	
a. Motor-Driven Auxiliary Feedwater Pumps	60
b. Turbine-Driven Auxiliary Feedwater Pump	60
c. Control Room Area Ventilitation	N.A.
d. Emergency Diesel Generator Operation	11
1) Diesel Building Ventilation Operation	N.A.
2) Nuclear Service Water Operation	65(3)/76(4)
14. Trip of All Main Feedwater Pumps	
a. Motor-Driven Auxiliary Feedwater Pumps	60
b. Turbine Trip	N.A.
15. Auxiliary Feedwater Suction Pressure-Low (Suction Supply Automatic Realignment)	21(6)
16. Refueling Water Storage Tank Level-Low	
Coincident with Safety Injection Signal (Automatic Switchover to Containment Sump)	60
17. Loss of Power	
a. 4 kV Bus Undervoltage Loss of Voltage	8.5
b. 4 kV Bus Undervoltage-Grid Degraded Voltage	600

Initiation Signal and Function	Maximum Response Time (sec)
18. Suction Transfer-Low Pit Level	
Nuclear Service Water Operation	N.A.

Notes:

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 centrifugal charging pumps, Safety Injection and residual heat removal pumps.
2. Valves KC305B and KC315B are exceptions to the response times listed in the table. The following response times in seconds are the required values for these valves for the initiating signal and function indicated:

   2.a.3 $30^{(3)}/40^{(4)}$
   3.a.3 $30^{(3)}$

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.
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.
5. Response time for motor-driven auxiliary feedwater pumps on all Safety Injection signals shall be less than or equal to 60 seconds. Response time limit includes attainment of discharge pressure for auxiliary feedwater pumps.
6. Response time includes a time delay of up to 6 seconds.
7. The VQ System valves are designed to close on a Phase "A" Isolation Signal with corresponding 18/28 second response times.
8. Valves NW20A and NW69B are exceptions to the response times listed in the table. The following response times in seconds are the required values for these valves for the initiating signal and function indicated (PIP C99-0821).

   2.a.3 $65^{(3)}/76^{(4)}$
   3.a.3 $65^{(3)}/76^{(4)}$

9. The Containment Air Return Fan (CARF) reaches its functional state within 600 seconds. The 600 seconds response time represents the maximum time that the Hydrogen Skimmer System (HSS) suction valves start opening and the Hydrogen Skimmer Fan (HSF) starts operating.

Table 7-16. Main Control Board Indicators and/or Recorders Available to the Operator (Condition II, III, and IV Events)

Function	Design Requirement	Range	Purpose	Accuracy
1. Wide Range T_{hot} and T_{cold}	Two T_{hot} and two T_{cold} indicator channels. The T_{hot} channels are on a separate power supply from the T_{cold} channels. Capability of recording both T_{hot} and T_{cold} in each loop is provided.	0 to 700°F	1. Main the plant in a safe shutdown conditon. 2. Ensure proper cooldown rate 3. Ensure proper relationship between system pressure and temperature	± 8% of full range ± 8% of full range ± 8% of full range
2. Pressurizer Water Level	Two channels on separate power supplies with one channel recorded.	Entire distance between taps	1. Maintain proper reactor coolant inventory 2. Determine return of water level to pressurizer following steam break and steam generator tube ruptures.	Sufficient accuracy to indicate water level is above pressurizer heaters and below 100% of span (Approximately ± 25% of span) Same as above
3. System Wide Range Pressure	Two channels on separate power supplies with one channel recorded.	0 to 3000 psi	Ensure proper relationship between system pressure and temperature	± 8% of full range
4. Containment Pressure	Two channels on separate power supplies with both channels recorded.	-5 psig to + 60 psig	Monitor containment conditions following primary or secondary system break inside containment	± 4% of full scale
5. Steamline Pressure	Two channels per steamline on separate power supplies with one channel per steamline recorded.	0 to 1300 psig	1. Needed to determine type of accident that has occurred and the proper recovery procedure to use. 2. Determine that plant is in a safe shutdown condition	± 4% of full scale ± 4% of full scale

Function	Design Requirement	Range	Purpose	Accuracy
6. Steam Generator Water Level	Two narrow range channels per Steam Generator on separate power supplies. One wide range channel per Steam Generator, which may share a power supply with one of the narrow range channels. Each wide range channel is recorded.	0 to 100% of span	1. Maintain adequate heat sink following an accident 2. Needed in recovery procedure following Steam Generator tube rupture 3. Ensure that Steam Generator Tubes are covered following a LOCA	Sufficient accuracy to indicate water level is between 0 and 100% of span
7. Refueling Water Storage Tank Level	Two channels on separate power supplies with one channel recorded.	0 to 100% of span	Determine when to perform the necessary manual actions following switchover from the injection phase to the recirculation phase of safety injection after a LOCA	± 3% of level span
8. Boric Acid Tank Level	Two channels on separate power supplies with one channel recorded.	0 to 100% level	To ensure that borated water is leaving the boric acid tanks	± 5%
9. Containment Radiation Level	Two channels on separate power supplies with one channel recorded. Detectors are located on the primary shield wall approximately 180° apart	10E0 to 10E8 R/hr	Monitor containment conditions following an accident	± 1/2 decade
10. Containment Hydrogen Concentration	Two channels on separate power supplies with one channel recorded.	0 to 30% Hydrogen by Volume	Monitor containment conditions following an accident	(later)

Function	Design Requirement	Range	Purpose	Accuracy
11. Containment Sump Level	Two channels on separate power supplies with both channels recorded.	0 to 20 feet	1. Monitor containment conditions following a primary or secondary system break 2. Determine when to perform the necessary manual actions following switchover from the injection phase to the recirculation phase of safety injection following a LOCA	± 10%