ATTACHMENT ONE (1)

CONTROL SYSTEMS SINGLE FAILURE STUDY

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1.0 INTRODUCTION

This report analyzes if a single power supply, impulse line, or instrument sensor failure can cause multiple control system malfunctions that result in plant events that are not bounded by the FSAR Chapter 15 analyses. The analysis results demonstrate that all single power source, sensor, or impulse line failures result in plant conditions that are clearly bounded by the existing FSAR Chapter 15 analyses.

2.0 METHODOLOGY

The methodology was to determine if there are any single power source, sensor, or impulse line failures that cause multiple control system malfunctions that lead to transients that are not clearly bounded by FSAR Chapter 15 analyses. This was accomplished in four discrete steps as described in the following:

2.1 Identify the control systems of interest

The control systems of interest are those that control the major process parameters that affect plant behavior, particularly during transients. These were determined by reviewing the flow diagrams of the major process systems, FSAR Section 7.7 and FSAR Chapter 15 to identify the controlled components of interest (e.g., main feedwater flow control valves, letdown flow control valves, etc.). The control circuits for these components were then traced to find the control systems of interest.

Many of the controlled components of interest require support systems in addition to control system signals for proper operation (e.g., instrument air, electric power, plant protection system, etc.). These are not control systems per se, but their malfunction can be caused by the same failures that are postulated to affect the control systems. As such, these systems are important couplings for the analysis and were considered as well.

2.2 Analyze the effects of the power source, sensor, and impulse line failures on the control systems through the controlled components

The effects of the power source, sensor, and impulse line failures on the control system and controlled components were determined by developing analyzing logic models called fault tree diagrams. The fault tree diagrams were developed through a detailed review of the control wiring diagrams (CWDs), process analog control drawings (PACs), setpoint documents, instrumentation location drawings, and power distribution and motor data (PD&MD). The unwanted state(s) of the controlled component was postulated and traced back through the control circuit (e.g., power sources, interposing relays, interlocks, bistables and PAC cards, etc.) to determine the conditions necessary to cause the corresponding unwanted control command. The logic development assumed that the control circuit itself operated properly except as affected by the power source, sensor, or impulse line failures. These are grouped in AND or OR logic as appropriate. Power source, sensor, and impulse line successes required to achieve the component state are included in the fault tree diagrams as well so that physically unrealistic combinations of components behavior are not predicted.

Each fault tree diagram logic was reduced using standard Boolean algebra to the basic events of power source, sensor, and impulse line that caused the component state being modelled. The single (excluding compliments) basic events that caused the component state were tabulated and retained for further consideration.

2.3 Collect the basic events that cause multiple control system malfunctions

The results of the individual system analyses were reviewed to collect the power source, sensor, and impulse line failures that caused malfunction of more than one control system. These basic events were re-tabulated to include the control systems and controlled components affected by the failure.

2.4 Compare the predicted component behaviors to the events analyzed in FSAR Chapter 15

The predicted component behaviors resulting from each failure were compared to the events analyzed in FSAR Chapter 15. In making this comparison, the power source, sensor, and impulse line failures were considered as initiating events during normal plant operation. Concurrent random failures or other events not directly related to or caused by the power source, sensor, or impulse line failures were not considered. If the predicted component behaviors are equal to or less severe than those analyzed in FSAR Chapter 15, the FSAR Chapter 15 transient analysis is considered to be clearly bounding.

3.0 RESULTS

The control systems analyzed for this study were:

- Control Element Drive Mechanism Control System
- Reactor Power Cut Back System
- Pressurizer Level Control System
- Pressurizer Pressure Control System
- Steam Bypass Control System
- Feedwater Control System
- Reactor Regulating System
- Turbine Control System
- Main Steam Atmospheric Dump Valve Control System
- Boron Control System (dilution mode)
- Plant Protection System
- Instrument Air System
- Electric Power Distribution System

PPS is considered only for its potential to initiate or aggravate a plant event caused by a power source, sensor, or impulse line failure.

The power source, sensor, and impulse line failures that can affect more than one control system are given on Tables 1 through 3, respectively along with the FSAR Chapter 15 analysis that clearly bounds the effect of the failure.

The fault trees are presented for each system of interest in Appendix A along with the results of the effects of the power source, sensor, and impulse line failures and the FSAR Chapter 15 analysis that clearly bounds the effect of the failure on that system.

4.0 CONCLUSIONS

The Waterford Unit 3 control systems and associated power sources are well designed such that single failures of power sources, sensors, or impulse lines do not cause multiple control system malfunctions that lead to severe transients. Major features of the design that protect against this are:

- redundant or independent power supplies to some of the process control cabinets
- use of multiple sensors for many of the input parameters used for process control
- utilization of semi-independent control systems for the major processes as opposed to a centralized control arrangement.

In conclusion, the results of this control system study indicate that the control system failures are clearly bounded by the FSAR Chapter 15 analyses.

CONTROL SYSTEMS SINGLE FAILURE STUDY

ENCLOSURES

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TABLE 1 - LOSS OF COMMON POWER SUPPLY TO MULTIPLE CONTROL SYSTEMS

POWER SOURCES	AFFECTED SYSTEM	EFFECT	BOUNDING EVENT
120VAC PDP 384A	Steam Bypass Control System	Steam bypass control valves fail to open or modulate on demand	The combined effects are bounded by FSAR Section 15.2.1.3 Loss of Condenser Vacuum
	Turbine Control System	Turbine runback signal is not generated from Steam Bypass Control System if required	
120VAC PDP 3014AB	Reactor Regulating System	A. No pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control System B. Automatic Withdrawal Prohibit (AWP) signal is not generated from Reactor Regulating System to terminate the control rod withdrawal if required	The combined effects are bounded by FSAR Section 15.2.3.1 Feedwater System Pipe Brerks. The RCS is protected during this transient by the reactor trips from steam generator low level, low pressure, low DNBR and high pressurizer pressure.
	Pressurizer Level Control System	Letdown flow path isolated, letdown flow control valve CVC113A and CVC113B fail closed. However, the lead charging pump continues running which could result in higher pressurizer level and pressure, possibly to safety valve actuation	
	Pressurizer Pressure Control System	Normal spray valves RC301A and RC301B fail to open on demand	
	Steam Bypass Control System	Steam bypass control valves fail to open or modulate on demand	
	Feedwater Control System	Main feedwater control valves FW173A, 173B and bypass feedwater control valves FW166A and 166B fail closed resulting in loss of normal feedwater to steam generators 1 and 2	

TABLE 2 - COMMON SENSOR FAILURE TO MULTIPLE CONTROL SYSTEMS

SENSOR	FUNCTIONS	AFFECTED SYSTEM	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
LT-110X (when X channel is selected	Pressurizer Level	Pressurizer Level Control System	Low	A. Letdown flow path isolated, letdown flow control valves CVC113A and CVC113B fail closed B. Charging flow increases, one charging pump continues running and the other two pumps will start to run when the low level and low-low level setpoints are reached	Charging flow increases, letdown flow path isolates and heaters fail to turn on. The combined effects are bounded by FSAR Section 15.5.1.1 Chemical and Volume Control System Malfunction that Increases Reactor Coolant System Inventory
		Pressurizer Pressure Control System		A. Pressurizer proportional heater banks fail to turn on B. Pressurizer backup heater banks fail to turn on	
LT-110Y (when Y channel is selected)	Pressurizer Level	Pressurizer Level Control System	Low	A. Letdown flow path isolated, letdown flow control valves CVC113A and CVC113B fail closed B. Charging flow increases, one charging pump continues running the other two pumps will start to run when low level and low-low level setpoints are reached	Charging flow increases, letdown flow path isolates, and heaters fail to turn on. The combined effects are bounded by FSAR Section 15.5.1.1 Chemical and Volume Control System Malfunction that Increases Reactor Coolant System Inventory
		Pressurizer Pressure Control System		A. Pressurizer proportional heater banks fail to turn on B. Pressurizer backup heater banks fail to turn on	

TABLE 3 - COMMON IMPULSE LINE RUPTURE TO MULTIPLE CONTROL SYSTEMS
(COMMON IMPULSE LINE SERVES MULTIPLE SENSORS)

IMPULSE LINE NUMBER	ASSOCIATED SENSOR	FUNCTION	AFFECTED SYSTEM	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
RC1A-7-T-45	LT-110X (when X channel is selected)	Pressurizer Level	Pressurizer Level Control System	High	A. Charging flow decreases to one charging pump B. letdown flow path not isolated, letdown flow control valves CVC113A and CVC113B open too far	Decreased charging flow and letdown flow path not isolated results in decrease in RCS inventory and subsequent depressurization of the RCS. Pressurizer heaters may be damaged. The combined effects are bounded by FSAR Section 15.6.3.3 Loss of Coolant Accidents.
	PT-100X (when X channel is selected)	Pressurizer Pressure	Pressurizer Pressure Control System	Low	A. Pressurizer proportional heater banks fail to modulate properly B. Pressurizer backup heater banks fail to trip C. Normal spray valves RC301A and RC301B close too far	
	PT-102A	Pressurizer Pressure	Plant Protection System	Low	ESFAS auxiliary relay SIAS/CIAS coil not energized. Two out of four input relay coils not energized will cause SIAS and CIAS present. Therefore failure of a single input relay coil not energized will not cause inadvertent actuations of SIAS/CIAS	The system is designed for two out four logics. Therefore, the failure of one channel will not cause inadvertent actuation of SIAS/CIAS

TABLE 3 - COMMON IMPULSE LINE RUPTURE TO MULTIPLE CONTROL SYSTEMS
(COMMON IMPULSE LINE SERVES MULTIPLE SENSORS)

IMPULSE LINE NUMBER	ASSOCIATED SENSOR	FUNCTION	AFFECTED SYSTEM	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
RC1B-3-T-46	LT-110Y (when Y channel is selected)	Pressurizer Level	Pressurizer Level Control System	High	A. Charging flow decreases to one charging pump B. Letdown flow path not isolated, letdown flow control valves CV113A and CVC113B open too far	Decreased charging flow and letdown flow path not isolated results in decrease in RCS inventory and subsequent depressurization of the RCS. Pressurizer heater may be damaged. The combined effects are bounded by FSAR 15.6.3.3 Loss of Coolant Accidents.
	PT-100Y (when Y channel is selected)	Pressurizer Pressure	Pressurizer Pressure Control System	Low	A. Pressurizer proportional heater banks fail to modulate properly B. Pressurizer back up heater banks fail to trip C. Normal spray valves RC301A and RC301B close too far	
	PT-102B	Pressurizer Pressure	Plant Protection System	Low	ESFAS auxiliary relays SIAS/CIAS coil not energized. Two out of four input relay coils not energized will cause SIAS and CIAS present. Therefore failure of a single input relay coils not energized will not cause inadvertent actuation of SIAS/CIAS	The system is designed for two out of four logics. Therefore, the failure of one channel will not cause inadvertent act ation of SIAS/CIAS.

TABLE 3 - COMMON IMPULSE LINE RUPTURE TO MULTIPLE CONTROL SYSTEMS
(COMMON IMPULSE LINE SERVES ONE SENSOR AND UTILIZED BY MULTIPLE CONTROL SYSTEMS)

IMPULSE LINE NUMBER	ASSOCIATED SENSOR	FUNCTION	AFFECTED SYSTEM	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
RC1A-8-T-28 (High Pressure)	LT-110X (when X channel is selected)	Pressurizer Level	Pressurizer Level Control System	Low	A. Letdown flow path isolated, letdown flow control valves CVC113A and CVC113B fail closed B. Charging flow increases, one charging pump continues running and the other tow pumps will start to run when the low level and low-low level setpoints are reached	Charging flow increases, letdown flow path isolates, and heaters fail to turn on. The combined effects are bounded by FSAR Section 15.5.1.1 Chemical and Volume Control System Malfunction that Increases Reactor Coolant System Inventory
			Pressurizer Pressure Control System		C. Pressurizer proportional heater banks fail to turn on D. Pressurizer backup heater banks fail to turn on	
RC1B-4-T-26 (High Pressure)	LT-110Y (when Y channel is selected)	Pressurizer Level	Pressurizer Level Control System	Low	A. Letdown flow path isolated, letdwon flow control valves CVC113A and CVC113B fail closed B. Charging flow increases, one charging pump continues running and the other two pumps will start to run when low level and low-low level setpoints are reached	Charging flow increases, letdown flow path isolates, and heaters fail to turn on. The combined effects are bounded by FSAR Section 15.5.1.1 Chemical and Volume Control System Malfunction that Increases Reactor Coolant System Inventory
			Pressurizer Pressure Control System		C. Pressurizer proportional heater banks fail to turn on D. Pressurizer backup heater banks fail to turn on	

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APPENDIX A

SYSTEM ANALYSIS

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CONTROL ELEMENT DRIVE MECHANISM CONTROL SYSTEM

A. System Description

The Control Element Drive Mechanism Control System (CEDMCS) is designed to maintain reactor coolant average temperature by regulating core reactivity. The Control Element Drive Mechanism Control System accepts automatic CEA motion demand signals from the RRS or manual motion signals from the CEDMCS control panel and converts these signals to direct current pulses that are transmitted to the CEDM coils to cause CEA motion.

Control is achieved by regulating control rod speed and direction. The CEDMCS is capable of automatic operation in the range between 15 and 100 percent of rated power. Rod withdrawal commands must pass through a series of permissive interlocks which prevent control bank withdrawal when setpoints are reached which indicate an approach to a DNBR limit or KW/FT limit.

CEDMCS is interlocked with the Steam Bypass Control System which generates an Automatic Motion Inhibit and an Automatic Withdraw Prohibit. It is also interlocked with the Reactor Regulating and Plant Protection systems which generate an Automatic Withdraw Prohibit and a Control Rod Withdrawal Prohibit Signal respectively.

B. Fault Tree Bases

The following bases are used in developing the fault trees:

a) Failure of the Control Element Drive Mechanism Control system is defined as any inadvertent rod withdrawal which results in a positive reactivity insertion such that core design limits would be exceeded.

b) The Control Element Drive Mechanism Control system is in the automatic sequential mode of operation,

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c) No credit is taken for operator intervention.

d) The detailed evaluation of the effects on the Control Element Drive Mechanism Control System caused by sensor failure, impulse line rupture and power losses is presented in the fault trees.

e) The referenced documents for developing the fault trees are presented in Table 1.

C. Conclusions

There exists no single sensor, power source, or impulse line whose failure will result in an inadvertent control rod withdrawal.

TABLE 1

CONTROL ELEMENT DRIVE MECHANISM CONTROL SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1000	Control Element Drive Mechanism Control System Malfunction	187/11 196/8 198/10	1564-3174/6 1564-4641/2			PSAR Sections 7.2.1 & 7.7 PD&MD LOU 1564 B-289 Sheets 136/Rev 8, B-289 Sheet 137/Rev 7, B-289 Sheet 150/Rev 5
1001	CWP Signal Not Present	266/8	1564-3174/6		G-428S07/7	PSAR Section 7.2.1 PD&MD LOU 1564 B-289 Sheet 143/Rev 7 B-289 Sheet 144/Rev 6 B-289 Sheet 145/Rev 6 B-289 Sheet 146/Rev 6

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REACTOR POWER CUTBACK SYSTEM

A. System Description

The Reactor Power Cutback System (RPCS) is designed to provide a rapid reduction in reactor power, to avoid a reactor trip on loss of one feedwater pump transient. The step reduction in reactor power is accomplished by the simultaneous dropping of one or more preselected groups of full length regulating CEAs into the core. The RPCS is actuated upon receiving coincident two-out-of-two sensory logic signals indicating loss of one main feedwater pump.

B. Fault Tree Bases

The following bases are used in developing the fault trees:

a) Reactor Power Cutback System malfunctions are defined as:

1) Reactor Power Cutback signals are not generated on demand and pre-selected CEA groups fail to drop into the core.

2) Reactor Power Cutback signals are generated spuriously and pre-selected CEA group drop into the core inadvertently.

b) No credit is taken for operator intervention.

c) The detailed evaluation of the effects on the Reactor Power Cutback System malfunction by sensor failure, impulse line rupture and power loses is presented in the fault trees.

d) The referenced documents for developing the fault trees are presented in Table 2.

C. <u>Conclusion</u>

a) The effects of power supply failure on Reactor Power Cutback System (RPCS) is presented in Table 1. Loss of the 120VAC PDP 384A will result in failing to generate the Reactor Power Cutback signals during the loss of one main feed water pump.

b) There exists no single sensor, or impulse line whose failure will result in Reactor Power Cutback System malfunction.

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TABLE 1 - LOSS OF POWER SUPPLY

REACTOR POWER CUTBACK SYSTEM

POWER SOURCES	AFFECTED SYSTEM	EFFECT	BOUNDING EVENT
120VAC PDP 384A	Reactor Power Cutback System	Reactor Power Cutback signals are not generated during loss of one main feed water pump	Insertion of other CEA groups either automatically by the Reactor Regulating System or manually by the operator occurs as necessary. Not considered significant for Chapter 15 analysis.

TABLE 2

REACTOR POWER CUTBACK SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1100	Reactor Power Cutback System Malfunction	1430/12 1431/6 1460/10 1461/6 1685/7 1686/4	5817-5911/0			FSAR Section 7.7 SMP987/Rev 0

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PRESSURIZER LEVEL CONTROL SYSTEM

A. System Description

The Pressurizer Level Control System (PLCS) functions to maintain the proper reactor coolant water inventory and interlocks with the pressurizer heater banks. This inventory is maintained by controlling the charging pumps and letdown flow control valves in the Chemical and Volume Control System. The pressurizer water level is programmed by the Reactor Regulating System as a function of coolant average temperature, with the average reactor coolant temperature (Tavg) being used. For pressurizer water level above the programmed reference level signal which varies as a function of Tavg, the PLCS will trip the stand by charging pumps and increase the letdown flow rate. For pressurizer water level below the predetermined low level signal, the PLCS will turn off all heaters, start the standby charging pumps and minimize the letdown flow rate.

B. Fault Tree Bases

The following bases are used in developing the fault trees:

a) Pressurizer Level Control system malfunction is defined as:

1. An insurge of water into the pressurizer resulting in pressurizer overfill.

2. An outsurge of water from the pressurizer resulting in pressurizer underfill.

b) For an insurge of water into the pressurizer resulting in pressurizer overfill, the following cases are examined:

1. At least two out of three charging pumps fail to trip.
2. Letdown flow path is isolated.

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c) For an outsurge of water from the pressurizer resulting in pressurizer underfill, the following cases are examined:

   1. Lead charging pump does not function properly and the other two charging pumps do not function.
   2. Letdown flow exceeds charging flow.

d) There are two independent automatic control channels with channel selection by means of a manual control switch on CP-2. Automatic control is normally used during operation but manual control may be utilized at anytime.

e) No credit is taken for operator intervention.

f) The detailed evaluation of the effect on PLCS malfunction caused by sensor failure, impulse line rupture and power losses is presented in the fault trees.

g) The referenced documents for developing the fault trees are presented in Table 4.

C. <u>Conclusions</u>

a) Failure of a pressurizer level transmitter (low signal) or rupture of its associated high pressure impulse line will generate a spurious low pressurizer level signal. A spurious low level signal will cause an insurge of water into the pressurizer and result in pressurizer overfill.

b) Failure of a pressurizer level transmitter (high signal) or rupture of its associated low pressure impulse line will generate a spurious high pressurizer level signal. A spurious high level signal will cause an outsurge of water from the pressurizer and result in a pressurizer underfill.

c) Loss of the 120VAC PDP 3014AB will cause the loss of modulation signal to letdown flow control valves CVC113A and CVC113B, these valves will be in the fail closed position and isolate the letdown flow path. However, the lead charging pump continues running which could result in higher pressurizer level.

d) The effects of the loss of a single power source, sensor failures, and impulse line ruptures on Pressurizer Level Control System are presented in Tables 1, 2 and 3, respectively.

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TABLE 1 - SENSOR FAILURES

PRESSURIZER LEVEL CONTROL SYSTEM
(AN INSURGE OF WATER INTO THE PRESSURIZER)

SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
LT-110X (when X channel is selected)	Pressurizer Level	Low	A. Letdown flow path isolated, letdown flow control valves CVC113A and CVC113B fail closed B. Charging flow increases, one charging pump continues running and the other two pumps will start to run when the low level and low-low level setpoints are reached	Charging flow increases, letdown flow path isolates and heaters fail to turn on. The event is bounded by FSAR Section 15.5.1.1. Chemical and Volume Control System Malfunction that Increases Reactor Coolant System Inventory
LT-110Y (when Y channel is selected)	Pressurizer Level	Low	A. Letdown flow path isolated, letdown flow control valves CVC113A and CVC113B fail closed B. Charging flow increases, one charging pump continues running and the other two pumps will start to run when low level and low-low level setpoints are reached	Charging flow increases, letdown flow path isolates and heaters fail to turn on. The event is bounded by FSAR Section 15.5.1.1 Chemical and Volume Control System Malfunction that Increases Reactor Coolant System Inventory

TABLE 1 - SENSOR FAILURES

PRESSURIZER LEVEL CONTROL SYSTEM
(AN OUTSURGE OF WATER FROM THE PRESSURIZER)

SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
LT-110X (when X channel is selected)	Pressurizer Level	High	A. Charging flow decreases to one charging pump B. Letdown flow path not isolated, letdown flow control valves CVC113A and CVC113B open too far	Decreased charging low and letdown flow path not isolated results in decrease in RCS inventory and subsequent depressurization of the RCS. Pressurizer heaters may be damaged. Depressurization of the RCS event is bounded by FSAR Section 15.6.3.3 Loss of Coolant Accidents
LT-110Y (when Y channel is selected)	Pressurizer Level	High	A. Charging flow decreases to one charging pump B. Letdown flow path not isolated, letdown flow control valves CVC113A and CVC113B open too far	Decreased charging flow and letdown flow path not isolated results in decrease in RCS inventory and subsequent depressurization of the RCS. Pressurizer heaters may be damaged. Depressurization of the RCS event is bounded by FSAR Section 15.6.3.3 Loss of Coolant Accidents

TABLE 2 - IMPULSE LINE RUPTURE

PRESSURIZER LEVEL CONTROL SYSTEM
(AN INSURGE OF WATER INTO THE PRESSURIZER)

IMPULSE LINE NUMBER	ASSOCIATED SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
RC1A-8-T-28 (High Pressure)	LT-110X (when X channel is selected)	Pressurizer Level	Low	A. Letdown flow path isolated, letdown flow control valves CVC113A and CVC113B fail closed B. Charging flow increases, one charging pump continues running and the other two pumps will start to run when the low level and low-low level setpoints are reached	Charging flow increases, letdown flow path isolates, and heaters fail to turn on. The event is bounded by FSAR Section 15.5.1.1 Chemical and Volume Control System Malfunction that Increases Reactor Coolant System Inventory
RC1B-4-T-26 (High Pressure)	LT-110Y (when Y channel is selected)	Pressurizer Level	Low	A. Letdown flow path isolated, letdown flow control valves CVC113A and CVC113B fail closed B. Charging flow increases, one charging pump continues running and the other two pumps will start to run when low level and low-low level setpoints are reached	Charging flow increases, letdown flow path isolates, and heaters fail to turn on. The event is bounded by FSAR Section 15.5.1.1 Chemical and Volume Control System Malfunctions that Increases Reactor Coolant System Inventory

TABLE 2 - IMPULSE LINE RUPTURE

PRESSURIZER LEVEL CONTROL SYSTEM
(AN OUTSURGE OF WATER FROM THE PRESSURIZER)

IMPULSE LINE NUMBER	ASSOCIATED SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
RC1A-7-T-45 (Low Pressure)	LT-110X (when X channel is selected)	Pressurizer Level	High	A. Charging flow decreases to one charging pump B. Letdown flow path not isolated, letdown flow control valves CVC113A and CVC113B open too far	Decreased charging flow and letdown flow path not isolated results in decrease in RCS inventory and subsequent depressurization of the RCS. Pressurizer heaters may be damaged. Depressurization of the RCS event is bounded by FSAR Section 15.6.3.3 and Loss of Coolant Accidents
RC1B-3-T-46 (Low Pressure)	LT-110Y (when Y channel is selected)	Pressurizer Level	High	A. Charging flow decreases to one charging pump B. Letdown flow path not isolated, letdown flow control valves CVC113A and CVC113B open too far	Decreased charging flow and letdown flow path not isolated resulted in decrease in RCS inventory and subsequent depressurization of the RCS. Pressurizer heaters may be damaged. Depressurization of the RCS event is bounded by FSAR Section 15.6.3.3 Loss of Coolant Accidents

TABLE 3 - LOSS OF POWER SUPPLY

PRESSURIZER LEVEL CONTROL SYSTEM

POWER SOURCES	POWER OPERATED COMPONENTS	EFFECT	BOUNDING EVENT
120VAC PDP 3014AB	Letdown Flow Control Valves CVC113A and CVC113B	Letdown flow path isolated, letdown flow control valves CVC113A and CVC113B fail closed	Letdown flow path isolates, the lead charging pump continues running which could result in higher pressurizer level and pressure, possibly to safety valve actuation. Not considered significant for Chapter 15 event.

TABLE 4

PRESSURIZER LEVEL CONTROL SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1200	Pressurizer Level Control System Malfunction					FSAR Section 7.7 Flow Diagram G-168 Sheet 2/Rev 21
1201	Letdown Flow Control Valve Fail Closed	199/9 273/10 274/10 277/8 303/6 304/6	1564-3875, Sheet 15/13 1564-4090, Sheet 13/8 15/64-4091, Sheet 15/8 1564-60031/1 15/8		G-428S07/7	PD&MD LOU-1564 B-289 Sheet 227/Rev 0

TABLE 4

PRESSURIZER LEVEL CONTROL SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1202	Letdown Flow Control Valve Opens Too Far	199/9 273/10 274/10 277/8 303/6 304/6	1564-3875, Sheet 15/13 1564-4090, Sheet 13/8 1564-4091, Sheet 15/8 1564-6003/1		G-428S07/7	PD&MD LOU-1564 B-289 Sheet 227/Rev 0
1203, Sheets 1,2&3	Charging Pumps A&B Does Not Function	199/9 273/10 274/10 275/8 365/9 366/10 375/6 376/10 2341/7 2343/4 2391/9 2393/6	1564-3875, Sheet 15/13 1564-3875, Sheet 16/13 1564-4091, Sheet 13/8 1564-4091, Sheet 15/8	52B/5/8	G-428S07/7	PD&MD LOU-1564 B-289 Sheet 227/Rev 0

TABLE 4

PRESSURIZER LEVEL CONTROL SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1204 Sheets 1,2,3&4	Charging Pump AB does not Function	170/10 199/9 273/10 274/10 275/8 370/8 371/10	1564-3875, Sheet 15/13 1564/3875, Sheet 16/13 1564-4090, Sheet 13/8 1564-4091, Sheet 15/8	52B/5/8	G-428S07/7	PD&HD LOU-1564 B-289 Sheet 227/Rev 0

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PRESSURIZER PRESSURE CONTROL SYSTEM

A. System Description

The Pressurizer Pressure Control System (PPCS) maintains the pressure of the Reactor Coolant System at or near a fixed setpoint during both steady state and transient conditions. The system consists of a combination of heater banks and spray valves actuated as required by a pressure controller at various fixed pressure deviation points from the controller setpoint. If system pressure decreases significantly from the setpoint, the proportional heaters will modulate and provide proper heat output and in addition, the backup heaters will be turned on. For system pressure signal above the setpoint, all heaters will be turned off and the spray valves will be actuated proportionally over a fixed pressure range. For very large pressure transients, the pressurizer safety valve will be actuated to limit the pressure surge.

B. Fault Tree Bases

The following bases are used in developing the fault trees:

a) Pressurizer Pressure Control System (PPCS) malfunction is defined as the inability to perform PPCS function resulting in:

1. High pressurizer pressure
2. Low pressurizer pressure

b) For high pressurizer pressure, the following cases are examined:

1. Pressurizer proportional heaters fail to turn off/modulate properly or pressurizer backup heaters fail to trip.

2. Pressurizer pressure spray valves fail to open/close too far.

c) For low pressurizer pressure, the following cases are examined:

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1. Pressurizer proportional heaters fail to provide proper heat output and backup heaters fail to turn on.

2. Pressurizer spray valves open too far.

d) There are two independent automatic control channels with channel selection by means of a manual control switch on CP-2. Automatic control is normally used during operation but manual control of the heaters and spray valves may be utilized at any time.

e) No credit is taken for operator intervention.

f) The detailed evaluation of the effects on PPCS malfunction caused by sensor failure, impulse line rupture and power losses is presented in the fault trees.

g) The referenced documents for developing the fault trees are presented in Table 4.

C. Conclusions

a) Failure of a single pressurizer pressure transmitter (low signal) or rupture of its associated impulse line will generate a spurious low pressure signal. With heaters remain on, this will result in an increase of pressurizer pressure through failing to open of the spray valves. The pressure could increase above their setpoint and possibly to safety valve actuation.

b) Rupture of the pressurizer pressure transmitter impulse line will generate a spurious low pressure signal. This will result in an increase of pressurizer pressure through failing to trip the backup heaters or modulate improperly the proportional heaters.

c) Failure of a single pressurizer pressure transmitter (high signal) will generate a spurious high pressure signal. This will result in a decrease of pressurizer pressure thrugh opening too far of the spray valves or failing to turn on the backup heaters, and the proportional heaters.

d) Failure of a single pressurizer level transmitter (low signal) or rupture of its associated high pressure impulse line will generate a spurious low level signal. This will result in a decrease of pressurizer pressure through turning off all the heaters.

e) Loss of the 120VAC PDP 390-SA will cause loss of instrument air supply to spray valves. Upon loss of instrument air supply, these valves will assume in their fail closed position. However, the RCS pressure will be maintained properly by the PPCS.

f) Loss of the 120VAC PDP 3014AB could result in an increase of pressurizer pressure through failing to open the spray valves on demand. The pressure could increase above their setpoint and possibly to safety valve actuation.

g) The effects of sensor failures, impulse line ruptures and loss of a single power source on the Pressurizer Pressure Control System are presented in Tables 1, 2 and 3, respectively.

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TABLE 1 - SENSOR FAILURES

PRESSUR.ZER PRESSURE CONTROL SYSTEM
(INCREASE PRESSURIZER PRESSURE)

SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
PT-100X (when X channel is selected)	Pressurizer Pressure	Low	Normal spray valves RC301A and RC301B close too far	Heaters being on cause increase in pressurizer pressure, and can possibly lead to safety valve actuation. Not considered significant for Chapter 15 event
PT-100Y (when Y channel is selected)	Pressurizer Pressure	Low	Normal spray valves RC301A and RC301B close too far	Heaters being on cause increase in pressurizer pressure, and can possibly lead to safety valve actuation. Not considered significant for Chapter 15 event

TABLE 1 - SENSOR FAILURES

PRESSURIZER PRESSURE CONTROL SYSTEM
(DECREASE PRESSURIZER PRESSURE)

SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
PT-100X (when X channel is selected)	Pressurizer Pressure	High	A. Pressurizer proportional heater banks fail to turn on B. Pressurizer backup heater banks fail to turn on C. Normal spray valves RC301A and RC301B open too far	FSAR Section 15.6.3.4 Inadvertent Opening of a Pressurizer Safety Valve
PT-100Y (when Y channel is selected)	Pressurizer Pressure	High	A. Pressurizer proportional heater banks fail to turn on B. Pressurizer backup heater banks fail to turn on C. Normal spray valve RC301A and RC301B open too far	FSAR Section 15.6.3.4 Inadvertent Opening of a Pressurizer Safety Valve
LT-110X (when X channel is selected)	Pressurizer Level	Low	A. Pressurizer proportional heater fanks fail to turn on B. Pressurizer backup heater banks fail to turn on	Combining effects of Pressurizer Level Control System malfunctions, charging flow increases, letdown flow path isolates, and heaters fail to turn on. The event is bounded by FSAR Section 15.5.1.1 Chemical and Volume Control System Malfunction that Increases Reactor Coolant System Inventory

TABLE 1 - SENSOR FAILURES

PRESSURIZER PRESSURE CONTROL SYSTEM
(DECREASE PRESSURIZER PRESSURE)

SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
LT-110Y (when Y channel is selected)	Pressurizer Level	Low	A. Pressurizer proportional heater banks fail to turn on B. Pressurizer backup heater banks fail to turn on	Combining effects of Pressurizer Level Control System malfunctions, charging flow increases, letdown flow path isolates, and heaters fail to turn on. The event is bounded by FSAR Section 15.5.1.1 Chemical and Volume Control System Malfunction that Increases Reactor Coolant System Inventory

TABLE 2 - IMPULSE LINE RUPTURE

PRESSURIZER PRESSURE CONTROL SYSTEM
(INCREASE PRESSURIZER PRESSURE)

IMPULSE LINE NUMBER	ASSOCIATED SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
RC1A-7-T-45	PT-100X (when X channel is selected)	Pressurizer Pressure	Low	A. Pressurizer proportional heater banks fail to modulate properly B. Pressurizer backup heater banks fail to trip C. Normal spray valves RC301A and RC301B close too far	Combining effects of Pressurizer Level Control system malfunction, charging flow decreases, letdown flow path not isolated results in the depressurization of Reactor Coolant System. Pressurizer heaters may be damaged. Depressurization of RCS event is bounded by FSAR Section 15.6.3.3 Loss of Coolant Accidents.
RC1B-3-T-46	PT-100Y (when Y channel is selected)	Pressurizer Pressure	Low	A. Pressurizer proportional heater banks fail to modulate properly B. Pressurizer backup heater banks fail to trip C. Normal spray valves RC301A and RC301B close too far	Combining effects of Pressurizer Level Control System malfunction, charging flow decreases, letdown flow path not isolated results in the depressurization of Reactor Coolant System. Pressurizer heaters may be damaged. Depressurization of RCS event is bounded by FSAR Section 15.6.3.3 Loss of Coolant Accidents.

TABLE 2 - IMPULSE LINE RUPTURE

PRESSURIZER PRESSURE CONTROL SYSTEM
(DECREASE PRESSURIZER PRESSURE)

IMPULSE LINE NUMBER	ASSOCIATED SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
RC1A-8-T-28 (High Pressure)	LT-110X (when X channel is selected)	Pressurizer Level	Low	A. Pressurizer proportional heater banks fail to turn on B. Pressurizer backup heater banks fail to turn on	Combining effects of Pressurizer Level Control System malfunctions, charging flow increases, letdown flow path isolates, and heaters fail to turn on. The event is bounded by FSAR Section 15.5.1.1 Chemical and Volume Control System Malfunction that Increases Reactor Coolant System Inventory
RC1A-4-T-26 (High Pressure)	LT-110Y (when Y channel is selected)	Pressurizer Level	Low	A. Pressurizer proportional heater banks fail to turn on B. Pressurizer backup heater banks fail to turn on	Combining effects of Pressurizer Level Control System malfunctions, charging flow increases, letdown flow path isolates, and heaters fail to turn on. The event is bounded by FSAR Section 15.5.1.1 Chemical and Volume Control System Malfunction that Increases Reactor Coolant System Inventory

TABLE 3 - LOSS OF POWER SUPPLY

PRESSURIZER PRESSURE CONTROL SYSTEM

POWER SOURCES	POWER OPERATED COMPONENTS	EFFECT	BOUNDING EVENT
120VAC PDP 390-SA	Normal Spray Valves RC301A and RC301B	Loss of instrument air supply to normal spray valves RC301A and RC301B. Normal spray valves RC301A and RC301B in fail closed position	Heaters being on could cause increase in pressurizer pressure, PPCS will maintain the proper RCS pressure. Not considered significant for Chapter 15 event
120VAC PDP 3014AB	Normal Spray Valves RC301A and RC301B	Normal spray valves RC301A and RC301B fail to open on demand	Heaters being on could cause increase in pressurizer pressure, possible to safety valve actuation. Not considered significant for Chapter 15 event

TABLE 4

PRESSURIZER PRESSURE CONTROL SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1300	Pressurizer Pressure Control System Malfunction					FSAR Section 7.7 Flow Diagram G-172/Rev 16
1301 Sheets 1&2	Proportional Heaters Fail to Turn On/ Modulate Too Low	199/9 264/9 265/11 273/10 274/10 291/10 292/11 2491/12 2516/8 2938/0	1564-3875, Sheet 9/13 1564/3875, Sheet 10/13 1564-3875, Sheet 15/13 1564-3875, Sheet 16/13 1564-4455/2	52B/5/8 52B/6/8	G-428S07/7	
1302	Backup Heaters Fail to Turn On	199/9 264/9 273/10 274/10 285/10 286/10 287/10 288/8 289/10 290/10 2491/12 2516/8	1564-3875, Sheet 9/13 1564-3875, Sheet 15/13 1564-3875, Sheet 16/13	52B/5/8 52B/6/8	G-428S07/7	

TABLE 4

PRESSURIZER PRESSURE CONTROL SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1303	Normal Spray Valves	199/9 264/9 296/10	1564-3875, Sheet 9/13 1564-3875, Sheet 10/13 1564-6003/1		G-428S07/7	
1304	Backup Heaters Fail To Trip	199/9 264/9 273/10 274/10 285/10 286/10 287/10 288/8 289/10 290/10 2491/12 2516/8	1564-3875, Sheet 9/13 1564-3875, Sheet 15/13 1564-3875, Sheet 16/13	52B/5/8 52B/6/8	G-428S07/7	

TABLE 4

PRESSURIZER PRESSURE CONTROL SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1305	P.oportional Heaters F il to Turn Off/ Modulate Properly	199/9 264/9 265/11 273/10 274/10 291/10 292/11 2491/12 2516/8 2938/0	1564-3875, Sheet 9/13 1564-3875, Sheet 10/13 1564-3875, Sheet 15/13 1564-3875, Sheet 16/13 1564-4455/2	52B/5/8 52B/6/8	G-428507/7	

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STEAM BYPASS CONTROL SYSTEM

A. System Description

The purpose of the Steam Bypass Control System (SBCS) is to maximize plant availability by making full utilization of the steam bypass control valve capacity to remove NSSS thermal energy. This objective is achieved by the selective use of turbine bypass valves and/or dropping of selected CEA groups to avoid unnecessary reactor trips and prevent the opening of secondary side safety valves whenever these occurrences can be averted by the controlled release of steam or rapid reduction of power.

To reduce the effects of a transient imposed on the Reactor Coolant System during load rejection or turbine trip, the system will maintain an artificial load by bypassing steam to the condenser.

A valve quick opening demand signal is generated whenever the size of the load rejection is such that it cannot be accommodated with the normal valve modulation speed.

An automatic CEA withdrawal prohibit (AWP) signal is generated whenever an automatic bypass valve opening demand signal exists, since this implies the existence of excess energy in the NSSS. The AWP function fault tree is presented in Reactor Regulating System section.

B. Fault Tree Bases

The following bases are used in developing the fault trees:

a) Steam Bypass Control System malfunctions are defined as:

   1) Failure of any steam bypass control valve to open or modulate on demand.

   2) Spurious operation (inadvertent opening) of one or more steam bypass control valves.

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b) No credit is taken for operator intervention.

c) The detailed evaluation of the effects on the Steam Bypass Control System malfunction caused by sensor failure, impulse line rupture and power losses is presented in the fault trees.

d) The referenced documents for developing the fault trees are presented in Table 4.

C. Conclusions

a) Steam bypass control valves will fail to open on demand under the following conditions:

1) Failure of any condenser vacuum pressure switch.

2) A spurious low signal from failure of either main steam header pressure transmitter or rupture of their associated impulse lines.

3) A spurious high signal from either main steam flow transmitter or rupture of their associated low pressure impulse lines.

4) Loss of 120VAC PDPs 3014AB or 384A will result in all steam bypass control valves failing to open on demand.

5) Loss of 125VDC PDP 3AB-DC-A will result in steam bypass control valves MS319A, MS319C and MS320A failing to open on demand.

6) Loss of 125VDC PDP 3AB-DC-B will result in steam bypass control valves MS319B, MS320B and MS320C failing to open on demand.

b) The effects of sensor failures, impulse line ruptures and loss of single power source on Steam Bypass Control System are presented in Tables 1, 2 and 3, respectively.

c) There exists no single power source, sensor, or impulse line whose failure will result in spurious operation (inadvertent opening) of one or more steam bypass control valves.

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TABLE 1 - SENSOR FAILURE

STEAM BYPASS CONTROL SYSTEM

SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
PS-ES1904A	Condenser A Vacuum Pressure	Low	Steam bypass control valves fail to open or modulate on demand	FSAR Section 15.2.1.3 Loss of Condenser Vacuum
PS-ES1904B	Condenser B Vacuum Pressure	Low	Steam bypass control valves fail to open or modulate on demand	FSAR Section 15.2.1.3 Loss of Condenser Vacuum
PS-ES1904C	Condenser C Vacuum Pressure	Low	Steam bypass control valves fail to open or modulate on demand	FSAR Section 15.2.1.3 Loss of Condenser Vacuum
PT-MS1010	Main Steam Header 1 Pressure	Low	Steam bypass control valves fail to open or modulate on demand	FSAR Section 15.2.1.3 Loss of Condenser Vacuum
PT-MS1020	Main Steam Header 2 Pressure	Low	Steam bypass control valves fail to open or modulate on demand	FSAR Section 15.2.1.3 Loss of Condenser Vacuum
FT-MS1011	SG-1 Main Steam Flow	High	Steam bypass control valves fail to open or modulate on demand	FSAR Section 15.2.1.3 Loss of Condenser Vacuum
FT-MS1021	SG-2 Main Steam Flow	High	Steam bypass control valves fail to open or modulate on demand	FSAR Section 15.2.1.3 Loss of Condenser Vacuum

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TABLE 2 - IMPULSE LINE RUPTURE

STEAM BYPASS CONTROL SYSTEM

IMPULSE LINE NUMBER	SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
TC52-1-T-56	PT-MS1010	Main Steam Header 1 Pressure	Low	Steam bypass control valves fail to open or modulate on demand	FSAR Section 15.2.1.3 Loss of Condenser Vacuum
TC51-5-T-54	PT-MS1020	Main Steam Header 2 Pressure	Low	Steam bypass control valves fail to open or modulate on demand	FSAR Section 15.2.1.3 Loss of Condenser Vacuum
RC1A-2-T-43	FT-MS1011	SG-1 Main Steam Flow	High	Steam bypass control valves fail to open or modulate	FSAR Section 15.2.1.3 Loss of Condenser Vacuum
RC2B-4-T-60	FT-MS1021	SG-2 Main Steam Flow	High	Steam bypass control valves fail to open or modulate on demand	FSAR Section 15.2.1.3 Loss of Condenser Vacuum

TABLE 3 - LOSS OF POWER SUPPLY

STEAM BYPASS CONTROL SYSTEM

POWER SOURCES	POWER OPERATED COMPONENTS	EFFECT	BOUNDING EVENT
125 VDC PDP 3AB-DC-A	Steam bypass control valves MS319A, 4S319C and MS320A	Steam bypass control valves MS319A, MS319C and MS320A fail to open or modulate on demand	FASAR Section 15.2.1.3 Loss of Condenser Vacuum
125 VDC PDP 3AB-DC-B	Steam bypass control valves MS319B, MS320B and MS320C	Steam bypass control valves MS319B, MS320B and MS320C fail to open or modulate on demand	FSAR Section 15.2.1.3 Loss of Condenser Vacuum
120 VAC PDP 3014AB	Steam bypass control valves MS319A, MS319B, MS319C, MS320A, MS320B and MS320C	All Steam bypass control valves fail to open or modulate on demand	FSAR Section 15.2.1.3 Loss of Condenser Vacuum
120 VAC PDP 384A	Steam bypass control valves MS319A, MS319B, MS319C, MS320A, MS320B and MS320C	All Steam bypass control valves fail to open or modulate on demand	FSAR Section 15.2.1.3 loss of Condenser Vacuum

TABLE 4

STEAM BYPASS CONTROL SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1400	Steam Bypass Control System Malfunction					FSAR Section 7.7 Flow Diagram G-151, Sheet 2/Rev 21
1401 Sheets 1&2	Steam Bypass Control System Valves Fail to Open On Demand	1689/5 1690/7 1691/6 1692/6 1693/6 1694/6 1695/6 1696/7	1564-4637/4 1564-4641/2 1564-6002/3 1564-6179/1		G-427S04/6 G-428S07/7	PD&MD LOU-1564 B-289 Sheet 227/Rev 0
1402 Sheets 1&2	Steam Bypass Control System Valves Inadvertently Open	1689/5 1690/7 1691/6 1692/6 1693/6 1694/6 1695/6 1696/7	1564-4637/4 1564-4641/2 1564-6002/3 1564-6179/1		G-427S04/6 G-428S07/7	PD&MD LOU-1564 B-289 Sheet 227/Rev 0

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FEEDWATER CONTROL SYSTEM

A. System Description

One Feedwater Control System (FWCS) is provided for each steam generator. The two steam generators are operated in parallel. Each steam generator's downcomer level is individually maintained by a three element controller. Each controller provides a modulation signal to control the position of either a main or a bypass feedwater control valve and also adjust the speed of main feedwater pumps to regulate the feedwater flow to the respective steam generator. During normal operation, each FWCS provides output signal by continuously comparing steam flow, feedwater flow and steam generator downcomer level. In addition, each FWCS simultaneously provides a pump speed setpoint to the turbine driven feed pump speed control systems.

When a reactor trip occurs, each FWCS automatically reduces the feedwater flowrate to its respective steam generator by closing the associated main feedwater control valves, partially opening the bypass feedwater control valves, and limiting the feedwater pump speed.

B. Fault Tree Bases

The following bases are used in developing the fault trees:

a) Feedwater Control System malfunctions are defined as:

   1. Main or bypass feedwater control valves open too far resulting in steam generator overfeeding.

   2. Main or bypass feedwater control valves fail closed resulting in loss of feedwater flow to steam generators.

b) For the overfeeding case, it is assumed that either the plant is in low power operation (with use of bypass feedwater control valves) or power operation (with use of main feedwater control valves) at one given time. Excess opening of any one loop feedwater control valve is assumed to cause overfeeding of a steam generator.

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c) For a loss of feedwater flow to the steam generators, it is assumed that both loops must have control valves that fail closed.

d) No credit is taken for operator intervention.

e) The detailed evaluation of the effect on the Feedwater Control System malfunction caused by sensor failure, impulse line rupture and power losses is presented in the fault trees.

f) The reference documents for developing the fault trees are presented in Table 4.

C. Conclusions

a) Any one of the following failures will result in a main feedwater control valve failing closed leading to loss of feedwater flow to steam generators:

1) A spurious high signal on either steam generator downcomer level transmitter or rupture of its associated low pressure impulse line.

2) A spurious high signal from either steam generator feedwater flow transmitter or its associated low pressure impulse line.

3) A spurious low signal from either main steam flow transmitter or rupture of its associated high pressure impulse line.

4) Loss of 120 VAC PDP 3014AB.

b) Any one of the following failures will result in a Bypass Feedwater Control Valve failing closed leading to loss of feedwater flow to steam generators.

1) A spurious high signal on either steam generator downcomer level transmitter or rupture of its associated low pressure impulse line.

2) A spurious high signal from either steam generator feedwater flow transmitter or its associated low pressure impulse line.

3) A spurious low signal from either main steam flow transmitter or rupture of its associated high pressure impulse line.

4) Loss of 120 VAC PDP 3014AB.

c) The effects of the loss of a single power source, sensor failure and impulse line rupture on FWCS are presented in Tables 1, 2 and 3, respectively.

d) There exists no single power source, sensor, or impulse line whose failure will result in main or bypass feedwater control valves opening too far.

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TABLE 1 - SENSOR FAILURE

FEEDWATER CONTROL SYSTEM

SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
LT-1111	SG-1 Downcomer Level	High	Main feedwater control valve FW173A fails closed resulting loss of normal feedwater flow to steam generator 1. Bypass feed-water control valve FW166A fails closed resulting in loss of normal feedwater flow to steam generator 1.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.
LT-1105	SG-1 Downcomer Level	High	Main feedwater control valve FW173A fails closed resulting loss of normal feedwater flow to steam generator 1. Bypass feed-water control Valve FW166A fails closed resulting in loss of normal feedwater flow to steam generator 1.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.
FT-1011	Main Steam Header 1 Flow	Low	Main feedwater control valve FW173A fails closed resulting loss of normal feedwater flow to steam generator 1. Bypass feed-water control valve FW166A fails closed resulting in loss of normal feedwater flow to steam generator 1.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.
FT-1111	Main Feedwater to SG-1 Flow	High	Main feedwater control valve FW173A fails closed resulting loss of normal feedwater flow to steam generator 1. Bypass feed-water control valve FW166A fails closed resulting in loss of normal feedwater flow to steam generator 1.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.
LT-1121	SG-2 Downcomer Level	High	Main feedwater control valve FW173B fails closed resulting loss of normal feedwater flow to steam generator 2. Bypass feed-water control valve FW166B fails closed resulting in loss of normal feedwater flow to steam generator 2.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.

TABLE 1 - SENSOR FAILURE

FEEDWATER CONTROL SYSTEM

SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
LT-1106	SG-2 Downcomer Level	High	Main feedwater control valve FW173B fails closed resulting loss of normal feedwater flow to steam generator 2. Bypass feedwater control valve FW166B fails closed resulting in loss of normal feedwater flow to steam generator 2.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.
FT-1021	Main Steam Header 2 Flow	Low	Main feedwater control valve FW173B fails closed resulting loss of normal feedwater flow to steam generator 2. Bypass feedwater control Valve FW166B fails closed resulting in loss of normal feedwater flow to steam generator 2.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.
FT-1121	Main Feedwater to SG-2 Flow	High	Main feedwater control valve FW173B fails closed resulting loss of normal feedwater flow to steam generator 2. Bypass feedwater control valve FW166B fails closed resulting in loss of normal feedwater flow to steam generator 2.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.

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TABLE 2 - IMPULSE LINE RUPTURE

FEEDWATER CONTROL SYSTEM

IMPULSE LINE NUMBER	ASSOCIATED SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
RC1A-6-T-39	LT-1111	SG-1 Downcomer Level	High	Main feedwater control valve FW173A fails closed resulting loss of normal feedwater flow to steam generator 1. Bypass feedwater control valve FW166A fails closed resulting in loss of normal feedwater flow to steam generator 1.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.
RC1D-1-T-42	LT-1105	SG-1 Downcomer Level	High	Main feedwater control valve FW173A fails closed resulting loss of normal feedwater flow to steam generator 1. Bypass feedwater control valve FW166A fails closed in resulting in loss of normal feedwater flow to steam generator 1.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.
RC1A-1-T-43	FT-1011	Main Steam Header 1 Flow	Low	Main feedwater control valve FW173A fails closed resulting loss of normal feedwater flow to steam generator 1. Bypass feedwater control valve FW166A fails closed resulting in loss of normal feedwater flow to steam generator 1.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.
AC24-2-T-140	FT-1111	Main Feedwater to SG-1 Flow	High	Main feedwater control valve FW173A fails closed resulting loss of normal feedwater flow to steam generator 1. Bypass feedwater control valve FW166A fails closed resulting in loss of normal feedwater flow to steam generator 1.	FSAR Sect[illegible] 15.2.2.5 Loss of Normal Feedwater Flow.

TABLE 2 - IMPULSE LINE RUPTURE

FEEDWATER CONTROL SYSTEM

IMPULSE LINE NUMBER	ASSOCIATED SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
RC2A-2-T-56	LT-1121	SG-2 Downcomer Level	High	Main feedwater control valve FW173B fails closed resulting loss of normal feedwater flow to steam generator 2. Bypass feedwater control valve FW166B fails closed resulting in loss of normal feedwater flow to steam generator 2.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.
RC2D-1-T-59	LT-1106	SG-2 Downcomer Level	High	Main feedwater control valve FW173B fails closed resulting loss of normal feedwater flow to steam generator 2. Bypass feedwater control calve FW166B fails closed resulting in loss of normal feedwater flow to steam generator 2.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.
RC2B-3-T-60	FT-1021	Main Steam Header 2 Flow	Low	Main feedwater control valve FW173B fails closed resulting loss of normal feedwater flow to steam generator 2. Bypass feedwater control valve FW166B fails closed resulting in loss of normal feedwater flow to steam generator 2.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.
AC24-6-T-142	FT-1121	Main Feedwater to SG-2 Flow	High	Main feedwater control valve FW173B fails closed resulting loss of normal feedwater flow to steam generator 2. Bypass feedwater control valve FW166B fails closed resulting in loss of normal feedwater flow to steam generator 2.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.

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TABLE 3 - LOSS OF POWER SUPPLY

FEEDWATER CONTROL SYSTEM

POWER SOURCES	POWER OPERATED COMPONENTS	EFFECT	BOUNDING EVENT
120VAC PDP 3014AB	Main feedwater control valves FW173A and FW173B	Main feedwater control valves FW173A and FW173B fail closed resulting in loss of normal feedwater flow to steam generqtors 1 and 2 during normal operation.	FSAR Section 15.2.2.5 Loss of Normal Feedwater Flow.
	Bypass feedwater control valves FW166A and FW166B	Bypass feedwater control valves FW166A and FW166B fail closed resulting in loss of normal feedwater flow to steam generators 1 and 2 during reactor trip or reducing power operation.	

TABLE 4

FEEDWATER CONTROL SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1500	Feedwater Control System Malfunction					
1501	Main Feedwater Control Valves FW173A & FW173B Fail Closed	199/9 1500/11 1502/13 1503/2 1516/11 1517/8 1518/9 1519/3	1564-3876, Sheet 33/12 1564-3876, Sheet 31/12 1564-3876, Sheet 34/12 1564-4732/4 1564-4733/3 1564-6000/1 1564-6002/3		G-432S08/8 G-428S07/7 G-428S09/7	Flow Diagram G-153 Sheet 4/Rev 22 PD&MD LOU-1564 B-289 Sheet 227/ Rev 0
1502	Bypass Control Valves FW166A & FW166B Open Too Far and Fail Closed	199/9 1500/11 1502/13 1503/2 1516/11 1517/8 1518/9 1519/3	1564-3876, Sheet 31/12 1564-3876, Sheet 3[illegible]/12 1564-4732/4 1564-4733/3 1564-6000/1 1564-6002/3		G-432S08/8 G-428S07/7 G-428S09/7	PD&MD LOU-1564 B-289 Sheet 227/ Rev 0
1503	Main Feedwater Control Valves FW173A & FW173B Open Too Far	199/9 1500/11 1502/13 1503/2 1516/11 1517/8 1518/9 1519/3	1564-3876, Sheet 31/12 1564-3876, Sheet 32/12 1564-4732/4 1564-4733/3 1564-6000/1 1564-6002/3		G-432S08/8 G-428S07/7 G-428S09/7	PD&MD LOU-1564 B-289 Sheet 227/ Rev 0

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REACTOR REGULATING SYSTEM

A. System Description

The Reactor Regulating System (RRS) generates a reference temperature (Tref) as a function of turbine power as measured by turbine first stage pressure. The Tref signal is used by the RRS as a temperature set point for automatic CEA Control. In addition, using inputs of hot leg and cold leg temperatures, the RRS calculates the average reactor coolant temperatures (Tavg). The Tavg signal is used as primary feedback signal for automatic CEA control. The RRS also uses the Tavg signal to calculate pressurizer level setpoint signal, and control actions of the Steam Bypass Control System.

B. Fault Tree Bases

The following bases are used in developing the fault tree:

a) Five cases of operation of the Reactor Regulating System are analyzed:

CASE 1 - CEDMCS receives process signal from RRS and causes inadvertent CEA withdrawal

CASE 2 - Pressurizer level setpoint signal unavailable from the RRS

CASE 3 - Pressurizer level setpoint signal abnormally high from the RRS

CASE 4 - Pressurizer level setpoint signal abnormally low from the RRS

CASE 5 - AWP signal is not generated from the inputs of the RRS

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b) The cold leg RTD selector switches, HS-111 and HS-121, are selected to the "normal" position. Transmitters TT-RC-111Y and TT-RC-121Y will receive signals from RTD's TE-RC-111Y and TE-RC-121Y, respectively. Upon maintenance or failure of the "normal" RTD's, the operator can turn the selector switches to the "alternate" position so that transmitters TT-RC-111Y and TT-RC-121Y will receive signals from RTD's TE-RC-115 and TE-RC-125, respectively. Both cold leg and hot leg temperature signals are processed and inputted to either RRS cabinets CP-12A or CP-12B. The system will process the higher signal through an analog computer circuit to generate the setpoint signal.

c) The compensated temperature error and compensated power error signals are used for automatic CEA Control.

d) Either RRS cabinet CP-12A or CP-12B is selected in service at one time.

e) No credit is taken for operator intervention.

f) The detailed evaluation of the effects of a RRS signal caused by sensor failure, impulse line rupture and power loss is presented in the fault trees.

g) The referenced documents for developing the fault trees are presented in Table 3.

C. Conclusions

a) An inadvertent control rod withdrawal could result from a spurious low signal of the selected excore neutron flux detectors X or Y, or a spurious high signal of the selected first stage turbine pressure sensor. No adverse affects will be noted from the above failures since high pressurizer pressure trip action will be automatically initiated. The effects and bounding events of these failures are presented in Table 1.

b) A spurious high Tavg signal will result in a high pressurizer level setpoint signal to the Pressurizer Level Control System. This could increase the charging flow to the pressurizer with the letdown flow path not isolated. The effects and bounding events of the sensor failure are presented in Table 1.

c) A spurious low Tavg signal will result in a low pressurizer level setpoint signal to the Presurizer Level Control System, as well as make an AWP signal unavailable from the Reactor Regulating System and a CEA withdrawal signal. The effects and bounding events of the sensor failure are presented in Table 1.

d) There exists no single impulse line whose failure will result in the malfunction of the Reactor Regulating System.

e) Loss of power sources 120 VAC PDP 3AB1 and 120 VAC PDP 3014AB will result in a no pressurizer level setpoint signal from the Reactor Regulating System to the Pressurizer Level Control System, and an AWP signal unavailable from the Reactor Regulating System to terminate the control rod withdrawal if required. The effects and bounding events of the loss of a single power source are presented in Table 2.

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REACTOR REGULATING SYSTEM

SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
PT-ES1001	Turbine First Stage Pressure	High	A. Automatic Withdrawal Prohibit (AWP) signal is not generated from Reactor Regulating System to terminate control rod withdrawal if required. B. CEA withdrawal signal is generated from Reactor Regulating System when it is not required.	FSAR Section 15.4.1.2 uncontrolled CEA withdrawal at power
PT-ES1002	Turbine First Stage Pressure	High	A. Automatic Withdrawal Prohibit (AWP) signal is not generated from Reactor Regulating System to terminate control rod withdrawal if required. B. CEA withdrawal signal is generated from Reactor Regulating System when it is not required.	FSAR Section 15.4.1.2 uncontrolled CEA withdrawal at power
X	Excore Neutron Flux Detector Channel X	Low	A. Automatic Withdrawal Prohibit (AWP) signal is not generated from Reactor Regulating System to terminate control rod withdrawal if required. B. CEA withdrawal signal is generated from Reactor Regulating System when it is not required.	FSAR Section 15.4.1.2 uncontrolled CEA withdrawal at power

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TABLE 1 - SENSOR FAILURE

REACTOR REGULATING SYSTEM

SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
Y	Excore Neutron Flux Detector Channel Y	Low	A. Automatic Withdrawal Prohibit (AWP) signal is not generated from Reactor Regulating System to terminate control rod withdrawal if required. B. CEA withdrawal signal is generated from Reactor Regulating System when it is not required.	FSAR Section 15.4.1.2 uncontrolled CEA withdrawal at power
TE-RC111X	Reactor Coolant Hot Leg 1 Temperature	Low	A. Automatic Withdrawal Prohibit (AWP) signal is not generated from Reactor Regulating System to terminate control rod withdrawal if required. B. CEA withdrawal signal is generated from Reactor Regulating System when it is not required. C. Low pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control Sytem.	FSAR Section 15.4.1.2 uncontrolled CEA withdrawal at power
TE-RC111Y	Reactor Coolant Cold Leg 1 Temperature	Low	A. Automatic Withdrawal Prohibit (AWP) signal is not generated from Reactor Regulating System to terminate control rod withdrawal if required. B. CEA withdrawal signal is generated from Reactor Regulating System when it is not required. C. Low pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control Sytem.	FSAR Section 15.4.1.2 uncontrolled CEA withdrawal at power

TABLE 1 - SENSOR FAILURE

REACTOR REGULATING SYSTEM

SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
TE-RC115	Reactor Coolant Cold Leg 1 Temperature	Low	A. Automatic Withdrawal Prohibit (AWP) signal is not generated from Reactor Regulating System to terminate control rod withdrawal if required. B. CEA withdrawal signal is generated from Reactor Regulating System when it is not required. C. Low pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control Sytem.	FSAR Section 15.4.1.2 uncontrolled CEA withdrawal at power
TE-RC121X	Reactor Coolant Hot Leg 2 Temperature	Low	A. Automatic Withdrawal Prohibit (AWP) signal is not generated from Reactor Regulating System to terminate control rod withdrawal if required. B. CEA withdrawal signal is generated from Reactor Regulating System when it is not required. C. Low pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control Sytem.	FSAR Section 15.4.1.2 uncontrolled CEA withdrawal at power

TABLE 1 - SENSOR FAILURE

REACTOR REGULATING SYSTEM

SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
TE-RC121Y	Reactor Coolant Cold Leg 2 Temperature	Low	A. Automatic Withdrawal Prohibit (AWP) signal is not generated from Reactor Regulating System to terminate control rod withdrawal if required. B. CEA withdrawal signal is generated from Reactor Regulating System when it is not required. C. Low pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control Sytem.	FSAR Section 15.4.1.2 uncontrol-led CEA withdrawal at power
TE-RC125	Reactor Coolant Cold Leg 2 Temperature	Low	A. Automatic Withdrawal Prohibit (AWP) signal is not generated from Reactor Regulating System to terminate control rod withdrawal if required. B. CEA withdrawal signal is generated from Reactor Regulating System when it is not required. C. Low pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control Sytem.	FSAR Section 15.4.1.2 uncontrol-led CEA withdrawal at power
TE-RC111X	Reactor Coolant Hot Leg 1 Temperature	High	High pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control System	Charging flow increases, pressurizer heaters are on and letdown flow path not isolated. Steady state will be reached at full power pressurizer level. Not considered significant for Chapter 15 event.
TE-RC111Y	Reactor Coolant Cold Leg 1 Temperature	High	High pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control System	Charging flow increases, pressurizer heaters are on and letdown flow path not isolated. Steady state will be reached at full power pressurizer level. Not considered significant for Chapter 15 event.

TABLE 1 - SENSOR FAILURE

REACTOR REGULATING SYSTEM

SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
TE-RC121X	Reactor Coolant Hot Leg 2 Temperaure	High	High pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control System	Charging flow increases, pressurizer heaters are on and letdown flow path not isolated. Steady state will be reached at full power pressurizer level. Not considered significant for Chapter 15 event.
TE-RC121Y	Reactor Coolant Cold Leg 2 Temperaure	High	High pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control System	Charging flow increases, pressurizer heaters are on and letdown flow path not isolated. Steady state will be reached at full power pressurizer level. Not considered significant for Chapter 15 event.
TE-RC115	Reactor Coolant Cold Leg 1 Temperaure	High	High pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control System	Charging flow increases, pressurizer heaters are on and letdown flow path not isolated. Steady state will be reached at full power pressurizer level. Not considered significant for Chapter 15 event.
TE-RC125	Reactor Coolant Cold Leg 2 Temperature	High	High pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control System	Charging flow increases, pressurizer heaters are on and letdown flow path not isolated. Steady state will be reached at full power pressurizer level. Not considered significant for Chapter 15 event.

REACTOR REGULATING SYSTEM

POWER SOURCES	POWER OPERATED COMPONENTS	EFFECT	BOUNDING EVENT
120VAC PDP 3AB1	Power supply to CP-12A & CP-12B	A. No pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control System	Letdown flow path isolates, the lead charging pump continues running which could result in higher pressurizer level and pressure, and possibly to safety valve actuation. In addition, the RCS can be protected by the reactor trips from low DNBR and high pressurizer pressure. Not considered significant for Chapter 15 event.
		B. Automatic Withdrawal Prohibit (AWP) signal is not generated from Reactor Regulating System to terminate the control rod withdrawal if required.	
120VAC PDP 3014AB	Power Supply to CP-30 & CP-31	A. No pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control System	Letdown flow path isolates, the lead charging pump continues running which could result in higher pressurizer level and pressure, and possibly to safety valve actuation. In addition, the RCS can be protected by the reactor trips from low DNBR and high pressurizer pressure. Not considered significant for Chapter 15 event.
		B. Automatic Withdrawal Prohibit (AWP) signal is not generated from Reactor Regulating System to terminate the control rod withdrawal if required.	

TABLE 3

REACTOR REGULATING SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1600 Sheet 1	CEDMCS Receives CEA Withdraw Signal from RRS	198/10	1564-1487/0 1564-3174/6			FSAR Sections 7.2.1&7.7 PD&MD LOU-1564 B-289 Sheet 141/Rev 6
1600 Sheet 2	CEA Withdraw Signal from RRS Not Present	196/8 197/6 200/14 204/12 205/9 206/11	1564-2558/4 1564-3174/6 1564-3712, Sheet 6/13 1564-3712, Sheet 7/10 1564-3712, Sheet 8/10 1564-3712, Sheet 9/10			FSAR Sections 7.2.1&7.7 PD&MD LOU-1564 B-289 Sheet 141/Rev 6 B-289 Sheet 227/Rev 0

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TABLE 3

REACTOR REGULATING SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1601	Pressurizer Level Setpoint Signal	196/8 197/6 200/14 204/12 205/9 206/11	1564-3714/6 1564-3712, Sheet 6/13 1564-3712, Sheet 7/10 1564-3712, Sheet 8/10 1564-3712, Sheet 9/10			FSAR Section 7.7 PD&MD LOU-1564 B-289 Sheet 141/Rev 5 B-289 Sheet 227/Rev 0

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TURBINE CONTROL SYSTEM

A. System Description

The Main Turbine is controlled by a digital electrohydraulic (DEH) control system to control turbine valve movement. The system is designed to provide automatic speed/load control and overspeed protection for the turbine.

The flow of the main inlet steam is controlled by the governing valves. Each valve is actuated by an actuator assembly mounted directly on the valve. The valves are spring loaded and close automatically whenever the unit is tripped manually or automatically by protective signals.

The DEH controller positions the throttle and governor valves by electrohydraulic servo loops. DEH Control System receives three feedbacks from the turbine: speed, generator MW output, and first stage pressure which is proportional to the turbine load. The feedback signals are used to develop control signals to turbine steam valves for speed/load control of the turbine and overspeed protection.

The turbine generator is provided with two overspeed protection systems:

a) Electrical
b) Mechanical

Electrical overspeed protection consists of an electrohydraulic control system that controls turbine overspeed in the event of a partial or complete loss of load, and if the turbine reaches or exceeds 103 percent of rated speed. It trips the turbine at 111.5 percent of rated speed.

Overspeed information is supplied via three reluctance pickup speed sensors coupled magnetically to a notched wheel of the turbine rotor.

A redundant and diverse means of tripping the turbine is provided by a centrifugal clutch which will drain the hydraulic fluid at 111% of rated speed.

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B. Fault Tree Bases

The following bases are used in developing the fault trees:

a) Turbine Control System Malfunctions are defined as:

1) Failure of any throttle valve to close on demand.

2) Failure of any Governor Valve to close on demand.

3) Loss of Turbine Trip capability.

4) Turbine runback signal is not generted on demand.

b) The detailed evaluation of the effects on the Turbine Control System caused by sensor failure, impulse line rupture and power losses is presented in the fault trees.

c) The referenced documents for developing the fault trees are presented in Table 2.

C. Conclusions

a) The effects of power supply failure on the Turbine Control System is presented in Table 1. Loss of 120VAC PDP 384A will result in a turbine runback signal not being generated from Steam Bypass Control System if required.

b) There exist no single sensor failure, or impulse line rupture whose failure will result in failure of the Turbine Control System to fulfill its intended function.

TABLE 1 - LOSS OF POWER SUPPLY

TURBINE CONTROL SYSTEM

POWER SOURCES	POWER OPERATED COMPONENTS	EFFECT	BOUNDING EVENT
120 VAC PDP 384A	Turbine Control System	Turbine runback signal is not generated from Steam Bypass Control System if required.	Turbine trip will occur on turbine overspeed. This event is bounded by FSAR Section 15.2.1.2 Turbine Trip.

TABLE 2

TURBINE CONTROL SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1700	Turbine Control System Malfunction					FSAR Sections 7.7 & 10.4
1701	Turbine Runback Signal Not Generated On Demand	199/9 1752/13	1564-4641/2		C-427S04/6	
1702	Throttle Valves		1564-9418/0			PD&MD LOU-1564 B-289 Sheet 227/Rev 0
1703	Governor Valves	1858/8	1564-9418/0		C-427S04/6	PD&MD LOU-1564 B-289 Sheet 227/Rev0
1704	Loss of Turbine Trip Capability	199/9 1750/8 1751/7 1752/13 1753/9 1754/12 1755/10 1856/10 2140/14 2201/8 2205/10	1564-349/8 15 64-374/11		C-427S04/6	PD&MD LOU-1564 B-289 Sheet 227/ Rev 0 SMP-987/0
1705	Loss of Load Signal Not Generated from SBCS	1685/7 1686/4	1564-4637/4 1564-4641/2		C-428S07/7	PD&MD LOU-1564 B-289 Sheet 133/ Rev 7 & Sheet 227/Rev 0 SMP-987/0

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MAIN STEAM ATMOSPHERIC DUMP VALVE CONTROL SYSTEM

A. System Description

Each main steam line is provided with one atmospheric dump valve in order to permit the removal of heat from the NSSS and avoid challenging the steam generator code class safety relief valves. The ADV's are required whenever the main steam lines are isolated and during mild transients, in the event of the main condenser is not available or the preferred main steam bypass control valves are not in proper operations.

B. Fault Tree Bases

The following bases are used in developing the fault trees:

a) Main Steam Atmospheric Dump Valve Control System malfunction is defined as one or more atmospheric dump valves inadvertently open.

b) No credit is taken for operator intervention.

c) The detailed evaluation of the effects on the Main Steam Atmospheric Dump Valve Control System caused by sensor failure, impulse line rupture and power losses is presented in the fault trees.

d) The referenced documents for developing the fault trees are presented in Table 2.

C. Conclusions

a) Failure of a main steam pressure transmitter (high signal) will generate a spurious high main steam pressure signal. This signal can cause an inadvertent opening of an atmospheric dump valve and depressurization of the main steam system. The effects of a single sensor failure are presented in Table 1.

b) There exists no single power source or impulse line whose failure will result in an inadvertent opening of the atmospheric dump valves.

TABLE 2

MAIN STEAM ATMOSPHERIC DUMP VALVE CONTROL SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1800	Main Steam Atmospheric Dump Valve Control System Malfunction	1643/6 1658/9 2912/10	5817-1098/4 5817-1099/3 5817-1100/3 5817-1943/2 5817-1944/5 5817-1945/4			

TABLE 1 - SENSOR FAILURE

MAIN STEAM ATMOSPHERIC DUMP VALVE CONTROL SYSTEM

SENSOR	FUNCTION	ASSUMED FAILURE DIRECTION	EFFECT	BOUNDING EVENT
PT-MS0303AS	Main Steam Pressure A	High	Main Steam System depressurizes. Atmospheric Dump Valve MS116A inadvertently opens	FSAR Section 15.1.1.4 Inadvertent Opening of a Steam Generator Atmospheric Dump Valve or Steam Generator Safety Valve
PT-MS0303BS	Main Steam Pressure B	High	Main Steam System depressurizes. Atmospheric Dump Valve MS116B inadvertently opens	FSAR Section 15.1.1.4 Inadvertent Opening of a Steam Generator Atmospheric Dump Valve or Steam Generator Safety Valve

8607160153-71

BORON CONTROL SYSTEM

A. System Description

The Chemical and Volume Control System (CVCS) dilution and boration modes are utilized to achieve the control of the boron concentration in the reactor coolant system. The analyzed mode of operation is the CVCS normal dilution mode which supplies primary grade water into the RCS via the primary makeup portion of the CVCS.

B. Fault Tree Bases

The following bases are used in developing the fau t trees:

a) Failure of the boron control function of he Chemical and Volume Control System is defined as any subsyste malfunction which would lead to an uncontrolled dilution of the eactor coolant system and an excess reactivity insertion.

b) The boron control function of the CVCS is manually placed in the normal dilution mode.

c) The Boron Monitoring System is not used to determine the reactor coolant boron concentration.

d) The detailed evaluation of the CVCS dilution malfunctions caused by sensor failure, impulse line rupture and power losses is presented in the fault trees.

e) The referenced documents for developing the faul trees are presented in Table 1.

C. Conclusion

a) For the normal dilution path there exists no single power source, sensor, or impulse line whose failure will result in an uncontrolled reactor coolant overdilution event.

TABLE 1 - SENSOR FAILURE

BORON CONTROL SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1900	Boron Control System Malfunction					FSAR Section 7.7 Flow Diagrams G-168, Sheet 1/19 G-168, Sheet 2/21
1901 Sheets 1&2	Charging Pump A&B Running	199/9 273/10 274/10 275/8 365/9 366/10 375/6 376/10 2341/7 2343/4 2391/9 2393/6	1564-3875 Sheet 15/13 1564-3875 Sheet 16/13 1564-4090 Sheet 15/8	52B/5/8	G-427S07/7	PD&MD LOU-1564 B-289 Sheet 227/ Rev 0
1902	Charging Pump AB Running	170/10 199/9 273/10 274/10 275/8 370/8 371/10	1564-3875, Sheet 15/13 1564-3875, Sheet 16/13 1564-4090, Sheet 13/8 1564-4091, Sheet 15/18	52B/5/8	G-428S07/7	PD&MD LOU-1564 B-289 Sheet 227/ Rev 0
1903	Volume Control Tank Discharge Valve CVC 183 Open	199/9 322/10 327/9	1564-3876, Sheet 15/12	53A/4/8	G-432S05/8	
1904	Reactor Makeup Stop Valve CVC 510 Open	199/9 322/9 355/7 356/6 357/8	1564-3876, Sheet 14/12	53A/4/8	G-432S05/8	

TABLE 1 - SENSOR FAILURE

BORON CONTROL SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
1905	RMW Flow Control Valve PMU 144 Opens Too Far	199/9 354/9 356/6 357/8	1564-3876, Sheet 16/12 1564-6002/3		G-432S02/7	
1906	Primary Water Makeup Pumps A&B Running	1357/9 1358/6				

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PLANT PROTECTION SYSTEM

A. System Description

The Plant Protection System generates the Engineered Safety Feature Actuation System (ESFAS) signals. These signals serve as interlocking circuits to de-energize auxiliary relays to control the power operated components. the ESFAS signals investigated in the system fault tree analysis are: a) Safety Injection Actuation Signal (SIAS); b) Main Steam Isolation Signal (MSIS); and c) Containment Isolation Actuation Signal (CIAS). For parameters that initiate ESFAS signals on low process output signals, transmitter failure, or loss of auctioneered power supplies to its Process Protective Cabinets will cause its associated bistable relay to de-energize.

B. Fault Tree Bases

The following assumptions are used in developing the fault tree:

a) The ESFAS auxiliary relay contacts ((a) open and (b) close) are defined as the inability to de-energize the coil when ESFAS signals are generated.

b) The ESFAS auxiliary relay contacts ((a) close and (b) open) are defined as the inability to energize the coils when ESFAS signals are not generated.

c) All relays (bistable, matrix, solid-state, ESFAS auxiliary) are not selected for their test mode.

d) The operator has not initiated the ESFAS signals manually.

e) The detailed evaluation of the effect on ESFAS signals caused by sensor failure, impulse line rupture and power losses is presented in the fault trees.

f) The referenced documents for developing the fault trees are presented in Table 1.

C. Conclusions

a) Each process parameter of ESFAS signals has four redundant measurement channels associated with it. Each type of ESFAS signal is generated by at least two out of four measurement channels reaching their predetermined setpoint. Therefore, the loss of any one channel power source, sensor or any single impulse line rupture will not affect the system function.

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TABLE 1

PLANT PROTECTION SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
2000 Sheets 1&2	Safety Injection Actuation Signal Present	160/6 165/4 199/9	1564-648/2 1564-656/4 1564-657/3 1564-668/4 1564-669/4 1564-670/4 1564-671/4 1564-672/4 1564-734/3 1564-4090/8 1564-4091/8 1564-4092/9 1564-4093/9 1564-6410/3 1564-6411/4 1564-7463/1		G-428S07/7	FSAR Section 7.3

TABLE 1

PLANT PROTECTION SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
2001 Sheets 1&2	Safety Injection Actuation Signal Not Present	160/6 165/4 199/9	1564-648/2 1564-656/4 1564-657/3 1564-667/4 1564-668/4 1564-669/4 1564-670/4 1564-671/4 1564-672/4 1564-734/3 1564-4090/8 1564-4091/8 1564-4092/9 1564-4093/9 1564-6410/3 1564-6411/4 1564-7463/1			

TABLE 1

PLANT PROTECTION SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
2002	Containment Isolation Actuation Signal Present	160/6 165/4 199/9	1564-648/2 1564-656/4 1564-657/3 1564-667/4 1564-668/4 1564-669/4 1564-670/4 1564-671/4 1564-672/4 1564-734/3 1564-4090/8 1564-4091/8 1564-4092/9 1564-4093/9 1564-6410/3 1564-6411/4 1564-7463/1		G-428S07/7	FSAR Section 7.3

TABLE 1

PLANT PROTECTION SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
2003 Sheets 1&2	Main Steam Isolation Signal Present	160/6 165/4 199/9	1564-648/2 1564-656/4 1564-657/3 1564-667/4 1564-668/4 1564-669/4 1564-670/4 1564-671/4 1564-672/4 1564-734/3 1564-4090/8 1564-4091/8 1564-4092/9 1564-4093/9 1564-6410/3 1564-6411/4 1564-7463/1		G-428S07/7 G-428S08/7	FSAR Section 7.3

TABLE 1

PLANT PROTECTION SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
2004 Sheets 1&2	Main Steam Isolation Signal Not Present	160/6 165/4 199/9	1564-648/2 1564-656/4 1564-657/3 1564-667/4 1564-668/4 1564-669/4 1564-670/4 1564-671/4 1564-672/4 1564-734/3 1564-4090/8 1564-4091/8 1564-4092/9 1564-4093/9 1564-6410/3 1564-6411/4 1564-7463/1		G-428S07/7 G-428S08/7	FSAR Section 7.3

8607160153-81

INSTRUMENT AIR SYSTEM

A. System Description

The instrument air system is a process auxiliary system whose function is to deliver dry, filtered, oil free compressed air to meet pneumatic instrument and control requirements. The system consists of two, 100% capacity air compressors aligned in parallel which feed a common distribution header.

The instrument air system can also be fed from the station air system through a cross connecting self actuated pressure control valve.

B. Fault Tree Bases

The following bases are used in developing the fault trees:

a) Failure of the instrument air system is defined as the "loss of instrument air supply to components inside containment" or "loss of instrument air supply to balance of plant components," as required.

b) The detailed evaluation of the loss of instrument air supply events caused by sensor failure, impulse line rupture and power losses is presented in the fault trees.

c) The referenced documents for developing fault trees are presented in Table 2.

C. Conclusions

a) A loss of instrument air supply to components inside containment will occur upon loss of 120 VAC PDP 390-SA which will cause the single, fail closed, containment isolation valve IA980 to cycle closed. This will isolate components located inside containment from their required instrument air supply source causing them to assume their respective failed positions. The effects of loss of power supply are presented in Table 1.

b) Due to the redundant, independent power supplies to the full capacity air compressors, loss of a single power source will not result in a loss of instrument air supply to balance of plant components.

c) There exists no single sensor or impulse line whose failure will result in a loss of instrument air supply to any air operated component.

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TABLE 1 - LOSS OF POWER SUPPLY

INSTRUMENT AIR SYSTEM

POWER SOURCES	POWER OPERATED COMPONENTS	EFFECT	BOUNDING EVENT
120 VAC PDP 390-SA	Instrument Air Containment Isolation Valve IA 908	Containment Isolation Valve IA 908 Closed	FSAR Section 15.5.1.1 Chemical and Volume Control System Malfunction Which Causes an Increase in Reactor Coolant System Inventory
	The following components will be affected by loss of instrument air supply:	Letdown flow path isolated,	
	1) Letdown Line Isolation Valve CVC 103	1) Letdown line isolation valve CVC 103 closed and,	
	2) Letdown Stop Valve CVC 101	2) Letdown flow path isolated, letdown stop valve CVC 101, closed	
	3) Pressurizer Normal Spray Valve RC301A and RC301B	3) Pressurizer normal spray valves RC301A and RC301B remain closed	

TABLE 2

INSTRUMENT AIR SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
2100	Instrument Air Unavailable	990/7 992/10 997/8 2331/6 2232/11 2340/6 2381/8 2382/8 2390/9			G-427S03/6	FSAR Section 9.3.1 Flow Diagrams G-152, Sheet 1/Rev 2 G-157,Sheet 1/Rev 23
2101	Air Supply from Station Air Compressors A, B & C Unavailable	985/6 987/6 989/0 2416/7 2446/7			G-427S03/6	FSAR Section 9.3.1 Flow Diagrams G-152 Sheet 1/Rev 2 G-157, Sheet 1/Rev 23

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ELECTRIC POWER DISTRIBUTION SYSTEM

A. System Description

The Electric Power Distribution System provides power to the power operated components, sensors and control systems. The distribution system consists of: (1) the transformers, buses and motor control centers necessary to provide the correct voltage as required, and (2) interconnecting breakers and cables between the various transformers, buses, motor control centers and power distribution panels.

B. Fault Tree Bases

The following bases are used in developing the fault trees:

a) Failure of the electric power distribution system is defined as sudden and complete loss of voltage to any transformer, bus, motor control center, power distribution panel or interconnecting breaker whose failure will in turn cause one or more control system failures.

b) No credit is taken for operator intervention in either changing tie breaker positions from their normal alignment or operating manual breakers.

c) Passive component failures are not considered in this analysis.

d) Failure of the 125VDC buses and 120VAC vital buses can result from either induced failures due to simultaneous loss of the normal supply source, alternate supply source and the associated DC battery or by an independent bus failure. Loss of voltage from the DC battery sources is not considered a credible event.

e) The detailed evaluation of the Electric Power Distribution System is presented in the fault trees.

f) The referenced documents for developing the fault trees are presented in Table 2.

C. Conclusions

a) Analysis of the control systems has identified that failure of the following low voltage (120VAC and 125VDC) buses will result in a malfunction in one or more control systems.

1) 120VAC PDP 3014AB
2) 120VAC PDP 384A
3) 120VAC PDP 390-SA
4) 125VAC PDP 3AB-DC-A
5) 125VAC PDP 3AB-DC-B
6) 120VAC PDP 3AB1

The effects and their bounding events of the above single power bus failure are presented in Table 1.

8607160153-86

TABLE 1 -- LOSS OF POWER SUPPLY

ELECTRIC POWER DISTRIBUTION SYSTEM

POWER SOURCES	POWER OPERATED COMPONENTS	EFFECT	BOUNDING EVENT
120VAC PDP 390-SA	Instrument Air Containment Isolation Valve IA 908	Containment Isolation Valve IA 908 Closed	The combined effects are bounded by FSAR Section 15.5.1.1 Chemical and Volume Control System Malfunction that increases Reactor Coolant System Inventory
	The following components will be affected by loss of instrument air supply:	Letdown flow path isolated,	
	1) Letdown line isolation valve CVC103	1) Letdown line isolation valve CVC103 closed and,	
	2) Letdown stop valve CVC101	2) Letdown flow path isolated, letdown stop valve CVC101 closed	
	3) Pressurizer normal spray valves RC301A and RC301B	3) Pressurizer normal spray valves RC301A and RC301B remain closed	
120VAC PDP 384A	Steam Bypass Control System (Power Supply to CP-5)	Steam bypass control valves fail to open or modulate on demand	The combined effects are bounded by FSAR Section 15.2.1.3 Loss of Condenser Vacuum
	Turbine Control System (Power Supply to CP-5)	Turbine runback signal is not generated from Steam Bypass Control System if required	
120VAC PDP 3014AB	Reactor Regulating System (Power Supply to CP-30&CP-31)	A. No pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control System	The combined effects are bounded by FSAR Section 15.2.3.1 Feedwater System Pipe Breaks. The RCS is protected during this transient by the reactor trips from steam generator low level, low pressure and low DNBR and high pressurizer pressure

TABLE 1 - LOSS OF POWER SUPPLY

ELECTRIC POWER DISTRIBUTION SYSTEM

POWER SOURCES	POWER OPERATED COMPONENTS	EFFECT	BOUNDING EVENT
		B. Automatic Withdrawal Prohibit (AWP) signal is not generated from Reactor Regulating System to terminate the control rod withdrawal if required	
	Pressurizer Level Control System (Power Supply to CP-30&CP-31)	Letdown flow path isolated, letdown flow control valves CVC113A and CVC113B fail closed. However, the lead charging pump continues running which could result in higher pressurizer level and pressure, possibly lead to safety valve actuation.	
	Pressurizer Pressure Control System (Power Supply to CP-30&CP-31)	Normal spray valves RC301A and RC301B fail to open on demand	
	Steam Bypass Control System (Power Supply to CP-30)	Steam bypass control valves fail to open or modulate on demand	
	Feedwater Control System (Power Supply to CP-11A, CP-11B&CP-29)	Main feedwater control valves FW173A, 173B and bypass feedwater control valves FW166A and 166B fail closed resulting in loss of normal feedwater to steam generators 1 and 2	

TABLE 1 - LOSS OF POWER SUPPLY

ELECTRIC POWER DISTRIBUTION SYSTEM

POWER SOURCES	POWER OPERATED COMPONENTS	EFFECT	BOUNDING EVENT
120VAC PDP 3AB1	Reactor Regulating System (Power Supply to CP-12A&CP-12B)	A. No pressurizer level setpoint from Reactor Regulating System to Pressurizer Level Control System B. Automatic Withdrawal Prohibit (AWP) signal is not generated from Reactor Regulating System to terminate control rod withdrawal if required	Letdown flow path isolates, the lead charging pump continues running which could result in higher pressurizer level and pressure, and possibly lead to safety valve actuation. In addition, the RCS can be protected by the reactor trips from low DNBR and high pressurizer. Not considered significant for Chapter 15 event
125VDC PDP 3AB-DC-A	Steam Bypass Control Valves MS319A, MS319C and MS320A	Steam bypass control valves MS319A, MS319C and MS320A fail to open or modulate on demand	FSAR Section 15.2.1.3 Loss of Condenser Vacuum
125VDC PDP 3AB-DC-B	Steam Bypass Control Valves MS319B, MS320B and MS320C	Steam bypass control valves MS319B, MS320B and MS320C fail to open or modulate on demand	FSAR Section 15.2.1.3 Loss of Condenser Vacuum

TABLE 2

ELECTRIC POWER DISTRIBUTION SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
2200	120 VAC PDP 3014AB					One Line Diagram LOU 5817 G-247-S01/Rev 4
2201	120 VAC PDP 384A					PD & MD LOU 1564 B-289 Sheet 133/Rev 8
2202	125 VDC PDPS 3A-DC-S, 3AB-DC-S, 3AB-DC-A & 3AB-DC-B					One Line Diagram LOU 1564 G-287/Rev 4
2203	120 VAC PDP 3AB1					One Line Diagram LOU 1564 G-287/Rev 4
2204	120 VAC PDP 390-SA					One Line Diagram LOU 1564 G-287/Rev 4

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TABLE 2

ELECTRIC POWER DISTRIBUTION SYSTEM

FAULT TREE REFERENCED DOCUMENTS

FAULT TREE NO.	FAULT TREE TITLE	CWD (LOU-1564, B-424) SHEET NO./REV NO.	EMDRAC DRAWING NO./REV NO.	SETPOINT DOCUMENT SYSTEM NO./PAGE NO./REV NO.	INSTRUMENT LOCATION DRAWING NO./REV NO.	OTHER DOCUMENTS
2205	480V MCC Buses 3A311-S 3A312-S, 3A313-S & 3AB311-S Feeder Breakers Open	2340/6 2479/5 2480/5 2481/5 2531/7				One Line Diagram LOU 1564 G-286/Rev 7
2206	480V MCC Bus 3AB312 Feeder Breaker Open	2411/6 2532/6				One Line Diagram LOU 1564 G-286/Rev 7

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