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ARIZONA NUCLEAR PUBLIC POWER
PALO VERDE NUCLEAR GENERATING STATION 1

CALCULATION OF TRIP SETPOINT VALUES, PLANT PROTECTION SYSTEM

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LEGAL NOTICE

ABSTRACT

The method used in this calculation tabulates and combines equipment uncertainties with Safety Analysis Setpoints to produce Trip Setpoints and Allowable Values for the Technical Specifications.

The objective of this calculation is to provide Trip Setpoint Allowable Values and Response Times for the following functio

Reactor Protection System (RPS)

1. Variable Overpower
2. High Logarithmic Power
3. High Pressurizer Pressure
4. Low Pressurizer Pressure
5. Low Steam Generator Pressure
6. Low Steam Generator Water Level
7. High Steam Generator Water Level
8. High Containment Pressure

Engineered Safety Features Actuation System (ESFAS)

1. Safety Injection Actuation System (SIAS)
2. Containment Spray Actuation System (CSAS)
3. Containment Isolation Actuation System (CIAS)
4. Main Steamline Isolation System (MSIS)
5. Recirculation Actuation System (RAS)
6. Auxiliary Feedwater Actuation System (AFAS)

Supplementary Protection System (SPS)

1. High Pressurizer Pressure

The Plant Protection System (PPS) consists of the RPS and the ESFAS.

The calculation results are tabulated in Section 2.0 of this document.

The calculation assumptions are contained in Section 3.0 of this document.

QUALITY ASSURANCE:

This calculation has been organized and carried out in accordance with current Nuclear Regulatory Commission requirements for Safety Grade Systems.

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1.0 INTRODUCTION

1.1 PURPOSE

This calculation provides input to Technical Specification Tables 2.2-1, 3.3-2, 3.3-4 and 3.3-5. These tables list the trip setpoints and response times for the Reactor Protection System (RPS), the Engineered Safety Features Actuation System (ESFAS) and the Supplementary Protection System (SPS). The Plant Protection System (PPS) consists of these three systems.

1.2 SCOPE

Section 2.0 summarizes the results and provides the necessary data for the Technical Specification Tables. Channel diagrams are provided in the Appendix.

2.0 SUMMARY

The tables in this Section summarize the results of the calculations of Section 4.0.

Table 2.1 and Table 2.2 provide the Trip Setpoints and Allowable Values for the Technical Specifications. Table 2.1 provides the input to Technical Specification Table 2.2-1 (RPS) and Table 2.2 provides the input to Technical Specification Table 3.3-4 (ESFAS).

Table 2.3 provides the RPS response times, from the sensor to the Reactor Trip Switch Gear, for Technical Specification Table 3.3-2.

Table 2.4 provides the ESFAS response times, from the sensor to the output of the ESF Cabinet, for Technical Specification Table 3.3-5.

Table 2.5 and Table 2.6 provide the voltage equivalents of the PPS Trip Setpoints and Allowable Values. The Trip Setpoint voltage will be set into the equipment during calibration and it incorporates all necessary allowances. The Allowable Value voltage is required to allow for equipment drift between surveillance tests.

Table 2.7 provides Pretrip Setpoints and their equivalent voltages. These values are recommendations based on expected operation and may be changed as necessary.

Table 2.8 and Table 2.10 provide the calibration tolerances, which serve as error limits during periodic tests. If the instrument reading is within this tolerance band, no recalibration is necessary.

Table 2.9 and Table 2.11 provide the periodic test error limits. If the instrument reading is outside the calibration tolerance band but within the periodic test error band, the channel segment is functioning as intended although recalibration is required. If the reading is outside of the periodic test error band, the instrumentation is not behaving as expected. The source of the anomaly and the possibility of exceeding the Allowable Value should be investigated. Only the violation of the Allowable Value is a reportable incident.

Process instrument periodic test errors support a calibration schedule of 22.5 months. Consequently, all four channels of each trip function must be recalibrated within this time period.

In the tables, some items are followed by integers in parentheses. These numbers refer to explanatory notes, which follow the collection of tables.

TABLE 2.1

REACTOR PROTECTION SYSTEM TRIP SETPOINT LIMITS

FUNCTION (1)	TRIP SETPOINT	ALLOWABLE VALUE
Variable Overpower (2)		
CEILING (3)	<= 110.0 %	<= 111.0 %
RATE (4)	<= 10.6 %/min	<= 11.0 %/min
STEP (5)	<= 9.8 %	<= 10.0 %
High Logarithmic Power Level (2,6)	<= 0.798 %	<= 0.895 %
High Pressurizer Pressure	<= 2383 psia	<= 2388 psia
Low Pressurizer Pressure (7)	>= 1837 psia	>= 1822 psia
High Containment Pressure	<= 3.0 psig	<= 3.2 psig
Low Steam Generator Pressure (8)	>= 919 psia	>= 912 psia
Low Steam Generator Water Level (9)	>= 44.2 % WR	>= 43.7 % WR
High Steam Generator Water Level (9,10)	<= 91.0 % NR	<= 91.5 % NR
SPS - High Pressurizer Pressure	<= 2434 psia	<= 2439 psia

TABLE 2.2

ENGINEERED SAFETY FEATURES ACTUATION SYSTEM
TRIP SETPOINT LIMITS

FUNCTION and INITIATING SIGNAL (1)	TRIP SETPOINT	ALLOWABLE VALUE
SAFETY INJECTION (SIAS)		
High Containment Pressure	<= 3.0 psig	<= 3.2 psig
Low Pressurizer Pressure (7)	>= 1837 psia	>= 1822 psia
CONTAINMENT SPRAY (CSAS)		
High-High Containment Pressure	<= 8.5 psig	<= 8.9 psig
CONTAINMENT ISOLATION (CIAS)		
High Containment Pressure	<= 3.0 psig	<= 3.2 psig
Low Pressurizer Pressure (7)	>= 1837 psia	>= 1822 psia
MAIN STEAM LINE ISOLATION (MSIS)		
High Containment Pressure	<= 3.0 psig	<= 3.2 psig
Low Steam Generator Pressure (8)	>= 919 psia	>= 912 psia
High Steam Generator Water Level (9)	<= 91.0 % NR	<= 91.5 % NR

TABLE 2.2, CONT.

ENGINEERED SAFETY FEATURES ACTUATION SYSTEM
TRIP SETPOINT LIMITS

FUNCTION and INITIATING SIGNAL (1)	TRIP SETPOINT	ALLOWABLE VALUE
CONTAINMENT SUMP RECIRCULATION (SRAS)		
Low Refueling Water Tank Level (11)	>= 8.9 %	>= 8.4 %
EMERGENCY FEEDWATER (EFAS)		
Low Steam Generator Water Level (9)	>= 25.8 % WR	>= 25.3 % WR
High Steam Generator delta Pressure	<= 185 psid	<= 192 psid

TABLE 2.3

REACTOR PROTECTION SYSTEM
RESPONSE TIMES

FUNCTION (1)	RESPONSE TIME in SECONDS (12)
Variable Overpower (13)	<= 1.15
High Logarithmic Power Level (13)	<= 0.55
High Pressurizer Pressure	<= 1.15
Low Pressurizer Pressure	<= 1.15
High Containment Pressure	<= 1.15
Low Steam Generator Pressure	<= 1.15
Low Steam Generator Water Level	<= 1.15
High Steam Generator Water Level (10)	<= 1.15
SPS - High Pressurizer Pressure	<= 1.15

TABLE 2.4

ENGINEERED SAFETY FEATURES ACTUATION SYSTEM
RESPONSE TIMES

FUNCTION and INITIATING SIGNAL (1)	RESPONSE TIME in SECONDS
LOW PRESSURIZER PRESSURE (14)	
Safety Injection	<= 1.15
Containment Isolation	<= 1.15
Containment Cooling	<= 1.15
HIGH CONTAINMENT PRESSURE (14)	
Safety Injection	<= 1.15
Containment Isolation	<= 1.15
Containment Cooling	<= 1.15
Main Steam Isolation	<= 1.15
HIGH-HIGH CONTAINMENT PRESSURE (14)	
Containment Spray	<= 1.15
LOW STEAM GENERATOR PRESSURE (14)	
Main Steam Isolation	<= 1.15
Emergency Feedwater	<= 1.15
LOW REFUELING WATER TANK LEVEL (15)	
Containment Sump Recirculation	<= 45.0
LOW STEAM GENERATOR WATER LEVEL (14)	
Emergency Feedwater	<= 1.15
HIGH STEAM GENERATOR DELTA PRESSURE (14)	
Emergency Feedwater	<= 1.15

TABLE 2.5

PLANT PROTECTION SYSTEM
TRIP SETPOINTS AND VOLTAGES

FUNCTION (1)	TRIP SETPOINT	SETPOINT VOLTAGE (16)
Variable Overpower (2)		
CEILING (3)	<= 110.0 %	<= 5.500 volts
RATE (4)	<= 10.6 %/min	<= 0.530 V/min
STEP (5)	<= 9.8 %	<= 0.490 volts
High Logarithmic Power Level (2)	<= 0.798 %	<= 7.601 volts
High Pressurizer Pressure	<= 2383 psia	<= 8.830 volts
Low Pressurizer Pressure	>= 1837 psia	>= 6.123 volts
Low Steam Generator Pressure	>= 919 psia	>= 6.030 volts
Low Steam Generator Water Level (9,10) (RPS)	>= 44.2 % WR	>= 4.420 volts
Low Steam Generator Water Level (9,10) (EFAS)	>= 25.8 % WR	>= 2.580 volts
High Steam Generator Water Level (9)	<= 91.0 % NR	<= 9.100 volts
High Steam Generator delta Pressure	<= 185 psid	<= 1.214 volts
High Containment Pressure	<= 3.0 psig	<= 2.167 volts
High-High Containment Pressure	<= 8.5 psig	<= 1.562 volts
Low Refueling Water Tank Level (11)	>= 8.9 %	>= 1.356 volts
SPS - High Pressurizer Pressure	<= 2434 psia	<= 4.736 volts

TABLE 2.6

PLANT PROTECTION SYSTEM
ALLOWABLE VALUES AND VOLTAGES

FUNCTION (1)	ALLOWABLE VALUE	VOLTAGE (17)
Variable Overpower (2)		
CEILING (3)	<= 111.0 %	<= 5.550 volts
RATE (4)	<= 11.0 %/min	<= 0.550 V/min
STEP (5)	<= 10.0 %	<= 0.500 volts
High Logarithmic Power Level (2)	<= 0.895 %	<= 7.651 volts
High Pressurizer Pressure	<= 2388 psia	<= 8.880 volts
Low Pressurizer Pressure	>= 1822 psia	>= 6.073 volts
Low Steam Generator Pressure	>= 912 psia	>= 5.984 volts
Low Steam Generator (RPS)	>= 43.7 % WR	>= 4.370 volts
Water Level (9,10) (EFAS)	>= 25.3 % WR	>= 2.530 volts
High Steam Generator Water Level (9)	<= 91.5 % NR	<= 9.150 volts
High Steam Generator delta Pressure	<= 192 psid	<= 1.260 volts
High Containment Pressure	<= 3.2 psig	<= 2.200 volts
High-High Containment Pressure	<= 8.9 psig	<= 1.580 volts
Low Refueling Water Tank Level (11)	>= 8.4 %	>= 1.336 volts
SPS - High Pressurizer Pressure	<= 2439 psia	<= 4.756 volts

TABLE 2.7

PLANT PROTECTION SYSTEM
PRETRIP SETPOINTS AND VOLTAGES (18)

FUNCTION (1)		PRETRIP SETPOINT	SETPOINT VOLTAGE
Variable Overpower (2,19)		- 6.0 %	- 0.300 volts
High Logarithmic Power Level (2)		<= 0.001 %	<= 4.699 volts
High Pressurizer Pressure		<= 2359 psia	<= 8.590 volts
Low Pressurizer Pressure		>= 1880 psia	>= 6.267 volts
Low Steam Generator Pressure		>= 960 psia	>= 6.299 volts
Low Steam Generator Water Level (9)	(RPS)	>= 47.1 % WR	>= 4.710 volts
	(EFAS)	>= 28.7 % WR	>= 2.870 volts
High Steam Generator Water Level (9)		<= 88.6 % NR	<= 8.860 volts
High Steam Generator delta Pressure		<= 124 psid	<= 0.814 volts
High Containment Pressure		<= 2.5 psig	<= 2.083 volts
High-High Containment Pressure		<= 6.0 psig	<= 1.449 volts
Low Refueling Water Tank Level (11)		>= 12.5 %	>= 1.500 volts
SPS - High Pressurizer Pressure		<= 2396 psia	<= 4.584 volts

TABLE 2.8

PLANT PROTECTION SYSTEM CABINET
CALIBRATION DATA AND VOLTAGES (20,21,22)

FUNCTION	CALIBRATION ERROR	VOLTAGE
Variable Overpower (2)		
CEILING (3)	+/- 0.155 %	+/- 0.008 volts
RATE (4)	+/- 0.106 %/min	+/- 0.005 V/min
STEP (5)	+/- 0.155 %	+/- 0.008 volts
High Logarithmic Power Level (2)	+/- 0.011 %	+/- 0.006 volts
High Pressurizer Pressure	+/- 0.585 psi	+/- 0.006 volts
Low Pressurizer Pressure	+/- 2.327 psi	+/- 0.008 volts
Low Steam Generator Pressure	+/- 1.182 psi	+/- 0.008 volts
Low Steam Generator Water Level (9)	+/- 0.058 % WR	+/- 0.006 volts
High Steam Generator Water Level (9)	+/- 0.058 % NR	+/- 0.006 volts
High Steam Generator delta Pressure	+/- 0.959 psi	+/- 0.006 volts
High Containment Pressure	+/- 0.035 psi	+/- 0.006 volts
High-High Containment Pressure	+/- 0.130 psi	+/- 0.006 volts
Low Refueling Water Tank Level (11)	+/- 0.146 %	+/- 0.006 volts
SPS - High Pressurizer Pressure	+/- 2.060 psi	+/- 0.008 volts

TABLE 2.9

PLANT PROTECTION SYSTEM CABINET
PERIODIC TEST DATA AND VOLTAGES (20,22.23)

FUNCTION	PERIODIC ERROR	VOLTAGE
Variable Overpower (2)		
CEILING (3)	+/- 0.214 %	+/- 0.011 volts
RATE (4)	+/- 0.200 %/min	+/- 0.010 V/min
STEP (5)	+/- 0.214 %	+/- 0.011 volts
High Logarithmic Power Level (2)	+/- 0.015 %	+/- 0.008 volts
High Pressurizer Pressure	+/- 0.832 psi	+/- 0.008 volts
Low Pressurizer Pressure	+/- 3.210 psi	+/- 0.011 volts
Low Steam Generator Pressure	+/- 1.631 psi	+/- 0.011 volts
Low Steam Generator Water Level (9)	+/- 0.083 % WR	+/- 0.008 volts
High Steam Generator Water Level (9)	+/- 0.083 % NR	+/- 0.008 volts
High Steam Generator delta Pressure	+/- 1.349 psi	+/- 0.009 volts
High Containment Pressure	+/- 0.050 psi	+/- 0.008 volts
High-High Containment Pressure	+/- 0.185 psi	+/- 0.008 volts
Low Refueling Water Tank Level (11)	+/- 0.208 %	+/- 0.008 volts
SPS - High Pressurizer Pressure	+/- 2.613 psi	+/- 0.010 volts

TABLE 2.10

PLANT PROTECTION SYSTEM MEASUREMENT CHANNEL
CALIBRATION DATA AND VOLTAGES (24,25,26)

FUNCTION	CALIBRATION ERROR	VOLTAGE
Variable Overpower (2)	+/- 2.6 %	+/- 0.130 volts
High Logarithmic Power Level (2)	+ 0.259 % - 0.195 %	+ 0.122 volts - 0.122 volts
High Pressurizer Pressure	+/- 7.6 psi	+/- 0.076 volts
Low Pressurizer Pressure	+/- 28.1 psi	+/- 0.094 volts
Low Steam Generator Pressure	+/- 14.4 psi	+/- 0.094 volts
Low Steam Generator Water Level (9)	+/- 1.0 % WR	+/- 0.100 volts
High Steam Generator Water Level (9)	+/- 0.8 % NR	+/- 0.080 volts
High Steam Generator delta Pressure	+/- 14.4 psi	+/- 0.094 volts
High Containment Pressure	+/- 0.14 psi	+/- 0.023 volts
High-High Containment Pressure	+/- 0.51 psi	+/- 0.023 volts
Low Refueling Water Tank Level (11)	+/- 0.6 %	+/- 0.024 volts
SPS - High Pressurizer Pressure	+/- 5.6 psi	+/- 0.022 volts

TABLE 2.11

PLANT PROTECTION SYSTEM MEASUREMENT CHANNEL
PERIODIC TEST DATA AND VOLTAGES (24,26,27)

FUNCTION	PERIODIC ERROR	VOLTAGE
Variable Overpower (2)	+/- 2.8 %	+/- 0.140 volts
High Logarithmic Power Level (2)	+ 0.621 % - 0.349 %	+ 0.250 volts - 0.250 volts
High Pressurizer Pressure	+ 22.2 psi - 52.2 psi	+ 0.222 volts - 0.522 volts
Low Pressurizer Pressure	+/- 68.5 psi	+/- 0.228 volts
Low Steam Generator Pressure	+/- 34.9 psi	+/- 0.229 volts
Low Steam Generator Water Level (9)	+/- 2.3 % WR	+/- 0.230 volts
High Steam Generator Water Level (9)	+/- 2.3 % NR	+/- 0.230 volts
High Steam Generator delta Pressure	+/- 34.9 psi	+/- 0.229 volts
High Containment Pressure	+ 1.38 psi - 0.99 psi	+ 0.230 volts - 0.165 volts
High-High Containment Pressure	+ 2.61 psi - 1.18 psi	+ 0.117 volts - 0.053 volts
Low Refueling Water Tank Level (11)	+ 3.6 % - 1.3 %	+ 0.144 volts - 0.052 volts
SPS - High Pressurizer Pressure	+ 39.7 psi - 29.7 psi	+ 0.159 volts - 0.119 volts

TABLE NOTES

1. (<=) implies "less than or equal to" and (>=) implies "greater than or equal to".

2. Percent of rated thermal power.

3. The maximum value of the trip setpoint.

4. The maximum rate of increase of the trip setpoint.

5. The amount by which the trip setpoint is above the input signal unless limited by the RATE or CEILING.

6. Trip may be manually bypassed above 0.0001 % of Rated Thermal Power. Bypass will be automatically removed when Thermal Power is less than or equal to 0.0001 % of Rated Thermal Power.

7. Setpoint may be decreased manually, to a minimum of 100 psia, as pressurizer pressure is reduced, provided the margin between the pressurizer pressure and the setpoint is maintained at less than or equal to 400 psi. The setpoint will be increased automatically as pressurizer pressure is increased to maintain the margin between pressurizer pressure and the setpoint at less than or equal to 400 psi until the trip setpoint is reached. Trip may be manually bypassed below 400 psia. Bypass will be automatically removed whenever pressurizer pressure is greater than or equal to 500 psia.

8. Setpoint may be decreased manually as steam generator pressure is reduced, provided the margin between the steam generator pressure and the setpoint is maintained at less than or equal to 200 psi. The setpoint will be increased automatically to maintain the margin between steam generator pressure and the setpoint at less than or equal to 200 psi as steam generator pressure is increased until the trip setpoint is reached.

9. Percent of the distance between the steam generator upper and lower level instrument nozzles. (WR) means wide range and (NR) means narrow wide range.

10. Trip function not required to ensure that the reactor core and reactor coolant system will not exceed their safety limits.

TABLE NOTES CONT.

11. Percent of water level instrument span.

12. Time interval from when the monitored parameter exceeds the trip setpoint value at the input to the channel sensor until electrical power is interrupted to the CEA Drive Mechanism.

13. Neutron detectors are exempt from Response Time Testing. Response time will be measured from detector output or from the input of the first electric component in the channel.

14. Time interval from when the monitored parameter exceeds the trip setpoint value at the input to the channel sensor until the output of the actuation relays in the ESF cabinet change state. The response time provided does not include the actuated components (e.g. valves, pumps, etc.).

15. The response time provided includes the actuated components (e.g. valves, pumps, etc.).

16. This voltage is the equivalent of the trip setpoint and should be set into the PPS Cabinet bistable during calibration.

17. This voltage is used to ensure acceptable equipment drift between surveillance tests. The bistable can change state at this voltage or at a voltage in a conservative direction from it.

18. These values are recommendations based on expected operation and may be changed as necessary. They are not necessary to ensure that the reactor core and reactor coolant system will not exceed their safety limits.

19. Suggested setting below variable setpoint.

20. Tolerances are based on providing the test input at the PPS Cabinet and measuring the value that causes the bistable to change state. There is an offset between the actual trip and the observed value of between + 0.016 volts and - 0.016 volts that is dependent on the process level at the time of measurement and the bistable operating configuration. This offset will be determined by the technician at the time of the measurement and is not included in this data.

TABLE NOTES CONT.

21. Calibration data (tolerances) are applicable to the initial calibration of the PPS Cabinet bistable and include an assumed calibration equipment error of +/- 0.005 volts.

22. The tolerances provided are based on calibrating and testing the equipment under the following control room environmental conditions:

    Temperature: 65 to 85 degrees Fahrenheit.

    Relative Humidity: 40 to 60 percent.

    Pressure: Atmospheric.

23. Periodic test data (tolerances) are applicable to the 39-day maximum surveillance interval (channel functional test) of the PPS Cabinet bistables.

24. Tolerances are based on providing the test input at the channel sensor and measuring its output to the PPS Cabinet.

25. Calibration data (tolerances) are applicable to the initial calibration of the measurement channel and include an assumed calibration equipment error of +/- 0.5 percent of span of the device being tested.

26. The tolerances provided are based on calibrating and testing the equipment under the following containment environmental conditions:

    Temperature: +/- 10 degrees Fahrenheit of the normal ambient temperature at the installed location.

    Relative Humidity: 20 to 90 percent.

    Pressure: Atmospheric.

27. Periodic test data (tolerances) are applicable to the 22.5 month maximum surveillance interval of the measurement channel.

3.0 ASSUMPTIONS

The following assumptions were made in determining the PPS setpoints and have to be verified by the customer:

3.1 CALIBRATION AND TESTING ENVIRONMENT

The tolerances provided are based on calibrating and testing the equipment under the following environmental conditions:

A. Control Room

Temperature: 65 to 85 degrees Fahrenheit (dF)
Relative Humidity: 40 to 60 percent
Pressure: Atmospheric

B. Containment

Temperature: +/- 10 dF of the ambient temperature at the installed location.
Relative Humidity: 20 to 90 percent
Pressure: Atmospheric

3.2 CALIBRATION AND TESTING EQUIPMENT

A. The equipment used to calibrate and test the PPS and SPS Cabinets will have an accuracy better than or equal to +/- 0.005 volts.

B. The equipment used to calibrate and test the process instrumentation will have an accuracy better than or equal to +/- 0.5 percent of the span of the device being tested.

C. The PPS Cabinet self-test equipment will be used.

3.3 CALIBRATION AND TESTING INTERVAL

A. The PPS Cabinet will be calibrated and tested on an interval that does not exceed 39 days.

B. The process instrumentation will be calibrated on an interval that does not exceed 22.5 months.

3.4 NUCLEAR INSTRUMENTATION CALIBRATION INTERVAL

Will not exceed 3000 hours.

3.5 NUCLEAR INSTRUMENTATION CALORIMETRIC CALIBRATION

The uncertainty associated with a secondary calorimetric evaluation of the nuclear instrumentation and subsequent process drift will not exceed +/- 4.0 % of full power.

3.6 BARTON TRANSMITTER FIBERGLASS WASHER BACKFIT

All Barton Transmitters have been backfit with fiberglass washers to reduce the effects of thermal drift, or have been returned to the factory for recompensation.

3.7 CONTAINMENT WIRE CONNECTIONS

The error introduced by containment wire connections (e.g. terminal blocks, splices, etc.) under accident conditions is less than or equal to + 1.0 percent during the first hour of an accident.

3.8 REFUELING WATER TANK CAPACITY

A. The Refueling Water Tank shall contain a minimum indicated amount of 485,000 gallons of borated water at all times during normal operation.

B. The calibrated span of the transmitter extends from elevation 94' 10" to the bottom of the overflow line at elevation 154' 2".

3.9 BISTABLE UNIT DELAY TIMES

A. The bistable unit delay time for all PPS trip functions, except Variable Overpower, will be set between 100 and 110 milliseconds.

B. The Variable Overpower bistable unit delay time will be set between 40 and 60 milliseconds.

3.10 CONTAINMENT PRESSURE VARIATIONS

A. Containment pressure variations during normal operation will not exceed +/- 0.5 psi.

B. Containment pressure spikes during maneuvering transients will not exceed 1.2 psi over ambient pressure.

From NUREG-0737, Section II.E.4.2.

> "The containment pressure history during normal operation should be used as a basis for arriving at an appropriate minimum pressure setpoint for initiating containment isolation. ...Applicants for an operating license and operating plant licensees that have operated less than one year should use pressure history data from similar plants that have operated for more than one year..."

3.11 PPS CABINET GENERIC CALIBRATION DISCREPANCY

The required offset between the actual trip setpoint and the observed value will be utilized for all calibration and periodic testing of all PPS Cabinet Trip Functions.

THE FOLLOWING ASSUMPTIONS DO NOT NEED TO BE VERIFIED BY THE CUSTOMER

3.12 That accident condition errors for the feedwater line break event are no worse than accident condition errors for the main steam line break event.

3.13 The PPS Cabinet response time for the Variable Overpower trip is less than or equal to 97 milliseconds. The response time for all other trip functions is less than or equal to 150 milliseconds. These response times envelope the delay times in Assumption 3.9.

3.14 That combination of instrument uncertainties from various sources by the root-sum-square method is realistic and conservative enough when these uncertainties are independent of each other.

3.15 That combination of instrument uncertainties from various sources by algebraic summation is the most conservative method whenever the errors are non-random.

NOTE:

Random errors (errors of uncertain algebraic sign) are indicated by the upper case letters A, B, C, ..., N. When encountered in the analysis, these errors are combined by the RSS technique, denoted by RSS(A, B, C, ..., N).

Non-random errors (errors of known algebraic sign) are indicated by the upper case letters A', B', C', ..., N'. When encountered in the analysis, these errors are added algebraically.

Errors may have both random and non-random components. When this occurs, the notation A+A', B+B', C+C', ..., N+N' is used to indicate the combination of the two error types.

Calibration Equipment Uncertainty is taken twice in the calculation of periodic test error because it must be reapplied at the end of the test interval.

4.1 CALCULATION OF VARIABLE OVERPOWER TRIP

I. ANALYSIS VALUES

A. Analysis Setpoints

CEILING	(1):	117.0 % Power
	(2):	116.0 % Power
RATE	(1):	11.0 %/min.
STEP	(1):	10.0 % Power

B. Sensor Delay Time (1,2): 0.600 sec.
C. Signal Delay Time (1,2): 0.550 sec.

TOTAL ANALYSIS RESPONSE TIME

B + C = 1.15 sec. (For RPS Tech. Spec. Use)

II. PPS CABINET UNCERTAINTIES

Instrument Range: 0 to 200 % Power
Voltage Range: 0 to 10 volts
Conversion Factor: 20 % Power/volt

Conversion Equations: %P = 20V
V = %P/20

A. Cal. Equip. Unc. (3): +/- 0.100 % Power
B. Equipment Accuracy (4): +/- 0.119 % Power
C. Bistable Drift (5): +/- 0.075 % Power
D. Temperature Effects
   1. Ambient (6): +/- 0.078 % Power
   2. Worst Case Normal (6): +/- 0.312 % Power

CALIBRATION ERROR

RSS(A,B) = +/- 0.155 % Power

PERIODIC TEST ERROR

RSS(A,A,B,C,D1) = +/- 0.214 % Power

WORST CASE NORMAL ERROR

RSS(A,B,C,D2) = +/- 0.357 % Power

III. PROCESS EQUIPMENT UNCERTAINTIES

E. Cal. Equip. Unc.:	+/- 1.0 % Power
F. CPC Calibration Error (7):	+/- 0.2 % Power
G. CPC Long Term Drift (7,8):	+/- 0.6 % Power
H. CPC Temperature Effects	
1. Ambient (7):	+/- 0.5 % Power
2. Worst Case Normal (7):	+/- 1.0 % Power
I. Detector Non-linearity:	+/- 2.0 % Power
J. Power Signal Accuracy	
1. Ambient (9):	+/- 1.0 % Power
2. Worst Case Normal (9):	+/- 2.0 % Power
K. Power Signal Linearity	
1. Ambient (9):	+/- 0.1 % Power
2. Worst Case Normal (9):	+/- 0.2 % Power

CALIBRATION ERROR

RSS(E,F,G,H1,I,J1,K1) = +/- 2.581 % Power
= +/- 2.6 % Power

PERIODIC TEST ERROR

RSS(E,E,F,G,H1,I,J1,K1) = +/- 2.768 % Power
= +/- 2.8 % Power

WORST CASE NORMAL/ACCIDENT ERROR

RSS(E,F,G,H2,I,J2,K2) = +/- 3.231 % Power

IV. TOTAL CHANNEL ERROR

Combine:

A. PPS Cabinet W.C.N. Error:	+/- 0.357 % Power
B. Process Equipment W.C.N. Error:	+/- 3.231 % Power
C. Calorimetric Unc. (10):	+/- 4.000 % Power

RSS(A,B,C) = +/- 5.154 % Power
= +/- 5.2 % Power

V. SETPOINTS, ALLOWABLE VALUES, PRETRIP OFFSET

1. CEILING:

Setpoint = Analysis Setpoint - Total Channel Error
= 116.0 % Power - 5.2 % Power
= 110.8 % Power

Allowable Value = Setpoint + PPS Cabinet PTE
= 110.8 % Power + 0.214 % Power
= 111.0 % Power

To reduce the possiblity of a Licensee Event Report, the Trip Setpoint is offset from the calculated Allowable Value by 0.5 % of Span. Based on a span of 200 % Power, the offset is 1.0 % Power and the new Trip Setpoint becomes 110.0 % Power.

Pretrip Offset = - 6.0 % Power (12)

2. RATE:

Setpoint = Analysis Setpoint - PPS Cabinet Clock Error
= 11.0 % Power/min - 0.4 % Power/min
= 10.6 % Power/min (11)

Allowable Value = Setpoint + PPS Cabinet Clock Error
= 10.6 % Power/min + 0.4 % Power/min
= 11.0 % Power/min (11)

V. SETPOINTS, ALLOWABLE VALUES, PRETRIP OFFSET (cont.)

3. STEP:

Setpoint = Analysis Setpoint - PPS Cabinet PTE
= 10.0 % Power - 0.214 % Power
= 9.8 % Power

Allowable Value = Trip Setpoint + PPS Cabinet PTE
= 9.8 % Power + 0.2 % Power
= 10.0 % Power

VI. VOLTAGE EQUIVALENTS FOR V.

The PPS Cabinet input ranges from 0 to 10 volts. This is equivalent to a process range of 0 to 200 % Power. Based on these endpoints the following linear conversion equations can be derived:

$$V = (\%P)/20$$

Based on this, the following data can be calculated:

	Value	Voltage
CEILING:		
Setpoint	110.0 % Power	5.500 volts
Allowable Value	111.0 % Power	5.550 volts
Pretrip Offset (12)	- 6.0 % Power	- 0.300 volts
RATE:		
Setpoint	10.6 % Power/min	0.530 V/min
Allowable Value	11.0 % Power/min	0.550 V/min
STEP:		
Setpoint	9.8 % Power	0.490 volts
Allowable Value	10.0 % Power	0.500 volts

Cabinet Calib. (13)	+/- 0.155 % Power	+/- 0.008 volts
RATE Calib. (11,14)	+/- 0.106 %/min	+/- 0.005 volts/min
Cabinet PTE (13)	+/- 0.214 % Power	+/- 0.011 volts
RATE PTE (11,14)	+/- 0.200 %/min	+/- 0.010 volts/min
Proc. Equip. Calib.	+/- 2.6 % Power	+/- 0.130 volts
Proc. Equip. PTE	+/- 2.8 % Power	+/- 0.140 volts

VII. MEASUREMENT CHANNEL RESPONSE TIMES

A.	Process Equipment:	0.001 sec.
B.	PPS Cabinet (RPS):	0.097 sec.
C.	Reactor Trip Switch Gear:	0.100 sec.

TOTAL CHANNEL RESPONSE TIME

A + B + C = 0.198 sec. (For RPS)

The actual RPS channel delay time is less than the 1.15 second RPS Tech. Spec. Response Time.

CALCULATION NOTES:

1. For CEA Ejection.

2. For Feedwater Line Break and Steam Line Break.

3. Based on an assumed Calibration Equipment accuracy of +/- 0.005 volts.

4. Based on a PPS Cabinet accuracy of +/- 0.00593 volts.

5. For a 39 day period. Based on a 30 day drift of 0.00289 volts linearly extrapolated to 39 days.

6. Worst Case Normal errors were based on a +/- 50 degree Fahrenheit shift producing a +/- 0.0156 volt change. One fourth of this was used to determine ambient temperature effects.

7. The linear power signal is adjusted, once per shift, to match the excore power calculated by the Core Protection Calculators (CPCs). Accordingly, errors in the CPC system will be reflected in the linear power system. Worst case error applies to a 55 to 135 degree Fahrenheit range. One half of this was used to determine ambient temperature effects.

8. For 3000 hours of continuous operation.

CALCULATION NOTES CONT.:

9. A normal operating error is not defined for this equipment. Error is defined over the worst case of environmental conditions. The equipment is specified such that its error will not exceed the worst case normal (W.C.N.) error during any condition, including accidents. Worst case error applies to a 55 to 135 degree Fahrenheit range. One half of this was used to determine ambient temperature effects.

10. Reflects the uncertainty assumed (Section 3.5) in performing a secondary calorimetric evaluation of the detector.

11. The PPS Cabinet clock specification is +/- 1.0 % of the installed rate. The use of 0.4 % Power/min. is based on engineering judgement and is conservative. The clock specification was used for the PPS Cabinet calibration error. Approximately twice this was chosen as a PPS Cabinet periodic test error.

12. Suggested setting below variable setpoint.

13. These apply to both the CEILING and the STEP.

14. The RATE is verified by measuring the time lapse while the setpoint traverses a test voltage increment. The errors in this test voltage were ignored. Consequently, the calibration and periodic test entries are narrower than need be and are conservative.

4.2 CALCULATION OF HIGH LOGARITHMIC POWER LEVEL TRIP

I. ANALYSIS VALUES

A. Analysis Setpoint (1): 2.0 % Power
B. RPS Signal Delay Time (1): 0.550 sec.

TOTAL ANALYSIS RESPONSE TIME

B = 0.55 sec. (For RPS Tech. Spec. Use)

II. PPS CABINET UNCERTAINTIES

Instrument Range (2): 2.0E-08 to 200 % Power
Voltage Range: 0 to 10 volts
Conversion Factor (3): % P = 2.0E(V-8)

A. Cal. Equip. Unc.: +/- 0.005 volts
B. Equipment Accuracy: +/- 0.00303 volts
C. Bistable Drift (4): +/- 0.00229 volts
D. Temperature Effect
 1. Ambient (5): +/- 0.00219 volts
 2. Worst Case Normal (5): +/- 0.00877 volts

CALIBRATION ERROR

RSS(A,B) = +/- 0.006 volts

PERIODIC TEST ERROR

RSS(A,A,B,C,D1) = +/- 0.008 volts

WORST CASE NORMAL ERROR

RSS(A,B,C,D2) = +/- 0.011 volts

III. PROCESS EQUIPMENT UNCERTAINTIES

E. Cal. Equip. Unc.: +/- 0.050 volts
F. Detector Non-linearity (6): +/- 0.100 volts
G. Electronic Cal. Error (7): +/- 0.050 volts
H. Long Term Drift (8): +/- 0.150 volts
I. Temperature Effects
 1. Ambient (9): +/- 0.150 volts
 2. Worst Case Normal (10): +/- 0.300 volts

III. PROCESS EQUIPMENT UNCERTAINTIES CONT.

CALIBRATION ERROR

RSS(E,F,G) = +/- 0.122 volts

PERIODIC TEST ERROR

RSS(E,E,F,G,H,I1) = +/- 0.250 volts

WORST CASE NORMAL ERROR

RSS(E,F,G,H,I2) = +/- 0.357 volts

IV. TOTAL CHANNEL ERROR

Combine:

A. PPS Cabinet W.C.N Error: +/- 0.011 volts
B. Process Equipment W.C.N. Error: +/- 0.357 volts

RSS(A,B) = +/- 0.357 volts

V. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT

Using the equation, %P = 2.0E(V-8), the Analysis Setpoint of 2.0 % Power produces an input to the PPS Cabinet of 8.0 volts.

Trip Setpoint = Analysis Setpoint - Total Channel Error
= 8.000 volts - 0.357 volts
= 7.643 volts

Allowable Value = Trip Setpoint + PPS Cabinet PTE
= 7.643 volts + 0.008 volts
= 7.651 volts

To reduce the possiblity of a Licensee Event Report, the Trip Setpoint is offset from the Allowable Value by 0.5 % of Span. Based on a Span of 10 volts, the offset is 0.050 volts and the new Trip Setpoint becomes 7.601 volts.

V. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT (cont.)

The Pretrip Setpoint is set at 0.001 % Power based on engineering judgement.

Pretrip Setpoint = 8 + log(%P) - log 2
= 8 + (-3) - 0.3010
= 4.699 volts

VI. POWER EQUIVALENTS OF V.

Solving the equation %P = 2.0E(V-8) for % Power results in the following data:

	Voltage	log %P	% Power
Trip Setpoint	7.601 volts	- 0.098	0.798 %
Allowable Value	7.651 volts	- 0.048	0.895 %
Pretrip Setpoint	4.699 volts	- 3.000	0.001 %
Trip + 0.006	7.607 volts	- 0.092	0.809 %
Trip - 0.006	7.595 volts	- 0.104	0.787 %
Trip + 0.008	7.609 volts	- 0.090	0.813 %
Trip - 0.008	7.593 volts	- 0.106	0.783 %
Trip + 0.122	7.723 volts	+ 0.024	1.057 %
Trip - 0.122	7.479 volts	- 0.220	0.603 %
Trip + 0.250	7.851 volts	+ 0.152	1.419 %
Trip - 0.250	7.351 volts	- 0.348	0.449 %

PPS Cabinet	0.809 % - 0.798 % = + 0.011 % Power
Calibration Unc	0.787 % - 0.798 % = - 0.011 % Power
PPS Cabinet	0.813 % - 0.798 % = + 0.015 % Power
Periodic Test Unc	0.783 % - 0.798 % = - 0.015 % Power
Process Equipment	1.057 % - 0.798 % = + 0.259 % Power
Calibration Unc	0.603 % - 0.798 % = - 0.195 % Power
Process Equipment	1.419 % - 0.798 % = + 0.621 % Power
Periodic Test Unc	0.449 % - 0.798 % = - 0.349 % Power

VII. MEASUREMENT CHANNEL RESPONSE TIMES

A.	Process Equipment (11):	0.075 sec.
B.	PPS Cabinet (RPS):	0.130 sec.
C.	Reactor Trip Switch Gear:	0.100 sec.

TOTAL CHANNEL RESPONSE TIME

A + B + C = 0.325 seconds

The actual RPS channel delay time is less than the 0.55 second RPS Tech. Spec. Response Time.

CALCULATION NOTES:

1. For CEA Ejection, Feedwater Line Break and Steam Line Break. Signal Delay Time includes opening of Reactor Trip Switchgear.

2. The notation 2.0E-08 means 2.0 times 10 raised to the minus 8 power.

3. The notation 2.0E(V-8) means 2.0 times 10 raised to the (V-8) power where V equals the input voltage.

4. For a 39 day period. Based on a 30 day drift of +/- 0.00176 volts linearly extrapolated to 39 days.

5. Worst Case Normal errors were based on a +/- 50 degree Fahrenheit shift. One fourth of this was used to determine ambient temperature effects.

6. Based on a detector non-linearity of +/- 1.0 % of equivalent linear full scale output and an output signal range of 0 to 10 volts.

7. Based on an electronic calibration error of +/- 0.5 % of equivalent linear full scale output and an output signal range of 0 to 10 volts.

8. For 3000 hours of continuous operation. Based on a maximum expected drift of +/- 0.5 % of equivalent linear full scale output and an output signal range of 0 to 10 volts.

9. A normal operating error is not defined for this equipment. Error is defined over the worst case of environmental conditions. The equipment is specified such that its error will not exceed the Worst Case Normal (W.C.N.) error during any condition, including accidents. One half of this was used to determine ambient temperature effects.

10. Based on a 55 to 135 degree Fahrenheit range worst case operating error of +/- 3.0 % of equivalent linear full scale output and an output signal range of 0 to 10 volts.

11. The Response Time was chosen as the maximum value in the range of operations.

4.3 CALCULATION OF HIGH PRESSURIZER PRESSURE TRIP

I. ANALYSIS VALUES

A. Analysis Setpoint (1): 2450 psia
(2): 2475 psia

B. Sensor Response Time (1,2): 0.600 sec.

C. RPS Signal Delay Time (1,2): 0.550 sec.

TOTAL ANALYSIS RESPONSE TIME

B + C = 1.15 Seconds (For RPS Tech. Spec. Use)

II. PPS CABINET UNCERTAINTIES

Instrument Range: 1500 to 2500 psia
Voltage Range: 0 to 10 volts
Conversion Factor: 100 psi/volt

Conversion Equations: P = 100V + 1500
V = (P-1500)/100

A. Cal. Equip. Unc. (3): +/- 0.500 psi
B. Equipment Accuracy (4): +/- 0.303 psi
C. Bistable Drift (5): +/- 0.229 psi
D. Temperature Effects
1. Ambient (6): +/- 0.219 psi
2. Worst Case Normal (6): +/- 0.877 psi

CALIBRATION ERROR

RSS(A,B) = +/- 0.585 psi

PERIODIC TEST ERROR

RSS(A,A,B,C,D1) = +/- 0.832 psi

WORST CASE NORMAL ERROR

RSS(A,B,C,D2) = +/- 1.079 psi

III. PROCESS INSTRUMENTATION ERRORS

E.	Cal. Equip. Unc.:	+/- 5.0 psi
F.	Barton 763 Accuracy:	+/- 5.0 psi
G.	Foxboro I/E Accuracy:	+/- 2.5 psi
H.	Dropping Resistor Error:	+/- 0.1 psi
I.	Foxboro I/E Temperature Effects	
	1. Ambient (7):	+/- 1.0 psi
	2. Worst Case Normal (11):	+/- 4.0 psi
J.	Barton 763 Temperature Effects	
	1. Ambient (8):	+/- 5.0 psi
	2. Worst Case Normal (8):	+/- 10.0 psi
	3. Accident Conditions (13):	+/- 46.8 psi
K.	Barton 763 Radiation Errors	
	1. Normal Operating (9):	+/- 5.0 psi
	2. Accident Conditions (14):	+/- 30.0 psi
L.	Barton 763 Drift (10):	+/- 18.9 psi
M.	Barton 763 Seismic Errors	
	1. During Event:	+/- 20.0 psi
	2. After Event:	+/- 10.0 psi
N.	Foxboro I/E Seismic Error (12):	+/- 5.0 psi
O.	Terminal Block Accident Error:	+ 10.0 psi
P.	Elevated Range Effect (15):	- 30.0 psi

CALIBRATION ERROR

RSS(E,F,G,H) = +/- 7.501 psi
= +/- 7.6 psi

PERIODIC TEST ERROR

RSS(E,E,F,G,H,I1,J1,K1,L) + P' = +/- 22.124 + 0.0 psi
- 30.0 psi

= + 22.2 psi
= - 52.2 psi

WORST CASE NORMAL (NON-ACCIDENT) ERROR w/SEISMIC (16)

RSS(E,F,G,H,I2,J2,K1,L,M1,N) + P' = +/- 31.296 + 0.0 psi
- 30.0 psi

WORST CASE ACCIDENT ERROR (16)

RSS(E,F,G,H,I2,J2,J3,K1,L,M1,N) + O' + P' =

+/- 56.300 + 10.0 psi
- 30.0 psi

IV. TOTAL CHANNEL WORST CASE NORMAL ERROR w/SEISMIC (16)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 1.079 psi
B. PE Worst Case Normal Error: +/- 31.296 - 30.0 psi

RSS(A,B) + B' = +/- 31.315 + 0.0 psi
- 30.0 psi
= + 32 psi
= - 62 psi

V. TOTAL CHANNEL ACCIDENT ERROR (270 degrees Fahrenheit)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 1.079 psi
B. PE Worst Case Accident Error: +/- 56.300 + 10.0 psi
- 30.0 psi

RSS(A,B) + B' = +/- 56.310 + 10.0 psi
- 30.0 psi

= + 67 psi
= - 87 psi

VI. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT

(I-1) (IV)
Trip Setpoint = Analysis Setpoint - Total Channel Error
= 2450 psia - 62 psi
= 2388 psia (17)

(I-2) (V)
Trip Setpoint = Analysis Setpoint - Total Channel Error
= 2475 psia - 87 psi
= 2388 psia (17)

Allowable Value = Trip Setpoint + PPS Cabinet PTE
= 2388 psia + 0.832 psi
= 2388 psia

To reduce the possiblity of a Licensee Event Report, the Trip Setpoint is offset from the calculated Allowable Value by 0.5 % of Span. Based on a Span of 1000 psi, the offset is 5.0 psi, and the new Trip Setpoint becomes 2383 psia.

VI. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT (cont.)

The Pretrip Setpoint is set at 2359 psia based on engineering judgement.

VII. VOLTAGE EQUIVALENTS FOR VI.

The PPS Cabinet input ranges from 0 to 10 volts. This is equivalent to a process range of 1500 to 2500 psia. Based on these endpoints the following linear conversion equations can be derived:

$$V = (P-1500)/100$$

Based on this, the following data can be calculated:

	Value	Voltage
Trip Setpoint	2383 psia	8.830 volts
Allowable Value	2388 psia	8.880 volts
Pretrip Setpoint	2359 psia	8.590 volts
Cabinet Calib.	+/- 0.585 psi	+/- 0.006 volts
Cabinet PTE	+/- 0.832 psi	+/- 0.008 volts
Proc. Equip. Calib.	+/- 7.6 psi	+/- 0.076 volts
Proc. Equip. PTE	+ 22.2 psi - 52.2 psi	+ 0.222 volts - 0.522 volts

VIII. MEASUREMENT CHANNEL RESPONSE TIMES

A. Process Equipment: 0.180 sec.
B. Foxboro I/E Converter: 0.050 sec.
C. PPS Cabinet (RPS): 0.130 sec.
D. Reactor Trip Switch Gear: 0.100 sec.

TOTAL CHANNEL RESPONSE TIME

A + B + C + D = 0.480 sec. (For RPS)

The actual RPS channel delay time is less than the 1.15 second RPS Tech. Spec. Response Time.

CALCULATION NOTES:

1. For Loss of Load, Loss of Condensor Vacuum, and Main Steam Isolation Valve Closure.

2. For Feedwater Line Break and for Steam Line Break.

3. Based on an assumed Calibration Equipment accuracy of +/- 0.005 volts.

4. Based on a PPS Cabinet accuracy of +/- 0.00303 volts.

5. For a 39 day period. Based on a maximum expected drift of +/- 0.00176 volts over 30 days linearly extrapolated to 39 days.

6. Worst Case Normal errors were based on a +/- 50 degree Fahrenheit shift producing a +/- 0.00877 volt change. One fourth of this was used to determine ambient temperature effects.

7. For +/- 10 degree Fahrenheit change within a 40-120 degree Fahrenheit range.

8. Worst case normal error for an 80-130 degree Fahrenheit range. One half of this was used to determine ambient temperature effects.

9. Background radiation for a 40 year period and a total dose not exceeding 10 million Rads.

10. For a 22.5 month period and normal environment.

11. For a +/- 40 degree Fahrenheit change within a 40-120 degree Fahreheit range.

12. Uncertainty during the event. Uncertainty after the event was not stated.

13. For a 270 degree Fahrenheit environment. The High Containment Pressure trip function at 6.0 psig will limit the containment environment to this temperature prior to reactor trip.

14. Based on a 40 million Rad dose. This error was not used because High Pressurizer Pressure is not credited for events releasing significant amounts of radiation.

CALCULATION NOTES (cont.):

15. Transmitter defect resulting in a negative shift in the output during initial exposure to operating pressure. The amount of the shift is dependant on the process pressure and the calibrated span of the transmitter, and can occur at any time. Arizona intends to return these transmitters to Barton for repair. Once repairs have been completed the - 30 psi offset can be removed to permit additional operatin space.

16. All equipment is required to function during and after a seismic event.

17. The same trip setpoint satisfies both Safety Analysis requirements.

4.4 CALCULATION OF LOW PRESSURIZER PRESSURE TRIP

I. ANALYSIS VALUES

A. Analysis Setpoint (1): 1785 psia
(2): 1600 psia
(3): 1580 psia

B. Sensor Response Time (4): 0.600 sec.

C. RPS Signal Delay Time (4): 0.550 sec.
D. ESFAS Signal Delay Time (4): 0.550 sec.

TOTAL ANALYSIS RESPONSE TIME

B + C = 1.15 sec. (For RPS Tech. Spec. Use)
B + D = 1.15 sec. (For ESFAS Tech.Spec. Use)

II. PPS CABINET UNCERTAINTIES

Instrument Range: 0 to 3000 psia
Voltage Range: 0 to 10 volts
Conversion Factor: 300 psi/volt

$$P = 300V$$
$$V = P/300$$

A. Cal. Equip. Unc. (5): +/- 1.500 psi
B. Equipment Accuracy (6): +/- 1.779 psi
C. Bistable Drift (7): +/- 1.127 psi
D. Temperature Effect
  1. Ambient (8): +/- 1.170 psi
  2. Worst Case Normal (8): +/- 4.680 psi

CALIBRATION ERROR

RSS(A,B) = +/- 2.327 psi

PERIODIC TEST ERROR

RSS(A,A,B,C,D1) = +/- 3.210 psi

WORST CASE NORMAL ERROR

RSS(A,B,C,D2) = +/- 5.347 psi

III. PROCESS EQUIPMENT UNCERTAINTIES

E.	Cal. Equip. Unc.:	+/- 15.0 psi
F.	Barton 763 Accuracy:	+/- 15.0 psi
G.	Foxboro I/E Accuracy (9):	+/- 10.6 psi
H.	Foxboro E/I Accuracy:	+/- 15.0 psi
I.	Dropping Resistor Error:	+/- 0.3 psi
J.	Foxboro I/E Temperature Effects	
	1. Ambient (10):	+/- 4.2 psi
	2. Worst Case Normal (14):	+/- 17.0 psi
K.	Foxboro E/I Temperature Effects	
	1. Ambient (10):	+/- 3.0 psi
	2. Worst Case Normal (14):	+/- 12.0 psi
L.	Barton 763 Temperature Effects	
	1. Ambient (11):	+/- 15.0 psi
	2. Worst Case Normal (11):	+/- 30.0 psi
	3. Accident Conditions (16):	+/- 140.5 psi
M.	Barton 763 Radiation Errors	
	1. Normal Operation (12):	+/- 15.0 psi
	2. Accident Conditions (17):	+/- 90.0 psi
N.	Barton 763 Drift (13):	+/- 56.5 psi
O.	Barton 763 Seismic Errors	
	1. During Event:	+/- 60.0 psi
	2. After Event:	+/- 30.0 psi
P.	Foxboro I/E Seismic Error (15):	+/- 21.2 psi
Q.	Foxboro E/I Seismic Error (15):	+/- 15.0 psi
R.	Terminal Block Accident Error:	+ 30.0 psi

CALIBRATION ERROR

RSS(E,F,G,H,I) = +/- 28.062 psi
= +/- 28.1 psi

PERIODIC TEST ERROR

RSS(E,E,F,G,H,I,J1,K1,L1,M1,N) = +/- 68.420 psi
= +/- 68.5 psi

WORST CASE NORMAL (NON-ACCIDENT) ERROR w/SEISMIC (18)

RSS(E,F,G,H,I,J2,K2,L2,M1,N,O1,P,Q) = +/- 99.073 psi

WORST CASE ACCIDENT ERROR (18)

RSS(E,F,G,H,I,J2,K2,L2,L3,M1,M2,N,O1,P,Q) + R' =

+/- 194.051 + 30.0 psi
- 0.0 psi

IV. TOTAL CHANNEL WORST CASE NORMAL ERROR w/SEISMIC (18)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 5.347 psi
B. PE Worst Case Normal Error: +/- 99.073 psi

RSS(A,B) = +/- 99.217 psi
= +/- 100 psi

V. TOTAL CHANNEL ACCIDENT ERROR (270 DEGREES FAHRENHEIT)

COMBINE:

A. PPS Cabinet W.C.N. Error: +/- 5.347 psi
B. PE Worst Case Accident Error: +/- 194.051 + 30.0 psi

RSS(A,B) + B' = +/- 194.125 + 30.0 psi
- 0.0 psi

= + 225 psi
= - 195 psi

VI. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT

(I-2) (V)
Trip Setpoint = Analysis Setpoint + Total Channel Error
= 1600 psia + 225 psi
= 1825 psia

Allowable Value = Trip Setpoint - PPS Cabinet PTE
= 1825 psia - 3.210 psi
= 1822 psia

To reduce the possiblity of a Licensee Event Report, the Trip Setpoint is offset from the calculated Allowable Value by 0.5 % of Span. Based on a Span of 3000 psi, the offset is 15.0 psi, and the new Trip Setpoint becomes 1837 psia.

The Pretrip Setpoint is set at 1880 psia based on engineering judgement.

Protection for the Steam Generator Tube Rupture Event (Analysis Setpoint of 1785 psia) has been provided by the Core Protection Calculators. See Note 1 for additional information.

VII. VOLTAGE EQUIVALENTS FOR VI.

The PPS Cabinet input ranges from 0 to 10 volts. This is equivalent to a process range of 0 to 3000 psia. Based on these endpoints the following linear conversion equations can be derived:

$$V = P/300$$

Based on this, the following data can be calculated:

	Value	Voltage
Trip Setpoint	1837 psia	6.123 volts
Allowable Value	1822 psia	6.073 volts
Pretrip Setpoint	1880 psia	6.267 volts
Cabinet Calib.	+/- 2.327 psi	+/- 0.008 volts
Cabinet PTE	+/- 3.210 psi	+/- 0.011 volts
Proc. Equip. Calib.	+/- 28.1 psi	+/- 0.094 volts
Proc. Equip. PTE	+/- 68.5 psi	+/- 0.228 volts

VIII. MEASUREMENT CHANNEL RESPONSE TIMES

A.	Process Equipment:	0.180 sec.
B.	Foxboro I/E Converters:	0.100 sec.
C.	Foxboro E/I Converter:	0.080 sec.
D.	PPS Cabinet (RPS):	0.150 sec.
E.	PPS Cabinet (ESFAS):	0.150 sec.
F.	Reactor Trip Switch Gear:	0.100 sec.
G.	ESFAS Cabinet Delay Time:	0.300 sec.

TOTAL CHANNEL RESPONSE TIME

A + B + C + D + F = 0.610 sec. (For RPS)
A + B + C + E + G = 0.810 sec. (For ESFAS)

The actual RPS channel delay time is less than the 1.15 second RPS Tech. Spec. Response Time.

The actual ESFAS channel delay time is less than the 1.15 second ESFAS Analysis Response Time.

CALCULATION NOTES:

1. For Steam Generator Tube Rupture. Protection for this non-environmental event is provided by the Core Protection Calculators (CPC's). The CPC operating space for Pressurizer Pressure ranges from 1785 to 2415 psia. Operation outside of this space will cause the CPC's to trip the reactor. This operating space has been reduced to 1861 psi on the lower side by a total CPC channel error of 76 psi. This guarantees a reactor trip before the 1785 psia Analysis Setpoint is reached.

2. For Large and Small Break LOCA, Feedwater Line Break and Steam Line Break. Initiates a Reactor Trip, CCAS, CSAS and SIAS.

3. For CEA Ejection. Initiates CIAS and SIAS.

4. Applies for all events. For ESFAS applications, signal response time includes sensor input through actuation relays.

5. Based on an assumed Calibration Equipment accuracy of +/- 0.005 volts.

6. Based on a PPS Cabinet accuracy of +/- 0.00593 volts.

7. For a 39 day period. Based on a maximum expected drift of +/- 0.00289 volts over 30 days linearly extrapolated to 39 days.

8. Worst Case Normal errors were based on a +/- 50 degree Fahreheit shift producing a +/- 0.0156 volt change. One fourth of this was used to determine Ambient Temperature effects.

9. Channel B Contains two Foxboro current to voltage conversion cards. The error shown reflects the combined effect of both. This approach has also been used to determine ambient temperature effects, worst case normal errors and seismic errors.

10. For +/- 10 degree Fahrenheit change within a 40-120 degree Fahrenheit range.

11. Worst case normal error for an 80-130 degree Fahrenheit range. One half of this was used to determine ambient temperature effects.

12. Background radiation for a 40 year period and a total dose not exceeding 10 million Rads.

CALCULATION NOTES (cont.):

13. For a 22.5 month period and normal environment.
14. For a +/- 40 degree Fahrenheit change within a 40-120 degree Fahrenheit range.
15. Uncertainty during the event. Uncertainty after the event was not stated.
16. For a 270 degree Fahrenheit environment. The High Containment Pressure trip function at 6.0 psig will limit the containment environment to this temperature prior to reactor trip.
17. Based on a 40 million Rad dose.
18. All equipment is required to function during and after a seismic event.

4.5 CALCULATION OF LOW STEAM GENERATOR PRESSURE TRIP

I. ANALYSIS VALUES

A. Analysis Setpoint (1): 820 psia
(2): 810 psia

B. Sensor Response Time (1,2): 0.600 sec.

C. RPS Signal Time (1,2): 0.550 sec.
D. ESFAS Signal Delay Time (3): 0.550 sec.

TOTAL ANALYSIS RESPONSE TIME

B + C = 1.15 sec. (For RPS Tech. Spec. Use)
B + D = 1.15 sec. (For ESFAS Tech. Spec. Use)

II. PPS CABINET UNCERTAINTIES

Instrument Range: 0 to 1524 psia
Voltage Range: 0 to 10 volts
Conversion Factor: 152.4 psi/volt

Conversion Equations: P = 52.4V
V = P/152.4

A. Cal. Equip. Unc. (4): +/- 0.762 psi
B. Equipment Accuracy (5): +/- 0.904 psi
C. Bistable Drift (6): +/- 0.573 psi
D. Temperature Effect
1. Ambient (7): +/- 0.594 psi
2. Worst Case Normal (7): +/- 2.377 psi

CALIBRATION ERROR

RSS(A,B) = +/- 1.182 psi

PERIODIC TEST ERROR

RSS(A,A,B,C,D1) = +/- 1.631 psi

WORST CASE NORMAL ERROR

RSS(A,B,C,D2) = +/- 2.716 psi

III. PROCESS EQUIPMENT UNCERTAINTIES

E.	Cal. Equip. Unc.:	+/- 7.7 psi
F.	Barton 763 Accuracy:	+/- 7.7 psi
G.	Foxboro I/E Accuracy (8):	+/- 5.4 psi
H.	Foxboro E/I Accuracy:	+/- 7.7 psi
I.	Dropping Resistor Error:	+/- 0.2 psi
J.	Foxboro I/E Temperature Effects	
	1. Ambient (9):	+/- 2.2 psi
	2. Worst Case Normal (13):	+/- 8.7 psi
K.	Foxboro E/I Temperature Effects	
	1. Ambient (9):	+/- 1.6 psi
	2. Worst Case Normal (13):	+/- 6.1 psi
L.	Barton 763 Temperature Effects	
	1. Ambient (10):	+/- 7.7 psi
	2. Worst Case Normal (10):	+/- 15.3 psi
	3. Accident Conditions (15):	+/- 71.4 psi
M.	Barton 763 Radiation Errors	
	1. Normal Operation (11):	+/- 7.7 psi
	2. Accident Conditions (16):	+/- 45.8 psi
N.	Barton 763 Drift (12):	+/- 28.7 psi
O.	Barton 763 Seismic Errors	
	1. During Event:	+/- 30.5 psi
	2. After Event:	+/- 15.3 psi
P.	Foxboro I/E Seismic Error (14):	+/- 10.8 psi
Q.	Foxboro E/I Seismic Error (14):	+/- 7.7 psi
R.	Terminal Block Accident Error:	+ 15.3 psi

CALIBRATION ERROR

RSS(E,F,G,H,I) = +/- 14.390 psi
= +/- 14.4 psi

PERIODIC TEST ERROR

RSS(E,E,F,G,H,I,J1,K1,L1,M1,N) = +/- 34.872 psi
= +/- 34.9 psi

WORST CASE NORMAL (NON-ACCIDENT) ERROR w/SEISMIC (17)

RSS(E,F,G,H,I,J2,K2,L2,M1,N,O1,P,Q) = +/- 50.430 psi

WORST CASE ACCIDENT ERROR (270 dF, Full Seismic)

RSS(E,F,G,H,I,J2,K2,L2,L3,M1,N,O1,P,Q) + R' =

+/- 87.414 + 15.3 psi

IV. TOTAL CHANNEL WORST CASE NORMAL ERROR w/SEISMIC (17)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 2.716 psi
B. PE Worst Case Normal Error: +/- 50.430 psi

RSS(A,B) = +/- 50.503 psi
= +/- 51 psi

V. TOTAL CHANNEL ACCIDENT ERROR (270 dF, Full Seismic)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 2.716 psi
B. PE Worst Case Accident Error: +/- 87.414 + 15.3 psi

RSS(A,B) + B' = +/- 87.456 + 15.3 psi
- 0.0 psi

= + 103 psi
= - 88 psi

VI. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT

Trip Setpoint = Analysis Setpoint (I-1) + Total Channel Error (IV)
= 820 psia + 51 psi
= 871 psia

Trip Setpoint = Analysis Setpoint (I-2) + Total Channel Error (V)
= 810 psia + 103 psi
= 913 psia (18)

Allowable Value = Trip Setpoint - PPS Cabinet PTE
= 913 psia - 1.631 psi
= 912 psia

To reduce the possiblity of a Licensee Event Report, the Trip Setpoint is offset from the calculated Allowable Value by 0.5 % of Span. Based on a Span of 1524 psi, the offset is 7.0 psi, and the new Trip Setpoint becomes 919 psia.

The Pretrip Setpoint is set at 960 psia based on engineering judgement.

VII. VOLTAGE EQUIVALENTS FOR VI.

The PPS Cabinet input ranges from 0 to 10 volts. This is equivalent to a process range of 0 to 1524 psia. Based on these endpoints the following linear conversion equations can be derived:

$$V = P/152.4$$

Based on this, the following data can be calculated:

	Value	Voltage
Trip Setpoint	919 psia	6.030 volts
Allowable Value	912 psia	5.984 volts
Pretrip Setpoint	960 psia	6.299 volts
Cabinet Calib.	+/- 1.182 psi	+/- 0.008 volts
Cabinet PTE	+/- 1.631 psi	+/- 0.011 volts
Proc. Equip. Calib.	+/- 14.4 psi	+/- 0.094 volts
Proc. Equip. PTE	+/- 34.9 psi	+/- 0.229 volts

VIII. MEASUREMENT CHANNEL RESPONSE TIMES

A.	Process Equipment:	0.180 sec.
B.	Foxboro I/E Converters:	0.100 sec.
C.	Foxboro E/I Converter:	0.080 sec.
D.	PPS Cabinet (RPS):	0.150 sec.
E.	PPS Cabinet (ESFAS):	0.150 sec.
F.	Reactor Trip Switch Gear:	0.100 sec.
G.	ESFAS Cabinet Delay:	0.300 sec.

Total Channel Response Time

A + B + C + D + F = 0.610 seconds (For RPS)
A + B + C + E + G = 0.810 seconds (For ESFAS)

The actual RPS Channel Delay Time is less than the 1.15 second RPS Tech. Spec. Response Time.

The actual ESFAS Channel Delay Time is less than the 1.15 second ESFAS Analysis Response Time.

CALCULATION NOTES:

1. For Non-environmental events requiring MSIS.
2. For Feedwater Line Break and Steam Line Break. Initiates a Reactor Trip and MSIS.
3. For ESFAS applications, signal response time includes sensor input through ESFAS actuation relays.
4. Based on an assumed Calibration Equipment accuracy of +/- 0.005 volts.
5. Based on a PPS Cabinet accuracy of +/- 0.00593 volts.
6. For a 39 day period. Based on a maximum expected drift of +/- 0.00289 volts over 30 days linearly extrapolated to 39 days.
7. Worst Case Normal errors were based on a +/- 50 degree Fahrenheit shift producing a +/- 0.0156 volt change. One fourth of this was used to determine Ambient Temperature effects.
8. Channel B contains two Foxboro current to voltage conversion cards. The error shown reflects the combined effect of both. This approach has also been used to determine ambient temperature effects, worst case normal errors and seismic errors.
9. For +/- 10 degree Fahrenheit change within a 40-120 degree Fahrenheit range.
10. Worst case normal error for an 80-130 degree Fahrenheit range. One half of this was used to determine ambient temperature effects.
11. Background radiation for a 40 year period and a total dose not exceeding 10 million Rads.
12. For a 22.5 month period and normal environment.
13. For a +/- 40 degree Fahrenheit change within a 40-120 degree Farenheit range.
14. Uncertainty during the event. Uncertainty after the event was not stated.
15. For a 270 degree Fahrenheit environment. The High Containment Pressure trip function at 6.0 psig will limit the containment environment to this temperature prior to a reactor trip.

CALCULATION NOTES (cont.):

16. Based on a 40 million Rad dose. This error was not used because Low Steam Generator Pressure is not credited for events releasing significant amounts of radiation.

17. All equipment is required to function during and after a seismic event.

18. The setpoint associated with the Feedwater Line Break and Steam Line Break events was chosen as the most conservative.

4.6 CALCULATION OF LOW STEAM GENERATOR WATER LEVEL TRIP

I. ANALYSIS VALUES

A. Analysis Setpoint (1): 40 % of WR
(2): 35 % of WR
(3): 15 % of WR
(4): 10 % of WR

B. Sensor Response Time (5): 0.600 sec.

C. RPS Signal Time (1,2): 0.550 sec.
D. ESFAS Signal Delay Time (6): 0.550 sec.

TOTAL ANALYSIS RESPONSE TIME

B + C = 1.15 sec. (For RPS Tech. Spec. Use)
B + D = 1.15 sec. (For ESFAS Tech. Spec. Use)

II. PPS CABINET UNCERTAINTIES

Instrument Range: 0 to 100 % Span (7)
Voltage Range: 0 to 10 volts
Conversion Factor: 10 % Span/volt

Conversion Equations: %S = 10V
V = %S/10

A. Cal. Equip. Unc. (8): +/- 0.0500 % Span
B. Equipment Accuracy (9): +/- 0.0303 % Span
C. Bistable Drift (10): +/- 0.0229 % Span
D. Temperature Effect
1. Ambient (11): +/- 0.0219 % Span
2. Worst Case Normal (11): +/- 0.0877 % Span

CALIBRATION ERROR

RSS(A,B) = +/- 0.058 % Span

PERIODIC TEST ERROR

RSS(A,A,B,C,D1) = +/- 0.083 % Span

WORST CASE NORMAL ERROR

RSS(A,B,C,D2) = +/- 0.108 % Span

III. PROCESS EQUIPMENT UNCERTAINTIES

E.	Cal. Equip. Unc.:	+/- 0.5 %
F.	Barton 764 Accuracy:	+/- 0.5 %
G.	Foxboro I/E Accuracy (12):	+/- 0.35 %
H.	Foxboro E/I Accuracy:	+/- 0.5 %
I.	Dropping Resistor Error:	+/- 0.01 %
J.	Foxboro I/E Temperature Effects	
	1. Ambient (13):	+/- 0.14 %
	2. Worst Case Normal (17):	+/- 0.57 %
K.	Foxboro E/I Temperature Effects	
	1. Ambient (13):	+/- 0.1 %
	2. Worst Case Normal (17):	+/- 0.4 %
L.	Barton 764 Temperature Effects	
	1. Ambient (14):	+/- 0.5 %
	2. Worst Case Normal (14):	+/- 1.0 %
	3. Accident Conditions (19):	+/- 2.84 %
	4. Accident Conditions (20):	+/- 4.95 %
M.	Barton 764 Radiation Errors	
	1. Normal Operation (15):	+/- 0.5 %
	2. Accident Conditions (21):	+/- 3.0 %
N.	Barton 764 Drift (16):	+/- 1.9 %
O.	Barton 764 Seismic Errors	
	1. During Event:	+/- 2.5 %
	2. After Event:	+/- 1.0 %
P.	Foxboro I/E Seismic Error (18):	+/- 0.71 %
Q.	Foxboro E/I Seismic Error (18):	+/- 0.5 %
R.	Terminal Block Accident Error:	+ 1.0 %
S.	Reference Leg Errors	
	1. 120 dF to 200 dF Change:	+ 3.7 %
	2. 120 dF to 280 dF Change:	+ 8.6 %

CALIBRATION ERROR

RSS(E,F,G,H,I) = +/- 0.934 % Span
= +/- 1.0 % Span

PERIODIC TEST ERROR

RSS(E,E,F,G,H,I,J1,K1,L1,M1,N) = +/- 2.294 % Span
= +/- 2.3 % Span

WORST CASE NORMAL ERROR w/POST SEISMIC (22)

RSS(E,F,G,H,I,J2,K2,L2,M1,N,O2,P,Q) = +/- 2.823

WORST CASE ACCIDENT ERROR (200 dF, Post Seismic)

RSS(E,F,G,H,I,J2,K2,L2,L3,M1,N,O2,P,Q) + R' + S1' =

+/- 4.005 + 4.7 % Span
- 0.0 % Span

III. PROCESS EQUIPMENT UNCERTAINTIES (Cont.)

WORST CASE ACCIDENT ERROR (280 dF, Post Seismic)

RSS(E,F,G,H,I,J2,K2,L2,L4,M1,N,O2,P,Q) + R' + S2'

+/- 5.699 + 9.6 % Span
- 0.0 % Span

IV. TOTAL CHANNEL WORST CASE NORMAL ERROR w/SEISMIC (22)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 0.108 % Span
B. PE Worst Case Normal Error: +/- 2.823 % Span

RSS(A,B) + B' = +/- 2.825 % Span
= +/- 2.9 % Span

V. TOTAL CHANNEL ACCIDENT ERROR (200 dF, Post Seismic)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 0.108 % Span
B. PE Worst Case Accident Error: +/- 4.005 + 4.7 % Span

RSS(A,B) + B' = +/- 4.006 + 4.7 % Span
- 0.0 % Span

= + 8.7 % Span
= - 4.0 % Span

VI. TOTAL CHANNEL ACCIDENT ERROR (280 dF, Post Seismic)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 0.108 % Span
B. PE Worst Case Accident Error: +/- 5.699 + 9.6 % Span

RSS(A,B) + B' = +/- 5.700 + 9.6 % Span
- 0.0 % Span

= + 15.3 % Span
= - 5.7 % Span

VII. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT

```
                          (I,RPS)                (V)
Trip Setpoint = Analysis Setpoint + Total Channel Error
              = 40.0 % Span + 2.9 % Span = 42.9 % Span
              = 35.0 % Span + 8.7 % Span = 43.7 % Span
              = 43.7 % Span (RPS,23)

                          (I,EFAS)              (VI)
Trip Setpoint = Analysis Setpoint + Total Channel Error
              = 15.0 % Span + 2.9 % Span = 17.9 % Span
              = 10.0 % Span + 15.3 % Span = 25.3 % Span
              = 25.3 % Span (EFAS,23)
```

```
Allowable Value = Trip Setpoint - PPS Cabinet PTE
                = 43.7 % Span - 0.083 % Span
                = 43.7 % Span (RPS)

Allowable Value = Trip Setpoint - PPS Cabinet PTE
                = 25.3 % Span - 0.083 % Span
                = 25.3 % Span (EFAS)
```

To reduce the possiblity of a Licensee Event Report, the Trip Setpoint is offset from the calculated Allowable Value by 0.5 % of Span. Based on a Span of 100 %, the offset is 0.5 %, and the new Trip Setpoint becomes 44.2 % for the RPS, and 25.8 % for the EFAS.

```
Pretrip Setpoint = Trip Setpoint + Total Channel Error
                 = 44.2 % Span + 2.9 % Span
                 = 47.1 % Span (RPS)

Pretrip Setpoint = Trip Setpoint + Total Channel Error
                 = 25.8 % Span + 2.9 % Span
                 = 28.7 % Span (EFAS)
```

VIII. VOLTAGE EQUIVALENTS FOR VII.

The PPS Cabinet input ranges from 0 to 10 volts. This is equivalent to a process range of 0 to 100 % Span. Based on these endpoints the following linear conversion equations can be derived:

V = % Span/10

Based on this, the following data can be calculated:

VIII. VOLTAGE EQUIVALENTS FOR VII. (Cont.)

	Value	Voltage
Trip Setpoint		
RPS	44.2 % Span (WR)	4.420 volts
EFAS	25.8 % Span (WR)	2.580 volts
Allowable Value		
RPS	43.7 % Span (WR)	4.370 volts
EFAS	25.3 % Span (WR)	2.530 volts
Pretrip Setpoint		
RPS	47.1 % Span (WR)	4.710 volts
EFAS	28.7 % Span (WR)	2.870 volts

Cabinet Calib.	+/- 0.058 % Span	+/- 0.006 volts
Cabinet PTE	+/- 0.083 % Span	+/- 0.008 volts
Proc. Equip. Calib.	+/- 1.0 % Span	+/- 0.100 volts
Proc. Equip. PTE	+/- 2.3 % Span	+/- 0.230 volts

IX. MEASUREMENT CHANNEL RESPONSE TIMES

A.	Process Equipment:	0.180 sec.
B.	Foxboro I/E Converters:	0.100 sec.
C.	Foxboro E/I Converter:	0.080 sec.
D.	PPS Cabinet (RPS):	0.150 sec.
E.	PPS Cabinet (ESFAS):	0.150 sec.
F.	Reactor Trip Switch Gear:	0.100 sec.
G.	ESFAS Cabinet Delay:	0.300 sec.

Total Channel Response Time

A + B + C + D + F = 0.610 seconds (For RPS)
A + B + C + E + G = 0.810 seconds (For ESFAS)

The actual RPS Channel Delay Time is less than the 1.15 second RPS Tech. Spec. Response Time.

The actual ESFAS Channel Delay Time is less than the 1.15 second ESFAS Analysis Response Time.

CALCULATION NOTES:

1. For non-environmental events. Initiates a reactor trip based on wide range indication. Only post-seismic errors are required.

2. For Feedwater Line Break and Steam Line Break events. Initiates a Reactor Trip based on wide range (WR) indication. Only post-seismic errors are required.

3. For Loss of Condenser Vaccum, Main Steam Isolation Valve Closure, Locked RCP Rotor with Loss of Power, and Steam Generator Tube Rupture Events. Initiates EFAS based on wide range indication.

4. Lower limit for LOCA and Steam Line Break events. EFAS Initiation based on wide range indication must occur before this.

5. Applies to events listed in notes 1 through 4.

6. Applies to events listed in notes 3 and 4. For ESFAS applications, signal response time includes sensor input through ESFAS actuation relays.

7. The calibrated span of the transmitter is 262.80 inches of water. The tap span is 376.25 inches of water.

8. Based on an assumed Calibration Equipment accuracy of +/- 0.005 volts.

9. Based on a PPS Cabinet accuracy of +/- 0.00303 volts.

10. For a 39 day period. Based on a maximum expected drift of +/- 0.00176 volts over 30 days linearly extrapolated to 39 days.

11. Worst Case Normal errors were based on a +/- 50 degree Fahrenheit shift producing a +/- 0.00877 volt change. One fourth of this was used to determine Ambient Temperature Effects.

12. Channel B contains two Foxboro current to voltage conversion cards. The error shown reflects the combined effect of both. This approach has also been used to determine ambient temperature effects, worst case normal errors and seismic errors.

13. For +/- 10 degree Fahrenheit change within a 40-130 degree Fahrenheit range.

CALCULATION NOTES (cont.):

14. Worst case normal error for an 80-140 degree Fahrenheit range. One half of this was used to determine ambient temperature effects.

15. Background radiation for a 22.5 month period and a total dose not exceeding 0.465 million Rads.

16. For a 22.5 month period and normal environment.

17. For a +/- 40 degree Fahrenheit change within a 40-120 degree Fahrenheit range.

18. Uncertainty during the event. Uncertainty after the event was not stated.

19. For a 200 degree Fahrenheit environment. Analytical requirements indicate that this is the maximum containment temperature that is expected prior to a reactor trip.

20. For a 280 degree Fahrenheit environment. Analytical requirements indicate that this is the maximum containment temperature that is expected.

21. Based on a 40 million Rad dose. This error was not used because Low Steam Generator Level is not credited for events releasing significant amounts of radiation.

22. All equipment is required to function during and after a seismic event.

23. The higher level accomodates both analysis requirements.

4.7 CALCULATION OF HIGH STEAM GENERATOR WATER LEVEL TRIP

I. ANALYSIS VALUES

A. Analysis Setpoint (1): 99.0 % of NR

B. Sensor Response Time (1): 0.600 sec.

C. RPS Signal Delay Time: 0.550 sec.

TOTAL ANALYSIS RESPONSE TIME

B + C = 1.15 sec. (For RPS Tech. Spec. Use)

CESSAR, Section 7.2.2.5, requires for level setpoints that no analysis setpoint is within 5.0 percent of the ends of the level span. Accordingly, the analysis setpoint is adjusted downward to 95.0 percent to meet this criteria.

II. PPS CABINET UNCERTAINTIES

Instrument Range: 0 to 100 % Span
Voltage Range: 0 to 10 volts
Conversion Factor: 10 % Span/volt

Conversion Equations: %S = 10V
V = %S/10

A.	Cal. Equip. Unc. (2):	+/- 0.0500 % Span
B.	Equipment Accuracy (3):	+/- 0.0303 % Span
C.	Bistable Drift (4):	+/- 0.0229 % Span
D.	Temperature Effects	
	1. Ambient (5):	+/- 0.0219 % Span
	2. Worst Case Normal (5):	+/- 0.0877 % Span

CALIBRATION ERROR

RSS(A,B) = +/- 0.058 % Span

PERIODIC TEST ERROR

RSS(A,A,B,C,D1) = +/- 0.083 % Span

WORST CASE NORMAL ERROR

RSS(A,B,C,D2) = +/- 0.108 % Span

CALCULATION NOTES (cont.):

13. For a 22.5 month period and normal environment.

14. For a +/- 40 degree Fahrenheit change within a 40-120 degree Fahrenheit range.

15. Uncertainty during the event. Uncertainty after the event was not stated.

16. For a 270 degree Fahrenheit environment. The High Containment Pressure trip function at 6.0 psig will limit the containment environment to this temperature prior to reactor trip.

17. Based on a 40 million Rad dose.

18. All equipment is required to function during and after a seismic event.

4.5 CALCULATION OF LOW STEAM GENERATOR PRESSURE TRIP

I. ANALYSIS VALUES

A. Analysis Setpoint (1): 820 psia
(2): 810 psia

B. Sensor Response Time (1,2): 0.600 sec.

C. RPS Signal Time (1,2): 0.550 sec.
D. ESFAS Signal Delay Time (3): 0.550 sec.

TOTAL ANALYSIS RESPONSE TIME

B + C = 1.15 sec. (For RPS Tech. Spec. Use)
B + D = 1.15 sec. (For ESFAS Tech. Spec. Use)

II. PPS CABINET UNCERTAINTIES

Instrument Range: 0 to 1524 psia
Voltage Range: 0 to 10 volts
Conversion Factor: 152.4 psi/volt

Conversion Equations: P = 52.4V
V = P/152.4

A. Cal. Equip. Unc. (4): +/- 0.762 psi
B. Equipment Accuracy (5): +/- 0.904 psi
C. Bistable Drift (6): +/- 0.573 psi
D. Temperature Effect
1. Ambient (7): +/- 0.594 psi
2. Worst Case Normal (7): +/- 2.377 psi

CALIBRATION ERROR

RSS(A,B) = +/- 1.182 psi

PERIODIC TEST ERROR

RSS(A,A,B,C,D1) = +/- 1.631 psi

WORST CASE NORMAL ERROR

RSS(A,B,C,D2) = +/- 2.716 psi

III. PROCESS EQUIPMENT UNCERTAINTIES

E.	Cal. Equip. Unc.:	+/- 7.7 psi
F.	Barton 763 Accuracy:	+/- 7.7 psi
G.	Foxboro I/E Accuracy (8):	+/- 5.4 psi
H.	Foxboro E/I Accuracy:	+/- 7.7 psi
I.	Dropping Resistor Error:	+/- 0.2 psi
J.	Foxboro I/E Temperature Effects	
	1. Ambient (9):	+/- 2.2 psi
	2. Worst Case Normal (13):	+/- 8.7 psi
K.	Foxboro E/I Temperature Effects	
	1. Ambient (9):	+/- 1.6 psi
	2. Worst Case Normal (13):	+/- 6.1 psi
L.	Barton 763 Temperature Effects	
	1. Ambient (10):	+/- 7.7 psi
	2. Worst Case Normal (10):	+/- 15.3 psi
	3. Accident Conditions (15):	+/- 71.4 psi
M.	Barton 763 Radiation Errors	
	1. Normal Operation (11):	+/- 7.7 psi
	2. Accident Conditions (16):	+/- 45.8 psi
N.	Barton 763 Drift (12):	+/- 28.7 psi
O.	Barton 763 Seismic Errors	
	1. During Event:	+/- 30.5 psi
	2. After Event:	+/- 15.3 psi
P.	Foxboro I/E Seismic Error (14):	+/- 10.8 psi
Q.	Foxboro E/I Seismic Error (14):	+/- 7.7 psi
R.	Terminal Block Accident Error:	+ 15.3 psi

CALIBRATION ERROR

RSS(E,F,G,H,I) = +/- 14.390 psi
= +/- 14.4 psi

PERIODIC TEST ERROR

RSS(E,E,F,G,H,I,J1,K1,L1,M1,N) = +/- 34.872 psi
= +/- 34.9 psi

WORST CASE NORMAL (NON-ACCIDENT) ERROR w/SEISMIC (17)

RSS(E,F,G,H,I,J2,K2,L2,M1,N,O1,P,Q) = +/- 50.430 psi

WORST CASE ACCIDENT ERROR (270 dF, Full Seismic)

RSS(E,F,G,H,I,J2,K2,L2,L3,M1,N,O1,P,Q) + R' =

+/- 87.414 + 15.3 psi

IV. TOTAL CHANNEL WORST CASE NORMAL ERROR w/SEISMIC (17)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 2.716 psi
B. PE Worst Case Normal Error: +/- 50.430 psi

RSS(A,B) = +/- 50.503 psi
= +/- 51 psi

V. TOTAL CHANNEL ACCIDENT ERROR (270 dF, Full Seismic)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 2.716 psi
B. PE Worst Case Accident Error: +/- 87.414 + 15.3 psi

RSS(A,B) + B' = +/- 87.456 + 15.3 psi
- 0.0 psi

= + 103 psi
= - 88 psi

VI. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT

Trip Setpoint = Analysis Setpoint (I-1) + Total Channel Error (IV)
= 820 psia + 51 psi
= 871 psia

Trip Setpoint = Analysis Setpoint (I-2) + Total Channel Error (V)
= 810 psia + 103 psi
= 913 psia (18)

Allowable Value = Trip Setpoint - PPS Cabinet PTE
= 913 psia - 1.631 psi
= 912 psia

To reduce the possiblity of a Licensee Event Report, the Trip Setpoint is offset from the calculated Allowable .alue by 0.5 % of Span. Based on a Span of 1524 psi, the offset is 7.0 psi, and the new Trip Setpoint becomes 919 psia.

The Pretrip Setpoint is set at 960 psia based on engineering judgement.

VII. VOLTAGE EQUIVALENTS FOR VI.

The PPS Cabinet input ranges from 0 to 10 volts. This is equivalent to a process range of 0 to 1524 psia. Based on these endpoints the following linear conversion equations can be derived:

$$V = P/152.4$$

Based on this, the following data can be calculated:

	Value	Voltage
Trip Setpoint	919 psia	6.030 volts
Allowable Value	912 psia	5.984 volts
Pretrip Setpoint	960 psia	6.299 volts
Cabinet Calib.	+/- 1.182 psi	+/- 0.008 volts
Cabinet PTE	+/- 1.631 psi	+/- 0.011 volts
Proc. Equip. Calib.	+/- 14.4 psi	+/- 0.094 volts
Proc. Equip. PTE	+/- 34.9 psi	+/- 0.229 volts

VIII. MEASUREMENT CHANNEL RESPONSE TIMES

A.	Process Equipment:	0.180 sec.
B.	Foxboro I/E Converters:	0.100 sec.
C.	Foxboro E/I Converter:	0.080 sec.
D.	PPS Cabinet (RPS):	0.150 sec.
E.	PPS Cabinet (ESFAS):	0.150 sec.
F.	Reactor Trip Switch Gear:	0.100 sec.
G.	ESFAS Cabinet Delay:	0.300 sec.

Total Channel Response Time

A + B + C + D + F = 0.610 seconds (For RPS)
A + B + C + E + G = 0.810 seconds (For ESFAS)

The actual RPS Channel Delay Time is less than the 1.15 second RPS Tech. Spec. Response Time.

The actual ESFAS Channel Delay Time is less than the 1.15 second ESFAS Analysis Response Time.

CALCULATION NOTES:

1. For Non-environmental events requiring MSIS.
2. For Feedwater Line Break and Steam Line Break. Initiates a Reactor Trip and MSIS.
3. For ESFAS applications, signal response time includes sensor input through ESFAS actuation relays.
4. Based on an assumed Calibration Equipment accuracy of +/- 0.005 volts.
5. Based on a PPS Cabinet accuracy of +/- 0.00593 volts.
6. For a 39 day period. Based on a maximum expected drift of +/- 0.00289 volts over 30 days linearly extrapolated to 39 days.
7. Worst Case Normal errors were based on a +/- 50 degree Fahrenheit shift producing a +/- 0.0156 volt change. One fourth of this was used to determine Ambient Temperature effects.
8. Channel B contains two Foxboro current to voltage conversion cards. The error shown reflects the combined effect of both. This approach has also been used to determine ambient temperature effects, worst case normal errors and seismic errors.
9. For +/- 10 degree Fahrenheit change within a 40-120 degree Fahrenheit range.
10. Worst case normal error for an 80-130 degree Fahrenheit range. One half of this was used to determine ambient temperature effects.
11. Background radiation for a 40 year period and a total dose not exceeding 10 million Rads.
12. For a 22.5 month period and normal environment.
13. For a +/- 40 degree Fahrenheit change within a 40-120 degree Farenheit range.
14. Uncertainty during the event. Uncertainty after the event was not stated.
15. For a 270 degree Fahrenheit environment. The High Containment Pressure trip function at 6.0 psig will limit the containment environment to this temperature prior to a reactor trip.

CALCULATION NOTES (cont.):

16. Based on a 40 million Rad dose. This error was not used because Low Steam Generator Pressure is not credited for events releasing significant amounts of radiation.

17. All equipment is required to function during and after a seismic event.

18. The setpoint associated with the Feedwater Line Break and Steam Line Break events was chosen as the most conservative.

4.6 CALCULATION OF LOW STEAM GENERATOR WATER LEVEL TRIP

I. ANALYSIS VALUES

A. Analysis Setpoint (1): 40 % of WR
(2): 35 % of WR
(3): 15 % of WR
(4): 10 % of WR

B. Sensor Response Time (5): 0.600 sec.

C. RPS Signal Time (1,2): 0.550 sec.
D. ESFAS Signal Delay Time (6): 0.550 sec.

TOTAL ANALYSIS RESPONSE TIME

B + C = 1.15 sec. (For RPS Tech. Spec. Use)
B + D = 1.15 sec. (For ESFAS Tech. Spec. Use)

II. PPS CABINET UNCERTAINTIES

Instrument Range: 0 to 100 % Span (7)
Voltage Range: 0 to 10 volts
Conversion Factor: 10 % Span/volt

Conversion Equations: %S = 10V
V = %S/10

A. Cal. Equip. Unc. (8): +/- 0.0500 % Span
B. Equipment Accuracy (9): +/- 0.0303 % Span
C. Bistable Drift (10): +/- 0.0229 % Span
D. Temperature Effect
1. Ambient (11): +/- 0.0219 % Span
2. Worst Case Normal (11): +/- 0.0877 % Span

CALIBRATION ERROR

RSS(A,B) = +/- 0.058 % Span

PERIODIC TEST ERROR

RSS(A,A,B,C,D1) = +/- 0.083 % Span

WORST CASE NORMAL ERROR

RSS(A,B,C,D2) = +/- 0.108 % Span

III. PROCESS EQUIPMENT UNCERTAINTIES

E.	Cal. Equip. Unc.:	+/- 0.5 %
F.	Barton 764 Accuracy:	+/- 0.5 %
G.	Foxboro I/E Accuracy (12):	+/- 0.35 %
H.	Foxboro E/I Accuracy:	+/- 0.5 %
I.	Dropping Resistor Error:	+/- 0.01 %
J.	Foxboro I/E Temperature Effects	
	1. Ambient (13):	+/- 0.14 %
	2. Worst Case Normal (17):	+/- 0.57 %
K.	Foxboro E/I Temperature Effects	
	1. Ambient (13):	+/- 0.1 %
	2. Worst Case Normal (17):	+/- 0.4 %
L.	Barton 764 Temperature Effects	
	1. Ambient (14):	+/- 0.5 %
	2. Worst Case Normal (14):	+/- 1.0 %
	3. Accident Conditions (19):	+/- 2.84 %
	4. Accident Conditions (20):	+/- 4.95 %
M.	Barton 764 Radiation Errors	
	1. Normal Operation (15):	+/- 0.5 %
	2. Accident Conditions (21):	+/- 3.0 %
N.	Barton 764 Drift (16):	+/- 1.9 %
O.	Barton 764 Seismic Errors	
	1. During Event:	+/- 2.5 %
	2. After Event:	+/- 1.0 %
P.	Foxboro I/E Seismic Error (18):	+/- 0.71 %
Q.	Foxboro E/I Seismic Error (18):	+/- 0.5 %
R.	Terminal Block Accident Error:	+ 1.0 %
S.	Reference Leg Errors	
	1. 120 dF to 200 dF Change:	+ 3.7 %
	2. 120 dF to 280 dF Change:	+ 8.6 %

CALIBRATION ERROR

RSS(E,F,G,H,I) = +/- 0.934 % Span
= +/- 1.0 % Span

PERIODIC TEST ERROR

RSS(E,E,F,G,H,I,J1,K1,L1,M1,N) = +/- 2.294 % Span
= +/- 2.3 % Span

WORST CASE NORMAL ERROR w/POST SEISMIC (22)

RSS(E,F,G,H,I,J2,K2,L2,M1,N,O2,P,Q) = +/- 2.823

WORST CASE ACCIDENT ERROR (200 dF, Post Seismic)

RSS(E,F,G,H,I,J2,K2,L2,L3,M1,N,O2,P,Q) + R' + S1' =

+/- 4.005 + 4.7 % Span
- 0.0 % Span

III. PROCESS EQUIPMENT UNCERTAINTIES (Cont.)

WORST CASE ACCIDENT ERROR (280 dF, Post Seismic)

RSS(E,F,G,H,I,J2,K2,L2,L4,M1,N,O2,P,Q) + R' + S2'

+/- 5.699 + 9.6 % Span
- 0.0 % Span

IV. TOTAL CHANNEL WORST CASE NORMAL ERROR w/SEISMIC (22)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 0.108 % Span
B. PE Worst Case Normal Error: +/- 2.823 % Span

RSS(A,B) + B' = +/- 2.825 % Span
= +/- 2.9 % Span

V. TOTAL CHANNEL ACCIDENT ERROR (200 dF, Post Seismic)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 0.108 % Span
B. PE Worst Case Accident Error: +/- 4.005 + 4.7 % Span

RSS(A,B) + B' = +/- 4.006 + 4.7 % Span
- 0.0 % Span

= + 8.7 % Span
= - 4.0 % Span

VI. TOTAL CHANNEL ACCIDENT ERROR (280 dF, Post Seismic)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 0.108 % Span
B. PE Worst Case Accident Error: +/- 5.699 + 9.6 % Span

RSS(A,B) + B' = +/- 5.700 + 9.6 % Span
- 0.0 % Span

= + 15.3 % Span
= - 5.7 % Span

VII. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT

```
                        (I,RPS)                (V)
Trip Setpoint = Analysis Setpoint + Total Channel Error
              = 40.0 % Span + 2.9 % Span = 42.9 % Span
              = 35.0 % Span + 8.7 % Span = 43.7 % Span
              = 43.7 % Span (RPS,23)

                        (I,EFAS)              (VI)
Trip Setpoint = Analysis Setpoint + Total Channel Error
              = 15.0 % Span + 2.9 % Span = 17.9 % Span
              = 10.0 % Span + 15.3 % Span = 25.3 % Span
              = 25.3 % Span (EFAS,23)
```

```
Allowable Value = Trip Setpoint - PPS Cabinet PTE
                = 43.7 % Span - 0.083 % Span
                = 43.7 % Span (RPS)

Allowable Value = Trip Setpoint - PPS Cabinet PTE
                = 25.3 % Span - 0.083 % Span
                = 25.3 % Span (EFAS)
```

To reduce the possiblity of a Licensee Event Report, the Trip Setpoint is offset from the calculated Allowable Value by 0.5 % of Span. Based on a Span of 100 %, the offset is 0.5 %, and the new Trip Setpoint becomes 44.2 % for the RPS, and 25.8 % for the EFAS.

```
Pretrip Setpoint = Trip Setpoint + Total Channel Error
                 = 44.2 % Span + 2.9 % Span
                 = 47.1 % Span (RPS)

Pretrip Setpoint = Trip Setpoint + Total Channel Error
                 = 25.8 % Span + 2.9 % Span
                 = 28.7 % Span (EFAS)
```

VIII. VOLTAGE EQUIVALENTS FOR VII.

The PPS Cabinet input ranges from 0 to 10 volts. This is equivalent to a process range of 0 to 100 % Span. Based on these endpoints the following linear conversion equations can be derived:

$$V = \% \text{ Span}/10$$

Based on this, the following data can be calculated:

VIII. VOLTAGE EQUIVALENTS FOR VII. (Cont.)

	Value	Voltage
Trip Setpoint		
RPS	44.2 % Span (WR)	4.420 volts
EFAS	25.8 % Span (WR)	2.580 volts
Allowable Value		
RPS	43.7 % Span (WR)	4.370 volts
EFAS	25.3 % Span (WR)	2.530 volts
Pretrip Setpoint		
RPS	47.1 % Span (WR)	4.710 volts
EFAS	28.7 % Span (WR)	2.870 volts

Cabinet Calib.	+/- 0.058 % Span	+/- 0.006 volts
Cabinet PTE	+/- 0.083 % Span	+/- 0.008 volts
Proc. Equip. Calib.	+/- 1.0 % Span	+/- 0.100 volts
Proc. Equip. PTE	+/- 2.3 % Span	+/- 0.230 volts

IX. MEASUREMENT CHANNEL RESPONSE TIMES

A.	Process Equipment:	0.180 sec.
B.	Foxboro I/E Converters:	0.100 sec.
C.	Foxboro E/I Converter:	0.080 sec.
D.	PPS Cabinet (RPS):	0.150 sec.
E.	PPS Cabinet (ESFAS):	0.150 sec.
F.	Reactor Trip Switch Gear:	0.100 sec.
G.	ESFAS Cabinet Delay:	0.300 sec.

Total Channel Response Time

A + B + C + D + F = 0.610 seconds (For RPS)
A + B + C + E + G = 0.810 seconds (For ESFAS)

The actual RPS Channel Delay Time is less than the 1.15 second RPS Tech. Spec. Response Time.

The actual ESFAS Channel Delay Time is less than the 1.15 second ESFAS Analysis Response Time.

CALCULATION NOTES:

1. For non-environmental events. Initiates a reactor trip based on wide range indication. Only post-seismic errors are required.

2. For Feedwater Line Break and Steam Line Break events. Initiates a Reactor Trip based on wide range (WR) indication. Only post-seismic errors are required.

3. For Loss of Condenser Vaccum, Main Steam Isolation Valve Closure, Locked RCP Rotor with Loss of Power, and Steam Generator Tube Rupture Events. Initiates EFAS based on wide range indication.

4. Lower limit for LOCA and Steam Line Break events. EFAS Initiation based on wide range indication must occur before this.

5. Applies to events listed in notes 1 through 4.

6. Applies to events listed in notes 3 and 4. For ESFAS applications, signal response time includes sensor input through ESFAS actuation relays.

7. The calibrated span of the transmitter is 262.80 inches of water. The tap span is 376.25 inches of water.

8. Based on an assumed Calibration Equipment accuracy of +/- 0.005 volts.

9. Based on a PPS Cabinet accuracy of +/- 0.00303 volts.

10. For a 39 day period. Based on a maximum expected drift of +/- 0.00176 volts over 30 days linearly extrapolated to 39 days.

11. Worst Case Normal errors were based on a +/- 50 degree Fahrenheit shift producing a +/- 0.00877 volt change. One fourth of this was used to determine Ambient Temperature Effects.

12. Channel B contains two Foxboro current to voltage conversion cards. The error shown reflects the combined effect of both. This approach has also been used to determine ambient temperature effects, worst case normal errors and seismic errors.

13. For +/- 10 degree Fahrenheit change within a 40-130 degree Fahrenheit range.

CALCULATION NOTES (cont.):

14. Worst case normal error for an 80-140 degree Fahrenheit range. One half of this was used to determine ambient temperature effects.

15. Background radiation for a 22.5 month period and a total dose not exceeding 0.465 million Rads.

16. For a 22.5 month period and normal environment.

17. For a +/- 40 degree Fahrenheit change within a 40-120 degree Fahrenheit range.

18. Uncertainty during the event. Uncertainty after the event was not stated.

19. For a 200 degree Fahrenheit environment. Analytical requirements indicate that this is the maximum containment temperature that is expected prior to a reactor trip.

20. For a 280 degree Fahrenheit environment. Analytical requirements indicate that this is the maximum containment temperature that is expected.

21. Based on a 40 million Rad dose. This error was not used because Low Steam Generator Level is not credited for events releasing significant amounts of radiation.

22. All equipment is required to function during and after a seismic event.

23. The higher level accomodates both analysis requirements.

4.7 CALCULATION OF HIGH STEAM GENERATOR WATER LEVEL TRIP

I. ANALYSIS VALUES

A. Analysis Setpoint (1): 99.0 % of NR

B. Sensor Response Time (1): 0.600 sec.

C. RPS Signal Delay Time: 0.550 sec.

TOTAL ANALYSIS RESPONSE TIME

B + C = 1.15 sec. (For RPS Tech. Spec. Use)

CESSAR, Section 7.2.2.5, requires for level setpoints that no analysis setpoint is within 5.0 percent of the ends of the level span. Accordingly, the analysis setpoint is adjusted downward to 95.0 percent to meet this criteria.

II. PPS CABINET UNCERTAINTIES

Instrument Range: 0 to 100 % Span
Voltage Range: 0 to 10 volts
Conversion Factor: 10 % Span/volt

Conversion Equations: %S = 10V
V = %S/10

A. Cal. Equip. Unc. (2): +/- 0.0500 % Span
B. Equipment Accuracy (3): +/- 0.0303 % Span
C. Bistable Drift (4): +/- 0.0229 % Span
D. Temperature Effects
1. Ambient (5): +/- 0.0219 % Span
2. Worst Case Normal (5): +/- 0.0877 % Span

CALIBRATION ERROR

RSS(A,B) = +/- 0.058 % Span

PERIODIC TEST ERROR

RSS(A,A,B,C,D1) = +/- 0.083 % Span

WORST CASE NORMAL ERROR

RSS(A,B,C,D2) = +/- 0.108 % Span

III. PROCESS EQUIPMENT UNCERTAINTIES

E.	Cal. Equip. Unc.:	+/- 0.5 %
F.	Barton 764 Accuracy:	+/- 0.5 %
G.	Foxboro I/E Accuracy:	+/- 0.25 %
H.	Dropping Resistor Error:	+/- 0.01 %
I.	Foxboro I/E Temperature Effects	
	1. Ambient (6):	+/- 0.1 %
	2. Worst Case Normal (10):	+/- 0.4 %
J.	Barton 764 Temperature Effects	
	1. Ambient (7):	+/- 0.5 %
	2. Worst Case Normal (7):	+/- 1.0 %
K.	Barton 764 Radiation Error (8):	+/- 0.5 %
L.	Barton 764 Drift (9):	+/- 1.9 %
M.	Barton 764 Seismic Error (11):	+/- 2.5 %
N.	Foxboro I/E Seismic Error (12):	+/- 0.5 %

CALIBRATION ERROR

RSS(E,F,G,H) = +/- 0.750 % Span
= +/- 0.8 % Span

PERIODIC TEST ERROR

RSS(E,E,F,G,H,I1,J1,K,L) = +/- 2.221 % Span
= +/- 2.3 % Span

WORST CASE NORMAL (NON-ACCIDENT) ERROR w/SEISMIC (13)

RSS(E,F,G,H,I2,J2,K,L,M,N) = +/- 3.476 % Span

IV. TOTAL CHANNEL WORST CASE NORMAL ERROR (13,14)

Combine:

A.	PPS Cabinet Max. Op. Error:	+/- 0.108 % Span
B.	PE Worst Case Normal Error:	+/- 3.476 % Span

RSS(A,B) = +/- 3.478 % Span
= +/- 3.5 % Span

V. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT

Trip Setpoint = Analysis Setpoint (I) - Total Channel Error (IV)
= 95.0 % Span - 3.5 % Span
= 91.5 % Span

V. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT (cont.)

Allowable Value = Trip Setpoint + PPS Cabinet PTE
= 91.5 % Span + 0.083 % Span
= 91.5 % Span

To reduce the possiblity of a Licensee Event Report, the Trip Setpoint is offset from the calculated Allowable Value by 0.5 % of Span. Based on a Span of 100 %, the offset is 0.5 %, and the new Trip Setpoint becomes 91.0 %.

The Pretrip Setpoint is set at 88.6 % Span based on engineering judgement.

VI. VOLTAGE EQUIVALENTS FOR V.

The PPS Cabinet input ranges from 0 to 10 volts. This is equivalent to a process range of 0 to 100 % Span. Based on these endpoints the following linear conversion equations can be derived:

$$V = \% \text{ Span}/10$$

Based on this, the following data can be calculated:

	Value	Voltage
Trip Setpoint	91.0 % Span (NR)	9.100 volts
Allowable Value	91.5 % Span (NR)	9.150 volts
Pretrip Setpoint	88.6 % Span (NR)	8.860 volts
Cabinet Calib.	+/- 0.058 % Span	+/- 0.006 volts
Cabinet PTE	+/- 0.083 % Span	+/- 0.008 volts
Proc. Equip. Calib.	+/- 0.8 % Span	+/- 0.080 volts
Proc. Equip. PTE	+/- 2.3 % Span	+/- 0.230 volts

VIII. MEASUREMENT CHANNEL RESPONSE TIMES

A. Process Equipment: 0.400 sec.
B. Foxboro I/E Converter: 0.050 sec.
C. PPS Cabinet (RPS): 0.150 sec.
D. Reactor Trip Switch Gear: 0.100 sec.

Total Channel Response Time

A + B + C + D = 0.700 seconds (For RPS)

The actual RPS Channel Delay Time is less than the 1.15 second RPS Tech. Spec. Response Time.

CALCULATION NOTES:

1. For increase in feedwater flow. Initiates Reactor Trip based on narrow range (NR) indication. This trip prevents moisture carry over which would fill the steam lines with water and damage the turbine.

2. Based on an assumed Calibration Equipment accuracy of +/- 0.005 volts.

3. Based on a PPS Cabinet accuracy of +/- 0.00303 volts.

4. For a 39 day period. Based on a maximum expected drift of +/- 0.00176 volts over 30 days linearly extrapolated to 39 days.

5. Worst Case Normal errors were based on a +/- 50 degree Fahrenheit shift producing a +/- 0.00877 volt change. One fourth of this was used to determine Ambient Temperature effects.

6. For +/- 10 degree Fahrenheit change within a 40-120 degree Fahrenheit range.

7. Worst case normal error for an 80-130 degree Fahrenheit range. One half of this was used to determine ambient temperature effects.

8. Background radiation for a 22.5 month period and a total dose not exceeding 0.465 million Rads.

9. For a 22.5 month period and normal environment.

10. For a +/- 40 degree Fahrenheit change within a 40-120 degree Fahrenheit range.

11. Uncertainty during the event. Uncertainty after the event is +/- 1.0 % Span.

12. Uncertainty during the event. Uncertainty after the event was not stated.

13. All equipment is required to function during and after a seismic event.

14. No accident condition uncertainties other than seismic are applicable because the High Steam Generator Level trip is not credited for any Design Basis conditions.

4.8 CALCULATION OF HIGH STEAM GENERATOR DELTA PRESSURE TRIP

I. ANALYSIS VALUES

A. Analysis Setpoint (1): 275 psid
(2): 325 psid

B. Sensor Response Time (1,2): 0.600 sec.
C. ESFAS Signal Delay Time (3): 0.550 sec.

TOTAL ANALYSIS RESPONSE TIME

B + C = 1.15 sec. (For ESFAS Tech. Spec. Use)

II. PPS CABINET UNCERTAINTIES

Instrument Range: 0 to 1524 psia
Voltage Range: 0 to 10 volts
Conversion Factor: 152.4 psi/volt

Conversion Equations: P = 152.4V
V = P/152.4

A. Cal. Equip. Unc. (4): +/- 0.762 psi
B. Equipment Accuracy (5): +/- 0.582 psi
C. Bistable Drift (6): +/- 0.412 psi
D. Temperature Effects
1. Ambient (7): +/- 0.386 psi
2. Worst Case Normal (7): +/- 1.545 psi

CALIBRATION ERROR

RSS(A,B) = +/- 0.959 psi

PERIODIC TEST ERROR

RSS(A,A,B,C,D1) = +/- 1.349 psi

WORST CASE NORMAL ERROR

RSS(A,B,C,D2) = +/- 1.864 psi

III. PROCESS EQUIPMENT UNCERTAINTIES

E. Cal. Equip. Unc.:	+/- 7.7 psi
F. Barton 763 Accuracy:	+/- 7.7 psi
G. Foxboro I/E Accuracy (8):	+/- 5.4 psi
H. Foxboro E/I Accuracy:	+/- 7.7 psi
I. Dropping Resistor Error:	+/- 0.2 psi
J. Foxboro I/E Temperature Effects	
1. Ambient (9):	+/- 2.2 psi
2. Worst Case Normal (13):	+/- 8.7 psi
K. Foxboro E/I Temperature Effects	
1. Ambient (9):	+/- 1.6 psi
2. Worst Case Normal (13):	+/- 6.1 psi
L. Barton 763 Temperature Effects	
1. Ambient (10):	+/- 7.7 psi
2. Worst Case Normal (10):	+/- 15.3 psi
3. Accident Conditions (17):	+/- 75.4 psi
4. Accident Conditions (18):	+/- 83.4 psi
M. Barton 763 Radiation Errors	
1. Normal Operation (11):	+/- 7.7 psi
2. Accident Conditions (19):	+/- 45.8 psi
N. Barton 763 Drift (12):	+/- 28.7 psi
O. Barton 763 Seismic Errors	
1. During Event (14):	+/- 30.5 psi
2. After Event (15):	+/- 15.3 psi
P. Foxboro I/E Seismic Error (16):	+/- 10.8 psi
Q. Foxboro E/I Seismic Error (16):	+/- 7.7 psi
R. Terminal Block Accident Error:	+ 15.3 psi

CALIBRATION ERROR (20)

RSS(E,F,G,H,I) = +/- 14.390 psi
= +/- 14.4 psi

PERIODIC TEST ERROR (20)

RSS(E,E,F,G,H,I,J1,K1,L1,M1,N) = +/- 34.872 psi
= +/- 34.9 psi

WORST CASE NORMAL (NON-ACCIDENT) ERROR (15,20,21)

RSS(E,F,G,H,I,J2,K2,L2,M1,N,O2,P,Q) = +/- 42.977 psi

WORST CASE NORMAL (NON-ACCIDENT) ERROR (14,20,21)

RSS(E,F,G,H,I,J2,K2,L2,M1,N,O1,P,R) = +/- 50.430 psi

WORST CASE ACCIDENT ERROR (300 dF, Post Seismic, 20)

RSS(E,F,G,H,I,J2,K2,L2,L4,M1,N,O2,P,Q) + R' =

+/- 93.822 + 15.3 psi
\- 0.0 psi

III. PROCESS EQUIPMENT UNCERTAINTIES CONT.

WORST CASE ACCIDENT ERROR (280 dF, FULL SEISMIC, 20)

RSS(E,F,G,H,I,J2,K2,L2,L3,M1,N,O1,P,Q) + R' =

+/- 90.710 + 15.3 psi
- 0.0 psi

IV. TOTAL CHANNEL WORST CASE NORMAL ERROR (15,21,22)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 1.864 psi
B. PE Worst Case Normal Error: +/- 42.977 psi

RSS(A,B,B) = +/- 60.807 psi
= +/- 61 psi

V. TOTAL CHANNEL WORST CASE NORMAL ERROR (14,21,22)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 1.864 psi
B. PE Worst Case Normal Error: +/- 50.430 psi

RSS(A,B,B) = +/- 71.343 psi
= +/- 72 psi

VI. TOTAL CHANNEL ACCIDENT ERROR (300 dF, Post Seismic, 22)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 1.864 psi
B. PE Worst Case Accident Random Error: +/- 93.822 psi
C. PE Worst Case Accident Additive Error: + 15.3 psi

RSS(A,B,B,C) = +/- 133.577 psi
= +/- 134 psi

VII. TOTAL CHANNEL ACCIDENT ERROR (280 dF, Full Seismic, 22)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 1.864 psi
B. PE Worst Case Accident Random Error: +/- 90.710 psi
C. PE Worst Case Accident Additive Error: + 15.3 psi

RSS(A,B,B,C) = +/- 129.206 psi
= +/- 130 psi

VIII. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT

```
                              (I-1)                  (IV)
Trip Setpoint = Analysis Setpoint - Total Channel Error
              = 275 psid - 61 psi
              = 214 psid

                              (I-2)                  (VI)
Trip Setpoint = Analysis Setpoint - Total Channel Error
              = 325 psid - 134 psi
              = 191 psid (23)
```

```
Allowable Value = Trip Setpoint + PPS Cabinet PTE
                = 191 psid + 1.349 psi
                = 192 psid
```

To reduce the possiblity of a Licensee Event Report, the Trip Setpoint is offset from the calculated Allowable Value by 0.5 % of Span. Based on a Span of 1524 psi, the offset is 7.0 psi, and the new Trip Setpoint becomes 185 psid.

```
Pretrip Setpoint = Trip Setpoint - Total Channel Error
                 = 185 psid - 61 psi
                 = 124 psid
```

IX. VOLTAGE EQUIVALENTS FOR VIII.

The PPS Cabinet input ranges from 0 to 10 volts. This is equivalent to a process range of 0 to 1524 psid. Based on these endpoints the following linear conversion equations can be derived:

Delta V = Delta P/152.4

Based on this, the following data can be calculated:

	Value	Voltage
Trip Setpoint	185 psid	1.214 volts
Allowable Value	192 psid	1.260 volts
Pretrip Setpoint	124 psid	0.814 volts
Cabinet Calib.	+/- 0.959 psi	+/- 0.006 volts
Cabinet PTE	+/- 1.349 psi	+/- 0.009 volts
Proc. Equip. Calib.	+/- 14.4 psi	+/- 0.094 volts
Proc. Equip. PTE	+/- 34.9 psi	+/- 0.229 volts

X. MEASUREMENT CHANNEL RESPONSE TIMES

A. Process Equipment: 0.180 sec.
B. Foxboro I/E Converters: 0.100 sec.
C. Foxboro E/I Converter: 0.080 sec.
D. PPS Cabinet (ESFAS): 0.150 sec.
E. ESFAS Cabinet Delay: 0.300 sec.

Total Channel Response Time

A + B + C + D + E = 0.810 seconds (For ESFAS)

The actual ESFAS Channel Delay Time is less than the 1.15 second ESFAS Analysis Response Time.

CALCULATION NOTES:

1. For outside containment breaks. Initiates steam generator isolation.

2. For Feedwater Line Break and Steam Line Break inside containment. Initiates steam generator isolation.

3. For ESFAS applications, signal response time includes sensor input through ESFAS actuation relays.

4. Based on an assumed Calibration Equipment accuracy of +/- 0.005 volts.

5. Based on a PPS Cabinet accuracy of +/- 0.00382 volts.

6. For a 39 day period. Based on a maximum expected drift of +/- 0.00208 volts over 30 days linearly extrapolated to 39 days.

7. Worst Case Normal errors were based on a +/- 50 degree Fahreheit shift producing a +/- 0.01014 volt change. One fourth of this was used to determine Ambient Temperature effects.

8. Channel B contains two Foxboro current to voltage conversion cards. The error shown reflects the combined effect of both. This approach has also been used to determine ambient temperature effects worst case normal errors and seismic errors.

9. For +/- 10 degree Fahrenheit change within a 40-120 degree Fahrenheit range.

10. Worst case normal error for an 80-130 degree Fahrenheit range. One half of this was used to determine ambient temperature effects.

11. Background radiation for a 40 year period and a total dose not exceeding 10 million Rads.

12. For a 22.5 month period and normal environment.

13. For a +/- 40 degree Fahrenheit change within a 40-120 degree Fahrenheit range.

14. This uncertainty not required by the Safety Analysis.

CALCULATION NOTES (cont.):

15. Identification of a ruptured steam generator can be delayed for 30 seconds. A seismic event will be over in 30 seconds. Accordingly, post seismic errors were used.

16. Uncertainty during the event. Uncertainty after the event was not stated.

17. For a 280 degree Fahrenheit environment. Analytical requirements indicate that this is the maximum long term stablilization temperature that is expected during a Feedwater Line Break.

18. For 300 degree Fahrenheit environment. After 100 seconds the containment stablizies at or below this temperature during a Steam Line Break. Peak temperatures encountered prior to this do not affect the transmitter.

19. Based on a 40 million Rad dose. This error was not used because High Steam Generator delta Pressure is not credited for events releasing significant amounts of radiation.

20. For a single process loop only.

21. All equipment is required to function during and after a seismic event. Refer to Notes 14 and 15 for additional information.

22. This trip function takes a signal from each steam generator, inverts one and adds the two together to obtain a differential pressure. The errors associated with each channel must be combined to obtain the total channel uncertainty. For this reason, random process errors are taken twice. The inversion and adding process will also make the non-random process instrument errors from each steam generator appear to be random depending on the state of each sensor. For this reason, they are treated as seperate, but random, components of the total channel uncertainty.

23. The setpoint associated with the Feedwater Line Break and Steam Line Break events was chosen as the most conservative.

4.9 CALCULATION OF HIGH CONTAINMENT PRESSURE TRIP

I. ANALYSIS VALUES

A. Analysis Setpoint (1): 6.0 psig
(2): 6.0 psig
(3): 6.0 psig
(4): 6.0 psig

B. Sensor Response Time (3): 0.600 sec.
C. RPS Signal Delay Time (3): 0.550 sec.
D. ESFAS Response Time (1,4,5): 1.150 sec.
(2,5): 2.100 sec.

TOTAL ANALYSIS RESPONSE TIME

B + C = 1.15 sec. (For RPS Tech. Spec. Use)
D = 1.15 sec. (For ESFAS Tech. Spec. Use)

II. PPS CABINET UNCERTAINTIES

Instrument Range: -4 to +20 psig
Voltage Range: 1 to 5 volts
Conversion Factor: 6.0 psig/volt

Conversion Equations: P = 6V - 10
V = (P+10)/6

A. Cal. Equip. Unc. (6): +/- 0.030 psi
B. Equipment Accuracy (7): +/- 0.018 psi
C. Bistable Drift (8): +/- 0.014 psi
D. Temperature Effects
1. Ambient (9): +/- 0.013 psi
2. Worst Case Normal (9): +/- 0.053 psi

CALIBRATION ERROR

RSS(A,B) = +/- 0.035 psi

PERIODIC TEST ERROR

RSS(A,A,B,C,D1) = +/- 0.050 psi

WORST CASE NORMAL ERROR

RSS(A,B,C,D2) = +/- 0.065 psi

III. PROCESS EQUIPMENT UNCERTAINTIES

E.	Cal. Equip. Unc.:	+/- 0.12 psi
F.	Rosemount 1153 Accuracy:	+/- 0.06 psi
G.	Dropping Resistor Error:	+/- 0.01 psi
H.	Rosemount 1153 Drift (10):	+/- 0.94 psi
I.	Rosemount 1153 Rad. Error (11):	+/- 0.23 psi
J.	Rosemount 1153 Seismic Error:	+/- 0.50 psi
K.	Rosemount 1153 Temp. Error (12):	+ 0.39 psi

CALIBRATION ERROR

RSS(E,F,G) = +/- 0.135 psi
= +/- 0.14 psi

PERIODIC TEST ERROR

RSS(E,E,F,G,H,I) + K' = +/- 0.984 + 0.39 psi
- 0.00 psi

= + 1.38 psi
= - 0.99 psi

WORST CASE NORMAL (NON-ACCIDENT) ERROR W/SEISMIC (13)

RSS(E,F,G,H,I,J) + K' = +/- 1.098 + 0.39 psi
- 0.00 psi

IV. TOTAL CHANNEL WORST CASE NORMAL ERROR W/SEISMIC (13)

Combine:

A.	PPS Cabinet W.C.N. Error:	+/- 0.065 psi
B.	PE Worst Case Normal Error:	+/- 1.098 + 0.39 psi

RSS(A,B) = +/- 1.100 + 0.39 psi
- 0.00 psi

= + 1.5 psi
= - 1.1 psi

V. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT

The Setpoint is bracketed by two methods:

A. Starting from 0.0 psig, the lowest possible value is calculated which would not interfere with operation unnecessarily.

Analysis Setpoint:	0.0 psig	
Positive Containment Press. Limit:	+ 0.5 psi	
Containment Pressure Spike:	+ 1.2 psi	
Total Channel Error:	+ 1.5 psig	(IV)
Low Trip Setpoint Limit =	3.2 psig	

B. Starting from 6.0 psig, the highest possible value is calculated which will guarantee a reactor trip when required.

Analysis Setpoint:	6.0 psig	(I)
Negative Containment Press. Limit:	- 0.5 psi	
Total Channel Error:	- 1.1 psi	(IV)
High Trip Setpoint Limit =	4.4 psig	

Trip Setpoint, Method A = 3.2 psig

Allowable Value = Trip Setpoint + PPS Cabinet Periodic Test Error
= 3.2 psig + 0.050 psi
= 3.2 psig

To reduce the possiblity of a Licensee Event Report, the Trip Setpoint is offset from the calculated Allowable Value by 0.2 psi. The new Trip Setpoint becomes 3.0 psig. This setpoint is slightly below the Method A limit. However, a false actuation is unlikely and the analytical requirements are better satisfied.

The Pretrip Setpoint is set at 2.5 psig based on engineering judgement.

VI. VOLTAGE EQUIVALENTS FOR V.

The PPS Cabinet input ranges from 1 to 5 volts. This is equivalent to a process range of -4 to +20 psig. Based on these endpoints the following linear conversion equations can be derived:

$$V = (P+10)/6$$

Based on this, the following data can be calculated:

	Value	Voltage
Trip Setpoint	3.0 psig	2.167 volts
Allowable Value	3.2 psig	2.200 volts
Pretrip Setpoint	2.5 psig	2.083 volts
Cabinet Calib.	+/- 0.035 psi	+/- 0.006 volts
Cabinet PTE	+/- 0.050 psi	+/- 0.008 volts
Proc. Equip. Calib.	+/- 0.14 psi	+/- 0.023 volts
Proc. Equip. PTE	+ 1.38 psi - 0.99 psi	+ 0.230 volts - 0.165 volts

VII. MEASUREMENT CHANNEL RESPONSE TIMES

A. Process Equipment: 0.280 sec.
B. PPS Cabinet (RPS): 0.150 sec.
C. PPS Cabinet (ESFAS): 0.150 sec.
D. Reactor Trip Switch Gear: 0.100 sec.
E. ESFAS Cabinet Delay Time: 0.300 sec.

TOTAL CHANNEL RESPONSE TIME

A + B + D = 0.530 sec. (For RPS)
A + C + E = 0.730 sec. (Eor ESFAS)

The actual RPS channel delay time is less than the 1.15 second RPS Tech. Spec. Response Time.

The actual ESFAS channel delay time is less than the 1.15 second ESFAS Analysis Response Time.

CALCULATION NOTES:

1. For Small and Large Break LOCA's. Initiates CCAS.

2. For Small and Large Break LOCA's. Initiates CIAS.

3. For CEA Ejection, Feedwater Line Break and Steam Line Break. Initiates a Reactor Trip.

4. For CEA Ejection, Feedwater Line Break and Steam Line Break. Initiates CCAS, CIAS, and MSIS.

5. For ESFAS applications, signal response time includes sensor input through ESFAS actuation relays.

6. Based on an assumed Calibration Equipment accuracy of +/- 0.005 volts.

7. Based on a PPS Cabinet accuracy of +/- 0.00303 volts.

8. For a 39 day period. Based on a maximum expected drift of +/- 0.00176 volts over 30 days linearly extrapolated to 39 days.

9. Worst Case Normal errors were based on a +/- 50 degrees Fahrenheit shift producing a +/- 0.00877 volt change. One fourth of this was used to determine Ambient Temperature effects.

10. For 22.5 month period and normal environment. Based on a maximum expected drift of 0.5 percent of upper range limit (100 psi) over 12 months linearly extrapolated to 22.5 months.

11. Based on an Auxiliary Building radiation of one million Rads total integrated dose.

12. Normal, worst case and accident environmental conditions are identical. Temperature effect is 1.6 percent of span based on an ambient temperature range of 50 to 104 degrees Fahrenheit in the Auxiliary Building. Wide variations in ambient temperature between calibration and periodic testing are expected. For this reason, the temperature effect was not reduced by one half to calculate a periodic test error. Accident conditions do not apply because the instruments are located outside of containment.

13. All equipment is required to function during and after a seismic event.

4.10 CALCULATION OF HIGH-HIGH CONTAINMENT PRESSURE TRIP

I. ANALYSIS VALUES

A. Analysis Setpoint (1): 10.0 psig
(2): 10.0 psig

B. Sensor Response Time (2): 0.600 sec.

C. Signal Response Time (2): 0.550 sec.
D. ESFAS Response Time (1,3): 1.150 sec.

TOTAL ANALYSIS RESPONSE TIME

D = 1.15 sec. (For ESFAS Tech. Spec. Use)

II. PPS CABINET UNCERTAINTIES

Instrument Range: -4 to +85 psig
Voltage Range: 1 to 5 volts
Conversion Factor: 22.25 psi/volt

Conversion Equations: P = (89V-105)/4
V = (4P+105)/89

A. Cal. Equip. Unc. (4): +/- 0.111 psi
B. Equipment Accuracy (5): +/- 0.067 psi
C. Bistable Drift (6): +/- 0.051 psi
D. Temperature Effects
1. Ambient (7): +/- 0.049 psi
2. Worst Case Normal (7): +/- 0.195 psi

CALIBRATION ERROR

RSS(A,B) = +/- 0.130 psi

PERIODIC TEST ERROR

RSS(A,A,B,C,D1) = +/- 0.185 psi

WORST CASE NORMAL ERROR

RSS(A,B,C,D2) = +/- 0.240 psi

III. PROCESS EQUIPMENT UNCERTAINTIES

E. Cal. Equip. Unc.: +/- 0.45 psi
F. Rosemount 1153 Accuracy: +/- 0.23 psi
G. Dropping Resistor Error: +/- 0.01 psi
H. Rosemount 1153 Drift (8): +/- 0.94 psi
I. Rosemount 1153 Rad. Error (9): +/- 0.23 psi
J. Rosemount 1153 Seismic Error (10): +/- 0.50 psi
K. Rosemount 1153 Temp. Error (11): + 1.43 psi

CALIBRATION ERROR

RSS(E,F,G) = +/- 0.505 psi
= +/- 0.51 psi

PERIODIC TEST ERROR

RSS(E,E,F,G,H,I) + K' = +/- 1.181 + 1.43 psi
- 0.00 psi

= + 2.61 psi
= - 1.18 psi

WORST CASE NORMAL (NON-ACCIDENT) ERROR W/SEISMIC (12)

RSS(E,F,G,H,I,J) + K' = +/- 1.201 + 1.43 psi
- 0.00 psi

IV. TOTAL CHANNEL WORST CASE NORMAL ERROR W/SEISMIC (12)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 0.240 psi
B. PE Worst Case Normal Error: +/- 1.201 + 1.43 psi

RSS(A,B) = +/- 1.225 + 1.43 psi
- 0.00 psi

= + 2.66 psi
= - 1.23 psi

V. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT

```
                         (I)                 (VI)
Trip Setpoint = Analysis Setpoint - Total Channel Error
              = 10.0 psig - 1.23 psi
              = 8.77 psig
```

```
Allowable Value = Trip Setpoint + PPS Cabinet Periodic
                                  Test Error
                = 8.77 psig + 0.185 psi
                = 8.9 psig
```

To reduce the possiblity of a Licensee Event Report, the Trip Setpoint is offset from the calculated Allowable Value by 0.4 psi. The new Trip Setpoint becomes 8.5 psig.

The Pretrip Setpoint is set at 6.0 psig based on engineering judgement.

VI. VOLTAGE EQUIVALENTS FOR V.

The PPS Cabinet input ranges from 1 to 5 volts. This is equivalent to a process range of -4 to +85 psig. Based on these endpoints the following linear conversion equations can be derived:

$$V = (4P+105)/89$$

Based on this, the following data can be calculated:

	Value	Voltage
Trip Setpoint	8.5 psig	1.562 volts
Allowable Value	8.9 psig	1.580 volts
Pretrip Setpoint	6.0 psig	1.449 volts
Cabinet Calib.	+/- 0.130 psi	+/- 0.006 volts
Cabinet PTE	+/- 0.185 psi	+/- 0.008 volts
Proc. Equip. Calib.	+/- 0.51 psi	+/- 0.023 volts
Proc. Equip. PTE	+ 2.61 psi - 1.18 psi	+ 0.117 volts - 0.053 volts

VIII. MEASUREMENT CHANNEL RESPONSE TIMES

A. Process Equipment: 0.280 sec.
B. PPS Cabinet (ESFAS): 0.150 sec.
C. ESFAS Cabinet Delay Time: 0.300 sec.

TOTAL CHANNEL RESPONSE TIME

A + B + C = 0.730 sec. (For ESFAS)

The actual ESFAS channel delay time is less than the 1.15 second ESFAS Analysis Response Time.

CALCULATION NOTES:

1. For Small Break and Large Break LOCA's. Initiates CSAS.

2. For CEA Ejection, Feedwater Line Break and Steam Line Break. Initiates CSAS.

3. For ESFAS applications, signal response time includes sensor input through ESFAS actuation relays.

4. Based on an assumed Calibration Equipment accuracy of +/- 0.005 volts.

5. Based on a PPS Cabinet accuracy of +/- 0.00303 volts.

6. For a 39 day period. Based on a maximum expected drift of +/- 0.00176 volts over 30 days linearly extrapolated to 39 days.

7. Worst Case Normal errors were based on a +/- 50 degree Fahrenheit shift producing a +/- 0.00877 volt change. One fourth of this was used to determine Ambient Temperature effects.

8. For a 22.5 month period and normal environment. Based on a maximum expected drift of 0.5 percent of upper range limit (100 psi) over 12 months linearly extrapolated to 22.5 months.

9. Based on an Auxiliary Building radiation of one million Rads total integrated dose.

10. Uncertainty during the event.

11. Normal, worst case and accident environmental conditions are identical. Temperature effect is 1.6 percent of span based on an ambient temperature range of 50 to 104 degrees Fahrenheit in the Auxiliary Building. Wide variations in ambient temperature between calibration and periodic testing are expected. For this reason, the temperature effect was not reduced by one half to calculate a periodic test error. Accident conditions do not apply because the instruments are located outside of containment.

12. All equipment is required to function during and after a seismic event.

4.11 CALCULATION OF LOW REFUELING WATER TANK LEVEL TRIP

I. ANALYSIS VALUES

A. Analysis Setpoint (1): 14,970 Gallons
(2): 399,200 Gallons

B. Analysis Delay Time (3): 45.0 sec.

The calibrated span of the transmitter extends from elevation 94' 10" to the bottom of the overflow line at elevation 154' 2". This equates to a span of 712 inches. (See Assumption 3.9)

II. PPS CABINET UNCERTAINTIES

Instrument Range: 0 to 100 % Span
Voltage Range: 1 to 5 volts
Conversion Factor: 25 % Span/volt

Conversion Equations: %S = 25V - 25
V = (%S+25)/25

A. Cal. Equip. Unc. (4): +/- 0.125 %
B. Equipment Accuracy (5): +/- 0.076 %
C. Bistable Drift (6): +/- 0.057 %
D. Temperature Effects
1. Ambient (7): +/- 0.055 %
2. Worst Case Normal (7): +/- 0.219 %

CALIBRATION ERROR

RSS(A,B) = +/- 0.146 % Span

PERIODIC TEST ERROR

RSS(A,A,B,C,D1) = +/- 0.208 % Span

WORST CASE NORMAL ERROR

RSS(A,B,C,D2) = +/- 0.269 % Span

III. PROCESS EQUIPMENT UNCERTAINTIES

E. Cal. Equip. Uncertainty:	+/- 0.50 %
F. Rosemount 1153 Accuracy:	+/- 0.25 %
G. Dropping Resistor Error:	+/- 0.01 %
H. Rosemount 1153 Drift (8):	+/- 0.99 %
I. Rosemount 1153 Seismic Error (9):	+/- 0.53 %
J. Rosemount 1153 Temp. Error (10):	+ 2.3 %
K. Vent Sizing Error (11):	- 1.2 %

CALIBRATION ERROR

RSS(E,F,G) = +/- 0.559 % Span
= +/- 0.6 % Span

PERIODIC TEST ERROR

RSS(E,E,F,G,H) + J' = +/- 1.242 + 2.3 % Span
- 0.0 % Span

= + 3.6 % Span
= - 1.3 % Span

WORST CASE PUMP DOWN ERROR W/SEISMIC (12)

RSS(E,F,G,H,I) + J' + K' = +/- 1.254 + 2.3 % Span
- 1.2 % Span

IV. TOTAL CHANNEL WORST CASE NORMAL ERROR W/SEISMIC (12)

Combine:

A. PPS Cabinet W.C.N. Error: +/- 0.269 % Span
B. PE W. C. Pump Down Error: +/- 1.254 + 2.3 - 1.2 % Span

RSS(A,B) + B' - B' = +/- 1.283 + 2.3 % Span
- 1.2 % Span

= + 3.6 % Span
= - 2.5 % Span

V. CONVERSION OF ANALYSIS SETPOINT

There are 7.48 gallons in one cubic feet of water.

(14,970)/(7.48) = 2,001.3 cu feet

The refueling water tank has an inside diameter of 46.46 feet. The cross-sectional area of the tank is:

(3.14)(46.46)(46.46)/(4.0) = 1,694.4 sq feet

The Analysis Setpoint in terms of inches of water is:

(2,001.3)(12)/(1,694.4) = 14.17 inches

The Analysis Setpoint in terms of percent of sensor span is:

(14.17)(100)/(712) = 2.0 %

CESSAR, Section 7.2.2.5, requires for level setpoints that no Analysis Setpoint is within 5.0 percent of the ends of the level span. Accordingly, the calculated Analysis Setpoint is adjusted upward by 3.0 percent to meet this criterion.

VI. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT

Trip Setpoint = Analysis Setpoint (I) + Total Channel Error (V)
= 5.0 % Span + 3.6 % Span
= 8.6 % Span

Allowable Value = Trip Setpoint - PPS Cabinet PTE
= 8.6 % Span - 0.208 % Span
= 8.4 % Span

To reduce the possiblity of a Licensee Event Report, the Trip Setpoint is offset from the calculated Allowable Value by 0.5 % of Span. Based on a Span of 100 %, the offset is 0.5 %, and the new Trip Setpoint becomes 8.9 % of Span.

Pretrip Setpoint = Trip Setpoint + Total Channel Error
= 8.9 % Span + 3.6 % Span
= 12.5 % Span

VII. VOLTAGE EQUIVALENTS FOR VI.

The PPS Cabinet input ranges from 1 to 5 volts. This is equivalent to a process range of 0 to 100 % Span. Based on these endpoints the following linear conversion equations can be derived:

$$V = (\%S+25)/25$$

Based on this, the following data can be calculated:

	Value	Voltage
Trip Setpoint	8.9 % Span	1.356 volts
Allowable Value	8.4 % Span	1.336 volts
Pretrip Setpoint	12.5 % Span	1.500 volts
Cabinet Calib.	+/- 0.146 % Span	+/- 0.006 volts
Cabinet PTE	+/- 0.208 % Span	+/- 0.008 volts
Proc. Equip. Calib.	+/- 0.6 % Span	+/- 0.024 volts
Proc. Equip. PTE	+ 3.6 % Span - 1.3 % Span	+ 0.144 volts - 0.052 volts

VIII. LIMITING CONDITION FOR OPERATION

A minimum fill capacity for the Refueling Water Tank must be established to ensure that 399,200 gallons of borated water has been pumped into containment before recirculation is initiated.

The minimum fill capacity must include the setpoint and one negative channel error interval in addition to the minimum transfer margin.

The sum of the setpoint and the error interval is:

8.9 % Span + 2.5 % Span = 11.4 % Span

In terms of gallons, this maximum setpoint is:

(0.114)(712 inches)/(12) = 6.764 feet

(6.764)(1,694.4) = 11,461 cubic feet

(11,461)(7.48) = 85,729 gallons

VIII. LIMITING CONDITION FOR OPERATION CONT.

Accordingly, the minimum fill capacity is:

399,200 + 85,729 = 484,929 gallons
= 485,000 gallons

This has been made an assumption and must be verified by the customer.

IX. MEASUREMENT CHANNEL RESPONSE TIMES

A.	Process Equipment:	0.220 sec.
B.	PPS Cabinet (ESFAS):	0.150 sec.
C.	ESFAS Cabinet Delay Time:	0.300 sec.

TOTAL CHANNEL RESPONSE TIME

A + B + C = 0.670 Seconds

This is less than the 45.0 seconds Analysis Response Time. Accordingly, the equipment is performing consistent with the Safety Analysis.

CALCULATION NOTES:

1. Minimum recirculation suction transfer margin. Recirculation must be initiated before this.

2. Minimum transfer volume requirement before recirculation is initiated.

3. Time interval from when the monitered parameter exceeds the Analysis Setpoint at the input to the channel sensor until the sump valves are fully open.

4. Based on an assumed calibration equipment accuracy of +/- 0.005 volts.

5. Based on a PPS Cabinet accuracy of +/- 0.00303 volts.

6. For a 39 day period. Based on a maximum expected drift of +/- 0.00176 volts over 30 days linearly extrapolated to 39 days.

7. Worst Case Normal errors were based on a +/- 50 degree Fahrenheit shift producing a +/- 0.00877 volt change. One fourth of this was used to determine Ambient Temperature effects.

8. For a 22.5 month period and normal environment. Based on a maximum expected drift of 0.5 % of upper range over 12 months linearly extrapolated to 22.5 months. Upper range limit is 750 inches of water and the calibrated span is 712 inches of water.

9. Based on a maximum expected seismic effect during the event of +/- 0.5 % of upper range. Upper range limit is 750 inches of water and the calibrated span is 712 inches of water.

10. Normal, Worst Case and Accident Environmental Conditions are identical. Temperature effect is 2.3 % of span based on an ambient temperature range of 25 to 116 degrees Fahrenheit in the yard area. Wide variations in ambient temperature between calibration and periodic testing are expected. For this reason, the temperature effect was not reduced by one half to calculate a periodic test error.

11. Due to the miscalculation of the vent size needed during a maximum pump down a vacuum of up to (-8) inches will be created during the pump down. This will cause the transmitter to see a level 8 inches below actual. The percent error was based on this 8 inches and a span of 712 inches.

CALCULATION NOTES (cont.):

12. All equipment is required to function during and after a seismic event.

13. The outside diameter is 46.5 feet and the liner thickness is 0.25 inch. Measurement errors in these dimensions are not taken into account.

4.12 CALCULATION OF SPS HIGH PRESSURIZER PRESSURE TRIP

I. ANALYSIS VALUES

A. Analysis Setpoint (1,2): 2475 psia

B. Sensor Response Time (1,2): 0.600 sec.
C. SPS Signal Delay Time (1,2): 0.550 sec.

TOTAL ANALYSIS RESPONSE TIME

B + C = 1.15 sec. (For SPS Tech. Spec. Use)

II. SPS CABINET UNCERTAINTIES

Instrument Range: 1500 to 2500 psia
Voltage Range: 1 to 5 volts
Conversion Factor: 250 psi/volt

Conversion Equations: P = 250V + 1250
V = (P-1250)/250

A. Cal. Equip. Unc. (3): +/- 1.250 psi
B. Equipment Accuracy (4): +/- 1.638 psi
C. Bistable Drift (5): +/- 0.635 psi
D. Temperature Effects
   1. Ambient (6): +/- 0.785 psi
   2. Worst Case Normal (7): +/- 2.488 psi

CALIBRATION ERROR

RSS(A,B) = +/- 2.060 psi

PERIODIC TEST ERROR

RSS(A,A,B,C,D1) = +/- 2.613 psi

WORST CASE NORMAL ERROR

RSS(A,B,C,D2) = +/- 3.292 psi

III. PROCESS EQUIPMENT UNCERTAINTIES

E. Cal. Equip. Unc.:	+/- 5.0 psi
F. Rosemount Accuracy:	+/- 2.5 psi
G. Rosemount Amb. Temp. Effect:	+/- 5.5 psi
H. Rosemount Drift (8):	+/- 28.2 psi
I. Rosemount W.C.N. Error (9):	+/- 18.5 psi
J. Rosemount Seismic Error(10):	+/- 15.0 psi
K. Rosemount Radiation Error (11):	+ 10.0 psi

CALIBRATION ERROR

RSS(E,F) = +/- 5.590 psi
= +/- 5.6 psi

PERIODIC TEST ERROR

RSS(E,E,F,G,H) + K' = +/- 29.694 + 10.0 psi
- 0.0 psi

= + 39.7 psi
= - 29.7 psi

WORST CASE NORMAL (NON-ACCIDENT) ERROR w/SEISMIC (12)

RSS(E,F,H,I,J) + K' = +/- 37.333 + 10.0 psi
0.0 psi

IV. TOTAL CHANNEL WORST CASE NORMAL ERROR w/SEISMIC (12)

Combine:

A. PPS Cabinet Max. Op. Error:	+/- 3.292 psi
B. PE Worst Case Normal Error:	+/- 37.333 + 10.0 psi

RSS(A,B) + B' = +/- 37.478 + 10.0 psi

= + 47.5 psi
= - 37.5 psi

V. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT

Trip Setpoint = Analysis Setpoint (I) - Total Channel Error (IV)
= 2475 psia - 37.5 psi
= 2437 psia

V. TRIP SETPOINT, ALLOWABLE VALUE, PRETRIP SETPOINT (cont.)

Allowable Value = Trip Setpoint + PPS Cabinet PTE
= 2437 psia + 2.613 psi
= 2439 psia

To reduce the possibility of a Licensee Event Report, the Trip Setpoint is offset from the calculated Allowable Value by 0.5 % of Span. Based on a Span of 1000 psi, the offset is 5.0 psi, and the new Trip Setpoint becomes 2434 psia.

Pretrip Setpoint = Trip Setpoint - Total Channel Error
= 2434 psia - 37.5 psi
= 2396 psia

VI. VOLTAGE EQUIVALENTS FOR V.

The PPS Cabinet input ranges from 1 to 5 volts. This is equivalent to a process range of 1500 to 2500 psia. Based on these endpoints the following linear conversion equations can be derived:

$$V = (P-1250)/250$$

Based on this, the following data can be calculated:

	Value	Voltage
Trip Setpoint	2434 psia	4.736 volts
Allowable Value	2439 psia	4.756 volts
Pretrip Setpoint	2396 psia	4.584 volts
Cabinet Calib.	+/- 2.060 psi	+/- 0.008 volts
Cabinet PTE	+/- 2.613 psi	+/- 0.010 volts
Proc. Equip. Calib.	+/- 5.6 psi	+/- 0.022 volts
Proc. Equip. PTE	+ 39.7 psi - 29.7 psi	+ 0.159 volts - 0.119 volts

VII. MEASUREMENT CHANNEL RESPONSE TIMES (2)

A. Process Equipment: 0.200 sec.
B. SPS Cabinet: 0.150 sec.
C. Reactor Trip Switch Gear: 0.100 sec.

TOTAL CHANNEL RESPONSE TIME

A + B + C = 0.450 sec.

The actual SPS channel delay time is less than the 1.15 second RPS High Pressurizer Pressure Tech. Spec. Response Time.

CALCULATION NOTES:

1. For Anticipated Transients Without Scram (ATWS) events. The SPS environment for qualification corresponds to the environment utilized for non-pipe break accidents.

2. No ATWS licensing requirements exist at the present time even though ATWS are the Design Basis Events for the SPS. Until such time as licensing requirements are finalized, the highest Analysis Setpoint and fastest response times for the RPS High Pressurizer Pressure trip function will be used.

3. Based on an assumed calibration equipment accuracy of +/- 0.005 volts.

4. Based on a SPS Cabinet accuracy of +/- 0.00655 volts.

5. For a 39 day period. Based on a maximum expected drift of +/- 0.00254 volts.

6. Based on an ambient temperature effect of +/- 0.00314 volts.

7. Based on a maximum temperature effect of +/- 0.00995 volts.

8. For a 22.5 month period.

9. Worst Case Normal Error.

10. Uncertainty during the event. Uncertainty after the event was not defined.

11. Due to normal background radiation over a 22.5 month period.

12. All equipment is required to function during a seismic event.

5.1 CHANNEL DIAGRAM FOR VARIABLE OVERPOWER

```
*****************************
*                           *
* Ex-Core Fission Chambers  *  Westinghouse
*                           *  ( Model 24036 )
*****************************
       *             *
       *            ***
       *             *
       *             *
       *             *
       *      ***************
       *      *   High      *
       *      *  Voltage    *  Westinghouse
       *      *  Filter     *  ( Model 24037 )
       *      ***************
       *             *
       *            ***
       *             *
       *             *
       *             *
*****************************
*      *                    *
*      ******************   *
*      *                *   *
*     ***               *   *
*      *                *   *
***************         *   *
* Rate-Limited*         *   *
*  Variable   *         *   *
*  Setpoint   *         *   *
***************         *   *
*      *                *   *
*      ***********      *   *
*                *      *   *
*               ***    ***  *
*                *      *   *
*             ***************
*             *             *
*             *  Bistable   *
*             * Trip Unit   *
*             ***************
*                           *
*                           *
* Plant Protection System   *
*         Cabinet           *
*                           *
*****************************
```

5.2 CHANNEL DIAGRAM FOR HIGH LOGARITHMIC POWER

```
****************************
*                          *
* Ex-Core Fission Chambers *  Westinghouse
*        ( Middle )        *  ( Model 24036 )
****************************
       *            *
       *           ***
       *            *
       *            *
       *            *
****************************
*            *    High     *
*   Pre-Amp  *   Voltage   *  Westinghouse
*            *   Filter    *  ( Model 24037 )
****************************
       *            *
       *           ***
       *            *
      ***           *
       *            *
****************************
*                          *
* Plant Protection System  *
*         Cabinet          *
*                          *
****************************
```

5.3 CHANNEL DIAGRAM FOR HIGH PRESSURIZER PRESSURE

```
 P-101 A,B,C,D

***************
*             *
*   PT-101    *  ITT Barton Transmitter
*             *  ( Model 763 )
***************
       *
       *
       *
      ***
       *
***************
*             *
*   PY-101    *  Foxboro I/E Converter
*             *  ( Model 2AI-I2V )
***************
       *
       ***********************
       *                     *
       *                     *
      ***                   ***
       *                     *
***************       ***************
*             *       *             *
* PPS Cabinet *       *    CPC's    *
*             *       *             *
***************       ***************
```

5.4 CHANNEL DIAGRAM FOR LOW PRESSURIZER PRESSURE

```
    P-102 B          P-102 A,C,D

***************    ***************
*             *    *             *
*   PT-102B   *    * PT-102A,C,D *  ITT Barton Transmitter
*             *    *             *  ( Model 763 )
***************    ***************
       *                  *
       *                  *
       *                  *
      ***                ***
       *                  *
***************    ***************
*             *    *             *
*  PY-102B-1  *    * PY-102A,C,D *  Foxboro I/E Converter
*             *    *             *  ( Model 2AI-I2V )
***************    ***************
       *                  *
       *                  *
       *                  *
      ***                 *
       *                  *
***************           *
*             *           *
*  PY-102B-2  *           *         Foxboro E/I Converter
*             *           *         ( Model 2AO-VAI )
***************           *
       *                  *
       *                  *
       *                  *
      ***                 *
       *                  *
***************           *
*             *           *
*   PY-102B   *           *         Foxboro I/E Converter
*             *           *         ( Model 2AI-I2V )
***************           *
       *                  *
       *                  *
       *                  *
      ***                ***
       *                  *
**********************************
*                                *
*     Plant Protection System    *
*            Cabinet             *
*                                *
**********************************
```

5.5 CHANNEL DIAGRAM FOR LOW STEAM GENERATOR PRESSURE

```
    P-1013 B            P-1013 A,C,D
  ( P-1023 B )        ( P-1023 A,C,D )

 ***************     ***************
 *             *     *             *
 *  PT-1013B   *     * PT-1013A,C,D*  ITT Barton Transmitter
 *    (1023)   *     *    (1023)   *  ( Model 763 )
 ***************     ***************
        *                   *
        *                   *
        *                   *
       ***                 ***
        *                   *
 ***************     ***************
 *             *     *             *
 *  PY-1013B-1 *     * PY-1013A,C,D*  Foxboro I/E Converter
 *    (1023)   *     *    (1023)   *  ( Model 2AI-I2V )
 ***************     ***************
        *                   *
        *                   *
        *                   *
       ***                  *
        *                   *
 ***************            *
 *             *            *
 *  PY-1013B-2 *            *         Foxboro E/I Converter
 *    (1023)   *            *         ( Model 2AO-VAI )
 ***************            *
        *                   *
        *                   *
        *                   *
       ***                  *
        *                   *
 ***************            *
 *             *            *
 *   PY-1013B  *            *         Foxboro I/E Converter
 *     (1023)  *            *         ( Model 2AI-I2V )
 ***************            *
        *                   *
        *                   *
        *                   *
       ***                 ***
        *                   *
 ***********************************
 *                                 *
 *     Plant Protection System     *
 *             Cabinet             *
 *                                 *
 ***********************************
```

5.6 CHANNEL DIAGRAM FOR LOW STEAM GENERATOR WATER LEVEL (WR)

```
       L-1113 B           L-1113 A,C,D
     ( L-1123 B )       ( L-1123 A,C,D )

   ***************     ***************
   *             *     *             *
   *  LT-1113B   *     * LT-1113A,C,D*  ITT Barton Transmitter
   *    (1123)   *     *    (1123)   *  ( Model 763 )
   ***************     ***************
          *                   *
          *                   *
          *                   *
         ***                 ***
          *                   *
   ***************     ***************
   *             *     *             *
   * LY-1113B-1  *     * LY-1113A,C,D*  Foxboro I/E Converter
   *   (1123)    *     *   (1123)    *  ( Model 2AI-I2V )
   ***************     ***************
          *                   *
          *                   *
          *                   *
         ***                  *
          *                   *
   ***************            *
   *             *            *
   * LY-1113B-2  *            *         Foxboro E/I Converter
   *   (1123)    *            *         ( Model 2AO-VAI )
   ***************            *
          *                   *
          *                   *
          *                   *
         ***                  *
          *                   *
   ***************            *
   *             *            *
   *  LY-1113B   *            *         Foxboro I/E Converter
   *    (1123)   *            *         ( Model 2AI-I2V )
   ***************            *
          *                   *
          *                   *
          *                   *
         ***                 ***
          *                   *
   ***********************************
   *                                 *
   *     Plant Protection System     *
   *             Cabinet             *
   *                                 *
   ***********************************
```

5.7 CHANNEL DIAGRAM FOR HIGH STEAM GENERATOR WATER LEVEL (NR)

```
  L-1114 A,B,C,D
( L-1124 A,B,C,D )

 ***************
 *             *
 *   LT-1114   *  ITT Barton Transmitter
 *      (1124) *  ( Model 764 )
 ***************
        *
        *
        *
       ***
        *
 ***************
 *             *
 *   LY-1114   *  Foxboro I/E Converter
 *      (1124) *  ( Model 2AI-I2V )
 ***************
        *
        *
        *
       ***
        *
 ***************
 *             *
 * PPS Cabinet *
 *             *
 ***************
```

5.8 CHANNEL DIAGRAM FOR STEAM GENERATOR DELTA PRESSURE

```
 PD-115 A,B,C,D      PD-125 A,B,C,D

***************     ***************
*             *     *             *
*   PDT-115   *     *   PDT-125   *  ITT Barton Transmitter
*             *     *             *  ( Model 764 )
***************     ***************
       *                   *
       *                   *
       *                   *
      ***                 ***
       *                   *
***************     ***************
*             *     *             *
*   PDY-115   *     *   PDY-125   *  Foxboro I/E Converter
*             *     *             *  ( Model 2AI-I2V )
***************     ***************
    *                         *
    *                         *
    *                         *
***********************************
*   *                         *   *
*   *********************     *   *
*   *                   *     *   *
*   *     ************* * *****   *
*   *     *             *     *   *
*   *     *             *     *   *
*  ***   ***           ***   ***  *
*   *     *             *     *   *
****************   ****************
*              *   *              *
* PPS Bistable *   * PPS Bistable *
*  SG2 > SG1   *   *  SG1 > SG2   *
*              *   *              *
****************   ****************
*                                 *
*     Plant Protection System     *
*             Cabinet             *
***********************************
```

5.9 CHANNEL DIAGRAM FOR HIGH CONTAINMENT PRESSURE

```
 P-351 A,B,C,D

***************
*             *
*   PT-351    *  Bechtel Supplied Transmitter
*             *
***************
       *
       *
       *
      ***
       *
***************
*             *
* PPS Cabinet *
*             *
***************
```

5.10 CHANNEL DIAGRAM FOR HIGH-HIGH CONTAINMENT PRESSURE

```
 P-352 A,B,C,D
***************
*             *
*   PT-352    *  Bechtel Supplied Transmitter
*             *
***************
       *
       *
       *
      ***
       *
***************
*             *
* PPS Cabinet *
*             *
***************
```

5.11 CHANNEL DIAGRAM FOR LOW REFUELING WATER TANK LEVEL

```
 L-203 A,B,C,D

***************
*             *
*   LT-203    *  Bechtel Supplied Transmitter
*             *
***************
       *
       *
       *
      ***
       *
***************
*             *
* PPS Cabinet *
*             *
***************
```

5.12 CHANNEL DIAGRAM FOR SPS (HIGH PRESSURIZER PRESSURE)

```
 P-199 A,B,C,D

***************
*             *
*   PT-199    *  Rosemount Transmitter
*             *  ( Model 1153 D )
***************
       *
       *
       *
      ***
       *
***************
*             *
* SPS Cabinet *
*             *
***************
```