ARKANSAS NUCLEAR ONE
CALCULATION COVER SHEET (Cont.)

Calc. No.: 92-EQ-0002-01 Unit: 2

Rev. No. 0(1) Verification Method: Design Review: X
Alternate Calc.: ____ Qual. Testing ____

Pages Revised and/or Added: Revised pages 17, 39, 41, 43

Purpose of Revision: Add note clarifying IR error value selection and change Variable Setpoint Step Increment from CE's newly established 400 PSI to the existing and more conservative value of 200 PSI.

Initiating Documents	Resulting Documents	Key Design Input Doc
DCP 92-2008		

Amends Calc(s): ____
Supercedes Calc(s): ____

Computer Software (Ver.): ____

By: Rhonda Eric Allen / RCA / 8-5-92 Rvw'd: ____ / ____ / ____
Chk'd: Curtis John Neumeier / CJN / 8-6-92 Apv'd: D. Wayne Coffman / DWC / 8-6-92
(print name) (init) (date) (print name) (init) (date)

Rev. No. 0(2) Verification Method: Design Review: XX
Alternate Calc.: ____ Qual. Testing ____

Pages Revised and/or Added: 8-9, 18-20, 22-25, 27-30, 35-41, 44, 46, 48. Electronic update of previous manual revisions on pgs 34, 41-44. Typos on pgs 47, 48. All Pages Repaginated.

Purpose of Revision: Revised to incorporate new IR error values and incorporate setting tolerance associated with SC1 and SC.

Initiating Documents	Resulting Documents	Key Design Input Doc
DCP 92-2008		

Amends Calc(s): ____
Supercedes Calc(s): ____

Computer Software (Ver.): ____

By: Rhonda Eric Allen / RCA / 9-3-92 Rvw'd: ____ / ____ / ____
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Check if Additional Revisions: ____

CALCULATION COVER SHEET

Calc No.: 92-EQ-0002-01 Unit: 2 Category: Q

Calc Title: Loop Error, Setpoint, and Time Response Analysis for Low Pressurizer Wide Range Pressure ESFAS and RPS Trip Functions

System(s): ~~ESFAS~~ RPS RCA 6-24-92

Topic(s): INUN, SETC

Calc Type: IC

Component No(s).: 2PT-4624-1, 2PT-4624-2, 2PT-4624-3, 2PT-4624-4

Plt Area: Bldg. _____ Elev _____
Room _____
Coordinates: _____

Abstract (Include Purpose/Results): To calculate the errors, setpoints, allowable values and time response of the ANO-2 Low Pressurizer Wide Range Pressure ESFAS and RPS instrumentation loops. The results are shown in the Summary section of this calculation.

Rev. No.: 0 Verification Method: Design Review: X
Alternate Calculation: _____ Qualification Testing: _____

Pages Revised and/or Added: All

Purpose of Revision: Original Issue (pages 1-48). Pages 33, 41, 42, and 43 were revised by Entergy Operations after receipt from vendor.

Initiating Documents	Resulting document(s)	Reference Calcs
DCP 92-2008		

Amends Calc(s): 85-EQ-0004-18

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Computer Software (Ver. 1): Lotus Symphony (2.2) / Freelance Plus (3.01) / Word Perfect (5.1) Always (2.2)
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Check if additional revisions ✓

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Prepared by: RSA Date: 9-3-92 Checked by: JCM Date: 9-3-92

1.0 PURPOSE/SCOPE

1.1 PURPOSE

The purpose of this calculation is to determine the uncertainties, setpoints, allowable values, and time responses of the ANO-2 Low Pressurizer Wide Range Pressure ESFAS and RPS Trip instrumentation loops. This calculation supersedes the Low Pressurizer Pressure portions of all previous ABB/CE setpoint calculations.

1.2 SCOPE

This calculation is applicable to the follcwing instrument loops:

Unit	Instrument Loop No.	Service
2	2PT-4624-1	Pressurizer Pressure
2	2PT-4624-2	Pressurizer Pressure
2	2PT-4624-3	Pressurizer Pressure
2	2PT-4624-4	Pressurizer Pressure

Instrument loop uncertainties are calculated for the Reference Condition, Abnormal Condition and Accident Condition.

2.0 INTRODUCTION

The statistical method of the Square Root of the Sum of Squares (SRSS) is used to determine the random error on a component level and for the loop. Non-random errors are combined algebraically with the random error term to establish total error.

This calculation is done in accordance with the guidelines set forth in the Instrument Loop Error Analysis and Setpoint Methodology Manual (Reference 6.2).

All percentages are expressed in terms of span unless otherwise noted.

All terms are considered random error terms unless noted by a lowercase "b" suffix to indicate a bias error term, or "t" suffix to indicate the total of the bias and random error terms.

3.0 ASSUMPTIONS AND GIVEN CONDITIONS

3.1 Calibration and Testing Environment

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

A. Control Room

The calibration temperature for PPS Equipment in the control room is assumed to be 75 deg F and the maximum operating temperature for PPS Equipment in the control room is assumed to be 84 deg F. All other conditions "normal" for a control room environment, per Reference 6.2.

B. Containment

The calibration temperature of the PPS Equipment inside containment is assumed to be 60 deg F and the maximum operating temperature of PPS Equipment inside containment is assumed to be 120 deg F. All other conditions "normal" for a containment environment, per Reference 6.2.

C. Outside Containment

The calibration temperature is assumed to be 60°F. This is a conservative temperature to envelope the expected ambient at the time of calibration. See Reference 6.2.

3.2 Calibration and Testing Equipment

The measurement and test equipment (M&TE) used to calibrate and test the PPS Equipment will have an accuracy twice as good as the accuracy of the device or loop being tested. For example: if a transmitter has a reference accuracy of +/- 1.0 % span, it's assumed M&TE uncertainty will be +/- 0.5 % of span. This assumed M&TE accuracy applies to all PPS Equipment unless otherwise specified. See Reference 6.2.

3.3 Calibration and Testing Interval

A. The PPS Cabinet (Bistable) 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.

ANO-2 Technical Specifications, Section 4.0.2, permits a 25% extension of the monthly (31 days) and refueling (18 months) calibration intervals.

3.4 Power Supply Variation

Unless specifically stated otherwise, the variation of the instrument power system is 120 ± 10 VAC and the maximum power supply variation is ± 10% of the nominal power supply. See Section 3.9.7 of Reference 6.2.

3.5 Fischer & Porter 50EK1000 Calibration

No calibration is required per Reference 6.21.

3.6 Seismic and Post-Seismic Errors

Seismic and post-seismic errors are not considered with any design basis events because ANO-2 will, after each seismic event, determine that the post-seismic error are negligible or will recalibrate all effected PPS equipment, per Reference 6.28.

3.7 Signal Converter Drift

Unless otherwise stated, the drift for the signal converters is assumed to be no worse than its reference accuracy, per Reference 6.27 and 6.2.

3.8 Transmitter Background Radiation Effect

Unless otherwise stated, the background radiation effect for the transmitters is assumed negligible because the effect of background radiation is calibrated out each refueling, per Reference 6.2.

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

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

3.11 The calibration uncertainties for process instrumentation assumes that there are separate calibration devices on the input and output of the instrument being calibrated, per Reference 6.2.

3.12 Error terms that are less than 0.05% of SPAN are considered negligible and are not included in the calculation per Reference 6.2.

3.13 Accident Temperature Effect

The temperature that the pressurizer pressure transmitters are exposed to during LOCA and SBLOCA events will be no greater than 200°F, and below 250°F for SLB events at time of actuation per Reference 6.34.

3.14 Foxboro Converters Power Supply Effect

The supply voltage for the Foxboro N2AO-V2I and N2AI-I2V converters is from a nest distribution module (Ref. 6.29.e). The nest supply voltage is +15 and -15 VDC (Ref. 6.31).

The line voltage effect is:

±10% line change: 0.2% of rated voltage (6.31)

The line voltage variation is:

120 ±10 VAC or ±8.3% (3.4)

Therefore the power supply variance is:

$$PS = (0.2\%)\frac{(8.3\%)}{(10.0\%)} = \pm 0.166\%$$

3.15 Fischer & Porter 50EK1000 Current-to-Current Converter

There will be no errors introduced by temperature effect and line voltage effect as long as the instrument is operated within the ambient temperature range of 30-130°F and the line voltage is 117 volts ±10% per Reference 6.32.

3.16 Accident Radiation Effect

The radiation effect for the LOCA and SBLOCA events is negligible, as the actual increase in dose prior to trip is not significantly above background in radiation per Reference 6.25. The radiation effect for the SLB is negligible.

3.17 Variable Setpoint Card Error

The temperature error used is associated with the pre-trip in the minimum region since it is the most conservative, see Reference 6.18. The calibration error of the variable setpoint card is assumed to be the same as the bistable card since the same MT&E is used.

3.18 Assumption and Given Condition (A&GC) 3.2 states that Measurement and Test Equipment (M&TE) will have an accuracy twice as good as the accuracy (RA) of the device or loop being tested. The calibration tolerance band or device tolerance (DTOL) for this device incorporates an additional setting tolerance (ST) such that DTOL = RA + ST. Thus, DTOL shall in essence be treated the same as the reference accuracy for this device and it shall conservatively be assumed that M&TE is twice as good as DTOL.

3.19 Per A&GC 3.7, drift (DR) is assumed to be no worse than reference accuracy (RA). The calibration tolerance band or device tolerance (DTOL) for this device incorporates an additional setting tolerance (ST) such that DTOL = RA + ST. Thus, DTOL shall in essence be treated the same as the reference accuracy for this device and it shall conservatively be assumed that DR is no worse than DTOL.

3.20 Although this is not a calibrated device (see A&GC 3.5), a functional check is performed per the periodic test procedure (Ref. 6.7). Considering the fact that this device cannot be calibrated and that the functional check is conducted across both the device and the associated downstream resistor (see Figures 4.1-4.4), a larger required accuracy of $\pm 0.5\%$ is incorporated. Therefore, a setting tolerance (ST) of $\pm 0.25\%$ is applied to this device such that with a reference accuracy (RA) of $\pm 0.25\%$ the total device tolerance (DTOL) is $\pm 0.50\%$. This is indeed conservative since the resistor accuracy is again applied in the resistor section of the calculation.

4.0 PPS FUNCTIONS

The PPS function included in this calculation is the Pressurizer Pressure - LOW function. The functional requirements of this PPS trip are given below.

4.1 PRESSURIZER PRESSURE

4.1.1 Functional Description

The low pressurizer pressure function of the Plant Protection System (PPS) provides a reactor trip, a containment cooling actuation signal (CCAS) and a safety injection actuation signal (SIAS) on a Low Pressurizer Pressure trip. The Low Pressurizer pressure function provides automatic bypass removal for SIAS and RAS. The reactor trip, CCAS and SIAS, and the bypass removal are initiated by separate bistables. See Figures 4.1 through 4.4.

The reactor trip 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 trip setpoint is maintained less than or equal to 200 psi. The trip setpoint will be increased automatically as pressurizer pressure is increased to maintain the margin between pressurizer pressure and the trip setpoint less than or equal to 200 psi until the normal operating trip setpoint is reached. The 100 psia minimum and 200 psi margin are based on engineering judgement and operating experience at C-E plants.

The pressurizer pressure transmitter is calibrated from 0 to 3000 psia and outputs a 4 to 20 mA signal. A 250 ohm dropping resistor provides a 1 to 5 volt signal to the bistables.

4.1.2 Design Basis and Requirements

The purpose of the low pressurizer pressure function is to limit core damage during a postulated accident.

The reactor trip and safety injection functions are credited in the SAR Chapter 6.0 Analysis with limiting the consequences of the Small Break LOCA event. The Chapter 6.0 Analysis determines the peak containment pressures and temperatures following a primary or secondary pipe break. Therefore, the SIAS analysis setpoint cannot be changed without determining the effect of this change on the Chapter 6.0 Analysis.

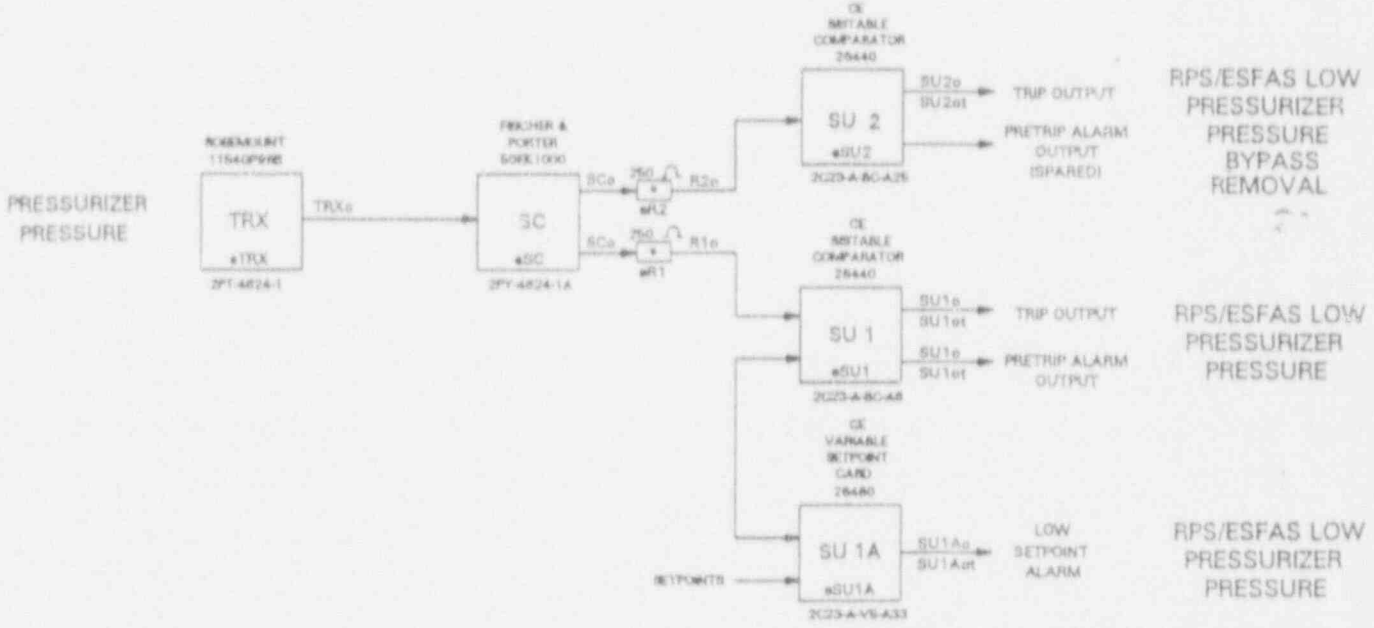
The safety injection function is credited in the SAR Chapter 15.0 LOCA analyses with limiting the consequences of the LOCA events.

The containment cooling function is credited with limiting the post-accident containment pressure during and following LOCA and SLB events. The CCAS analysis setpoint is determined by the SAR Chapter 6.0 Containment Analysis. Therefore, the analysis setpoint cannot be changed without determining the effect of this change on the Chapter 6.0 Analysis.

FIGURE 4.1

PRESSURIZER PRESSURE BLOCK DIAGRAM

CHANNEL A



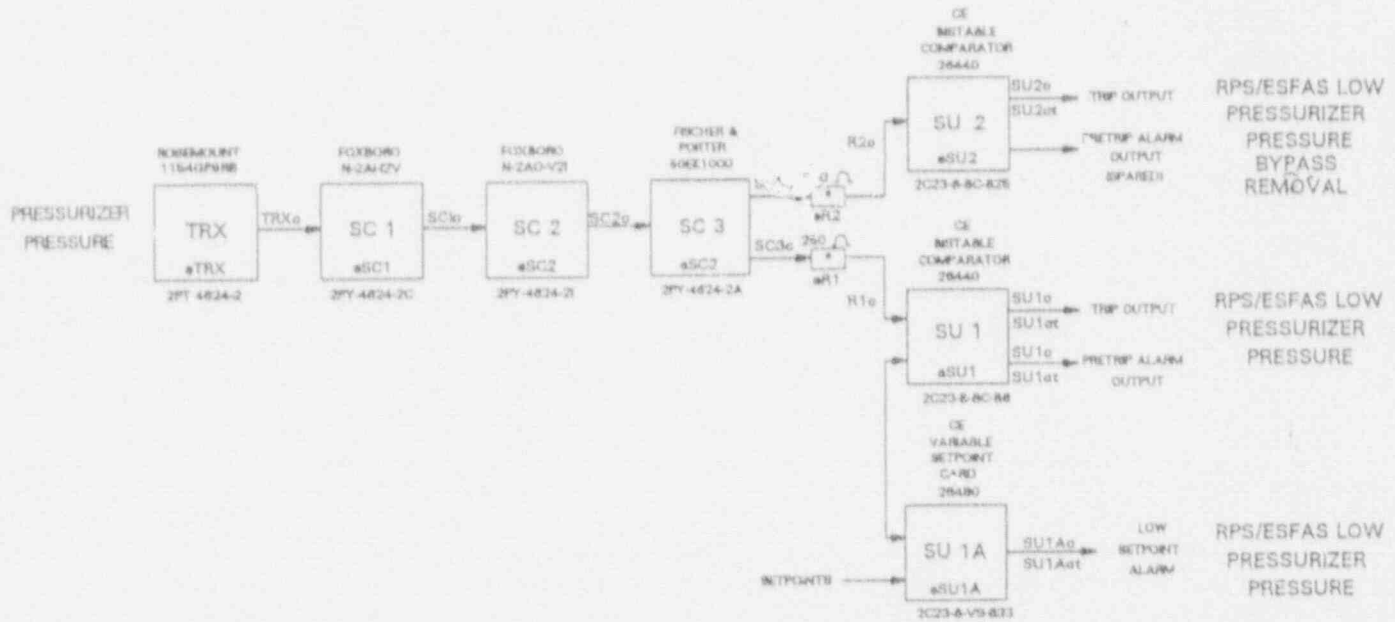
* - CURRENT DROPPING RESISTOR

Prepared by: REA Date: 9-3-92 Checked by: JCM Date: 9-3-92

FIGURE 4.2

PRESSURIZER PRESSURE BLOCK DIAGRAM

CHANNEL B



* - CURRENT DROPPING RESISTOR

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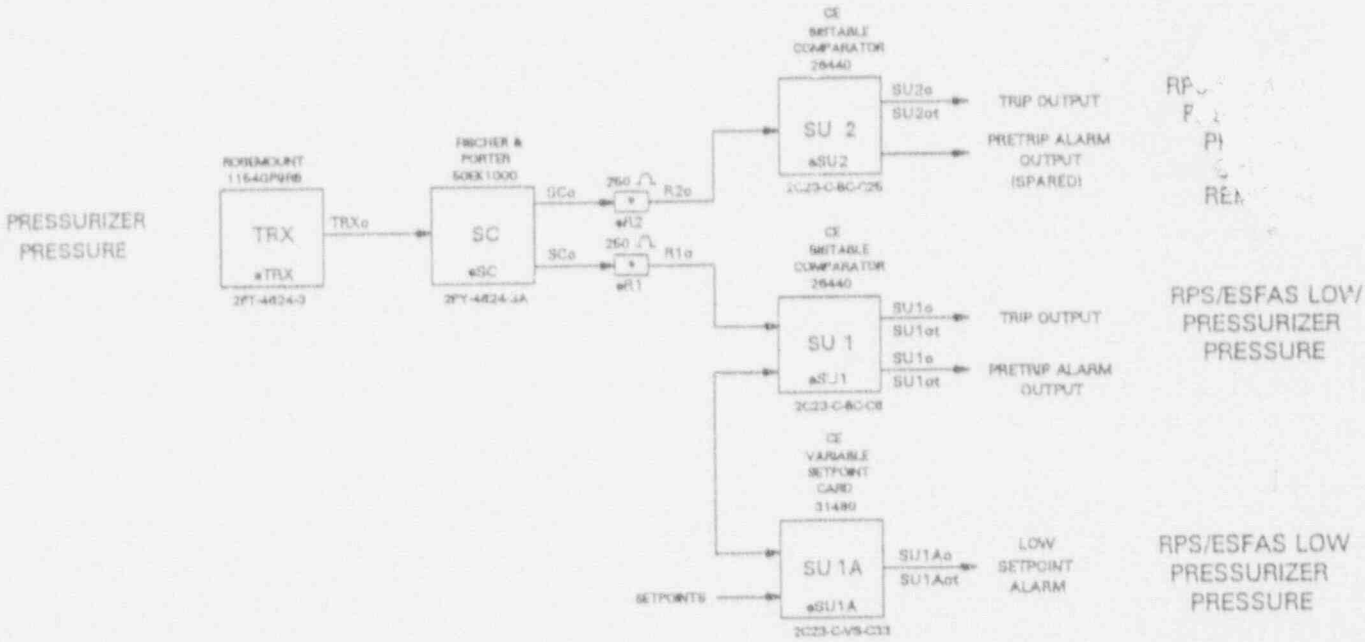
FIGURE 4.3

PRESSURIZER PRESSURE BLOCK DIAGRAM

CHANNEL C



* - CURRENT DROPPING RESISTOR

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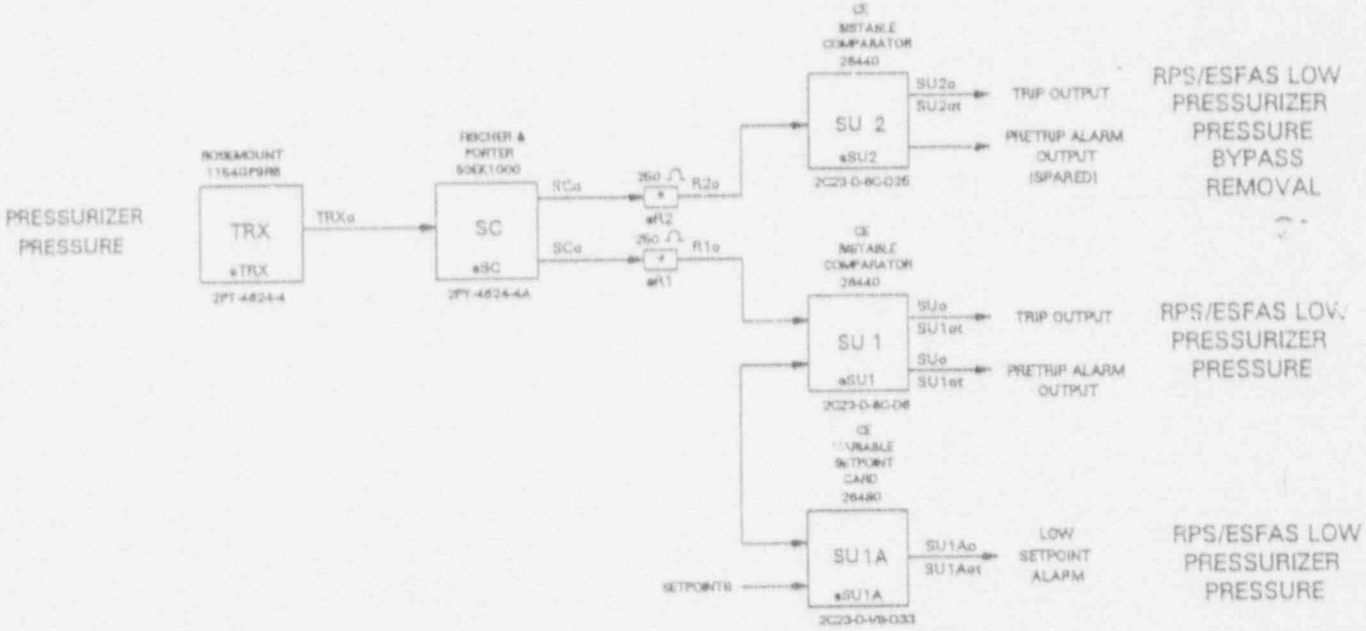
FIGURE 4.4

PRESSURIZER PRESSURE BLOCK DIAGRAM

CHANNEL D



* - CURRENT DROPPING RESISTOR

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4.1.3 Low Pressurizer Pressure Loop Error Calculation
4.1.3.1 Process Measurement

Two process measurement errors (PMEs) may influence this measurement:

1) sensing line head
2) containment ambient pressure

The water in the sensing line is assumed to normally be at containment ambient temperature. A change in temperature will result in a change in density of the water, thus, changing the static pressure seen by the transmitter at the high pressure port.

A gauge pressure transmitter is used for absolute pressure measurement. As containment ambient pressure varies from 0 PSIG, an error will be introduced. During an accident condition the transmitter's low pressure port, which is open to containment atmosphere, could sense a pressure of up to 53.4 PSIG per reference 6.38. Reference 6.34 takes credit for a High Containment Pressure trip at 6.0 PSIG to limit the containment enviroment to 250 deg F prior to reactor trip of SIAS or CCAS, the error associated with this calculation may be limited to a maximum of 6.0 PSI.

The bypass setpoint associated with this calculation is the only setpoint which considers ABN errors. Per reference 6.38, the PME error for abnormal (ABN) temperature is negligible. Therefore, ABN PME errors will have no affect upon the bypass setpoint and need not be considered further.

The Trip/Actuation setpoint associated with this calculation must consider ACC errors. The PME errors associated with this calculation cause errors in the negative direction. Since the Trip/Actuatuion setpoint is a "low" setpoint, only the positive errors are applicable. Therefore, ACC PME errors will have no affect upon the Trip/Actuation setpoint and need not be considered.

4.1.3.2 Low Pressurizer Pressure Transmitter

	COMPONENT ID					Source
Tag Number:	2PT-4624-1,2PT-4624-2,2PT-4624-3,2PT-4624-4					(6.22,6.37.b,6.37.g)
Model:	Rosemount 1154GP9RB					(6.22,6.37.f)
Range Limits:	0	to	3000	PSIG (URL = 3000 PSIG)		(6.20)
Calibrated Range:	0	to	3000	PSIA		(6.7)
Calibrated Span:			3000	PSI		(6.7)
Time Response:		0.2	sec			(6.20)

	PROCESS/ENVIRONMENTAL CONDITIONS			
Amb Cal Temp (AMB):	60	degF		(3.1.b)
Abn Amb Temp (ABN):	120	degF		(3.1.b)
Acc Amb Temp (ACC-LOCA):	200	degF	(LOCA/SBLOCA)	(3.13)
Acc Amb Temp (ACC-SLB):	250	degF	(SLB)	(3.13)
DT1 (ABN-AMB):	60	degF		
DT2 (ACC(LOCA)-AMB):	140	degF		
DT3 (ACC(SLB)-AMB):	190	degF		
Power Supply Voltage:	24	VDC		(6.7,6.36)
Power Supply Variance:	± 10.0%			(3.4)
(DV) :	± 2.4	VDC		
Max Voltage :	26.4	VDC		
Calibration Interval :	22.5	MONTHS	(18 months + 25% margin)	(3.3)
Acc Radiation :	3.3E+07	RAD		(6.37.a)

ERROR SUMMARY		ERROR % SPAN	ERROR PSI	
a. ACCURACY (RA):	±(0.25% SPAN)	± 0.250%	± 7.500	(6.20)
b. CALIBRATION (CAL): ±(2 TIMES MORE ACCURATE THAN INSTRUMENT)	±[(0.5RA)^2+(0.5RA)^2]^0.5 % SPAN	± 0.177%	± 5.303	(3.2,3.11)

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					ERROR % SPAN	ERROR PS	Source
c. DRIFT (DR):	±(0.20% URL FOR	30 MONTHS)		±	0.200% ±	6.000	(6.4)
d. POWER SUPPLY EFFECT (PS):	(Less than	0.005% SPAN/volt) 0.012% SPAN (NEGLIGIBLE)		±	0.000 ±	0.000	(6.20.3.12)
e. ABNORMAL TEMPERATURE EFFECT (TE):	±(0.75% URL +	0.50% SPAN)PER	100 degF	±	0.750% ±	22.500	(6.20)
f. ACCIDENT TEMPERATURE EFFECT (ATE-LOCA):	±(0.75% URL +	0.50% SPAN)PER	100 degF	±	1.750% ±	52.500	(6.20)
g. ACCIDENT TEMPERATURE EFFECT (ATE-SLB):	±(2.50% URL +	0.50% SPAN)		±	3.000% ±	90.000	(6.20)
h. ACCIDENT RADIATION EFFECT (ARE):		NEGLIGIBLE		±	0.000% ±	0.000	(3.16)

The transmitter error (eTRX) for Reference (REF), Abnormal (ABN) and Accident (ACC) conditions is given as follows:

REF eTRX =	± (RA + CAL)	±	0.427% ±	12.803
ABN eTRX =	± ((RA + CAL)^2 + DR^2 + PS^2 + TE^2)^0.5	±	0.886% ±	26.574
ACC (LOCA) eTRX =	± ((RA + CAL)^2 + DR^2 + PS^2 + ATE-LOCA^2 + ARE^2)^0.5	±	1.812% ±	54.371
ACC (SLB) eTRX =	± ((RA + CAL)^2 + DR^2 + PS^2 + ATE-SLB^2 + ARE^2)^0.5	±	3.037% ±	91.104

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The transmitter output error (TRXo) for Reference (REF), Abnormal (ABN) and Accident (ACC) conditions is given as follows:

			ERROR % SPAN		ERROR PSI	Source
REF TRXo =	±	REF eTRX	± 0.427%	±	12.803	
ABN TRXo =	±	ABN eTRX	± 0.886%	±	26.574	
ACC (LOCA) TRXo =	±	ACC (LOCA) eTRX	± 1.812		54.371	
ACC (SLB) TRXo =	±	ACC (SLB) eTRX	± 3.037%	±	91.104	

4.1.3.3 Insulation Resistance

The transmitter is located within the containment building, and as such the effects of a harsh environment on the loop signal cabling (i.e. cable, splices, penetrations, etc.) must be considered. The accident environment effects are considered for the cabling from the transmitter through the containment electrical penetrations.

The error attributed by the insulation resistance (IRb) for LOCA Accident (ACC) conditions (temp = 200°F) is given as follows: (3.13)

Channel A, C, D (200°F)							
IRb:	+	0.09% SPAN	+	0.090%	+	2.700	(6.11)
Channel B (200°F)							
IRb:	+	0.09% SPAN	+	0.090%	+	2.700	(6.11)

O(2)

The error attributed by the insulation resistance (IRb) for SLB Accident (ACC) conditions (temp = 250°F) is given as follows: (3.13)

Channel A, C, D (250°F)							
IRb:	+	0.15% SPAN	+	0.150%	+	4.500	(6.11)
Channel B (250°F)							
IRb:	+	0.15% SPAN	+	0.150%	+	4.500	(6.11)

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4.1.3.4 Pressurizer Pressure Signal Converter

	COMPONENT ID				Source
Tag Number:	2PY-4624-2C (Channel B only)				(6.22,6.37.b,6.37.g)
Model:	Foxboro N-2AI-I2V				(6.22,6.37.f)
Input Range:	4	to	20	mA	(6.7)
Output Range:	0	to	10	vdc	(6.7)
Time Response:	0.05 sec				(6.30)

	PROCESS/ENVIRONMENTAL CONDITIONS		
Amb Cal Temp (AMB):	60	degF	(3.1.c)
Abn Amb Temp (ABN):	105	degF	(6.24)
Acc Amb Temp (ACC):	105	degF	(6.24)
DT (ABN-AMB):	45	degF	
Power Supply Voltage:	+15 vdc and -15 vdc		(6.30)
Power Supply Variance:	± 0.166%		(3.14)

ERROR SUMMARY			ERROR % SPAN	ERROR PSI	
a. ACCURACY (RA):	±(0.25% SPAN)		± 0.250% ±	7.500	(6.36)
SETTING TOLERANCE (ST):	±(0.25% SPAN)		± 0.250% ±	7.500	(6.7)
DEVICE TOLERANCE (DTOL):	±((RA + ST)% SPAN)				
	±(0.50% SPAN)		± 0.500% ±	15.000	
b. CALIBRATION (CAL):					
±(2 TIMES MORE ACCURATE THAN INSTRUMENT)					
	±[(0.5 DTOL)^2+(0.5 DTOL)^2]^0.5	% SPAN	± 0.354% ±	10.607	(3.11,3.18)
c. DRIFT (DR):	± (DTOL)		± 0.500% ±	15.000	(3.19)

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4.1.3.4 Pressurizer Pressure Signal Converter

COMPONENT ID					Source
Tag Number:	2PY-4624-2C (Channel B only)				(6.22,6.37.b,6.37.g)
Model:	Foxboro N-2AI-I2V				(6.22,6.37.f)
Input Range:	4	to	20	mA	(6.7)
Output Range:	0	to	10	vdc	(6.7)
Time Response:		0.05 sec			(6.30)

PROCESS/ENVIRONMENTAL CONDITIONS			
Amb Cal Temp (AMB):	60	degF	(3.1.c)
Abn Amb Temp (ABN):	105	degF	(6.24)
Acc Amb Temp (ACC):	105	degF	(6.24)
DT (ABN-AMB):	45	degF	
Power Supply Voltage:	+15 vdc and -15 vdc		(6.36)
Power Supply Variance:	± 0.166%		(3.14)

ERROR SUMMARY			ERROR % SPAN	ERROR PSI	
a. ACCURACY (RA):	±(	0.25% SPAN)	± 0.250% ±	7.500	(6.36)
SETTING TOLERANCE (ST):	±(	0.25% SPAN)	± 0.250% ±	7.500	(6.7)
DEVICE TOLERANCE (DTOL):	±(	(RA + ST)% SPAN)			
	±(	0.50% SPAN)	± 0.500% ±	15.000	
b. CALIBRATION (CAL):					
±(2 TIMES MORE ACCURATE THAN INSTRUMENT)					
±[(0.5 DTOL)^2+(0.5 DTOL)^2]^0.5		% SPAN	± 0.354% ±	10.607	(3.11,3.18)
c. DRIFT (DR):	± (DTOL)		± 0.500% ±	15.000	(3.19)

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4.1.3.4 Pressurizer Pressure Signal Converter

COMPONENT ID					Source
Tag Number:	2PY-4624-2C (Channel B only)				(6.22,6.37.b,6.37.g)
Model:	Foxboro N-2AI-I2V				(6.22,6.37.f)
Input Range:	4	to	20	mA	(6.7)
Output Range:	0	to	10	vdc	(6.7)
Time Response:		0.05 sec			(6.30)

PROCESS/ENVIRONMENTAL CONDITIONS			
Amb Cal Temp (AMB):	60	degF	(3.1.c)
Abn Amb Temp (ABN):	105	degF	(6.24)
Acc Amb Temp (ACC):	105	degF	(6.24)
DT (ABN-AMB):	45	degF	
Power Supply Voltage:	+15 vdc and -15 vdc		(6.36)
Power Supply Variance:	± 0.166%		(3.14)

ERROR SUMMARY			ERROR % SPAN	ERROR PSI	
a. ACCURACY (RA):	±(0.25% SPAN)		± 0.250% ±	7.500	(6.36)
SETTING TOLERANCE (ST):	±(0.25% SPAN)		± 0.250% ±	7.500	(6.7)
DEVICE TOLERANCE (DTOL):	±((RA + ST)% SPAN)				
	±(0.50% SPAN)		± 0.500% ±	15.000	
b. CALIBRATION (CAL):					
±(2 TIMES MORE ACCURATE THAN INSTRUMENT)					
	±[(0.5 DTOL)^2+(0.5 DTOL)^2]^0.5	% SPAN	± 0.354% ±	10.607	(3.11,3.18)
c. DRIFT (DR):	± (DTOL)		± 0.500% ±	15.000	(3.19)

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d. POWER SUPPLY EFFECT (PS):	±(	0.20% SPAN) per	5.00%					
	±(	0.007% SPAN)	(NEGLIGIBLE)	±	0.000%	±	0.000	(6.36,3.12)
e. ABNORMAL TEMP. EFFECT (TE):								
Less than	±(	0.50% SPAN) per	50 degF	±	0.450%	±	13.500	(6.36)

The converter error (eSC1) is as follows:

		ERROR % SPAN		ERROR PSI	Source
REF eSC1 =	± (DTOL + CAL)	±	0.854%	± 25.607	
0(2) ABN eSC1 =	± ((DTOL + CAL)^2 + DR^2 + PS^2 + TE^2)^0.5	±	1.087%	± 32.603	
ACC eSC1 =	± ((DTOL + CAL)^2 + DR^2 + PS^2 + TE^2)^0.5	±	1.087%	± 32.603	

The output error term for the signal converter (SC1) is given as follows:

REF SC1o =	± (TRXo^2 + eSC1^2)^0.5	±	0.954%	± 28.629	
ABN SC1o =	± (TRXo^2 + eSC1^2)^0.5	±	1.402%	± 42.061	
ACC (LOCA) SC1o =	± (TRXo(LOCA)^2 + eSC1^2)^0.5	±	2.113%	± 63.397	
ACC (LOCA) SC1ob =	± IRb	+	0.090%	+ 2.700	
ACC (LOCA) SC1ot =	+ SC1o + SC1ob	+	2.203%	+ 66.097	
0(2)	- SC1o	-	2.113%	- 63.397	
ACC (SLB) SC1o =	± (TRXo(SLB)^2 + eSC1^2)^0.5	±	3.225%	± 96.762	
ACC (SLB) SC1ob =	± IRb	+	0.150%	+ 4.500	
ACC (SLB) SC1ot =	+ SC1o + SC1ob	+	3.375%	+ 101.262	
	- SC1o	-	3.225%	- 96.762	

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4.1.3.5 Pressurizer Pressure Signal Converter

	COMPONENT ID			Source
Tag Number:	2PY-4624-2I (Channel B only)			(6.22,6.37.b,6.37.g)
Model:	Foxboro N-2AO-V2I			(6.22,6.37.f)
Input Range:	0	to	10 vdc	(6.7)
Output Range:	4	to	20 mA	(6.7)
Time Response:		0.16 sec		(6.30)

	PROCESS/ENVIRONMENTAL CONDITIONS	
Amb Cal Temp (AMB):	60 degF	(3.1.c)
Abn Amb Temp (ABN):	105 degF	(6.24)
Acc Amb Temp (ACC):	105 degF	(6.24)
DT (ABN-AMB):	45 degF	
Power Supply Voltage:	+15 vdc and -15 vdc	(6.35)
Power Supply Variance:	± 0.166%	(3.14)

ERROR SUMMARY				ERROR % SPAN	ERROR PSI	
a. ACCURACY (RA):	±(0.50% SPAN)			± 0.500%	± 15.000	(6.35)
b. CALIBRATION (CAL): ±(2 TIMES MORE ACCURATE THAN INSTRUMENT) ±[(0.5 RA)^2+(0.5 RA)^2]^0.5		% SPAN		± 0.354%	± 10.6...	(3.11,3.2)
c. DRIFT (DR):	± (ACCURACY)			± 0.500%	± 15.000	(3.7)
d. POWER SUPLLY EFFECT (PS):	±(0.50% SPAN) per ±(0.017% SPAN)	5.00% (NEGLIGIBLE)		± 0.000%	± 0.000	(6.35,3.12)
e. ABNORMAL TEMP. EFFECT (TE): Less than	±(0.50% SPAN) per		50 degF	± 0.450%	± 13.500	(6.35)

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The converter error (eSC2) is as follows:

		ERROR % SPAN	ERROR PSI	Source
REF eSC2 =	± (RA + CAL)	± 0.854%	± 25.607	
ABN eSC2 =	± ((RA + CAL)^2 + DR^2 + PS^2 + TE^2)^0.5	± 1.087%	± 32.603	
ACC eSC2 =	± ((RA + CAL)^2 + DR^2 + PS^2 + TE^2)^0.5	± 1.087%	± 32.603	

The output error term for the signal converter (SC2) is given as follows:

REF SC2o =	± (SC1o^2 + eSC2^2)^0.5	± 1.280%	± 38.410	
ABN SC2o =	± (SC1o^2 + eSC2^2)^0.5	± 1.774%	± 53.217	
ACC (LOCA) SC2o =	± (SC1o(LOCA)^2 + eSC2^2)^0.5	± 2.376%	± 71.289	
ACC (LOCA) SC2ob =	± SC1ob	+ 0.090%	+ 2.700	
ACC (LOCA) SC2ot =	+ SC2o + SC2ob – SC2o	+ 2.466% – 2.376%	+ 73.989 – 71.289	
ACC (SLB) SC2o =	± (SC1o(SLB)^2 + eSC2^2)^0.5	± 3.404%	± 102.107	
ACC (SLB) SC2ob =	± SC1ob	+ 0.150%	+ 4.500	
ACC (SLB) SC2ot =	+ SC2o + SC2ob – SC2o	+ 3.554% – 3.404%	+ 106.607 – 102.107	

0(2)

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4.1.3.6 Pressurizer Pressure Signal Converter

	COMPONENT ID				Source
Tag Number:	2PY-4624-1A,2PY-4624-2A,2PY-4624-3A,2PY-4624-4A				(3.22,6.37.b,6.37.g)
Model:	Fischer & Porter 50EK1000				(6.22,6.37.f)
Input Range:	4	to	20	mA	(6.21,6.7)
Output Range:	4	to	20	mA	(6.21,6.7)
Time Response:	0.523 sec				(6.33)

	PROCESS/ENVIRONMENTAL CONDITIONS		
Amb Cal Temp (AMB):	60	degF	(3.1.c)
Abn Amb Temp (ABN):	105	degF	(6.24)
Acc Amb Temp (ACC):	105	degF	(6.24)
DT (ABN-AMB):	45	degF	
Line Voltage:	120	VAC	(6.37.b)
Line Volt. Variance:	± 10	VAC	(3.4)
(DV) :	± 8.3%		

ERROR SUMMARY			ERROR % SPAN	ERROR PSI	
a. ACCURACY (RA):	±(0.25% SPAN)		± 0.250% ±	7.500	(6.36)
SETTING TOLERANCE (ST):	±(0.25% SPAN)		± 0.250% ±	7.500	(3.20)
DEVICE TOLERANCE (DTOL):	±((RA + ST)% SPAN)				
	±(0.50% SPAN)		± 0.500% ±	15.000	
b. CALIBRATION (CAL):		(NONE)	± 0.000% ±	0.000	(3.5)
c. DRIFT (DR):	± (DTCL)		± 0.500% ±	15.000	(3.19)
d. TEMPERATURE EFFECT (TE):		(NONE)	± 0.000% ±	0.000	(3.15)
e. LINE VOLTAGE EFFECT (LV):		(NONE)	± 0.000% ±	0.000	(3.15)

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The converter error (eSC) is as follows:

			ERROR % SPAN	ERROR PSI	Source
REF eSC =	± (DTOL + CAL)	±	0.500% ±	15.000	
0(2) ABN eSC =	± ((DTOL + CAL)^2 + DR^2 + TE^2 + LV^2)^0.5	±	0.707% ±	21.213	
ACC eSC =	± ((DTOL + CAL)^2 + DR^2 + TE^2 + LV^2)^0.5	±	0.707% ±	21.213	

The output error term for the signal converter (SC) is given as follows for channels A,C and D:

REF SCo =	± (TRXo^2 + eSC^2)^0.5	±	0.657% ±	19.721	
ABN SCo =	± (TRXo^2 + eSC^2)^0.5	±	1.133% ±	34.003	
ACC (LOCA) SCo =	± (TRXo(LOCA)^2 + eSC^2)^0.5	±	1.945% ±	58.362	
ACC (LOCA) SCob =	± IRb	+	0.090% +	2.700	
ACC (LOCA) SCot =	+ SCo + SCob	+	2.035% +	61.062	
	- SCo	-	1.945% -	58.362	
0(2) ACC (SLB) SCo =	± (TRXo(SLB)^2 + eSC^2)^0.5	±	3.118% ±	93.541	
ACC (SLB) SCob =	± IRb	+	0.150% +	4.500	
ACC (SLB) SCot =	+ SCo + SCob	+	3.268% +	98.041	
	- SCo	-	3.118% -	93.541	

The output error term for the signal converter (SC3) is given as follows for channel B:

		ERROR % SPAN	ERROR PSI
REF SC3o =	± (SC2o^2 + eSC^2)^0.5	± 1.374%	± 41.235
ABN SC3o =	± (SC2o^2 + eSC^2)^0.5	± 1.910%	± 57.289
ACC (LOCA) SC3o =	± (SC2o(LOCA)^2 + eSC^2)^0.5	± 2.479%	± 74.378
ACC (LOCA) SC3ob =	± SC2ob	+ 0.090%	+ 2.700
ACC (LOCA) SC3ot =	+ SC3o + SC3ob	+ 2.569%	+ 77.078
	– SC3o	– 2.479%	– 74.378
ACC (SLB) SC3o =	± (SC2o(SLB)^2 + eSC^2)^0.5	± 3.476%	± 104.287
ACC (SLB) SC3ob =	± SC2ob	+ 0.150%	+ 4.500
ACC (SLB) SC3ot =	+ SC3o + SC3ob	+ 3.626%	+ 108.787
	– SC3o	– 3.476%	– 104.287

4.1.3.7 Pressurizer Pressure Resistors

									Source
			COMPONENT ID						
Type:	250 ohm Resistors								(5.22,6.37.b)
Input Range:	4	to	20	mA					(6.7)
Ouput Range:	1	to	5	vdc					(6.7)
			PROCESS/ENVIRONMENTAL CONDITIONS						
Amb Cal Temp (AMB):			60	degF =	15.6	degC			(3.1.c)
Abn Amb Temp (ABN):			105	degF =	40.6	degC			(6.24)
Acc Amb Temp (ACC):			105	degF =	40.6	degC			(6.24)
DT (ABN-AMB):			45	degF =	25	degC			
			ERROR SUMMARY				ERROR % SPAN	ERROR PSI	
a. Accurancy (RA):	±	0.10% SPAN					± 0.125%	± 3.750	(6.13)
b. Temp. Coeff. (TE):	±	3 ppm/degC							
		0.009% SPAN			(NEGLIGIBLE)		± 0.000%	± 0.000	(6.23,3.12)
c. Stability (DR):	±	35 ppm/year							
(22.5 months)		0.008% SPAN			(NEGLIGIBLE)		± 0.000%	± 0.000	(6.23,3.12)
The resistor error (eR) is as follows:									
REF eR =	± (RA)						± 0.125%	± 3.750	
ABN eR =	± (RA)						± 0.125%	± 3.750	
ACC eR =	± (RA)						± 0.125%	± 3.750	

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The output error term for the resistor (R1) after the signal converter is given as follows for channels A, C and D:

		ERROR % SPAN	ERROR PSI
REF R1o =	± (SCo^2 + eR^2)^0.5	± 0.669%	± 20.075
ABN R1o =	± (SCo^2 + eR^2)^0.5	± 1.140%	± 34.209
ACC (LOCA) R1o =	± (SCo(LOCA)^2 + eR^2)^0.5	± 1.949%	± 58.483
ACC (LOCA) R1ob =	+ SCob	+ 0.090%	+ 2.700
ACC (LOCA) R1ot =	+ R1o + R1ob	+ 2.039%	+ 61.183
	– R1o	– 1.949%	– 58.483
ACC (SLB) R1o =	± (SCo(SLB)^2 + eR^2)^0.5	± 3.121%	± 93.616
ACC (SLB) R1ob =	+ SCob	+ 0.150%	+ 4.500
ACC (SLB) R1ot =	+ R1o + R1ob	+ 3.271%	+ 98.116
	– R1o	– 3.121%	– 93.616

(R2)

The output error term for the resistor (R2) after the signal converter is given as follows for channels A, C and D:

		ERROR % SPAN	ERROR PSI
REF R2o =	± (SCo^2 + eR^2)^0.5	± 0.669%	± 20.075
ABN R2o =	± (SCo^2 + eR^2)^0.5	± 1.140%	± 34.209
ACC (LOCA) R2o =	± (SCo(LOCA)^2 + eR^2)^0.5	± 1.949%	± 58.483
ACC (LOCA) R2ob =	+ SCob	+ 0.090%	+ 2.700
ACC (LOCA) R2ot =	+ R2o + R2ob	+ 2.039%	+ 61.183
	– R2o	– 1.949%	– 58.483
ACC (SLB) R2o =	± (SCo(SLB)^2 + eR^2)^0.5	± 3.121%	± 93.616
ACC (SLB) R2ob =	+ SCob	+ 0.150%	+ 4.500
ACC (SLB) R2ot =	+ R2o + R2ob	+ 3.271%	+ 98.116
	– R2o	– 3.121%	– 93.616

0(2)

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The output error term for the resistor (R1) after the signal converter is given as follows for channel B:

		ERROR % SPAN	ERROR PSI
REF R1o =	± (SC3o^2 + eR^2)^0.5	± 1.380%	± 41.405
ABN R1o =	± (SC3o^2 + eR^2)^0.5	± 1.914%	± 57.412
ACC (LOCA) R1o =	± (SC3o(LOCA)^2 + eR^2)^0.5	± 2.482%	± 74.472
ACC (LOCA) R1ob =	+ SC3ob	+ 0.090%	+ 2.700
(0)(2) ACC (LOCA) R1ot =	+ R1o + R1ob	+ 2.572%	+ 77.172
	− R1o	− 2.482%	− 74.472
ACC (SLB) R1o =	± (SC3o(SLB)^2 + eR^2)^0.5	± 3.478%	± 104.355
ACC (SLB) R1ob =	+ SC3ob	+ 0.150%	+ 4.500
ACC (SLB) R1ot =	+ R1o + R1ob	+ 3.628%	+ 108.855
	− R1o	− 3.478%	− 104.355

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The output error term for the resistor (R2) after the signal converter is given as follows for channel B:

			ERROR % SPAN	ERROR PSI
REF R2o =	±	(SC3o^2 + eR^2)^0.5	± 1.380%	± 41.405
ABN R2o =	±	(SC3o^2 + eR^2)^0.5	± 1.914%	± 57.412
ACC (LOCA) R2o =	±	(SC3o(LOCA)^2 + eR^2)^0.5	± 2.482%	± 74.472
ACC (LOCA) R2ob =	+	SC3ob	+ 0.090%	+ 2.700
ACC (LOCA) R2ot =	+	R2o + R2ob	+ 2.572%	+ 77.172
	−	R2o	− 2.482%	− 74.472
ACC (SLB) R2o =	±	(SC3o(SLB)^2 + eR^2)^0.5	± 3.478%	± 104.355
ACC (SLB) R2ob =	+	SC3ob	+ 0.150%	+ 4.500
ACC (SLB) R2ot =	+	R2o + R2ob	+ 3.628%	+ 108.855
	−	R2o	− 3.478%	− 104.355

4.1.3.8 Presurizer Pressure Trip Bistable and Variable Setpoint Card

The low pressurizer pressure automatic bypass removal "trip" function is handled solely per a bistable card (SU2). The only output associated with the low pressurizer pressure automatic bypass removal is the "trip". Only the bistable card error (eSU) needs to be combined with the other loop errors when determining the total applicable output error (SU2ot).

The low pressurizer pressure "trip" and "pre-trip" functions are handled per a bistable card (SU1) and a variable setpoint card (SU1A). For the "trip" and "pre-trip" functions, the bistable and variable setpoint cards virtually function as a single card. All associated setpoints are set via the variable setpoint card. The variable setpoint card allows adjustment of the bistable "trip" and "pretrip" setpoints while providing additional setpoint adjustments such as the variable setpoint step increment adjustment, the minimum setpoint adjustment , and the low setpoint adjustment. The associated outputs from the respective cards are as follows:

SU1 Trip
SU1 Pre-Trip Alarm

SU1A Low Setpoint Alarm

The combination of both the bistable card errors (eSU) and the variable setpoint card errors (eSU1A) will be conservative for all associated outputs. To simplify the calculation effort, a single total output error term shall be determined that is applicable to outputs from both SU1 and SU1A. Therefore, both eSU and eSU1A shall be combined with the other loop when determining the total applicable output error (SU1/1Aot).

4.1.3.8.a Pressurizer Pressure Trip Bistable

	COMPONENT ID					Source
Tag Numbers:	2C23 A-BC-A6, 2C23 B-BC-B6, 2C23 C-BC-C6, 2C23 D-BC-D6					(6.22,6.37.f)
	2C23 A-BC-A25, 2C23 B-BC-B25, 2C23 C-BC-C25, 2C23 D-BC-D25					
Model:	CE Bistable Comparator Card 26440					(6.22,6.37.f)
Instrument Range:	0	to	3000	PSIA		(6.7)
Instrument Span:			3000	PSI		
Operating Range:	1	to	5	VDC		(6.7)
Full Range:	0	to	10	VDC		(6.18)
Conversion Factor:		750	psi/volt			
Time Response:		150	msec			(6.18)

ERROR SUMMARY				ERROR % SPAN		ERROR PSI	Source
a. ACCURACY (RA) (includes repeatability and resolution)	±	25	mV	± 0.625%	±	18.750	(6.18)
b. CALIBRATION (CAL)	±	12.50	mV	± 0.313%	±	9.375	(3.2)
c. DRIFT (DR): (39 days)	±	9.0	mV	± 0.225%	±	6.750	(6.18)
d. WORST CASE NORMAL TEMPERATURE EFFECT (± TE + TEb): (For a temperature shift of 20 degC)							
TE :	±	5.07	mV	± 0.127%	±	3.803	(6.18)
TEb :	+	1.52	mV	+ 0.038%	+	1.140	(6.18)

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The Bistable Comparator Card error (eSU) is as follows:

		ERROR % SPAN	ERROR PSI
REF eSU =	± (RA + CAL)	± 0.938%	± 28.125
ABN eSU =	± ((RA + CAL)^2 + DR^2 + TE^2)^0.5	± 0.972%	± 29.173
ABN eSUb =	(TEb)	+ 0.038%	+ 1.140
ACC eSU =	± ((RA + CAL)^2 + DR^2 + TE^2)^0.5	± 0.972%	± 29.173
ACC eSUb =	(TEb)	+ 0.038%	+ 1.140

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4.1.2.8.b Pressurizer Pressure Variable Setpoint Card

	COMPONENT ID				Source
Tag Numbers:	2C23 A-VS-A33, 2C23 B-VS-B33, 2C23 C-VS-C33, 2C23 D-VS-D33				(6.22,6.37.f)
Model:	CE Variable Setpoint Card 26480, 31480 (channel C)				(6.22,6.37.f)
Instrument Range:	0	to	3000	PSIA	(6.7)
Instrument Span:			3000	PSI	
Operating Range:	1	to	5	VDC	(6.7)
Full Range:	0	to	10	VDC	(6.18)
Conversion Factor:		750	psi/volt		

ERROR SUMMARY				ERROR % SPAN	ERROR PSI	
a. ACCURACY (RA) (includes repeatability and resolution)	±	25	mV	± 0.625%	± 18.750	(6.18)
b. CALIBRATION (CAL)	±	12.50	mV	± 0.313%	± 9.375	(3.2)
c. DRIFT (DR): (39 days)	±	9.0	mV	± 0.225%	± 6.750	(6.18)
d. WORST CASE NORMAL TEMPERATURE EFFECT (± TE + TEb): (For a temperature shift of 20 degC)						
TE :	±	5.82	mV	± 0.146%	± 4.365	(6.18,3.17)
TEb :	+	3.38	mV	+ 0.085%	+ 2.535	(6.18,3.17)

The Variable Setpoint Card error (eSU1A) is as follows:

REF eSU1A =	± (RA + CAL)	±	0.938%	± 28.125
ABN eSU1A =	± ((RA + CAL)^2 + DR^2 + TE^2)^0.5	±	0.975%	± 29.251
ABN eSU1Ab =	(TEb)	+	0.085%	+ 2.535
ACC eSU1A =	± ((RA + CAL)^2 + DR^2 + TE^2)^0.5	±	0.975%	± 29.251
ACC eSU1Ab =	(TEb)	+	0.085%	+ 2.535

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4.1.3.8.c Total Output Error Determination

SU2 Output Errors

The output error term for the bistable card (SU2) for Channels A, C and D is given as follows:

			ERROR % SPAN	ERROR PSI
REF SU2o =	± (R2o^2 + eSU^2)^0.5	±	1.152% ±	34.554
ABN SU2o =	± (R2o^2 + eSU^2)^0.5	±	1.499% ±	44.959
ABN SU2ob =	(eSUb)	+	0.038% +	1.140
ABN SU2ot =	+ SU2o + SU2ob – SU2o	+ –	1.537% + 1.499% –	46.099 44.959
ACC (LOCA) SU2o =	± (R2o(LOCA)^2 + eSU^2)^0.5	±	2.178% ±	65.355
ACC (LOCA) SU2ob =	(R2ob + eSUb)	+	0.128% +	3.840
ACC (LOCA) SU2ot =	+ SU2o + SU2ob – SU2o	+ –	2.306% + 2.178% –	69.195 65.355
ACC (SLB) SU2o =	± (R2o(SLB)^2 + eSU^2)^0.5	±	3.269% ±	98.056
ACC (SLB) SU2ob =	(R2ob + eSUb)	+	0.188% +	5.640
ACC (SLB) SU2ot =	+ SU2o + SU2ob – SU2o	+ –	3.457% + 3.269% –	103.696 98.056

The output error term for the bistable card (SU2) for Channel B is given as follows:

			ERROR % SPAN	ERROR PSI
REF SU2o =	±	(R2o^2 + eSU^2)^0.5	± 1.668%	± 50.054
ABN SU2o =	±	(R2o^2 + eSU^2)^0.5	± 2.147%	± 64.399
ABN SU2ob =		(eSUb)	+ 0.038%	+ 1.140
ABN SU2ot =	+	SU2o + SU2ob	+ 2.185%	+ 65.539
	−	SU2o	− 2.147%	− 64.399
ACC (LOCA) SU2o =	±	(R2o(LOCA)^2 + eSU^2)^0.5	± 2.666%	± 79.982
ACC (LOCA) SU2ob =		(R2ob + eSUb)	+ 0.128%	+ 3.840
ACC (LOCA) SU2ot =	+	SU2o + SU2ob	+ 2.794%	+ 83.822
	−	SU2o	− 2.666%	− 79.982
ACC (SLB) SU2o =	±	(R2o(SLB)^2 + eSU^2)^0.5	± 3.612%	± 108.356
ACC (SLB) SU2ob =		(R2ob + eSUb)	+ 0.188%	+ 5.640
ACC (SLB) SU2ot =	+	SU2o + SU2ob	+ 3.800%	+ 113.996
	−	SU2o	− 3.612%	− 108.356

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SU1/1A Output Errors

PERIODIC TEST ERROR =
± (SU(RA)^2 + SU(DR)^2 + SU(CAL)^2 + SU1A(RA)^2 + SU1A(DR)^2 + SU1A(CAL)^2)^0.5 ± 1.038% ± 31.145

The output error term for the bistable card/variable setpoint card (SU1/1A) for Channels A, C and D is given as follows:		ERROR % SPAN	ERROR PSI
REF SU1/1Ao =	± (R1o^2 + eSU^2 + eSU1A^2)^0.5	± 1.485%	± 44.554
ABN SU1/1Ao =	± (R1o^2 + eSU^2 + eSU1A^2)^0.5	± 1.788%	± 53.637
ABN SU1/1Aob =	(eSUb + eSU1Ab)	+ 0.123%	+ 3.675
ABN SU1/1Aot =	+ SU1/1Ao + SU1/1Aob	+ 1.910%	+ 57.312
	- SU1/1Ao	- 1.788%	- 53.637
ACC (LOCA) SU1/1Ao =	± (R1o(LOCA)^2 + eSU^2 + eSU1A^2)^0.5	± 2.387%	± 71.602
ACC (LOCA) SU1/1Aob =	(R1ob + eSUb + eSU1Ab)	+ 0.213%	+ 6.375
ACC (LOCA) SU1/1Aot =	+ SU1/1Ao + SU1/1Aob	+ 2.599%	+ 77.977
	- SU1/1Ao	- 2.387%	- 71.602
ACC (SLB) SU1/1Ao =	± (R1o(SLB)^2 + eSU^2 +eSU1A^2)^0.5	± 3.411%	± 102.326
ACC (SLB) SU1/1Aob =	(R1ob + eSUb + eSU1Ab)	+ 0.273%	+ 8.175
ACC (SLB) SU1/1Aot =	+ SU1/1Ao + SU1/1Aob	+ 3.683%	+ 110.501
	- SU1/1Ao	- 3.411%	- 102.326

The output error term for the bistable card/variable setpoint card (SU1/1A) for Channel B is given as follows:

			ERROR % SPAN		ERROR PSI
REF SU1/1Ao =	±	(R1o^2 + eSU^2 + eSU1A^2)^0.5	±	1.914% ±	57.414
ABN SU1/1Ao =	±	(R1o^2 + eSU^2 + eSU1A^2)^0.5	±	2.358% ±	70.730
ABN SU1/1Aob =		(eSUb + eSU1Ab)	+	0.123% +	3.675
ABN SU1/1Aot =	+	SU1/1Ao + SU1/1Aob	+	2.480% +	74.405
	−	SU1/1Ao	−	2.358% −	70.730
ACC (LOCA) SU1/1Ao =	±	(R1o(LOCA)^2 + eSU^2 + eSU1A^2)^0.5	±	2.839% ±	85.163
ACC (LOCA) SU1/1Aob =		(R1ob + eSUb + eSU1Ab)	+	0.213% +	6.375
ACC (LOCA) SU1/1Aot =	+	SU1/1Ao + SU1/1Aob	+	3.051% +	91.538
	−	SU1/1Ao	−	2.839% −	85.163
ACC (SLB) SU1/1Ao =	±	(R1o(SLB)^2 + eSU^2 +eSU1A^2)^0.5	±	3.741% ±	112.234
ACC (SLB) SU1/1Aob =		(R1ob + eSUb + eSU1Ab)	+	0.273% +	8.175
ACC (SLB) SU1/1Aot =	+	SU1/1Ao + SU1/1Aob	+	4.014% +	120.409
	−	SU1/1Ao	−	3.741% −	112.234

Preparer: EEA Date: 9-3-92 Checker: JCM Date: 9-3-92

4.1.4 Calculated Trip Setpoints and Allowable Values

The limiting safety analysis setpoints for the Low Pressurizer Pressure are: a reactor trip and safety injection actuation at 1625 psia for the Small Break LOCA event; containment cooling and safety injection actuation at 1578 psia for the LOCA, Steam Line Break, Steam Bypass Malfunction and Steam Generator Tube Rupture events. These setpoints are taken from references 6.39 and 6.19.

4.1.4.1 Trip/Actuation Setpoint

The largest channel errors, which are associated with channel B, are utilized in the following analysis.

SU1 Trip/Actuation Setpoint = RPS/SIAS Analysis Setpoint + ACC(LOCA) SU1/1Aot
= 1625.0 PSIA + 91.6 PSI
= 1716.6 PSIA

SU1 Trip/Actuation Setpoint = SIAS/CCAS Analysis Setpoint + ACC(SLB) SU1/1Aot
= 1578.0 PSIA + 120.5 PSI
= 1698.5 PSIA

The most limiting (i.e. highest) of the above setpoints is used:

SU1 Trip/Actuation Setpoint = MAX[RPS/SIAS Setpoint, SIAS/CCAS Setpoint]
= 1716.6 PSIA

Revision 0 of this calculation determined an SU1 Trip/Actuation Setpoint of 1717.4 PSIA. Subsequently, a Technical Specifications change request was submitted based on the 1717.4 PSIA setpoint value. Since the setpoint value calculated per revision 0 is still more conservative than the setpoint value calculated per this calculation revision (Rev. 0(2)), the originally calculated value of 1717.4 PSIA shall be retained. Thus, this calculation revision establishes a conservative setpoint margin of 0.8 PSI (1717.4–1716.6). The actual SU1 Trip/Actuation Setpoint is established as given below:

SU1 Trip/Actuation Setpoint = 1717.4 PSIA

4.1.4.2 Allowable Values

SU1 Allowable Value	=	SU1 Setpoint – SU1 PTE	
	=	1717.4 PSIA	-31.1 PSI
	=	1686.3 PSIA	

4.1.4.3 Alarm Setpoints

There are no safety analysis requirements for the pretrip (alarm) setpoints, therefore the following values may be changed as required.

SU1 Alarm Setpoint	=	SU1 Trip Setpoint + ABN SU1/1Aot	
	=	1717.4 PSIA +	74.5 PSI
	=	1791.9 PSIA	

The current pretrip (alarm) setpoint from reference 6.26, will be retained and is given as follows:

SU1 Alarm Setpoint	=	1803.75 PSIA

4.1.4.4 Bypass Setpoints

The Pressurizer Pressure function is required for automatic bypass removal of the safety injection and containment recirculation ESFAS functions. The Bypass Removal Anaylsis Setpoint is a nominal value based on insuring that the bypass is removed when going from Mode 5 to Mode 4 operation.

Bypass Removal Setpoint	=	Bypass Removal Analysis Setpoint
	=	500 PSIA

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4.1.4.5 Variable Setpoint Step Increment

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As discussed in 4.1.1, the variable Setpoint Step Increment is a nominal value based on engineering judgement and operating experience at CE plants.

Variable Setpoint Step Increment = 200 PSI

4.1.4.6 Variable Setpoint Minimum

The variable Setpoint Minimum is a nominal value based on engineering judgement and CE operating experience.

Variable Setpoint Minimum = 100 PSIA

4.1.4.7 Low Setpoint Alarm

The variable Setpoint card provides an alarm if the setpoint falls below pressurizer pressure by a set value. This value may be set as required by the field. The current value from Reference 6.26 is:

Low Setpoint Alarm = 588.75 PSI

4.1.5 Voltage Equivalents for Trip Setpoints and Allowable Values

The PPS Cabinet input ranges from 1 to 5 volts.
This is equivalent to a process range of 0 to 3000 PSIA
Based on these endpoints the following equation be derived:

V(PSIA) = (PSIA / 750.00) + 1.00
V(PSI) = (PSI / 750.00)

		Value		Voltage	
Trip Setpoints					
	SU1	1717.4	PSIA	3.290	volts
Allowable Values					
	SU1	1686.3	PSIA	3.249	volts
Pretrip Setpoints					
	SU1	1803.75	PSIA	3.405	volts
Bypass Setpoints					
	SU2	500	PSIA	1.666	volts
Setpoint Step Increment		200	PSI	0.266	volts
Variable Setpoint Minimum		100	PSIA	1.134	volts
Low Setpoint Alarm		588.75	PSI	0.785	volts

4.1.6 Measurement Channel Response Times

	SU1 (RPS)	SU1 (ESFAS)	Source
Rosemount Transmitter:	0.200 sec.	0.200 sec.	
I/V Converter:	0.050 sec.	0.050 sec.	
V/I Converter:	0.160 sec.	0.160 sec.	
I/I Converter:	0.523 sec.	0.523 sec.	
PPS Cabinet Bistable:	0.150 sec.	0.150 sec.	
Reactor Trip Switch Gear:	0.100 sec.	N/A	(6.29)
ESFAS Relay Cabinet Delay Time:	N/A	0.020 sec.	(6.29)
Total Channel Response Time:	1.183 sec.	1.103 sec.	

The RPS Channel Delay Time is the 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. The ESF Channel Delay Time is the 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 changes state. The ESF response time provided does not include the actuated components (e.g. pumps, valves, etc.). See ANO-2 Technical Specification Tables 3.3-2 and 3.3-5.

The expected RPS Channel Delay Time for SU1 exceeds the 0.9 second response time, from ANO-2 Technical Specification,Table 3.3-2, however it is less than the 1.2 second response time required by the safety analysis (Reference 6.39). Based on previous operating experience it is expected that the RPS channel will continue to pass the 0.9 second response time test. Previous surveillance testing has proven that the response time for all channels is less than the Technical Specification requirement. Future required surveillance testing will ensure that the Technical Specification required response time will continue to be met.

The expected ESFAS Channel Delay Time for SU1 is not significant compared to the 30 second response time (including sequence loading delays) of ANO-2 Technical Specification, Table 3.3-5.

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5.0 Conclusion – Low Pressurizer Pressure:

The most conservative channel (B) loop errors for instrument loop numbers 2PT-4624-1, 2PT-4624-2, 2PT-4642-3 and 2PT-4624-4 are given below. The negative ABN and ACC errors do not account for the process measurement errors (see Section 4.1.3.1) since they do not affect the setpoints associated with this calculation.

		% SPAN		PSI
REF SU1/1Aot =	±	1.914%	±	57.414
ABN SU1/1Aot =	+	2.480%	+	74.405
	-	2.358%	-	70.730
ACC (LOCA) SU1/1Aot =	+	3.051%	+	91.538
	-	2.839%	-	85.163
ACC (SLB) SU1/1Aot =	+	4.014%	+	120.409
	-	3.741%	-	112.234
REF SU2o =	±	1.668%	±	50.054
ABN SU2ot =	+	2.185%	+	65.539
	-	2.147%	-	64.399
ACC (LOCA) SU2ot =	+	2.794%	+	83.822
	-	2.666%	-	79.982
ACC (SLB) SU2ot =	+	3.800%	+	113.996
	-	3.612%	-	108.356

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The setpoint for these instrument loops is:

SU1 1717.4 PSIA 3.290 VOLTS

The allowable value for these instrument loops is:

SU1 1686.3 PSIA 3.249 VOLTS

The pretrip setpoint for these instrument loops is:

SU1 1803.75 PSIA 3.405 VOLTS

The bypass setpoint for these instrument loops is:

SU2 500.0 PSIA 1.666 VOLTS

The variable setpoint step increment for these instrument loops is:

SU2 200.0 PSI 0.266 VOLTS

The variable setpoint minimum for these instrument loops is:

SU2 100.0 PSIA 1.134 VOLTS

The low setpoint alarm for these instrument loops is:

SU2 588.8 PSI 0.785 VOLTS

The response time for these instrument loops is:

SU1 1.183 sec. (RPS)

SU1 1.103 sec. (ESFAS)

Preparer: RGA Date: 9-3-92 Checker: Jcm Date: 9-3-92

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Prepared by: REA Date: 9-3-92 Checked by: JCM Date: 9-3-92

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Prepared by: REA Date: 9-3-92 Checked by: JCM Date: 9-3-92

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Prepared by: RSA Date: 9-3-92 Checked by: Jcm Date: 9-3-92

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Prepared by: CEA Date: 9-3-92 Checked by: JCM Date: 9-3-92

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f) sIMS Component List

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Prepared by: REA Date: 9-3-92 Checked by: JCM Date: 9-3-92