Omaha Public Power District

Fort Calhoun Station
P.O. Box 550, Highway 75
Fort Calhoun, NE 68023-0550

December 22, 2003
LIC-03-0166

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

References:
1. Docket No. 50-285
2. Letter from OPPD (S. K. Gambhir) to NRC (Document Control Desk) dated August 28, 2003, Fort Calhoun Station (FCS) Unit No. 1 License Amendment Request, "Measurement Uncertainty Recapture Power Uprate" (LIC-03-0122)
3. Letter from NRC (A. B. Wang) to OPPD (R. T. Ridenoure) dated October 14, 2003, "Fort Calhoun Station Unit No. 1 – Measurement Uncertainty Recapture Power Uprate" (TAC No. MC0029) (NRC-03-198)
4. Letter from OPPD (S. K. Gambhir) to NRC (Document Control Desk) dated October 21, 2003, Response to Request for Additional Information - Measurement Uncertainty Recapture Power Uprate (LIC-03-0148)
5. Letter from OPPD (S. K. Gambhir) to NRC (Document Control Desk) dated December 15, 2003, Response to Additional Request for Information - Measurement Uncertainty Recapture Power Uprate (LIC-03-0164)

SUBJECT: Response to Additional Request for Information - Measurement Uncertainty Recapture Power Uprate (TAC No. MC0029)

On December 5, 2003, a telephone call between NRC/NRR staff members and Omaha Public Power District (OPPD) resulted in an additional request for information concerning instrument setpoint methodology. This request and the OPPD response were included in the Reference 5 letter.

During a telephone call on December 19, 2003, Mr. Alan Wang of the NRC/NRR staff requested that OPPD formally provide the calculation used as an example in previous discussions of setpoint methodology. Accordingly, attached is Calculation #FC05722, *Low Steam Generator Pressure Trip Setpoint Calculation.*

A001

Please contact T. C. Matthews at (402) 533-6938 if you require additional information.

I declare under penalty of perjury that the forgoing is true and correct. (Executed on December 22, 2003) No commitments to the NRC are made in this letter.

Sincerely,

R. T. Ridenoure
Vice President

TCM/tcm

Attachment

c: B. S. Mallett, Regional Administrator, NRC Region IV
A. B. Wang, NRC Project Manager
J. G. Kramer, NRC Senior Resident Inspector
Division Administrator - Public Health Assurance, State of Nebraska

LIC-03-0166
Attachment

FC05722
Low Steam Generator Pressure Trip Setpoint Calculation

CALCULATION COVER SHEET

Calculation Preparation, Review and Approval Form PED-QP-3.1 Form Page No. 1 of 2 Calculation Cover Sheet •SHORT TERM CALC: YES ☐ NO ☒	CALCULATION NUMBER: • EC05722	Calc. Page No. 1 •TOTAL PAGES ~~153~~ 51 QA Category: ☒ CQE ☐ LIMITED CQE ☐ FIRE PROT. ☐ NON CQE •FILE NO. PED DEPARTMENT DEN-Elec/I&C

CALCULATION TITLE	VENDOR CALC.NO.
LOW STEAM GENERATOR PRESSURE TRIP SETPOINT CALCULATION	☐ MR NO. ☐ ENGR. ANALYSIS ☐ DBD NO. ☐ ECN NO. ☒ OTHER Setpoint Program

•APPROVALS - SIGNATURE & DATE

PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)	•REV.NO.	SUPERSEDES •CALC NO.	CONFIRMATION •REQUIRED (✓) YES	NO
C McNall 7/1/92	John C Odom 7/6/92	John C Odom 7/6/92	Ø			✓
John C Odom 3/29/99 DJ Rosloniec 6/28/99	Ebrahim Nasseri 6-28-99	Ebrahim Nasseri 6-28-99	1			

•EXTERNAL ORGANIZATION DISTRIBUTION

NAME & LOCATION	COPY SENT (✓)	NAME & LOCATION	COPY SENT (✓)

CALCULATION COVER SHEET

Calculation Preparation, Review and Approval Form PED-QP-3.1 Form Page No. 2 of 2 Calculation Cover Sheet	CALCULATION NUMBER FC05722 FACILITY/SYSTEM KEYWORD °	Calc.Page No. 2

CALCULATIONS USED AS INPUT IN THE ANALYSIS		EQUIPMENT TAGS		
CALC./REV.NO.	DEPT.NO.°	SYSTEM	ADDED	DELETED
		MS	A/PT-902	
		↓	B/PT-902	
			C/PT-902	
			D/PT-902	
			A/PT-905	
			B/PT-905	
			C/PT-905	
			D/PT-905	

CALCULATION REVISION SHEET

Rev. #	Description/Reason for Change
0	Initial revision
1	The component of instrument uncertainty associated with measurement and test equipment (M&TE) was revised to include the effect of temperature changes on M&TE performance. Additionally, all attachments were eliminated from the calculation since they were draft copies of the main calculation.

Calculation No. FC05722

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CALCULATION AFFECTED DOCUMENTS

The Calculation Preparer is to identify documents affected by this Calculation. Markups are to be provided in an Attachment to the Calculation except those noted with an *. Changes not involving procedures should follow the associated change process. The preparer is to indicate below how the Calculation is to be processed by Document Control.

	Not Required, Calculation supports MR-FC- - or is used to support EA-FC- - this form can be signed off by the Calculation Preparer. Calculation "As Built" follows direction given for modifications.
	Modification or ECN, FLC, Preapproved NRC commitment change, or Condition Report need identified. Calculation is closed on receipt of the completed PED-QP-3.8 form.
	Change to a DBD, USAR, etc., without a change to plant procedures identified. Calculation is "As Built" on receipt of the completed PED-QP-3.8 form.
	Change to a DBD, USAR, etc., and plant procedures (no hardware) identified. Calculation is "As Built" on receipt of the completed PED-QP-3.8 form.
✓	No document changes or other changes are required. Calculation "As Built" on receipt of the completed PED-QP-3.8 form.

NOTE: Markups are to include any inputs or assumptions which define plant configuration and/or operating practices that must be implemented to make the results of the Calculation valid. The Calculation may provide the basis for a 10CFR50.59 analysis or substantiate a 10CFR50.59 analysis.

Affected Documents		
Document Type	Document Number (N/A = not applicable)	Procedure Change No., FLC No., etc.
Emergency Operating Procedure*	N/A	
Abnormal Operating Procedure*	N/A	
Annunciator Response Procedure	N/A	
Technical Data Book	N/A	
Surveillance Test Procedure	N/A	
Calibration Procedure	N/A	

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Affected Documents		
Document Type	Document Number (N/A = not applicable)	Procedure Change No., FLC No., etc.
Operating Procedure	N/A	
Maintenance Procedure	N/A	
PM Procedure	N/A	
EP/EPIP/RERP*	N/A	
Security Procedures * (Safeguards)*	N/A	
Operating Instructions	N/A	
System Training Manuals	N/A	
Technical Specification*	N/A	
USAR	N/A	
Licensing Commitments	N/A	
Standing Order	N/A	
Security Plan (Safeguards)	N/A	
CQE List	N/A	
Vendor Manual Changes	N/A	
Design Basis Documents	N/A	
Equipment Database	N/A	
Oil Spill Prevention, Control and Countermeasure (SPCC) Plan	N/A	
EEQ Manual	N/A	
SE-PM-EX-0600	N/A	
Updated Fire Hazard Analysis	N/A	
EPIX	N/A	
Electrical Load Distribution Listing (ELDL)	N/A	

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Affected Documents		
Document Type	Document Number (N/A = not applicable)	Procedure Change No., FLC No., etc.
Station Equipment Labeling	N/A	
Engineering Analysis	N/A	
Calculations	N/A	
Drawing Number	N/A	
Drawing Number	N/A	
Other	N/A	

Completed by Owner (if Plant Procedure Changes Required or N/A): **N/A**	Date: 6/28/99
Completed by Preparer: D J Koslosec	Date: 6/28/99

CALCULATION PREPARATION, REVIEW AND APPROVAL FORM PED-QP-3.3 PRODUCTION ENGINEERING CALCULATION SUMMARY SHEET	CALCULATION NO. FC05722
	REV. NO. 1

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1.0 PURPOSE

1.1 To determine the uncertainty of the Low Steam Generator Pressure instrument loop based upon recommended changes to the calibration procedures and M&TE calibration practices and evaluate the following:

1.1.1 Loop error impact on setpoint design margin

1.1.2 Loop measurement accuracy

1.1.3 Adequacy of setpoint value selection

1.1.4 Values to be used for Setting Tolerance, and Measurement and Test Equipment accuracy in the surveillance test procedures and in calibrating the Measurement and Test Equipment for these same procedures

1.1.5 Values to be used for determining loop operability during the calibration cycle and the functional testing cycle.

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2.0 SCOPE

2.1 This calculation is performed as a bounding calculation based upon recommended changes to the current surveillance procedure practices. Since the surveillance procedures, calibration devices, and device tolerances should be identical for all divisions of a loop function, this calculation applies to the following instrument loops:

Instrument loop No.	Function
A/902	Low Steam Generator Pressure (RC-2A)
B/902	Low Steam Generator Pressure (RC-2A)
C/902	Low Steam Generator Pressure (RC-2A)
D/902	Low Steam Generator Pressure (RC-2A)
A/905	Low Steam Generator Pressure (RC-2B)
B/905	Low Steam Generator Pressure (RC-2B)
C/905	Low Steam Generator Pressure (RC-2B)
D/905	Low Steam Generator Pressure (RC-2B)

2.2 This calculation applies to margin verification for normal operating conditions and excludes error attributed to accident environmental conditions.

2.3 Loop A/902 was selected as the bounding loop for this calculation since the environmental parameters, loop devices, calibration procedures, and mode of operation appeared to be identical for all of the 902 loops. A bounding Nominal Trip Setpoint, Allowable Value and Rack Allowance are desirable, to simplify calibration and to ensure a consistent application of the principles of loop operability.

2.4 The Omaha Public Power District (OPPD) Setpoint Methodology (Ref. 10.19) assumes that the transient time for "turning" the process variable, including loop response time, has been considered in the plant safety analysis. Therefore, no consideration of response time errors will be considered in this calculation.

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3.0 INTRODUCTION

The 902 and 905 loops have multiple output signals including bistables and indicators. This calculation will only cover the signal to the RPS trip units for Low Steam Generator Pressure. (Ref. 10.3)

The Low Steam Generator trip signal is provided by the narrow range steam generator pressure channels PT 902 A/B/C/D (RC-2A) AND PT 905 A/B/C/D (RC-2B). The signal is proportional to steam generator pressure with a range of 0-1000 psia. A pressure transmitter from each steam generator inputs to an auctioneer (TM/LP Calculator) that selects the lower of the two pressure signals and provides a pressure signal to TU-6. The setpoint is designed to protect the steam generators from excessive rate of heat extraction and subsequently a cooldown of the reactor coolant. The present Analytical Limit for Low Steam Generator Pressure is >478 PSIA, the current Technical Specification Requirement is ≥ 500 PSIA, and the current plant settings (based upon the 1990 refueling outage calibrations) is between 506 and 507 PSIA. (Reference 10.3 and 10.7.a)

This calculation determines the error that could exist in the Low Steam Generator pressure loop function based upon recommended changes to the surveillance test procedure and to the M&TE calibration practices. This calculation is based upon the tolerance changes recommended in the Conclusions section of this calculation. This calculation does not represent the current error of any loop but the maximum error which could be obtained using the procedures with the recommended changes. Because worst case loop errors are used, and tabulated in Section 8.0, this is a bounding calculation for the Low Steam Generator Pressure trip function.

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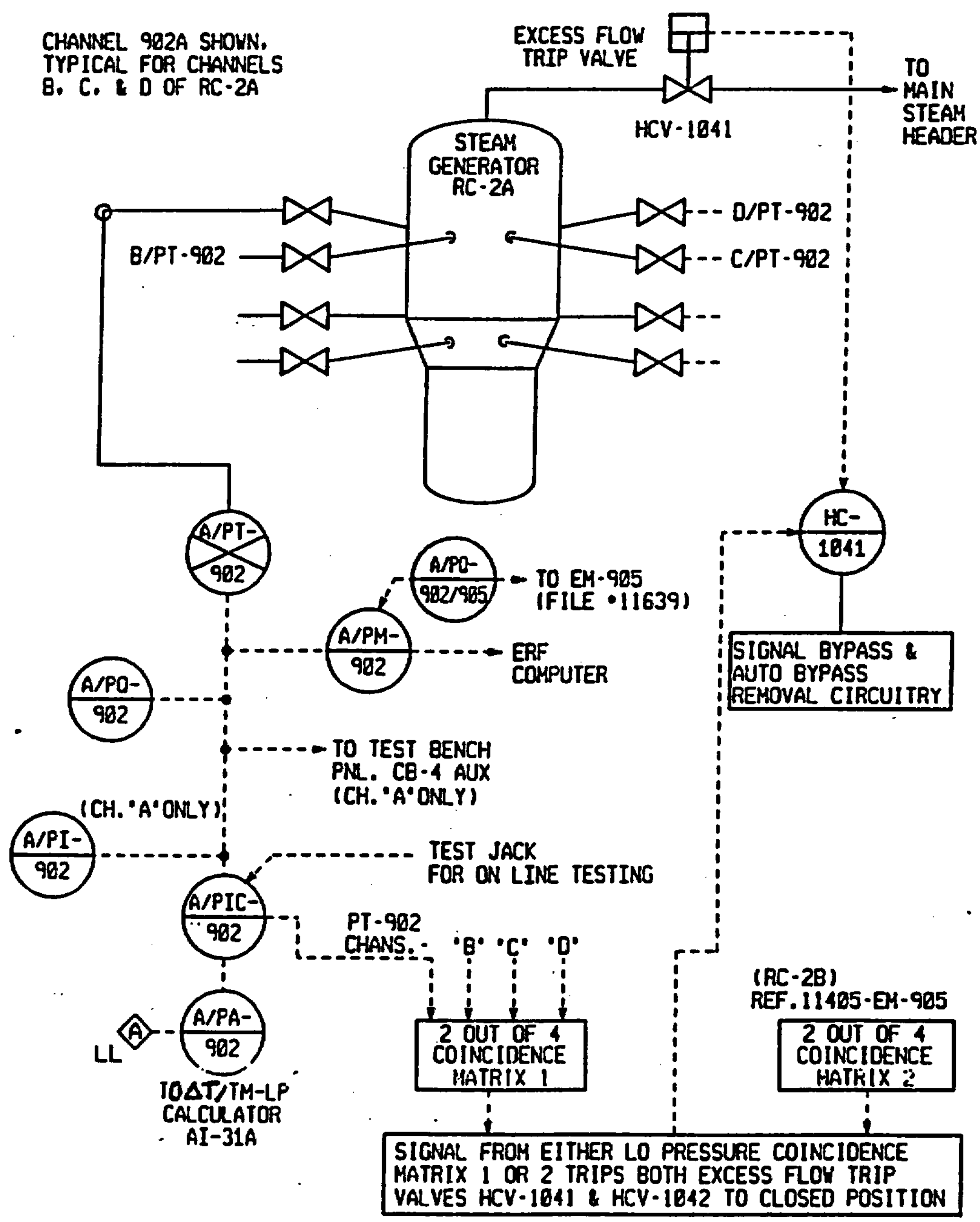
4.0 LOOP DIAGRAM



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5.0 ASSUMPTIONS

5.1 A positive (+) bias offsets a loop measurement to a higher value. A negative (-) bias offsets a loop measurement to a lower value.

5.2 All values are assumed to be in process units unless otherwise noted.

5.3 All data is assumed to be 2 sigma values with a 95% confidence level. This assumption is in accordance with the OPPD setpoint Methodology (Ref 10.19).

5.4 1 YR = 365.25 days * 24 hours/day
1 YR = 8766 HRS
1 MO = 31 days * 24 hours/day
1 MO = 744 hours

5.5 This calculation is based on normal environmental conditions, no accident effects are considered in the calculation. Environmental conditions are based upon Reference 10.12, OSAR and Reference 10.18, The S&L Temperature study.

5.6 Containment temperatures will vary between 72.4°F and 103.4°F during plant operation. Based on the S&L Temperature Study (Reference 10.18).

5.7 Atmospheric pressure at 998' elevation is approximately 14.2 psi.

5.8 All error components will be assumed to be random unless otherwise stated. The assumption of error components being random is in accordance with the OPPD Setpoint Methodology (Ref. 10.19).

5.9 The pressure transmitters are gauge and therefore the final absolute pressure reading of the 902 and 905 loops will be affected by the variations in the atmospheric pressure. It is assumed that the head correction and atmospheric pressure corrections are compensated for during the transmitter calibration.

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5.10 A containment pressure spike and subsequent trip is not part of the accident scenario that is bounded by a Low Steam Generator Pressure trip. The effects of containment pressure variations will be limited to the Tech Spec LCO of 3 PSIG. Local atmospheric pressure variations which increase the pressure are conservative and those that reduce the pressure will push the setpoint in a less conservative direction. Due to the limited magnitude of these atmospheric pressure changes, they will not be considered in this calculation. Specific drawings were not available to determine the as-built elevation for the process taps and the instrument installation. To ensure that this calculation is conservative, head correction calculations should be performed to ensure that the head correction for all eight channels of the Steam Generator Pressure function are considered during the device calibration.

5.11 The trip unit is assumed to be calibrated using the RPSCIP DVM calibrated to .02% R @ FS which equates to .2% when applied to the TM/LP Calculator module and the trip unit.

5.12 Loop A/902 was assumed as the bounding loop for this calculation since the environmental parameters, loop devices, calibration procedures, and mode of operation appeared to be identical for all of the 902 loops.

5.13 Reference 10.8 defines the power supply effect for the Foxboro Transmitter zero shift as "less than 0.1% of span for a 10% change in Voltage within limits." Foxboro limits the voltage for a 10 to 50 mA output to between 57 and 94 Vdc. OPPD operates the power supply between 50 and 55 volts. Foxboro has stated that this power supply will not degrade transmitter performance (Ref. 10.21). Therefore, the power supply effect will be assumed to be 0.1% of span for each 0.50 Vdc change. This provides the most conservative power supply accuracy effect.

5.14 10 CFR 75 allows a variation for the time of performance of Technical Specification surveillance. The yearly, refueling, or monthly requirements may be performed within 25% of the time period specified. This calculation assumes that the 25% allowance will be used and therefore multiplies all surveillance time periods by 1.25 to ensure conservatism.

5.15 All process devices are assumed to be calibrated in place, therefore the calibration temperature will be assumed to be equal to the minimum temperature for the device location. This assumption provides the most conservative device temperature errors.

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5.16 This loop utilizes mathematical functions within the Delta T Power Reference Thermal Margin/Low Pressure Trip Calculator.(TM/LP Calculator). Devices within the Calculator are not tagged individually, but designated within the wiring diagram by function and model number. This calculation assumes that based on the configuration of Drawing No. E-23866-411-061 (Ref 10.6e) each Steam Generator Pressure process loop provides a -1 to -5 vdc signal to it's respective Devar Type 20-320 Voltage Follower with Potentiometer Input. The two signals are then sent to a common Devar Type 20-321-1 Dual Amplifier configured as a mAx. Selector which selects the lower of the two signals to actuate TU-6. Per IC-ST-RPS-0018 (Ref 10.7e) TM/LP Calculator tolerances are measured at the TM/LP Calculator terminal blocks with a required output tolerance of +/-.1% for each 20-320 and +/-.1% for the 20-321 device. This calculation assumes that the total error to be included in the calculation is the tolerance represented by a measured path from one 20-320 through the 20-321-1. For this reason, the setting tolerance of the total Calculator function used in this calculation is assumed to be based on two +/-.1% devices. Assuming these device tolerances are dependent within the Calculator, the total tolerance would be +/-.2% span. Since tolerances established in the procedure (Ref 10.7a) have been met, and since vendor accuracy for the modules with modifications is not available, accuracy will be set equal to setting tolerance for the TM/LP Calculator in this setpoint calculation. This accuracy is assumed to include all gains and adjustments within the TM/LP Calculator for this signal output. This calculation will include the TM/LP Calculator functions as a single device within the loop with a total accuracy of +/-.2% span, and a setting tolerance of +/-.2% of span. Three M&TE devices are also included in the loop to account for the RPSCIP DVM devices used to verify the TM/LP Calculator tolerance. The M&TE errors are assumed to be dependent. No drift is assumed for these functions. The combined functions will be labeled as TM/LP Calculator for identification purposes within the calculation.

5.17 Historical plant survey information for the plant area in which the transmitters are located defines the normal radiation level at ≤ 25mR/hr. Due to this low dose rate and equipment qualification information, which states that no noticeable effect has been observed for electronic devices at levels below 1000 rad exposures, the effects of radiation exposure are assumed to be zero.

5.18 The OPPD Technical Specifications limit Control Room temperature to 105°F to protect panel equipment from temperatures not to exceed 120°F. This limiting condition is assumed to be based on the potential loss of HVAC and is established as a criteria for Tech. Spec. action. This calculation assumes that this does not represent normal conditions in the Control Room. Normal Control Room temperatures are assumed not to exceed 75°F and louvered panel temperatures buildup is assumed to be no greater than 10°F above that value.

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6.0 DESIGN INPUT

6.1 Methodology

The following Loop Uncertainty equations from Reference 10.19 will be used as the basis for this calculation. The methods for calculating the values associated with these variables are fully explained in Reference 10.19.

The Low Steam Generator Pressure Trip Setpoint in this calculation is being compared to a Technical Specification limit and an Analytical Limit using the concept of margin. The combination of effects os compared to the available separation between the NTSP and the Analytical Limit or Technical Specification value. If the combination is smaller than the separation, the margin is positive. Margin that is zero or positive indicates acceptable loop performance. Negative margin indicates that loop performance is not compatible with the specified limits according to the analysis techniques in use.

This calculation will treat all error components that are assumed to be random, statistically independent by combining them using the Square Root Sum of the Squares or the SRSS combination. Effects that are determined to be dependent with respect to one another will be added together prior to SRSS combination. Terms that are arbitrarily distributed or biases are not included in the SRSS but instead are added based on their sign to the SRSS result.

Device specific errors are combined based upon the following formulas to determine the Total Loop Error (TLE), Loop Drift (LD) and As-Found Tolerance (AFT). These values will then be used to determine three values: the Nominal Trip Setpoint (NTSP), this is the minimum value where the plant can set the trip setpoint for the bistable, other values more conservative than this value may be used for the actual plant setting, the Allowable Value (AV), this is the limiting value for the loop as-found during the refueling cycle calibration; and the Device As-Found Tolerance (AFT), this is the limiting as-found value for the rack components during the channel functional check. Exceeding this value does not imply that the design basis has been violated, but further evaluation should be performed to ensure that the loop is still operable.

$$TLE = (A+D+M+SPE+R_n+T_n+H_n+P+PCR)^{1/2} + PCN$$
$$LD = (A+D+M)^{1/2}$$
$$AFT = (a+d+m)^{1/2}$$

Where:

TLE	=	Total Loop Error Allowance
LD	=	Loop Drift Allowance
AFT	=	Device As-Found Tolerance

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A	=	Accuracy Allowance (Where setting tolerance is greater than device accuracy the setting tolerance is used in place of accuracy) (Ref. 10.19)
D	=	Drift Allowance
M	=	Maintenance and Test Equipment Allowance
V	=	Setting Allowance
R_n	=	Radiation Effects Allowance (normal)
R_a	=	Radiation Effects Allowance (accident)
T_n	=	Temperature Effects Allowance (normal)
T_a	=	Temperature Effects Allowance (accident)
H_n	=	Humidity Effects Allowance (normal)
SPE	=	Static Pressure Effects Allowance
P	=	Power Supply Effects Allowance
PCR	=	Random Process Consideration Allowances
PCN	=	Non-random Process Consideration Allowances

The values for TLE, LD and AFT calculated above are combined in the following manner to determine the Nominal Trip Setpoint (NTSP), The Allowable Value (AV), and the Device As-Found Tolerance Allowance (AFT). Since the setpoint is for a decreasing process, the total loop error will be added to the Analytical Limit to determine the Nominal Trip Setpoint. The Loop Drift term is subtracted from the calculated NTSP to determine the Allowable Value. The AV term is to be used to determine if the calibration for the loop is acceptable. If the as-found to as-left difference between the present and previous calibrations exceeds the Loop Drift value or the setpoint is determined to be above the AV, then the loop must be further evaluated for operability.

NTSP = AL - TLE

Where:

AL = Analytical Limit
TLE = Total Loop Error

AV = NTSP + LD

Where:

NTSP = Nominal Trip Setpoint (calculated above)

LD = Loop Drift

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6.2 Given Conditions:

6.2.1 Loop ID Number, A902 Bounding case for Low Steam Generator Pressure Loop (Assumption 5.12)

6.2.2 Loop Function, Low Steam Generator Pressure Trip

6.2.3 Loop Instrument List, Ref. 10.6.a and 10.6.b

A/PT-902 TM/LP CALCULATOR A/PA 902 (TU-6)
A/PT-905

This bounding calculation is also applicable to

B/PT-902 TM/LP CALCULATOR B/PA 902 (TU-6)
B/PT-905

C/PT-902 TM/LP CALCULATOR C/PA 902 (TU-6)
C/PT-905

D/PT-902 TM/LP CALCULATOR D/PA 902 (TU-6)
A/PT-905

Since the TM/LP Calculator function chooses a path based on the lowest signal input, only the one path error is considered to contribute to the trip function accuracy, therefore, this evaluation will combine the effects of A/PT-902, the TM/LP CALCULATOR and A/PA-902.

6.2.4 Device Dependency:

Device dependency is used to determine where a common external stimulus may cause instrument error effects to not react in a random manner. Where the same letter appears in a column for both instruments then the error effects are dependent and combined in accordance with the OPPD Setpoint Methodology (Ref. 10.19) for dependent errors.

Device	Environment Ref. 10.7.b	Power Ref 10.6.a & b	Calibration Ref. 10.7.a	Rad Zone Ref 10.7.b
A/PT-902	A	A	A	A
TM/LP	B	B	B	B
A/PA-902	B	B	B	B

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6.2.5 Process Considerations and Insulation Resistance:

Type (PC/IR)	magnitude (%Span)	Instrument Dependency	Uncertainty Dependency	Sign +/-
PC	0.3	Assumption 5.10		NP

This process consideration accounts for the three PSI difference allowed for containment pressure variation. This three PSI is a primary measurement error for the transmitter. The NP is an abbreviation for a non-random positive error or bias. Since this process concern would make the setpoint less conservative it will not be applied in the calculation. (Assumption 5.10)

PCN = 0.0000

6.2.6 Calibration Conditions:

Device	Temp (°F)	Static Press. (PSIG)	Atmosph Press. (PSIG)	Calib Period (MO.)
A/PT-902	72.4	14.2	14.2	18.000
TM/LP	75	N/A	N/A	1.000
A/PA-902	75	N/A	N/A	1.000

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6.2.7 Design Input Information:

- o Calibrated Span 0.00 to 1000.00 PSIA (Reference 10.7.a)
- o Analytical Limit 478.00 PSIA (Reference 10.1 and 10.3)
- o Process Max. Operating Pressure 1000.00 PSIG (Reference 10.3)
- o Operational Time Required After Accident 0.00 (Reference 10.7.b)

6.2.8 <u>Database Verified Equipment Information</u>

6.2.8.1 Device 1 <u>A/PT-902</u> Reference 10.6.a
Plant Room Containment 1013'
Power Supply Id A/PQ-902
Instrument Manufacturer Foxboro
Model Number N-E11GM-HIE2-AD
Surveillance Test Procedure Numbers Ref. 10.7.a

6.2.8.2 Device 2 <u>TM/LP Calculator</u> Reference 10.6.a and 10.6.b
Rack/Panel Number AI-31A
Power Supply Id A/PQ-902
Instrument Manufacturer Devar Inc.
Model Number (Assumption 5.16)

6.2.8.3 Device 3 <u>A/PA-902</u> Reference 10.6.b
Rack/Panel Number AI-31A
Power Supply Id A/PQ-902
Instrument Manufacturer G063
Model Number RPS-BISTABLE

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6.2.9 Instrument Specification Performance Data

6.2.9.1 Device 1 A/PT-902 Reference 10.8 and 10.20
Foxboro Model no N-E11GM-HIE2-AD
Tech Manual MI-020-162 DECEMBER 1981
Rng 0.00 to 2000.00 PSIG
Seismic 1% of Span
Temperature Note 1
Humidity not provided
Pressure not provided
Radiation {.0<= TID <=.035MR,0.5%*R}{.035MR<= TID <=200MR,6%*S}
Power 0.1% of Span for each 0.5 Vdc variation in power supply, Note 2
Drift 0.4% of Span for 12 months
Accuracy 0.55% of Span, Note 3

Note 1: Reference 10.20 Defined the following temperature effects:
zero shift: 1.5% per 100 deg F above or below 80 deg,
span range: 1.25% per 100 deg F above or below 80 deg

Note 2: Reference 10.8 defines the power supply effect zero shift as "less than 0.1% of span for a 10% change in Voltage within limits." Foxboro limits the voltage for a 10 to 50 mA output to between 57 and 94 Vdc. The power supply effect will be assumed to be 0.1% of span for each 0.57 Vdc change.

Note 3: Reference 10.20 assumed that accuracy does not include the considerations for REPEATABILITY, HYSTERESIS, DEADBAND. These effects have been combined using SRSS and are used for the accuracy value.

Sqrt ((square 0.5)+(square 0.1)+(square 0.2)+(square 0.05)) = 0.55

6.2.9.2 Device 2 TM/LP Calculator Reference 10.22
Mfg: Devar, Inc,
Model No. (Includes (2) models 20-320 and (1) model 20-321-1)
Tech Manual TD D142.0110
Range +/- 10 V nom.
Seismic Not provided
Temperature Effect negligible (Ref 10.22)
Humidity Not provided
Pressure Not applicable
Radiation Not applicable
Power +/-18V DC @ 10 mA plus load.

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Drift Included in accuracy (Assumption 5.16)
Accuracy 0.2% span (Assumption 5.16)

6.2.9.3 Device 3 A/PA-902 Reference 10.9, 10.10, 10.20

Mfg: Sorrento
Model no RPS-BISTABLE
Tech Manual E-115-131
Range 1.00 to 5.00 Vdc
Seismic Not provided
Temperature .009% of range per °F change
Humidity Not provided
Pressure Not applicable
Radiation Not applicable
Power Not provided
Drift 0.5% of range for 1.4 months
Accuracy 0.612% of range (.765% span)

For the RPS BISTABLE Reference 10.9 lists Repeatability as 0.5% of full range, the Linearity as 0.25% maximum deviation at 1 and 5 Vdc, and the Setting Resolution as 0.25%.

It is assumed that these are all components of device accuracy since no specific reference accuracy is provided. Since these components are independent, they will be combined using SRSS to determine the device reference accuracy as follows:

sqrt((sqr 0.5)+(sqr 0.25)+(sqr 0.25)) = 0.612

The drift was specified for this type component in Reference 10.20 as 0.5% of Range per 1000 hours This has been converted to 1.4 months. This same document defines the device temperature effect as 0.005% R per degree C. This has been converted to 0.009% of R per degree F with a reference temperature of 77 degrees F vice 25 degrees C.

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6.2.10 Environmental Conditions

6.2.10.1 Device 1 A/PT-902 Reference 10.7.c and 10.18
Room CONT 998'
Room Name CONTAINMENT 998 FT LEVEL
Harsh Environment No
Temperature (maximum normal) 103.4 °F (Assumption 5.6)
Humidity (maximum normal) 100 % RH
Pressure (maximum normal) 3 PSIG
Radiation (Background) 0.0025 R/hr Assumption 5.17
Seismic Response Spectrum 0.0000 ZPA

6.2.10.2 Device 2 TM/LP Calculator Reference 10.7.c
Room AI-31A
Room Name RPS TRIP PANEL CONTROL ROOM
Harsh Environment NO
Temperature 75 - 85°F Assumption 5.18
Humidity 65 % RH
Pressure 0.0 PSIG
Radiation 0.0000 R/hr
Seismic Response Spectrum 0.0000 G ZPA

6.2.10.3 Device 3 A/PA-902 Reference 10.7.c
Room AI-31A
Room Name RPS TRIP PANEL CONTROL ROOM
Harsh Environment NO
Temperature 75- 85°F Assumption 5.18
Humidity 65 % RH
Pressure 0.0 PSIG
Radiation 0.0000 R/hr
Seismic Response Spectrum 0.0000 G ZPA

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6.2.11 Calibration Data

6.2.11.1 Device 1 A/PT-902 Reference 10.7.a and Assumption 5.11

M&TE devices used	FLUKE 8060A 0-200mA scale HEISE gage 0-1000 scale
Calibrated input span	0.0 1000 PSIA
Calibrated output span	10.00 50.00 mAdc
Setting Tolerance	0.22 mAdc or .55% of Span Assumption 5.11

6.2.11.2 Device 2 TM/LP Calculator Reference 10.23

M&TE devices used	RPSPC DVM .02% Range @ Full Scale (40Vdc scale)
Calibrated input span	1.00 5.00 Vdc
Calibrated output span	1.00 to 5.00 Vdc
Setting Tolerance	0.2% (Assumption 5.16)

6.2.11.3 Device 3 A/PA-902 Reference 10.23

M&TE devices used	RPSCIP DVM .02% Range @ Full Scale (40 VDC scale)
Calibrated input span	1.00 5.00 Vdc
Calibrated output span	Not Applicable (Switch)
Setting Tolerance	0.031 Vdc or 0.765% of Span (Assumption 5.11)

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7.0 METHODS/ERROR ANALYSIS

7.1 Calculation of Device Uncertainties

7.1.1 Basic Accuracy (a)

a = va/CS * PS Reference 10.19

Where:

va = Vendor Stated Accuracy
CS = Calibrated Span
PS = Equivalent Process Span (1000.000 PSI)

7.1.1.1 Device 1 A/PT-902

va = 0.55% of Span

a_1 = 0.0055 * 40 mADC
a_1 = 0.22 mADC

In terms of process span:

a_1 = 0.0055 * 1000
a_1 = 5.50000 PSI

7.1.1.2 Device 2 TM/LP Calculator

va = 0.2% span Assumption 5.16

a_2 = 0.002 * 4 vdc
a_2 = 0.008 vdc

In terms of process span:

a_2 = 0.002 * 1000
a_2 = 2.00000 PSI

7.1.1.3 Device 3 A/PA-905

va = 0.612% of Range
R = 5.000
CS = 4.000

a_3 = (0.00612 * 5)/4 * 4 vdc
a_3 = 0.0306

In terms of process span:

a_3 = (0.00612 * 5)/4 * 1000
a_3 = 7.65000 PSID

7.1.2 <u>Maintenance and Test Equipment Accuracy (m)</u>

m = Error/cs * PS

Where:
Error = M&TE error
cs = Calibrated Span
PS = Equivalent Process Span (1000.00 PSI)

7.1.2.1 Device 1 <u>A/PT-902</u>

Accuracy of the M&TE used for the calibration of the transmitter is taken from the tolerances used to calibrate the multimeter and pressure calibrator in references 10.8 and 10.9. For the multimeter, the tolerance is 0.17 mA which equates to 4.25 psi for a transmitter span of 1000 psi. For the pressure gauge, the tolerance is 1.3 psi for a range of 0-1000 psi.

The error associated with equipment used to calibrate M&TE is included by using 25% of the tolerance for the M&TE calibration. This is consistent with I&C practice to calibrate M&TE using standards which meet a 4:1 minimum ratio between the accuracy of the M&TE and the accuracy of the standard.

M&TE temperature effect is included as follows. Vendor information for the Fluke Model 8060A which is used for instrument loop calibrations specifies that the performance of the multimeter is affected by temperatures above 28 °C. (This effect can also be applied to the Fluke Model 45). The temperature coefficient is 0.1 times the applicable accuracy per degree C from 28 to 50 °C. The accuracy specification for DC current in the range of interest is 0.3% of reading which equates to 0.15 mA for the purposes of this calculation, based on a maximum current reading of 50 mA. If it is assumed that the multimeter will not be

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used above a temperature of 40 °C. (104 °F), the temperature effect on the multimeter is calculated to be (40-28)*0.1*0.15 = 0.18 mA. (0.18 mA equates to an error of 4.5 psi). This assumption is reasonable since calibrations are normally performed with the plant shutdown which results in smaller temperature variations between the M&TE calibration room and the containment. However, even with the plant operating at full power during the summer months, it is not expected that the containment temperature is likely to be higher than 104 °F as demonstrated by actual temperature measurements documented in Enclosure 2 of the EEQ Manual.

The pressure device used to calibrate the transmitter needs no consideration of M&TE temperature effect because it is temperature compensated. However, for conservatism, an allowance of 50% of the M&TE calibration tolerance is included for pressure gauge temperature effect.

Total error for the multimeter as used in the calibration of the transmitter is:

Multimeter error = SRSS (tolerance, standard error, temperature error)

Where SRSS is the square root sum of squares of the factors in parentheses

Multimeter error = SRSS (4.25, 25% of 4.25, 4.5) = 6.28 psi

The total error for the pressure gauge is:

Gauge error = SRSS (tolerance, standard error, temperature error)

= SRSS (1.3, 25% of 1.3, 50% of 1.3) = 1.49 psi

Total M&TE error for the transmitter is:

m_1 = SRSS (Multimeter error, gauge error)

m_1 = SRSS (6.28, 1.49) = 6.45 psi

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7.1.2.2 TM/LP CALCULATOR

The TM/LP Calculator and Bistable tolerances are verified using the RPSCIP DVM. The DVM is used to establish the input, check the Calculator output and again during bistable calibration. Therefore, the errors are assumed to be dependent and the contribution of uncertainty due to the M&TE is the summation of the M&TE error at 3 points. The RPSCIP DVM calibration tolerance is required to be within .02% of Range @ Full Scale (40 vdc). This equates to .2% when applied to a 4 vdc span.

Error = (0.002 + 0.002 + 0.002)

Error = (0.006)

Substituting

$m_{2\&3}$ = 0.006 * 1000
$m_{2\&3}$ = 6.00 PSI

7.1.2.3 Device 3 A/PA-902

Included with the TM/LP Calculator M&TE error described above.

7.1.3 Device Setting Tolerance (v)

The inaccuracy introduced into the calibration process due to the procedural allowances given to the technician during instrument calibration. In the calculation the larger of this value or accuracy will be used.

v = st/cs * PS

Where

st = device setting tolerance
cs = Calibrated Span
PS = Equivalent Process Span (1000.000 PSI)

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7.1.3.1 Device 1 A/PT-902

Setting Tolerance is reduced to be equal to vendors specified accuracy for the process device of 0.55% of calibrated span. Assumption 5.11

$_{st1}$ =0.55% of span

Substituting:

$v_1 = 0.0055 * 1000$
$v_1 = 5.50000$ PSI

7.1.3.2 Device 2 TM/LP CALCULATOR

Per Assumption 5.16, setting tolerance for the TM/LP Calculator is .3% span
st = 0.2% span
Substituting:

$v_2 = 0.002 * 1000$
$v_2 = 2.00$ PSI

7.1.3.3 Device 3 A/PA-902

Setting Tolerance is defined to be device vendor stated accuracy of 0.612% of range. Assumption 5.11

st = 0.612% of Range
R = 5.00
cs = 4.00
Substituting:

$v_3 = (0.00612 * 5.00)/4 * 1000$
$v_3 = 7.6500$ PSI

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7.1.4 Vendor Drift (d):

Drift is specified by the instrument manufacturer based on testing under laboratory conditions. Drift is the undesired change in output over a period of time, which change is unrelated to the input, environment or load. Drift will be adjusted in this calculation to match the calibration period of the instruments.

d = 1.25*tc*vd*PS/CS   Reference 10.19

Where;

tc = Instrument Calibration Period (months)
vd = Vendor Drift Specification per month
CS = Calibrated Span
1.25 = Allowance given on Tech Spec. Time Requirements
(10 CFR 75)   Assumption 5.14
PS = Equivalent Process Span (1000.000 PSI)

7.1.4.1 Device 1 A/PT-902

tc = 18.000
vd = 0.4% * CS/12.
vd = 0.004 x 22.5 months/12 months = .0075
CS = 1000.000

d_1 = 1.25 * 18 * (0.004 * 40/12) * 1000/1000
d_1 = 0.3 mADC

In terms of process span:

d_1 = 1.25 * 18 * (0.004 * 1000/12) * 1000/1000
d_1 = 7.50000 PSI

7.1.4.2 Device 2 TM/LP CALCULATOR

Due to the nature of the devices contained in the TM/LP Calculator, no device drift is assumed in this calculation. Therefore,

d_2 = 0.0000 PSI

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7.1.4.3 Device 3 A/PA-902

tc = 1.000
vd = 0.5% * R/1.4
R = 5.00
CS = 4.000
d_3 = 1.25 * 1.0 * (0.005 * 5/1.4) * 4/4
d_3 = 0.0223 vdc

In terms of process span:
d_3 = 1.25 * 1.0 * (0.005 * 5/1.4) * 1000/4
d_3 = 5.58036

7.1.5 Device Temperature Effects (t_n & t_s):

The change in a loop instrument's input/output relationship due to the variations of ambient temperature in the loop instrument's environment.

t_n = |N-C|* VTE *PS/CS

Where:
N = Normal maximum Temperature
C = Calibration Temperature
VTE = Vendor Temperature Effect
CS = Calibrated Span
PS = Equivalent Process Span (1000.000 PSI)

7.1.5.1 Device 1 A/PT-902

N = 103.400 Assumption 5.6
C = 72.400 Assumption 5.6 and 5.15
VTE = 1 % * CS/40
CS = 1000.000

Substituting:
$t_{n1} = [(|103.4 - 72.4| * (0.015/100) * PS)^2 + (|103.4 - 72.4| * (0.0125/100) * PS)^2]^{1/2}$

$t_{n1} = [(4.65)^2 + (3.875)^2]^{1/2}$

t_{n1} = 6.0529 PSI

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7.1.5.2 Device 2 TM/LP CALCULATOR

No temperature effects were specified for functions within the TM/LP within this required operating range, therefore:

t_{n2} = 0.0000 PSI

7.1.5.3 Device 3 A/PA-902

N = 85.000 Assumption 5.18
C = 75.000 Assumption 5.15
VTE = 0.009% *R/1
R = 5.000
CS = 4.000

Substituting:

t_{n3} = |85 - 75| * (0.00009 * 5/1) * 1000/4
t_{n3} = 1.12500 PSI

7.1.6 Device Humidity Effects (h_n):

Normal Conditions Reference 10.19

h_n = |N-C|* VHE *PS/CS

Where:

N = Normal maximum Humidity
C = Calibration Humidity
VHE = Vendor Humidity Effect
CS = Calibrated Span
PS = Equivalent Process Span. (1000 PSI)

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7.1.6.1 Device 1 A/PT-902

N = 100.000 Ref. 10.7.c
C = 0.000
VHE = 0.00000
CS = 1000.000

Substituting:

h_{n1} = 0.00000 PSI

7.1.6.2 Device 2 TM/LP CALCULATOR

N = 100.000 Ref. 10.7.c
C = 0.000
VHE = 0.00000
CS = 1000.000

Substituting:

h_{n2} = 0.00000 PSI

7.1.6.2 Device 3 A/PA-902

N = 65.000 Ref. 10.7.c
C = 0.000
VHE = 0.00000
CS = 4.000

Substituting:

h_{n3} = 0.00000 PSI

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7.1.7 Device Radiation Effects (r_n):

Normal Conditions Reference 10.19
r_n = VRE * PS/CS , or
r_n = VRE * 1.25 * 744 * tc * N * (1 * 10^{-6}) * PS/CS
(second equation applies if VRE is expressed per megarad)

Where:

N = Normal Radiation Dose Rate R/hr
tc = Calibration period
VRE = Vendors Radiation Effect
CS = Calibrated Span
744 = Hours in a month (31*24)
PS = Equivalent Process Span (1000.000 PSI)
1.25 = Allowance given on Tech Spec Time Requirements (10 CFR 75) Assumption 5.14

7.1.7.1 Device 1 A/PT-902

N = 0.0025 Assumption 5.17 and Ref. 10.12
tc = 18.000
VREN = 0.5% * R for Radiation < 0.035 MRads
VREN = 0.00000 Assumption 5.17
CS = 1000.000
Substituting:

r_{n1} = 0.00000 PSI Assumption 5.17

7.1.7.2 Device 2 TM/LP CALCULATOR

N = 0.000 Ref. 10.12
tc = 1.000
VREN = Not Applicable
CS = 4.000

Substituting:

r_{n2} = 0.00000 PSI

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7.1.7.3 Device 3 A/PA-902

N = 0.000 Ref. 10.12
tc = 1.000
VREN = Not Applicable
CS = 4.000

Substituting:

r_{n3} = 0.00000 PSI

7.1.8 Device Seismic Effects (s)

s = VSE * PS/CS , or
s = VSE * SRS * PS/CS Ref. 10.19
(Second equation applies if VSE is expressed per g)

Where:
VSE = Vendors Seismic Effect
SRS = Seismic Response Spectrum
CS = Calibrated Span
PS = Equivalent Process Span(1000.000 PSI)

7.1.8.1 Device 1 A/PT-902

Loop devices are not required to function for a seismic event, therefore seismic error is 0.00.
Assumption 5.5

7.1.8.2 Device 2 TM/LP CALCULATOR

Loop devices are not required to function for a seismic event, therefore seismic error is 0.00.
Assumption 5.5

7.1.8.3 Device 3 A/PA-902

Loop devices are not required to function for a seismic event, therefore seismic error is 0.00.
Assumption 5.5

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7.1.9 Device Static Pressure Effects (spe):

Static Pressure Effect applies only to instruments in direct contact with the process. Additionally, static pressure effect does not apply to instruments other than differential pressure devices where both sides are in contact with the process. Since the loop's transmitter is not a differential pressure device, this loop has no device static pressure effects.
(Reference 10.19)

7.1.10 Device Power Supply Effect (p):

p = PSS * VPSE * PS/CS

Where:

PSS = Power Supply Stability
VPSE = Vendor Power Supply Effect
CS = Calibrated Span
PS = Equivalent Process Span (1000.000 PSI)

7.1.10.1 Device 1 A/PT-902

PSS = 2.627 Attachment 3
VPSE = 0.1% * CS/0.50 Assumption 5.13
CS = 1000.000

Substituting,

p_1 = 2.627 * (0.001 * 1000/0.50) * 1000/1000
p_1 = 5.254 PSI

7.1.10.2 TM/LP CALCULATOR

PSS = 2.627 Attachment 3
VPSE = Not Provided
CS = 8.000
Substituting,

p_2 = 0.00000 PSI

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7.1.10.3 Device 3 A/PA-902

PSS = 2.627 Attachment 3
VPSE = Not Provided
CS = 4.000
Substituting,
p_3 = 0.00000 PSI

7.1.11 Device As-Found Tolerance (AFT)

This calculation is used to determine a calibration tolerance only and is not used as a term within the calculation.

The As-Found tolerance allowance is based on the Square Root Sum of the Squares (SRSS) of Device Accuracy (a), M&TE (m) and Drift (d). The components are considered to be statistically independent of each other. This value may be used as an acceptable limit when recording th as-found value for this device over the standard calibration interval. This value is only valid if the interval used in this calculation has not been exceeded.

$AFT = (a^2 + m^2 + d^2)^{½}$

7.1.11.1 Device 1 A/PT-902

For this tolerance to be applicable, device setting tolerance must be set to vendor accuracy.

$AFT = (a^2 + m^2 + d^2)^{½}$
$AFT = (0.22^2 + 0.1360^2 + 0.3^2)^{½}$
$AFT = (0.1569)^{½}$

AFT = ± 0.40 mADC

7.1.11.2 Device 2 TM/LP CALCULATOR

N/A Device not calibrated

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7.1.11.3 Device 3 A/PA-902

For this tolerance to be applicable, device setting tolerance must be set to vendor accuracy.

$AFT = (a^2 + m^2 + d^2)^{½}$
$AFT = (0.031^2 + 0.024^2 + 0.0223^2)^{½}$
$AFT = (0.0367)^{½}$

$AFT = \pm 0.045$ VDC

7.2 Calculation of Combined Loop Effects

7.2.1 Accuracy Allowance (A):

$A = (a_1^2 + a_2^2 + ... + a_n^2)$

Recalling the device accuracies from Section 7.1.1

a_1 = 5.50000 PSIA
a_2 = 2.0000 PSIA
a_3 = 7.65000 PSIA

Substituting and combining according to device calibration dependency;

$A = [(5.5)^2 + (2)^2 + (7.65)^2]$
A = 92.7725

7.2.2 Drift Allowance (D):

Independent device drift uncertainties are combined as;

$D = (d_A^2 + d_B^2 + ... + d_F^2)$

Where the subscripts A through F represent the device drift effects in each independent loop segment.

Independent device uncertainties; $d_A = d_1$

Dependent device uncertainties; $d_B = (d_2 + d_3 + d_4)$
Recalling device drift from Section 7.1.4

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d_1 = 7.50000 PSIA
d_2 = 0.0000 PSIA
d_3 = 5.58036 PSIA

Substituting and combining according to device calibration dependency;

$D = [(7.5)^2 + (5.58036)^2]$
$D = 87.39042$

7.2.3 M&TE Allowance (M):

Independent device M&TE uncertainties are combined as;

$M = (m_A^2 + m_B^2 + ... + m_F^2)$

Where the subscripts A through F represent the device M&TE effects in each independent loop segment.

Independent device uncertainties; $m_A = m_1$
Dependent device uncertainties; $m_B = (m_2 + m_3 + m_4)$

Recalling device M&TE from Section 7.1.2,

m_1 = 6.45 PSI
$m_{2\&3}$ = 6.00000 PSI

Substituting and combining according to device calibration dependency;

$M = [(6.45)^2 + (6)^2]$
$M = 77.6$

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7.2.4 Setting Allowance (V):

Independent device setting tolerance uncertainties are combined as;

$V = (v_A^2 + v_B^2 + ...+ v_F^2)$

Where the subscripts A through F represent the device setting tolerance effects in each independent loop segment.
Independent device uncertainties; $v_A = v_1$
Dependent device uncertainties; $v_B = (v_2 + v_3 + v_4)$

Recalling device setting tolerance from Section 7.1.3,

$v_1 =$ 5.50000 PSI
$v_2 =$ 2.0000 PSI
$v_3 =$ 7.6500 PSI

Substituting and combining according to device calibration dependency;

$V = [(5.5)^2 + (2)^2 + (7.65)^2]$
V = 92.7725

7.2.5 Temperature Effect Allowance (T_n & T_a):

Independent environmental temperature effects are combined as follows:

There are no temperature dependent process concerns.

Normal, $T_n = (T_{nA}^2 + T_{nB}^2 + ...+ T_{nF}^2)$
Where the subscripts A through F represent the combined device temperature effects in each independent plant environment.

Independent device temperature effects; Normal: $T_{nA} = t_{n1}$
Dependent device temperature effects;

Normal: $T_{nB} = (t_{n2} + t_{n3} + Pc + IR)$

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Recalling device temperature effects from Section 7.1.5,

t_{n1} = 6.0529 PSI
t_{n2} = 0.00000 PSI
t_{n3} = 1.12500 PSI

Substituting and grouping according to device environmental dependency, process concern and insulation resistance dependency.
$Tn = [(6.0529)^2 + (1.125)^2]$

T_n = 37.577

7.2.6 Humidity Effects Allowance (H_n):

Independent environmental humidity effects are combined as follows:
There are no humidity dependent process concerns.

Normal, $H_n = (h_{nA}^2 + h_{nB}^2 + ... + h_{nF}^2)$

Where the subscripts A through F represent the combined device humidity effects in each independent plant environment.

Independent device humidity effects; Normal: $H_{nA} = h_{n1}$
Dependent device humidity effects; Normal: $H_{nB} = (h_{n2} + h_{n3} + Pc + IR)$
Recalling device humidity effects from Section 7.1.6,

h_{n1} = 0.00000
h_{n2} = 0.00000
h_{n3} = 0.00000

Substituting and grouping according to device environmental dependency,

H_n = 0.00000

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7.2.7 Radiation Effects Allowance (R_n):

Independent environmental radiation effects are combined as follows:
There are no radiation dependent process concerns.

Normal, $R_n = (r_{nA}^2 + r_{nB}^2 + ... + r_{nF}^2)$

Where the subscripts A through F represent the combined device radiation effects in each independent plant environment.

Independent device radiation effects;

Normal: $R_{nA} = r_{n1}$

Dependent device radiation effects;

Normal: $R_{nB} = (r_{n2} + r_{n3} + Pc + IR)$

Recalling device radiation effects from Section 7.1.7,

r_{n1} = 0.00000 PSI
r_{n2} = 0.00000 PSI
r_{n3} = 0.00000 PSI

Substituting and grouping according to device radiation dependency, process concern and insulation resistance dependency.

R_n = 0.00000

7.2.8 Seismic Allowance (S):

Independent device seismic uncertainties are combined as;
$S = (s_A^2 + s_B^2 + ... + s_F^2)$

Where the subscripts A through F represent the device seismic effects in each independent loop segment.

Independent device uncertainties; $s_A = s_1$

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Dependent device uncertainties; $s_B = (s_2 + s_3 + s_4)$

Recalling device seismic uncertainties from Section 7.1.8,

$s_1 =$ 0.00000 PSI
$s_2 =$ 0.00000 PSI
$s_3 =$ 0.00000 PSI

Substituting and combining according to device location dependency;

S = 0.00000

7.2.9 Power Supply Allowance (P):

Independent device power supply uncertainties are combined as;

$P = (p_A^2 + p_B^2 + ... + p_F^2)$

Where the subscripts A through F represent the device power supply effects in each independent loop segment.

Independent device uncertainties; $p_A = p_1$

Dependent device uncertainties; $p_B = (p_2 + p_3 + p_4)$

Recalling device power supply uncertainties from Section 7.1.10,

$p_1 =$ 5.254 PSI
$p_2 =$ 0.00000 PSI
$p_3 =$ 0.00000 PSI

Substituting and combining according to device power dependency;

$P = (5.254)^2$
P = 27.604516

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7.2.10 Process Concerns, (Pc):

Process Concerns can affect the form of the calculation in any of 3 possible ways depending on whether or not the process concerns are random or non-random and the dependency of random process concerns.

Random Process Considerations:
0.00000 PSI

PCR = 0.00000

Non-Random Process Considerations:

PCN = 0.00000

7.2.11 Static Pressure Allowances (SP):

There are no device static pressure effects associated with this loop, therefore

SP = 0

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8.0 CALCULATION/CHANNEL ANALYSIS

8.1 Error Combination

The errors are combined based upon the following formulas to determine the Total Loop Error (TLE), Loop Drift (LD) and As-Found Tolerance (AFT). These values will then be used to determine: the Nominal Trip Setpoint (NTSP), this is the minimum value where plant can set the trip setpoint for the bistable, other values more conservative then this value may be used for the actual plant setting, the Allowable Value (AV), this is the limiting value for the loop as-found during the refueling cycle calibration, and the Device As-Found Tolerance (AFT), this is the limiting as-found value for each of the components during the channel functional check. A summation of the recorded as-left to as-found delta for each device will verify that the Allowable Value has not been exceeded. Exceeding an as-found tolerance for any one device does not imply that the design basis has not been violated, however, further evaluation should be performed to determine the root cause of the unacceptable device performance.

$TLE = (A+D+M+SPE+R_n+T_n+H_n+P+PCR)^{½} + PCN$

$LD = (A+D+M)^{½}$

$AFT = (a^2 + m^2 + d^2)^{½}$ (for each device)

Where:

TLE	=	Total Loop Error Allowance
LD	=	Loop Drift Allowance
AFT	=	Device As-Found Tolerance
A	=	Accuracy Allowance (Where setting tolerance is greater than device accuracy the setting tolerance is used in place of accuracy) (Ref. 10.19)
D	=	Drift Allowance
M	=	maintenance and Test Equipment Allowance
V	=	Setting Allowance
R_n	=	Radiation Effects Allowance (normal)
T_n	=	Temperature Effects Allowance (normal)
H_n	=	Humidity Effects Allowance (normal)
SPE	=	Static Pressure Effects Allowance
P	=	Power Supply Effects Allowance
PCR	=	Random Process Consideration Allowances
PCN	=	Non-random Process Consideration Allowances

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The values for TLE, LD and AFT calculated above are combined in the following manner to determine the Nominal Trip Setpoint (NTSP), the Allowable value (AV) and the Device As-Found Tolerance Allowable (AFT). Since the setpoint is for a decreasing process, the total loop error will be added to the Analytical Limit to determine the Nominal Trip Setpoint. The Loop Drift term is then subtracted from the calculated NTSP to determine the Allowable Value. The AV term is to be used to determine if the calibration for the loop is acceptable. If the as-found to as-left difference between the present and previous calibrations exceeds the Loop Drift value or the setpoint is determined to be above the AV, then the loop must be further evaluated for operability.

NTSP = AL + TLE
where:

AL = Analytical Limit
TLE = Total Loop Error

AV = NTSP - LD

where:

NTSP = Nominal Trip Setpoint (calculated above)
LD = Loop Drift

Substituting;

$TLE = (A+D+M+SPE+R_n+T_n+H_n+P+PCR)^{1/2} +PCN$

Only the larger of accuracy or setting tolerance is used in the calculation (Ref. 10.19). Therefore, for this calculation "A" is set equal to setting tolerance since setting tolerance is the larger (by 0.0001) Humidity (H), Radiation (R), Static Pressure Effect (SPE), and random and dependent Process Concerns (PCR & PCN) have all been justified to not be applicable to the loop function or calculated to be zero. The remaining factors are therefore considered.

A = 92.7725 (7.2.1)
D = 87.39042 (7.2.2)
M = 77.6 (7.2.3)
V = 92.7725 (7.2.4)

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T_n = 37.577 (7.2.5)
P = 27.60452 (7.2.9)

$TLE = (A + D + M + T_n + P)^{1/2}$
$TLE = (92.7725 + 87.39042 + 77.6 + 37.577 + 27.5625)^{1/2}$
$TLE = (322.9)^{1/2}$

TLE = 18.0 PSIA

$LD = (A + D + M)^{1/2}$
$LD = (92.7725 + 87.39042 + 77.6)^{1/2}$
$LD = (257.8)^{1/2}$

LD = 16.1 PSIA

8.2 Determining NTSP, AV, and RA

The purpose of this calculation is to verify that the Nominal Trip Setpoint which is currently established in adequate to protect all design and safety requirements. Therefore, using the data calculated in section 7, the following was determined:

NTSP = AL + TLE

Where:

AL = Analytical Limit (478 PSIA)
TLE = Loop Error (18.0 PSIA)
AV = NTSP - LD

Where:

NTSP = Nominal Trip Setpoint (496.0 PSIA)
LD = Loop Drift (16.1 PSIA)

Substituting

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NTSP	=	496.0 PSIA	(This is the minimum calculated NTSP based on the Analytical Limit only. Plant settings should not be revised to this number without evaluation of current Technical Specification limits.)
AV	=	479.9 PSIA	(This AV represents the calculated Loop Drift and is only a valid value when set in conjunction with the minimum calculated NTSP. Current plant settings and Technical Specification limits should be evaluated prior to any modification of existing values.)

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9.0 CONCLUSIONS

9.1 Setpoint Analysis

The requirement of the Low Steam Generator Pressure is to trip at or below 478 PSIA as assumed in the accident analysis. The current plant setting of this trip is 507.5 PSIA. This calculation used the limiting errors based upon recommended changes to the calibration procedures for the process devices and plant standard procedures for calibration of the M&TE devices. This calculation demonstrates that the current process instrumentation specifications are sufficient to perform the safety function required.

Current Plant Setting Evaluation:

Plant Setting ________ 507.5 psia

Technical Specification Limit ________ 500 psia

Total Loop Error (18.0 PSI) ________ 496.0 psia
(NTSP + TLE)

Analytical Limit ________ 478 psia

Conclusions

This calculation provided the basis for the capability of the 902 and 905 loops to meet the requirements for the Low Steam Generator Pressure setpoint as used in the accident analysis based upon recommended changes to the calibration procedures and the documented standards for M&TE calibration.

Procedure IC-ST-RPS-0018 is used to verify the proper operation of the Steam Generator Low Pressure Setpoint and includes a verification that the signal common shared by the "A" Signal (902 loop) and the "B" signal (905 loop) is within 6 mV of the power supply common. The maximum potential on the signal common equates to a possible offset of 0.20% for a 3 volts input signal (500 psi low pressure trip setting) or 2.0 psi. This offset should be considered when the existing plant setting is changed.

This consideration is provided in response to Engineering Assistance Request, A/R # 25596.

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Recommendation

The current plant setting is set 7.5 psi from the current Technical Specification limit. This setting does not allow sufficient Margin to account for the total loop drift which may be present during loop surveillance. Since adequate Margin is available between the analytical limit and the plant setting to account for all potential loop inaccuracies, the Technical Specification limit could be decreased without impacting safety.

The standard M&TE calibration practices should be revised to consider the "turn down ratio" effect on the calibration of process instruments. The standard for M&TE calibration should be changed to ± 0.25% of M&TE span for pressure monitoring devices. Procedures should be developed to ensure that the span for the M&TE device is not greater than 2 times the process device calibrated span. The DVM (except for RPSCIP) should be calibrated to 0.1% of the DVM span to be used for the calibration. The Setting Tolerance for all devices should be equal to vendor specified basic accuracy. The expanded Setting Tolerance and M&TE accuracy requirements now used may mask the signs of process instrument failure.

Calibration Tolerances

This calculation supports the use of the following values to be used during calibration. The calibration device tolerance the technician is required to leave the device no greater than; (as-left tolerance) and a limit which the device may be found and still satisfy the loop performance acceptance criteria (as-found tolerance). These values are typical for all channels.

Device	As-Left Tol.	As-Found Tol.
A/PT-902	0.22 mADC	0.40 mADC
A/PA-902	0.031 Vdc	0.045 Vdc

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10.0 REFERENCES

10.1 FCS UNIT 1 Technical Specifications 1.3 (6)

a. Section 1.3
b. Section 2.14
c. Section 2.15
d. Table 2-1, 2-2, 2-3, 2-4

10.2 U.S. Nuclear Regulatory Commission, Regulatory Guide 1.105, Revision 2, February 1986, "Instrument Setpoints for Safety-Related Systems."

10.3 FCS, Updated Safety Analysis Report

a. Table 7.2
b. Section 7.2.3.5

10.4 ANSI/ISA-S67.04-1987, "Setpoints for Nuclear Safety-Related Instrumentation."

10.5 ISA RP67.04, Part II, Draft 8, "Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentations."

10.6 FCS Drawings

a. 11405-EM-902 Sheet 1 Rev. 9 and Sheet 2 Rev. 7
b. 11405-EM-905 Sheet 1 Rev. 9 and Sheet 2 Rev. 7
c. 161F561 Sheet 122 Rev. 27, Sheet 123 Rev. 21, Sheet 124 Rev. 22, Sheet 125 Rev. 21
d. 161F599 Sheet 1 Rev. 8
e. E-23866-411-061 Rev. 13
f. 11405-M-54 Sheet 35 Rev. 06 and Sheet 36 Rev. 06

10.7 FCS Documents

a. Calibration Procedures CP-A/902 Rev. 22, CP-B/902 Rev. 19, CP-C/902 Rev. 19, CP-D/902 Rev. 19CP-A/905 Rev. 22, CP-B/905 Rev. 21, CP-C/905 Rev. 21, CP-D/905 Rev. 21, IC-ST-MS-0026 Rev. 2, IC-ST-MS-0027 Rev. 2, IC-ST-MS-0028 Rev. 2, IC-ST-MS-0029 Rev. 2, IC-ST-MS-0030 Rev. 2, IC-ST-MS-0031 Rev. 2, IC-ST-MS-0032 Rev. 2, IC-ST-MS-0033 Rev. 2, IC-CP-03-0140, Calibration of Fluke Model 8060A digital Multimeter, Rev. 8, IC-CP-03-0005, Calibration of Eaton Model UPS3000 digital Pressure Indicator, Rev. 4

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b. OSAR 85-94

c. Last performed calibrations performed on loops A/902, B/902, C/902 D/902, A/905, B/905, C/905, and D/905 4/90

10.8 Foxboro Product Literature
Manual TM F180.0570, TD F180.0190, Rev. 0

10.9 Sorrento Electronics Literature (Gulf Atomics System)
Manual TM C490.040 to G063.0020 Rev. 0

10.10 GE Product Literature
Manual TM G080.1630, TD G080.1840, Rev. 0

10.11 DBD #32 Instrumentation & Control

10.12 OSAR 85-94 Appendix B

10.13 Standing Order M-28

10.14 Equipment Database

10.15 CE Steam Generator Pressure Error Analysis 23866-ICE-3633

10.16 Fluke 8060A Instruction Manual DTD 11/82 Rev. 1

10.17 Calibration records for MT-14004 and MT-00128 for the interval of use for the 902 and 905 calibration in 4/90.

10.18 Document SL-7143 S&L Temperature Study

10.19 Engineering Instruction EEI-3 Revision 1 "Instrument Selection and Uncertainty Analysis"

10.20 Combustion Engineering Calculation 23866-ICE-3633 Rev. 0

10.21 Foxboro Letters of May 8, 1984 and April 20, 1984 from John A. Sears to S.K. Gambhir stating that the use of the GE/MAC 52.5 Volt power supplies will not degrade the Foxboro transmitters performance with radiation less than 10 Mrads TID and loop load between 160 and 225 ohms.