ATTACHMENT 2

Clinton Power Station Setpoint Calculation IP-C-0094

CALCULATION COVER SHEET

DEPT	DIV	CALCULATION NO	REVISION	ADDENDUM	VOLUME
C	NSED	IP-C-0094	0	---	A

TITLE: SETPOINT CALCULATION FOR RPV LEVEL 2 AND LEVEL 8 (WR); TRANSMITTERS 1B21N073C,D,G,H

SIGNATURE BLOCK

PREPARED BY C. W. HALLETT (PRINT) — Assignment Card 2001-01-01
7/20/01 (DATE) — C W Hallett (SIGNATURE)

CHECKED BY J. M. ASHCRAFT (PRINT) — Assignment Card 2001-05-02
7/23/01 (DATE) — Jm Ashcraft (SIGNATURE)

REVIEWED BY J. M. ASHCRAFT (PRINT) — Assignment Card 2001-05-02
7/23/01 (DATE) — Jm Ashcraft (SIGNATURE)

APPROVED BY P. R. MARCUM (PRINT)
7/27/01 (DATE) — Paul Marcum (SIGNATURE)

OWNER'S REVIEW NON-CPS CALC

REVIEWED BY (PRINT)
__/__/__ (DATE) — N/A (SIGNATURE)

CORP PREPARED THIS CALC: CPS

QUALITY RELATED: YES [✓] NO [ ]

CONFIRMATION REQUIRED

YES/NO: NO PAGE NO(S): CONFIRMED: [ ]

Field Work To Be Performed Per ECN Listed Below

ECN NO	DESIGN RELEASED DATE	CID UPDATED
~~333801~~ and 12.2.03		
AR 78522-12		
AR 78721-02		

ECN's listed above shall include "Volume Report" as Affected Documents.

READY FOR INCORPORATION

YES/NO/(N/A): NO ASSIGNED TO: A DATE RFI:

COMMENTS:
AR 78522-12 is tracking ITS revision.
AR 78721-02 is tracking ORM revision

NF-161.01-1 R/0 (02/99)

ACN 1/1

CALCULATION BATCH LIST

(May use computer print out and attach it with cover sheet or specify it's location if provided elsewhere in the calculation.)

IS THIS A PARENT CALC: YES [✓] NO [ ]

DEPENDENT CALCULATIONS (Enter either a Parent, Revision, Alias, Addendum or Volume in the relationship column)

#	RELATIONSHIP	DEPT	DIV	CALCULATION NO	REV	ADD	VOL	STATUS BEFORE	STATUS AFTER
1	VOLUME	C	NSED	IP-C-0094	0	---	A	U	A

IMPACTED CALCULATIONS (Enter either an Input, Output, Supplements, or Supersedes in the relationship column)

#	RELATIONSHIP	DEPT	DIV	CALCULATION NO	REV	ADD	VOL	STATUS BEFORE	STATUS AFTER
1	INPUT	C	NSED	IP-C-0089	0	---	---	A	A

REFERENCED CALCULATIONS (Not included as Dependent or Impacted Calculations. Enter Referenced in the relationship column)

ACN 1/1

#	RELATIONSHIP	DEPT	DIV	CALCULATION NO	REV	ADD	VOL

C	NSED	IP-C-0094	0	---	A
DEPT	DIV	CALCULATION NO	REVISION	ADDENDUM	VOLUME

System Code(s) (or NA): NB

Equipment Identification No. (EINs) (or NA): 1B21N073C,D,G,H; 1B21N673C,D,G,H; 1B21N674C,D

Support Number(s) (or NA): NA

Location (Bldg/Elev/Area (or NA): NA

Historic ☐ Microfiche Attached: Yes ☐ No ☑ Topic Code: M98

Temporary: ☐

ACN 1/1

NON-CALC INPUTS/OUTPUTS/REFERENCES

(Specify the Location, if provided elsewhere in the calculation)
(Identify in Relationship Column)

#	DOC TYPE	DOC NO	SHT NO	REV NO	DATE	DESCRIPTION	Relation-ship (I,O,R)
						SECTION 4	I
						SECTION 5	O
						SECTION 6	R

REVISION HISTORY

C NSED	IP-C-0094	0	---	A
DEPT DIV	CALCULATION NO	REVISION	ADDENDUM	VOLUME

REVISION OBJECTIVE: ORIGINAL CALCULATION

WHAT INITIATED CHANGE: NA

AFFECTED PAGES: NA

NF-161.01-4 R/0 (02/99)

Note: Preparer provide explicit instructions for volume/Addendum Calculations to be Incorporated using "Administrative Revisions".

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ATTACHMENTS

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1.0 OBJECTIVE

1.1. Determine the As-Found Tolerance (AFT), As-Left Tolerance (ALT), setpoint and Allowable Value for the Reactor Pressure Vessel (RPV) Level 2 and Level 8 Wide Range (WR) instrumentation. This includes transmitters 1B21N073C,D,G,H: Level 2 and Level 8 trip units 1B21N673C,D,G,H and 1B21N674C,D, respectively.

1.2. This calculation evaluates the adequacy of the current setpoints in relationship to the results of 1.1 above.

1.3. The setpoint for RPV Levels 2 and 8 were originally calculated in GE letter IP-3040 (Input 4.8). GE letter IP-3040 provided CPS specific setpoint information in the absence of a formal CPS calculation. Now that this calculation is in place, these results shall be used in lieu of GE letter IP-3040 results for the parameters covered by this calculation.

2.0 ASSUMPTIONS

2.1 Published instrument vendor specifications are considered to be 2σ values unless specific information is available to indicate otherwise (Ref. 6.1, Section 4.1.3.4).

2.2 Temperature, humidity, power supply, and ambient pressure errors have been incorporated when provided by the manufacturer. Otherwise, these errors are assumed to be included in the manufacturer's accuracy or repeatability specifications (Ref. 6.1, Section 4.3.1 and Appendix A, Section A.2.1).

2.3 Changes in ambient humidity are assumed to have a negligible effect on the uncertainty of the instruments used in these loops (Ref. 6.1, Appendix I, Section I.2).

2.4 Normal radiation induced errors have been incorporated when provided by the manufacturer. Otherwise, these errors are assumed to be small and capable of being adjusted out each time the instrument is calibrated. Therefore, unless specifically provided, normal radiation errors can be assumed to be included within the instrument drift errors (Ref. 6.1, Appendix I, Section I.1).

2.5 This analysis assumes that the instrument power supply stability (PSS) is within $\pm$5% ($\pm$1.2 Vdc) of a nominal 24 Vdc (Ref. 6.1, App. I, Section I.11).

2.6 The Drift Effect will be determined with the assumption of a 30-month calibration interval (24-month nominal plus 25%). Drift will be determined using vendor provided data. Where vendor data is unavailable, drift will be determined in accordance with Reference 6.1.

2.7 It is assumed that the M&TE listed in Section 7.0 of the calibration procedures is calibrated to the required manufacturer's recommendations and within the manufacturer's required environmental conditions. Temperature related errors are based on the difference between the manufacturer's specific calibration temperature and the worst case temperature at which the device is used (Reference 6.5, Reference 6.1 Appendix H.1).

2.8 Per Reference 6.1, it is assumed that the reference standards used for calibrating M&TE or Calibration tools shall have an uncertainty requirement of not more than ¼ of the accuracy of the equipment being calibrated. A greater uncertainty may be acceptable as limited by "State of the Art". It is generally accepted that the published vendor accuracy of the M&TE or Calibration tool includes the uncertainty of the calibration standard M&TE when the 4:1 accuracy standard is satisfied. Hence, Calibration Standard uncertainty is considered negligible to the overall calibration error term and can be ignored. This assumption is based primarily upon inherent M&TE conservatism built into the calculation.

2.9 Review of historical maintenance work request for the loop indicates the effects associated with EMI and RFI have not resulted in equipment failure or degraded performance during the life of the plant. In addition, vendor performance specifications and qualification test reports do not provide an instrument error specification for the effects of EMI and RFI. As such, any effect related to EMI and RFI are assumed to be negligible. (Ref. 6.1, Section 4.3.1 and Appendix A, Section A.2.1).

2.10 Reference 6.1, Section C.3.14, states, "There are no realistic, identifiable events which would result in a pipe break inside containment of the magnitude required to cause a loss-of-coolant accident coincident with safe shutdown earthquake." Therefore, this calculation considers the effects of a seismic event and loss-of-coolant accident independently to establish the worst case scenario for the instrumentation being evaluated. Consideration has been given to the accident that this equipment is required to mitigate.

2.11 Per Reference 6.1, Section 4.1.2.2, CPS assumes that functions associated with setpoints will function in their first trip during an event, the point in time when they and they alone, are most relied upon for plant safety. Worst case environmental conditions, that assume failure of protective equipment, or conditions that would only exist after the point of time where manual operator action is expected, are not applicable to the automatic trip functions that are expected or relied upon to occur in the early part of an event. However, the plant operating conditions under which the automatic trip must be operable should be evaluated.

Per Input 4.8, the RPV Level 2 and 8 wide range (WR) trip functions are required for 30 minutes post accident. Both trip functions are assumed in the Small Break Accident Analysis (References 6.7 & 6.8). Therefore, this calculation assumes the worst rational environmental condition at the

time of the Level 2 or Level 8 trip operation will result in harsh temperature conditions concurrent with high humidity, particularly steam environments.

Per Reference 6.4, the Total Integrated Dose (TID) to the transmitters will be <0.1 MRAD and therefore no radiation effects need be considered.

Per Section 1.2.1 of Reference 6.4, "From the standpoint of establishing setpoints, Harsh Environment does not apply. This distinction is made to avoid confusion between the long-term functional requirements for the devices, which includes post-trip operation, and the operation requirements during the initial period leading to the first trip." The error introduced by such Harsh environment effects is referred to as Insulation Resistance Accuracy (IRA) error.

Based upon the foregoing, it is assumed that accident radiation effects and the error attributed to IRA are negligible.

2.12 ASME Steam Tables software was used to determine properties of water and steam used in this calculation. This software is provided with the ASME Steam Tables and represented as the computer code utilized to generate the actual tables. Software greatly reduces interpolation errors, and it is assumed the calculation reviewer will validate the accuracy of the program output by checking against Reference 6.6

2.13 This calculation assumes that the cold calibrated span for the level transmitters are greater than 155 inwc. This assumption provides a reasonable approximation of turndown ratio. Attachment 1 of this calculation determines head correction and cold calibration values specific to each of the level transmitters addressed by this calculation. The cold calibration results of Attachment 1 validate this assumption.

3.0 METHODOLOGY

This calculation will determine the instrument uncertainty associated with the RPV level transmitters. The Evaluation will determine the loop setpoints and Allowable Values for the Level 2 and 8 Functions. Instrument uncertainty will be determined in accordance with Reference 6.1, CI-01.00, "Instrument Setpoint Calculation Methodology." The evaluation will then compare the current setpoints and Allowable Values with the results determined by this calculation.

Section 2.1.3 of Reference 6.1, CI-01.00, "Instrument Setpoint Calculation Methodology" states the standard provides flexibility in the precise method in which a setpoint is determined.

As stated in Section 2.1.4 of CI-01.00, the setpoint methodology is based on the industry standard ANSI/ISA S67.04 (Reference 6.8). Recommended Practice ANSI/ISA S67.04.02-2000 (Reference 6.9) provides a detailed methodology for implementing Reference 6.8. CI-01.00 uses Method 1 of Recommended Practice (Ref. 6.9, Section 7), to establish the relationship between the Analytical Limit (AL), Allowable Value (AV) and Nominal Trip Setpoint (NTSP). The Recommended Practice details two other acceptable methods.

Use of the CI-01.00 standard methodology results in Level 2 & 8 NTSPs which would decrease plant operating margin (i.e., a setpoint closer to the operational RPV level range than the current field setpoint). methodology results in a more conservative approximation of loop uncertainty than the methodology of Reference 6.9. This extra conservatism comes as a result of effectively algebraically adding the Square Root Sum of the Squares (SRSS) of A_L, PMA & PEA to the SRSS of C_L & D_L, the sum of which, depending upon trip direction, is appropriately added or subtracted from the AL to determine the NTSP.

$$NTSP_{(INC)} = AL - [\,(A_L^2 + PMA^2 + PEA^2)^{1/2} + (C_L^2 + D_L^2)^{1/2}\,].$$

$$NTSP_{(DEC)} = AL + [\,(A_L^2 + PMA^2 + PEA^2)^{1/2} + (C_L^2 + D_L^2)^{1/2}\,].$$

Combining the same error terms entirely by the SRSS method, per Reference 6.9 Methods 2 & 3, yields a smaller error term and an NTSP which demonstrates the current RPV Level 2 & 8 setpoints are conservative.

$$NTSP_{(INC)} = AL - (A_L^2 + C_L^2 + D_L^2 + PMA^2 + PEA^2)^{1/2}$$

$$NTSP_{(DEC)} = AL + (A_L^2 + C_L^2 + D_L^2 + PMA^2 + PEA^2)^{1/2}$$

Removing unnecessary conservatism, through use of an alternative industry standard method, eliminates negative impact upon plant operation and costs necessary to implement a setpoint change.

Method 3 of the Recommended Practice provides for calculation of the Allowable value by summing the uncertainties of drift (D_L) , calibration uncertainty (C_L), and "uncertainties during normal operation."

The CI-01.00 method of determining AFT_L determines the SRSS of C_L and D_L.

The methodology used in this calculation to determine AV will be to appropriately sum AFT_L with NTSP.

$$AV_{(inc)} = NTSP + AFT_L$$
$$AV_{(dec)} = NTSP - AFT_L$$

M&TE error will be determined from the results of Calculation IP-C-0089 (Input 4.6.1) which uses building temperature minimum and maximums to develop the uncertainty, and review of the corresponding loop and device calibration procedure (Inputs 4.12.1 and 4.12.2).

Per Reference 6.1, Head Correction is determined by evaluating either drawings, survey data, and/or walk down data as applicable. However for this calculation, head correction associated with these transmitters will be determined using survey data.

This calculation requires an appreciation of the relationship between cold calibration span, and process span. Cold calibration span refers to the difference between the minimum and maximum pressures applied to the transmitter during calibration to simulate the differential pressure applied under normal operating pressure and temperature (NOP/NOT) that correspond with a vessel water level of 0% and 100%. Therefore, the terms cold calibration span and process span are equivalent when the plant is at NOP/NOT. Per Assumption 2.13 cold calibration span is 155 inwc and per Input 4.9.1 process span is 220 inches.

4.0 INPUTS

4.1 P&IDs

4.1.1 M05-1071, Sheet 1, Rev. AB, "Nuclear Boiler (NB)".
4.1.2 M05-1071, Sheet 2, Rev. Y, "Nuclear Boiler (NB)".

4.2 Technical Manuals

4.2.1 K2801-0091, Tab 2, Rev. 9, "Rosemount Model 1153 Series B Alphaline Pressure Transmitter for Nuclear Service" dated May, 1993.

4.3 System Design Criteria

4.3.1 DC-ME-09-CP, Rev. 11, "Equipment Environmental Design Conditions Design Criteria", (Zone Code H-26, Map Code C.3.1, HCU Modules El. 755'-0", page 72; Zone Code M-24, Map Code D.6.2, Main Control Room & Electric Panel Room, El. 800'-0", page 49).

4.4 CPS Drawings

4.4.1 E03-1P663-670, Rev. B, "Internal-External Wiring Diagram NSPS Div 3 Cabinet 1H13-P663"
4.4.2 E03-1P664-664, Rev. B, "Internal-External Wiring Diagram NSPS Div 4 Cabinet 1H13-P664"
4.4.3 E03-1P663 Sheet 604, Rev D, "Internal Wiring Diagram, NSPS Div. 1 Cabinet 1H13-P663".
4.4.4 E03-1P664 Sheet 604, Rev C, "Internal Wiring Diagram, NSPS Div. 2 Cabinet 1H13-P664".
4.4.5 M01-1107 Sheet 5, Rev. D, "General Arrangement Aux. Fuel Bldg & Containment Mezz. Floor Plan EL. 755'-0" & EL. 762'-0""
4.4.6 NB-910, Rev. 6, "Containment Bldg. Nuclear Boiler Piping"
4.4.7 NB-942, Rev. 3, "Containment Bldg. Nuclear Boiler Piping"
4.4.8 164C5902AC, Rev. 0, " GE Reactor Vessel Level & Pressure Local Panel C"
4.4.9 164C5911AC, Rev. 1, " GE Reactor Vessel Level & Pressure Local Panel D"
4.4.10 769E305 Sh. 3, Rev. 6 GE Design Drawing RPV Level
4.4.11 769E305 Sh. 5, Rev. 4 GE Design Drawing RPV Level

4.5 Passport (D030), For Information Only

4.5.1 EIN 1B21N073C,D,G,H Rosemount Transmitters, Model 1153DB4PC
4.5.2 EIN 1B21N673C,D,G,H Analog Trip Module, Model 147D8505G005
4.5.3 EIN PG1512, dated 10/15/00

4.6 Calculations

4.6.1 Calculation IP-C-0089, Rev. 0, "M&TE Uncertainty Calculation"

4.7 Equipment Qualification

4.7.1 SQ-CL001, Rev. 29, Rosemount 1153 Series B and 1154 transmitters.
4.7.2 SQ-CL603, Rev. 15, Qualification for MCR Panels.

4.8 IP-3040, Letter from L.H. Larson, to J.H.Greene, dated January 23, 1987, "Clinton Power Station, Unit 1 Setpoint Methodology Program"; CPS File Number N55-87 (1-23)6 #45123.

4.9 Design Specifications/Data Sheets

4.9.1 LT050, Rev. E, "Level Transmitters", Instrument Data Sheet for 1B21N073C,D,G,H
4.9.2 DSDS 22A4622AV, Rev 12, "Nuclear Boiler System Design Spec Data Sheet"
4.9.3 Performance Specification 22A7866, Revision 4, "Analog Trip Unit".
4.9.4 Design Specification 22A4622, Rev. 7, "Nuclear Boiler System"
4.9.5 PL442X493 Rev.18 "Card Ident List P663"
4.9.6 PL442X494 Rev.18 "Card Ident List P664"
4.9.7 EDDL DL851E380AC, Rev. 22 "HPCS System"

4.10 Construction Work Requests and Plant Survey Data

4.10.1 CWR 12339, Survey Data, dated 1/14/85
4.10.2 Homer Chastain plant survey data for RF-4, Document Number Y-103230, File Code U070-93(12-14)-6

4.11 Reports/Correspondence Related to RPV Level

4.11.1 Reactor Pressure Vessel Water Level Measurement System Evaluation Report, prepared by GE for CPS, dated November 1984
4.11.2 Not Used
4.11.3 Y-103435, RPV Level Head Corrections Using Survey Elevations from RF-4, 2/15/94
4.11.4 EDE-42-1289, Rev. 2, Clinton Reactor Vessel Water Level Transmitter Calibration, July 1990, Rev. 2
4.11.5 JAM-00185-NSED, Document Number Y-94738, File Code B94-90(08-20)-6, "GE SIL 470 Supp 1 and CR 1-88-09-058 RPV Level Head Corrections", Memo from J. A. Miller, Manager-NSED to J. G. Cook, Plant Manager, dated 8/20/90

4.12 Calibration Procedures

4.12.1 CPS 9433.07, Rev. 35a, "ECCS REACTOR VESSEL WATER LEVEL B21-N073C(G) CHANNEL CALIBRATION".
4.12.2 CPS 9433.08, Rev. 34b, "ECCS REACTOR VESSEL WATER LEVEL B21-N073D(H) CHANNEL CALIBRATION".
4.12.3 CPS 9433.08D001, Rev. 34, "ECCS REACTOR VESSEL WATER LEVEL B21-N073D CHANNEL CALIBRATION".
4.12.4 CPS 9433.08D002, Rev. 34, "ECCS REACTOR VESSEL WATER LEVEL B21-N073H CHANNEL CALIBRATION".
4.12.5 CPS 9030.01, Rev. 30, "Analog Trip Module (ATM) Functional and Calibration Check Instructions".
4.12.6 CPS 9030.01C002, Rev. 27, "HPCS Reactor Water Level B21-N673C(G,D,H) Checklist"

5.0 OUTPUTS

5.1 CPS 9433.07, Rev. 35a, "ECCS REACTOR VESSEL WATER LEVEL B21-N073C(G) CHANNEL CALIBRATION".

5.2 CPS 9433.08, Rev. 34b, "ECCS REACTOR VESSEL WATER LEVEL B21-N073D(H) CHANNEL CALIBRATION".

5.3 CPS 9433.08D001, Rev. 34, "ECCS REACTOR VESSEL WATER LEVEL B21-N073D CHANNEL CALIBRATION".

5.4 CPS 9433.08D002, Rev. 34, "ECCS REACTOR VESSEL WATER LEVEL B21-N073H CHANNEL CALIBRATION".

5.5 CPS 9030.01, Rev. 30, "Analog Trip Module (ATM) Functional and Calibration Check Instructions".

5.6 CPS 9030.01C002, Rev. 27, "HPCS Reactor Water Level B21-N673C(G,D,H) Checklist"

5.7 Operational Requirements Manual (ORM), Rev. 34

- 5.7.1 Attachment 2-8 Table 5 "Emergency Core Cooling System (ECCS) Instrumentation Trip Setpoints" Item 3.a
- 5.7.2 Attachment 2-8 Table 5 "Emergency Core Cooling System (ECCS) Instrumentation Trip Setpoints" Item 3.c
- 5.7.3 Attachment 2-12, Table 7, "Primary Containment and Drywell Isolation Instrumentation Trip Setpoints", Item 2.e

5.8 CPS Technical Specification, Amendment 140

- 5.8.1 Table 3.3.5.1-1, "Emergency Core Cooling System (ECCS) Instrumentation" Item 3a, "Reactor Vessel Water Level–Low Low, Level 2"
- 5.8.2 Table 3.3.5.1-1, "Emergency Core Cooling System (ECCS) Instrumentation" Item 3c, "Reactor Vessel Water Level–High, Level 8"
- 5.8.3 Table 3.3.6.1-1, "Primary Containment and Drywell Isolation Instrumentation", Item 2e, "Reactor Vessel Water Level–Low Low, Level 2 (HPCS NSPS Div 3 and 4)"

6.0 REFERENCES

6.1 CI-01.00, Rev. 2, Instrument Setpoint Calculation Methodology

6.2 CPS USAR, Rev. 9

- 6.2.1 Section 7.4.1.1, "Systems Required for Safe Shutdown", "Reactor Core Isolation Cooling System – Instrumentation and Controls"
- 6.2.2 Section 7.1.2.1.1, "Reactor Protection (Trip) System (RPS) Instrumentation and Controls".
- 6.2.3 Section 7.2.1.1.4, "Reactor Protection (Trip) System Instrumentation and Controls – Equipment Design"
- 6.2.4 Section 7.2.2.1, "Reactor Protection (Trip) System (RPS) Instrumentation and Controls".
- 6.2.5 Figure 3.11-3, "Environmental Zone Map, Auxiliary, Fuel & Containment Mezz. Floor Plan El. 755'-0" & 762'-0"".
- 6.2.6 Figure 3.11-13, "Environmental Zone Map, Control Building, Main Floor Plan El. 800'-0"".
- 6.2.7 Section 6.3.2.2.1 High-Pressure Core Spray (HPCS) System
- 6.2.8 Section 15.6 Decrease in Reactor Coolant Inventory

6.3 CPS Technical Specification, Amendment 140

- 6.3.1 Table 3.3.5.1-1, "Emergency Core Cooling System (ECCS) Instrumentation" Item 3a, "Reactor Vessel Water Level–Low Low, Level 2"
- 6.3.2 Table 3.3.5.1-1, "Emergency Core Cooling System (ECCS) Instrumentation" Item 3c, "Reactor Vessel Water Level–High, Level 8"
- 6.3.3 Bases Section 3.3.5.1, "Emergency Core Cooling System (ECCS) Instrumentation"
- 6.3.4 Table 3.3.6.1-1, "Primary Containment and Drywell Isolation Instrumentation", Item 2e, "Reactor Vessel Water Level–Low Low, Level 2 (HPCS NSPS Div 3 and 4)"
- 6.3.5 Bases Section 3.3.6.1, "Primary Containment and Drywell Isolation Instrumentation"

6.4 NEDC-31336, General Electric Instrument Setpoint Methodology, October 1986

6.5 CPS Procedure 1512.01, Rev. 17c, "Calibration and Control of Measuring and Test Equipment"

6.6 Meyer, C. A., McClintock, R. B., Silvestri, G. J., Spencer, Jr., R. C., "Thermodynamic and Transport Properties of Steam Comprising Tables and Charts for Steam and Water", The American Society of Mechanical Engineers, New York, New York, 1967.

6.7 Mark's Standard for Mechanical Engineers, Baumeister, Avallone, Baumeister, Eighth Edition.

6.8 ANSI/ISA-67.04.01-2000, Reaffirmation of ANSI/ISA-67.04, Part I-1994 "Setpoints for Nuclear Safety-Related Instrumentation" February 29, 2000

6.9 ANSI/ISA-67.04.02-2000, Recommended Practice "Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation" January 1, 2000

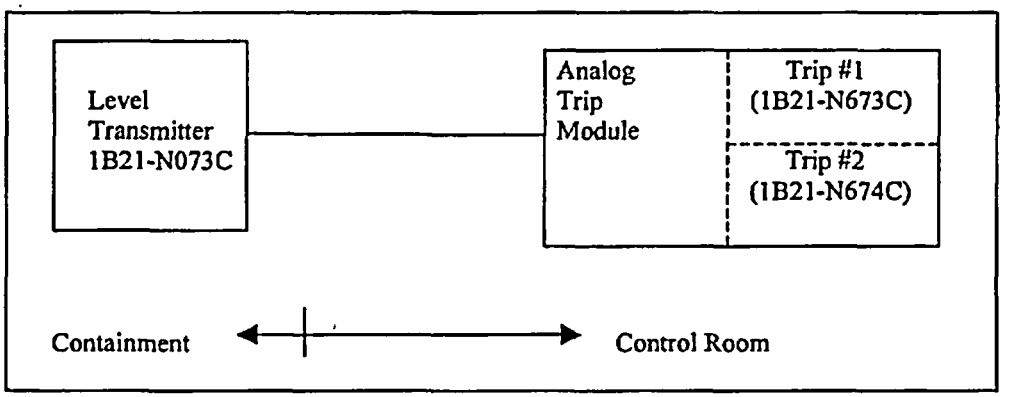
7 ANALYSIS AND COMPUTATION SECTION(S)

7.1 LOOP FUNCTION

From Input 4.9.2, 1B21-N673C,D,G,H provide Level 2 initiation signals for "HPCS". Also from Input 4.9.2, 1B21-N674C,D provide Level 8 signal to trip HPCS. Note there is only one physical Analog Trip Module per channel; 1B21-N674(A, B, C or D) is merely trip circuit #2 of the same module of which 1B21-N673(A, B, C or D) is trip circuit #1.

7.2 LOOP DIAGRAM

From Inputs 4.4.1 and 4.4.2;



The circuit shown above is that of the 1B21-N073C loop showing the level transmitter and trip unit. This configuration is typical for the 1B21-N073C,D loops. The 1B21-N073G and H loops are configured in the same way but there is no Trip #2 output.

1B21N073C,D,G & H

Environmental Zone	Contmt. H-26, Map Code C.3.1
Normal Temperature	65 to 104 °F
Normal Humidity	5 to 90% RH
Normal Radiation	1×10^4 Rads
Accident Temperature	104 to 185 °F
Accident Humidity	Up to 100% RH
Accident Radiation	2×10^8 Rads
Seismic	SQ-CL-001

1B21N673C,D,G & H; 1B21N674C & D

Environmental Zone	MCR M-24, Map Code D.6.2
Normal Temperature	65 to 104 °F
Normal Humidity	35 to 100% RH
Normal Radiation	1×10^3 Rads
Accident Temperature	65 to 104 °F
Accident Humidity	35 to 100% RH
Accident Radiation	1×10^3 Rads
Seismic	SQ-CL-603

From Inputs 4.3.1, 4.4.5, 4.4.8, 4.4.9 and Reference 6.2.5, show the 1B21N073C,D,G & H transmitters are in the environmental zone for the Containment 755 foot elevation (Zone H-26, Map Code C.3.1). From Inputs 4.3.1, 4.4.3, 4.4.4 and Reference 6.2.6, show the 1B21N673C, D, G & H ATM(s) are in the Main Control Room (MCR) (Zone Code M-24, Map Code D.6.2).

7.3 EQUATIONS

The equations for NTSP (Section 7.3.4) and AV (Section 7.3.5) are taken from Section 3.0, Methodology. All remaining equations in this section are taken from the table in CI-01.00 (Reference 6.1, Section 4.5.4).

7.3.1 Loop Accuracy (A_L):

Derived from the SSRS combination of loop components, where error attributed for each loop component is evaluated by:

$$A_i = \pm N \sqrt{\left(\frac{VA_i}{n}\right)^2 + \left(\frac{ATE_i}{n}\right)^2 + \left(\frac{OPE_i}{n}\right)^2 + \left(\frac{SPE_i}{n}\right)^2 + \left(\frac{SE_i}{n}\right)^2 + \left(\frac{RE_i}{n}\right)^2 + \left(\frac{HE_i}{n}\right)^2 + \left(\frac{PSE_i}{n}\right)^2 + \left(\frac{REE_i}{n}\right)^2} \pm B \qquad (2\sigma)$$

A_L is defined as:

$$A_L = \pm\sqrt{A_1^2 + A_2^2 + A_3^2 + \ldots} \pm B \qquad (2\sigma)$$

7.3.2 Loop Calibration Error (C_L):

$$C_L = \pm N\sqrt{\sum\left(\frac{ALT_i}{n}\right)^2 + \sum\left(\frac{C_i}{n}\right)^2 + \sum\left(\frac{C_iSTD}{n}\right)^2} \qquad (2\sigma)$$

7.3.3 Loop Drift (D_L):

$$D_L = \pm N\sqrt{\left(\frac{D_1}{n}\right)^2 + \left(\frac{D_2}{n}\right)^2 + \ldots + \left(\frac{D_n}{n}\right)^2} \qquad (2\sigma)$$

7.3.4 Nominal Trip Setpoint Calculation

The Nominal Trip Setpoint (NTSP) should be calculated using the equations below depending on the direction of process variable change when approaching the Analytical Limit.

For process variables that increase to trip.

$$NTSP = AL - \left(\frac{1.645}{2}\right)\sqrt{A_L^2 + C_L^2 + D_L^2 + PMA^2 + PEA^2} - B$$

For process variables that decrease to trip.

$$NTSP = AL + \left(\frac{1.645}{2}\right)\sqrt{A_L^2 + C_L^2 + D_L^2 + PMA^2 + PEA^2} + B$$

Note: An (1.645/N) adjustment is applicable to setpoints that have a limit approached in one direction (single sided interest).

7.3.5 Allowable Value Calculation

The Allowable Value may be calculated for an increasing trip as follows:

$\mathbf{AV_{(INC)} = NTSP + AFT_L}$

The Allowable Value may be calculated for a decreasing trip as follows:

$\mathbf{AV_{(DEC)} = NTSP - AFT_L}$

7.3.6 Calculation of As-Found Values

The device As-Found Tolerance will be determined via the Square-Root-Sum-of-the-Squares (SRSS) of the device's As-Left Tolerance, its drift, and the M&TE error used to calibrate the device.

$$AFT_i = \pm(N)\sqrt{\left(\frac{ALT_i}{n}\right)^2 + \left(\frac{D_i}{n}\right)^2 + \left(\frac{C_i}{n}\right)^2} \qquad (2\sigma)$$

Where:

ALT_i = device's As-Left Tolerance
D_i = device's drift value
C_i = errors of M&TE used to calibrate the device

The loop As-Found Tolerance (AFT) will be calculated as follows:

$$AFT_L = \pm(N)\sqrt{\left(\frac{C_L}{n}\right)^2 + \left(\frac{D_L}{n}\right)^2} \qquad (2\sigma)$$

Where:

D_L = Loop devices' drift value, as defined in Section 7.3.3
C_L = Loop devices' calibration effect, as defined in Section 7.3.2

However, since the transmitter and trip unit are calibrated as a string per Input 4.12.1, the As Found Tolerance determined by this calculation will be applicable to the string.

7.3.7 Calculation of As-Left Values

The loop As-Left Tolerance (ALT) will be calculated as follows:

$$ALT_L = \pm(N)\sqrt{\left(\frac{ALT_1}{n}\right)^2 + \left(\frac{ALT_2}{n}\right)^2 + \ldots + \left(\frac{ALT_n}{n}\right)^2} \qquad (2\sigma)$$

Where:

$$ALT_i = \pm VA_i \qquad (2\sigma)$$

7.4 Determination of Uncertainties

7.4.1 Rosemount 1153B Transmitters;

- From Input 4.9.1, EIN 1B21N073C, D, G & H are Rosemount 1153DB5PC transmitters.
- From Input 4.9.1, EIN1B21N073C,D,G & H may be either output Code "P" or "R". This analysis will use the "P" specification since they are more limiting.
- From Input 4.2.1, Vendor Accuracy = ±0.25% of Span
- From Input 4.2.1, Upper Range Limit = 750 inwc
- Level transmitter performance uncertainties are calculated as a percentage of cold calibrated span (%CC Span) to properly account for the impact of turn-down ratio. Per Assumption 2.13, Cold Calibrated Span = 155 inwc.

7.4.1.1 Vendor Accuracy of level transmitters (VA_{LT}) – Per Input 4.2.1, Vendor Accuracy is ±0.25% of calibrated Span. Therefore:

$$\mathbf{VA_{LT} = \pm 0.25\%CC\ Span} \qquad (3\sigma)$$

7.4.1.2 Accuracy Temperature Effect

7.4.1.2.1 Normal Accuracy Temperature Effect ($ATE_{LT(Normal)}$)

- Per Input 4.2.1, the ATE is calculated by ± (0.75% URL + 0.5% Span) per 100 °F.
- Per Section 7.2, the maximum Delta T (ΔT) equals 39°F (104°F – 65°F).
- Per Section 7.4.1, Upper Range Limit (URL) is 750 inwc.
- Per Section 7.4.1, Cold Calibrated Span is 155 inwc.

Therefore:

$ATE_{LT(Normal)} = \pm (0.75\%\ URL + 0.5\%\ Span) * (\Delta T / 100°F)$

$ATE_{LT(Normal)} = \pm ((0.75\% * 750\ inwc) + (0.5\% * 155\ inwc)) * (39°F / 100°F)$

$ATE_{LT(Normal)} = \pm 2.4960\ inwc$

Converting to % span:

$ATE_{LT(Normal)} = \pm 2.4960\ inwc / 155\ inwc * 100\%\ Span$

$\mathbf{ATE_{LT(Normal)} = \pm 1.6103\%CC\ Span}$ (3σ)

7.4.1.2.2 Accident Accuracy Temperature Effect ($ATE_{LT(Accid)}$)

- Per Input 4.2.1, the ATE is calculated by ± (0.75% URL + 0.5% Span) per 100°F.
- Per Section 7.2, the maximum Delta T (ΔT) under accident conditions equals 120°F (185°F – 65°F).
- Per Section 7.4.1, Upper Range Limit (URL) is 750 inwc.
- Per Section 7.4.1, Cold Calibrated Span is 155 inwc.

Therefore:

$ATE_{LT(Accid)}$ = ± (0.75% URL + 0.5% Span) * (ΔT / 100°F)

$ATE_{LT(Accid)}$ = ± ((0.75% * 750 inwc) + (0.5% * 155 inwc)) * (120°F /100°F)

$ATE_{LT(Accid)}$ = ± 7.6800 inwc

Converting to % span:

$ATE_{LT(Accid)}$ = ± 7.6800 inwc / 155 inwc * 100% span

$ATE_{LT(Accid)}$ = ± 4.9548%CC Span (3σ)

7.4.1.3 Humidity Effect (HE_{LT}) – The vendor does not provide any specification for this effect (Input 4.2.1). Therefore, per Assumption 2.3, Humidity Effects are negligible. Therefore:

$HE_{LT} = 0$

7.4.1.4 Radiation Effects

7.4.1.4.1 Normal Radiation Effects ($RE_{LT(Normal)}$) – Per Assumption 2.4, normal Radiation Effects are not distinguishable from Drift. Therefore:

$RE_{LT(Normal)} = 0$

7.4.1.4.2 Accident Radiation Effects ($RE_{LT(Accid)}$) - Per Assumption 2.11, accident radiation effects are not applicable to this calculation.

$RE_{LT(Accid)} = 0$

7.4.1.5 Power Supply Effects of level transmitters (PSE_{LT}) – Per Input 4.2.1, PSE is "less than ± 0.005% output span per Volt". Per Assumption 2.5, PSS is ± 1.2 Vdc. Therefore:

$PSE_{LT} = \pm(0.005\%\ Span/\ Vdc) * PSS$
$PSE_{LT} = \pm(0.005\%\ Span/Vdc) * 1.2\ Vdc$
$PSE_{LT} = \pm 0.0060\%$CC Span (3σ)

7.4.1.6 Static Pressure Effect (SPE_{LT}) – Per Input 4.2.1, the static level effect for the Rosemount transmitter is composed of a zero effect and a span effect. Per Input 4.12.1, the zero effect is calibrated out and the systematic span effect is calibrated out. Per Input 4.2.1, under these conditions there is still a correction uncertainty of ±0.5% of reading per 1000 psig static pressure.

- Per Input 4.9.1, the maximum process pressure is 1250 psig.

$SPE_{LT} = \pm 0.5\%$ span * (Static Pressure/1000 psig)
$SPE_{LT} = \pm 0.5\%$ span * (1250 psig/1000 psig)
$SPE_{LT} = \pm 0.6250\%$CC span (3σ)

7.4.1.7 Overpressure Effect (OPE_{LT}) – Per Reference 6.1, Section C.3.8, the Overpressure Effect is not applicable for instruments that are not over ranged by process pressure. Per Input 4.2.1 the Upper Range Limit is 750 inwc and per Attachment 1 the difference between the condensate pot and variable leg nozzle is approximately 250 inches. Therefore the differential pressure sensed by the level transmitters can not exceed the Upper Range Limit. Therefore;

$OPE_{LT} = 0$

7.4.1.8 Seismic Effect

7.4.1.8.1 Normal Seismic Effect ($SE_{LT(Normal)}$) – Seismic activity is not considered when determining instrument uncertainty under normal conditions. Therefore:

$SE_{LT(Normal)} = 0$

7.4.1.8.2 Accident Seismic Effect ($SE_{LT(Accid)}$) - Per Assumption 2.10, Seismic Effect is not considered to occur concurrent with an LOCA accident. Therefore:

$$\mathbf{SE_{LT(Accid)} = 0}$$

7.4.1.8.3 OBE/SSE Seismic Effect ($SE_{LT(Seismic)}$) – Per Input 4.2.1, Seismic Effect is ± 0.5% URL during and after a seismic disturbance defined by a required response spectrum with a ZPA of 4 g's.

- Per Section 7.4.1, Upper Range Limit (URL) is 750 inwc.
- Per Section 7.4.1, Span (URL) is 155 inwc.

$SE_{LT(Seismic)} = \pm (0.5\%)(URL)$
$SE_{LT(Seismic)} = \pm 0.5\% * 750$ inwc
$SE_{LT(Seismic)} = \pm 3.7500$ inwc

Converting to % span:
$SE_{LT(Seismic)} = \pm 3.7500$ inwc / 155 inwc * 100% span
$\mathbf{SE_{LT(Seismic)} = \pm 2.4194\%CC\ Span}$ (2σ)

7.4.1.9 RFI/EMI Effect (REE_{LT}) – Per Assumption 2.9, the effects of RFI/EMI are considered negligible.

$$\mathbf{REE_{LT} = 0}$$

7.4.1.10 Bias (B_{LT}) – From Appendix C of Reference 6.1, Bias is defined as a systematic or fixed instrument uncertainty that is predictable for a given set of conditions because of the existence of a known direction (positive or negative). Per Assumption 2.11, insulation resistance error effects are considered negligible for instrument setpoint actions that occur prior to or very early in a postulated LOCA event. This assumption is applicable to the subject of this analysis. Therefore:

$$\mathbf{B_{LT} = 0}$$

7.4.1.11 Per Section 7.3.1, the accuracy associated with the differential pressure transmitters is calculated below.

$$A_i = \pm N \sqrt{\left(\frac{VA_i}{n}\right)^2 + \left(\frac{ATE_i}{n}\right)^2 + \left(\frac{OPE_i}{n}\right)^2 + \left(\frac{SPE_i}{n}\right)^2 + \left(\frac{SE_i}{n}\right)^2 + \left(\frac{RE_i}{n}\right)^2 + \left(\frac{HE_i}{n}\right)^2 + \left(\frac{PSE_i}{n}\right)^2 + \left(\frac{REE_i}{n}\right)^2} \pm B \quad (2\sigma)$$

7.4.1.11.1 Normal Level Transmitter Accuracy ($A_{LT(Normal)}$)

Substituting into the A_i equation where:

VA_{LT}	= ± 0.2500%CC Span (3σ)	Section 7.4.1.1
$ATE_{LT\ (Normal)}$	= ± 1.6103%CC Span (3σ)	Section 7.4.1.2.1
OPE_{LT}	= 0	Section 7.4.1.7
SPE_{LT}	= ± 0.6250%CC Span (3σ)	Section 7.4.1.6
$SE_{LT\ (Normal)}$	= 0	Section 7.4.1.8.1
$RE_{LT\ (Normal)}$	= 0	Section 7.4.1.4.1
HE_{LT}	= 0	Section 7.4.1.3
PSE_{LT}	=± 0.0060%CC Span (3σ)	Section 7.4.1.5
REE_{LT}	= 0	Section 7.4.1.9
B_{LT}	= 0	Section 7.4.1.10

$$A_{LT\ (Normal)} = \pm 2 \sqrt{\left(\frac{0.25\%CC\ \ Span}{3}\right)^2 + \left(\frac{1.6103\%CC\ \ Span}{3}\right)^2 \cdots + \left(\frac{0.625\%CC\ \ Span}{3}\right)^2 + \left(\frac{0.006\%CC\ \ Span}{3}\right)^2} + 0$$

$$\mathbf{A_{LT(Normal)} = \pm 1.1636\%CC\ Span} \quad (2\sigma)$$

7.4.1.11.2 Accident Level Transmitter Accuracy ($A_{LT(Accid)}$)

Substituting into the A_i equation where:

VA_{LT}	= ± 0.2500%CC Span (3σ)	Section 7.4.1.1
$ATE_{LT\ (Accid)}$	= ± 4.9548%CC Span (3σ)	Section 7.4.1.2.2
OPE_{LT}	= 0	Section 7.4.1.7
SPE_{LT}	= ± 0.6250%CC Span (3σ)	Section 7.4.1.6
$SE_{LT\ (Accid)}$	= 0	Section 7.4.1.8.2
$RE_{LT\ (Accid)}$	= 0	Section 7.4.1.4.2
HE_{LT}	= 0	Section 7.4.1.3
PSE_{LT}	=± 0.0060 % Span (3σ)	Section 7.4.1.5
REE_{LT}	= 0	Section 7.4.1.9
B_{LT}	= 0	Section 7.4.1.10

$$A_{LT\ (Accid)} = \pm 2\sqrt{\left(\frac{0.25\%CC\ Span}{3}\right)^2 + \left(\frac{4.9548\%CC\ Span}{3}\right)^2 \cdots + \left(\frac{0.625\%CC\ Span}{3}\right)^2 + \left(\frac{0.006\%CC\ Span}{3}\right)^2} + 0$$

$A_{LT(Accid)}$ = **±3.3335%CC Span** (2σ)

7.4.1.11.3 Seismic Level Transmitter Accuracy ($A_{LT(Seismic)}$)

Substituting into the A_i equation where:

VA_{LT}	= ± 0.2500%CC Span (3σ)	Section 7.4.1.1
$ATE_{LT\ (Normal)}$	= ± 1.6103%CC Span (3σ)	Section 7.4.1.2.1
OPE_{LT}	= 0	Section 7.4.1.7
SPE_{LT}	= ± 0.6250%CC Span (3σ)	Section 7.4.1.6
$SE_{LT\ (Seismic)}$	= ± 2.4194%CC Span (2σ)	Section 7.4.1.8.3
$RE_{LT\ (Normal)}$	= 0	Section 7.4.1.4.1
HE_{LT}	= 0	Section 7.4.1.3
PSE_{LT}	=± 0.0060%CC Span (3σ)	Section 7.4.1.5
REE_{LT}	= 0	Section 7.4.1.9
B_{LT}	= 0	Section 7.4.1.10

$$A_{LT(Seismic)} = \pm 2\sqrt{\left(\frac{0.25\%CC\ Span}{3}\right)^2 + \left(\frac{1.6103\%CC\ Span}{3}\right)^2 + \left(\frac{0.625\%CC\ Span}{3}\right)^2 \cdots + \left(\frac{2.4194\%CC\ Span}{2}\right)^2 + \left(\frac{0.006\%CC\ Span}{3}\right)^2} + 0$$

$A_{LT(Seismic)}$ = **±2.6847%CC Span** (2σ)

7.4.1.11.4 Level Transmitter Accuracy (A_{LT})

Per Input 4.8, the "Accident Function Time" for the RPV Level 2 and Level 8 trips are 30 minutes per the small break analysis.

Based on the results shown above, the accident uncertainty is bounding for both the Level 2 and Level 8 trip functions. As discussed in Section 3.0, cold calibrated span is equivalent to process span when the plant is at NOP/NOT. Since the loop is required to function only when the plant is at NOP/NOT. Therefore:

%CC Span = % Process Span = % Span

$A_{LT} = A_{LT(Accid)}$
$A_{LT} = \pm 3.3335\%$ Span (2σ)

7.4.2 Analog Trip Module (ATM)

- Per Inputs 4.4.3, 4.4.4, 4.9.5 & 4.9.6, EINs 1B21N673C,D,G,& H are GE Analog Trip Units, Model Number 147D8505G005.
- Per Input 4.9.3, the input range for ATM is 4-20 mA.
- Per Input 4.9.3, the vendor accuracy is ±0.25% Full Scale (Span).
- Per Section 7.2, ATM's are located in a mild environment and therefore accident conditions need not be considered.

7.4.2.1 Vendor Accuracy (VA_{ATM}) - Per Inputs 4.4.3, 4.4.4, 4.9.5 and 4.9.6 , the Analog Trip Modules are GE Model Number 147D8505G005. Per Input 4.9.3, the vendor accuracy is ±0.25% Span. Therefore:

$VA_{ATM} = \pm 0.2500\%$ Span (2σ)

7.4.2.2 Accuracy Temperature Effect (ATE_{ATM}) – The vendor does not provide any specification for this effect (Input 4.9.3). Therefore Per Assumption 2.2, Accuracy Temperature Effect is considered to be included in vendor accuracy. Therefore,

$ATE_{ATM} = 0$

7.4.2.3 Overpressure Pressure Effect (OPE_{ATM}) – OPE is not applicable to Analog Trip Modules.

$OPE_{ATM} = 0$

7.4.2.4 Static Pressure Effect (SPE_{ATM}) – SPE is not applicable to Analog Trip Modules.

$$\mathbf{SPE_{ATM} = 0}$$

7.4.2.5 Seismic Effect (SE_{ATM}) – Analog Trip Modules have been seismically qualified using the manufacturer's published accuracy requirements (Input 4.7.2). Based on a review of Input 4.7.2, there are no additional error considerations which must be considered for seismic conditions. Therefore:

$$\mathbf{SE_{ATM} = 0}$$

7.4.2.6 Radiation Effect (RE_{ATM}) – The ATMs are located in a mild enviroment, and therefore, not subject to any significant radiation exposure. Therefore, the Radiation Effect is considered negligible.

$$\mathbf{RE_{ATM} = 0}$$

7.4.2.7 Humidity Effect (HE_{ATM}) – The vendor does not provide any specification for this effect (Input 4.9.3). Therefore, per Assumption 2.2, the Humidity Effect is considered to be included in the Vendor Accuracy.

$$\mathbf{HE_{ATM} = 0}$$

7.4.2.8 Power Supply Effect (PSE_{ATM}) - The vendor does not provide any specification for this effect (Input 4.9.3). Therefore, per Assumption 2.2, the Power Supply Effect is considered to be included in the Vendor Accuracy.

$$\mathbf{PSE_{ATM} = 0}$$

7.4.2.9 RFI/EMI Effect (REE_{ATM}) – Per Assumption 2.9, the effects of RFI/EMI are considered negligible.

$$\mathbf{REE_{ATM} = 0}$$

7.4.2.10 Bias (B_{ATM}) – From Appendix C of Reference 6.1, Bias is defined as a systematic or fixed instrument uncertainty that is predictable for a given set of conditions because of the existence of a known direction (positive or negative). No such error was identified for the ATMs used for measurement of RPV level. Therefore:

$$\mathbf{B_{ATM} = 0}$$

7.4.2.11 From Section 7.3.1, A_{ATM} is calculated by:

$$A_i = \pm N \sqrt{\left(\frac{VA_i}{n}\right)^2 + \left(\frac{ATE_i}{n}\right)^2 + \left(\frac{OPE_i}{n}\right)^2 + \left(\frac{SPE_i}{n}\right)^2 + \left(\frac{SE_i}{n}\right)^2 + \left(\frac{RE_i}{n}\right)^2 + \left(\frac{HE_i}{n}\right)^2 + \left(\frac{PSE_i}{n}\right)^2 + \left(\frac{REE_i}{n}\right)^2} \pm B \quad (2\sigma)$$

Substituting into the A_i equation where:

VA_{ATM}	$= \pm$ 0.2500% Span (2σ)	Section 7.4.2.1
ATE_{ATM}	$= 0$	Section 7.4.2.2
OPE_{ATM}	$= 0$	Section 7.4.2.3
SPE_{ATM}	$= 0$	Section 7.4.2.4
SE_{ATM}	$= 0$	Section 7.4.2.5
RE_{ATM}	$= 0$	Section 7.4.2.6
HE_{ATM}	$= 0$	Section 7.4.2.7
PSE_{ATM}	$= 0$	Section 7.4.2.8
REE_{ATM}	$= 0$	Section 7.4.2.9
B_{ATM}	$= 0$	Section 7.4.2.10

$$A_{ATM} = \pm 2\sqrt{\left(\frac{0.25\%\ Span}{2}\right)^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2 + (0)^2} + 0$$

$$\mathbf{A_{ATM} = \pm 0.2500\%\ Span} \quad (2\sigma)$$

7.4.3 Loop Accuracy

Per Section 7.2, a single transmitter and trip unit with 2 outputs generates the Level 2 and Level 8 trips. From Sections 7.4.1.11.4 and 7.4.2.11, the Level Transmitter Accuracy (A_{LT}) and ATM Accuracy (A_{ATM}) are the same regardless of trip function. Therefore a single Loop Accuracy (A_L) is representative of both trip functions.

From Section 7.3.1:

$$A_L = \pm\sqrt{A_1^2 + A_2^2 + A_3^2 + \ldots} \pm B \qquad (2\sigma)$$

Substituting into the equation for A_L where:

A_{LT}	= ± 3.3335% Span	(2σ)	Section 7.4.1.11.4
A_{ATM}	= ± 0.2500% Span	(2σ)	Section 7.4.2.11
B_{LT}	= 0		Section 7.4.1.11.4
B_{ATM}	= 0		Section 7.4.2.11

$$A_L = \pm\sqrt{A_{LT}^2 + A_{MTU}^2} \pm B_{LT} \pm B_{ATM}$$

$$A_L = \pm\sqrt{3.3335\%\ Span^2 + 0.25\%\ Span^2} \pm 0 \pm 0$$

A_L = ±3.3429% Span **(2σ)**

7.5 Loop Calibration Error (C_L)

Loop Calibration Error is determined by the SRSSs of As-Left Tolerance (ALT_i), Calibration Tool Error (C_i), and Calibration Standards Error ($C_{i\ STD}$) for the individual devices in the loop. The equation below is used to calculate this effect.

From Section 7.3.2:

$$C_L = \pm N\sqrt{\sum\left(\frac{ALT_i}{n}\right)^2 + \sum\left(\frac{C_i}{n}\right)^2 + \sum\left(\frac{C_i STD}{n}\right)^2} \qquad (2\sigma)$$

7.5.1 As-Left Tolerance (ALT_L)

From Section 7.3.7:

$$ALT_L = \pm(N)\sqrt{\left(\frac{ALT_1}{n}\right)^2 + \left(\frac{ALT_2}{n}\right)^2 + \ldots + \left(\frac{ALT_n}{n}\right)^2} \qquad (2\sigma)$$

Where:

$$ALT_i = \pm VA_i \qquad (2\sigma)$$

Determining the ALT for the transmitter (ALT_{LT}):

VA_{LT} = ± 0.2500% Span (Section 7.4.1.1)

Therefore;

ALT_{LT} = ±0.2500% Span (2σ)

Determining the ALT for the Analog Trip Unit (ALT_{ATM}):

VA_{ATM} = ± 0.2500% Span (Section 7.4.2.1)

Therefore;

ALT_{ATM} = ±0.2500% Span (2σ)

Per Section 7.2, a single transmitter and trip unit with 2 outputs generates the Level 2 and Level 8 trips. Therefore a single loop As-Left Tolerance (ALT_L) is representative of both trip functions.

Substituting ALT_{LT} and ALT_{ATM} into the equation for ALT_L;

$$ALT_L = \pm(N)\sqrt{\left(\frac{ALT_{LT}}{n}\right)^2 + \left(\frac{ALT_{ATM}}{n}\right)^2}$$

$$ALT_L = \pm(2)\sqrt{\left(\frac{0.25\%\ Span}{2}\right)^2 + \left(\frac{0.25\%\ Span}{2}\right)^2}$$

ALT_L = ± 0.3536% Span (2σ)

Converting ALT_L to "inwc" for comparison to tolerance in calibration procedures;

Per Assumption 2.13, Cold Calibrated Span = 155 inwc.

$ALT_L = \pm 0.3536\%$ Span
$ALT_L = \pm 0.3536\%$ Span * 155 inwc / 100%Span
$ALT_L = \pm 0.5481$ inwc (2σ)

Per Inputs 4.12.1, 4.12.3 and 4.12.4, the difference between upper and lower tolerance limits is 1.1 inwc and the As-Left Tolerance specified by the calibration procedures is non-symmetrical.

Per Section 4.4.2 of Reference 6.1, "ALT_L selected for use in the calibration procedure should be used to calculate C_L and AFT_L." Single sided uncertainties such as this one shall be taken as the span of a tolerance evenly distributed around the nominal setpoint. Therefore:

$ALT_L = \pm 0.55$ inwc (2σ)

Rounded down to the precision specified in the calibration procedure:

$ALT_L = \pm 0.5$ inwc (2σ)

Converting ALT_L to "% Span" for use in calculation;

Per Assumption 2.13, Cold Calibrated Span = 155.0 inwc.

$ALT_L = \pm 0.5$ inwc
$ALT_L = \pm 0.5$ inwc / (155 inwc / 100% Span)
$ALT_L = \pm 0.3226\%$CC Span (2σ)

As discussed in Section 3.0, cold calibrated span is equivalent to process span when the plant is at NOP/NOT. Since the loop is required to function only when the plant is at NOP/NOT. Therefore:

%CC Span = % Process Span = % Span

$ALT_L = \pm 0.3226\%$ Span (2σ)

Converting ALT_L to process units (Inches RPV Level):

$ALT_L = \pm 0.3226\%$ Span
$ALT_L = \pm 0.3226\%$ Span * 220 inches / 100%Span
$ALT_L = \pm 0.7097$ inches

Rounded to procedure precision

$ALT_L = \pm 0.7$ inches **(2σ)**

7.5.2 Calibration Tool Error (C_i)

7.5.2.1 Transmitter Calibration Tool Error (C_{LT})

Reference 6.1 provides the method for determining the Measure and Test Equipment (C_i) uncertainty.

Inputs 4.12.1 and 4.12.2 address the functional testing of the trip units (Section 8.1), loop calibration (Section 8.2), transmitter calibration (Section 8.3) and calibration of trip unit (Sections 8.4). Section 7.0 of Inputs 4.12.1, 4.12.2 require the use of a test gauge, Digital Voltmeter (DVM), and 250 ohm (Ω) precision resistor in addition to the DAC during performance of the procedure. Specifically:

- Functional testing of trip units is accomplished using only the DAC.
- Loop calibration requires usage of the test gage and DAC.
- Transmitter calibration employs the test gage, precision resistor and DVM.
- Calibration of the trip units is performed using only the DAC.

Per Section 7.0 of Input 4.12.1;

- the DVM shall be capable of measuring 0-5 Vdc ± 0.002 Vdc,
- the test gauge shall have a range of 0-250 inwc with an accuracy of ± 0.295 inwc, and
- the 250 Ω precision resistor is required to be within $\pm$ 0.02 Ω.

To enhance accuracy during calibration, this uncertainty calculation utilizes the Fluke 45 multimeter accuracy specification. Per page 10 of Attachment 3 of Input 4.6.1, Fluke 45 multimeter on slow response has an uncertainty of ±0.097% Span for the 1-5 VDC range. Similarly, a Heise Model HQS-2 Digital Pressure Module with a range of 0 – 300 inwc and an accuracy of ±0.0250% span will be used in calculating the uncertainty.

Level transmitter performance uncertainties are calculated as a percentage of cold calibrated span (%CC Span) to properly account for the impact of turn-down ratio. Per Assumption 2.13, Cold Calibrated Span = 155 inwc.

The M&TE error for the voltmeter (C_{VM}) is therefore:

C_{VM} = 0.097% Span (for 1-5 volt span) **(3 σ)**
C_{VM} = ±0.004 Vdc (max temp band of 22°C) Input 4.6.1

The M&TE error for the precision resistor (C_{PR}) is therefore:

C_{PR} = 0.02/250 *100
C_{PR} = 0.008% Span **(3 σ)**

The M&TE error for the Heise HQS-2 digital indicator (C_{PG}) is therefore:

The errors for this gauge are derived from Attachment 3, as follows:

Vendor Accuracy (VA) = ± 0.025% full scale

Per Attachment 3, the HQS-2 indicator is temperature compensated over a range of 20°F to 120°F, therefore:

- ATE = 0

Per Attachment 3, the HQS-2 indicator is calibrated to within ± 0.09 inwc over a 0-300 inwc range.

ALT = ± 0.09 inwc * (100% full scale/300 inwc)
ALT = ± 0.0300% full scale

Per Input 4.6.1, Paragraph 3.5, the digital indicator IRE is conservatively taken as the least significant digit of the digital display and is considered insignificant.

IRE = 0

$$C_{PG} = \pm [VA^2 + ATE^2 + IRE^2 + ALT^2]^{1/2}$$

Where, from above:

VA = ± 0.0250% Span
ATE = 0
IRE = 0
ALT = ± 0.0300% Span

Substituting:

C_{PG} = ± [0.0250² + 0 + 0 + 0.0300²] ½
= ± 0.0391% FS

Converting to inwc:
C_{PG} = ± 0.0391% Span (300 inwc/100% span)
C_{PG} = ± 0.1173 inwc

Converting to the 155 inwc span of the transmitter:
C_{PG} = ± 0.0391% Span (300 inwc/155 inwc)
C_{PG} = ± 0.0756% Span (3σ)

C_{PG} = ± 0.0756% Span (3σ)

Substituting terms:

$$C_{LT} = \pm \sqrt{C_{PG}^2 + C_{VM}^2 + C_{PR}^2}$$

$$C_{LT} = \pm \sqrt{0.0756\ \%\ span^2 + 0.097\ \%\ span^2 + 0.008\ \%\ span^2}$$

C_{LT} = ± 0.1232% Span (3 σ)

7.5.2.2 ATM Calibration Tool Error (C_{ATM})

The ATM's are calibrated using a DAC. The DAC accuracy has been evaluated in Input 4.6.1. Per Input 4.6.1 and CCF dated 12/15/00 in the calculation file, the DAC accuracy for the ATM is ± 0.151% span. Therefore:

C_{ATM} = ± 0.151% Span **(3σ)**

7.5.3 Calibration Standard Error (C_{STD}):

Per Assumption 2.8, Calibration Standard Error is considered negligible for the purposes of this analysis.

$C_{STD} = 0$

7.5.4 Loop Calibration Error (C_L):

Per Section 7.2, a single transmitter and trip unit with 2 outputs generate the Level 2 and Level 8 trips. Therefore a single loop Calibration Error (C_L) is representative of both trip functions.

Per Section 8.2 of Input 4.12.1, the loop calibration is performed using a pressure gauge only. Substituting into the equation from C_L:

From above:

ALT_L	= ±0.3226% Span	(2σ)	Section 7.5.1
C_{PG}	= ±0.0756% Span	(3σ)	Section 7.5.2.1
$C_i STD$	= 0		Section 7.5.3

$$C_L = \pm 2\sqrt{\left(\frac{0.3226\ \%\ Span}{2}\right)^2 + \left(\frac{0.0756\ \%\ Span}{3}\right)^2 + 0^2}$$

C_L = ± 0.3265% Span **(2σ)**

7.6 Loop Drift

7.6.1 Transmitter Drift (D_{LT}):

Per Input 4.2.1, Drift is ± 0.2% of URL for 30 months. Drift will be determined based on a nominal 30 month calibration interval (Assumption 2.6), in accordance with Technical Specifications allowance for extended surveillance for up to 1.25% of the required interval, or 30 months (24*1.25=30).

- Per Section 7.4.1, Cold Calibrated Span = 155 inwc
- Per Section 7.4.1, Upper Range Limit = 750 inwc

Therefore:

D_{LT} = ± 0.20% URL
D_{LT} = ± 0.2% * (750 inwc / 155 inwc)
D_{LT} = ± 0.9677%CC Span (2σ)

As discussed in Section 3.0, cold calibrated span is equivalent to process span when the plant is at NOP/NOT. Since the loop is required to function only when the plant is at NOP/NOT. Therefore:

%CC Span = % Process Span = % Span

D_{LT} = ± 0.9677% Span **(2σ)**

7.6.2 Analog Trip Unit Drift (D_{ATM}):

Per Input 4.9.3, Drift is ±0.25% of Span for a period of 30 days. Per the Technical Specifications (References under 6.3), the calibration frequency is quarterly. Technical Specifications allow for the surveillance to be delayed for up to 1.25% of the required interval, or 115 days (92*1.25=115). Therefore, per Eqn. 2 of Ref. 6.1:

D_{ATM} = ± 0.25% Span * (115 days/30 days)^{½}
D_{ATM} = ± 0.4895% Span **(2σ)**

7.6.3 Loop Drift

From Section 7.3.3, Loop Drift is calculated:

$$D_L = \pm N \sqrt{\left(\frac{D_1}{n}\right)^2 + \left(\frac{D_2}{n}\right)^2 + \ldots + \left(\frac{D_n}{n}\right)^2} \qquad (2\sigma)$$

Per Section 7.2, a single transmitter and trip unit with 2 outputs generates the Level 2 and Level 8 trips. Therefore a single loop Drift (D_L) is representative of both trip functions.

Substituting from above into the equation for D_L:

$$D_L = \pm 2 \sqrt{\left(\frac{0.9677 \ \% \ Span}{2}\right)^2 + \left(\frac{0.4895 \ \% \ Span}{2}\right)^2}$$

$\mathbf{D_L} = \mathbf{\pm 1.0845\% \ Span}$ $\qquad (2\sigma)$

7.7 Process Measurement Accuracy (PMA):

The parameter measured is wide range reactor vessel water level. Per Input 4.8, the PMA determined for Wide Range (WR) trip functions is 1.84 inches and is attributable to the change in density of the water in portions of the reference and variable legs both inside and outside the drywell.

Process Span = 220 inches Input 4.9.1

Converting to % span:

PMA = ±1.84 inches
= ±1.84 inches / 220 inches * 100% span
= **±0.8364% span** $\qquad (2\sigma)$

7.8 Primary Element Accuracy (PEA):

The parameter measured is the reactor water level. Per Input 4.8, the PEA for Wide Range (WR) trip functions is 0.5 inches and is attributable to uncertainty associated with the elevation measurement of the level transmitter reference leg condensation pot. Clinton Power Station commissioned a professional survey to determine condensate pot elevations. The results of this survey (Input 4.10.2) document the elevation of various points related to the top of the shield wall. Given the instruments used to take measurements and the qualification of the individuals performing and overseeing the work the 0.5 inches allowed for PEA in Input 4.8 is considered conservative.

Process Span = 220 inches Input 4.9.1

Converting to % span:

PEA = ±0.5 inches
= ±0.5 inches / 220 inches * 100% span
= **±0.2273% span** **(2σ)**

8.0 RESULTS

8.1 Calculation of the Trip Setpoint:

From Section 7.3.4;

For process variables that increase to trip.

$$NTSP = AL - \left(\frac{1.645}{2}\right)\sqrt{A_L^2 + C_L^2 + D_L^2 + PMA^2 + PEA^2} + B$$

For process variables that decrease to trip.

$$NTSP = AL + \left(\frac{1.645}{2}\right)\sqrt{A_L^2 + C_L^2 + D_L^2 + PMA^2 + PEA^2} + B$$

8.1.1 Calculation of the Level 2 NTSP ($NTSP_{Level\ 2}$)

From Input 4.9.2, the Analytical Limit (AL) for Reactor Vessel Water Level – Low Low, Level 2 is –52.6 inches.

Substituting into the equation for a decreasing setpoint where:

$AL_{Level\ 2}$	= -52.6 inches		Input 4.9.2
Process Span	= 220 inches		Input 4.9.1
PMA	= ± 1.84 inches		Section 7.7
PEA	= ± 0.500 inches		Section 7.8
A_L	= ± 3.3429% Span	(2σ)	Section 7.4.3
	= ± 3.3429% Span * 220 inches		
	= ± 7.3544 inches		
C_L	= ± 0.3265% Span	(2σ)	Section 7.5.4
	= ± 0.3265% Span * 220 inches		
	= ± 0.7183 inches		
D_L	= ± 1.0845% Span	(2σ)	Section 7.6.3
	= ± 1.0845% Span * 220 inches		
	= ± 2.3859 inches		
B	= 0		

$$NTSP_{Level\,3} = AL_{Level\,2} + \left(\frac{1.645}{N}\right)\sqrt{A_{L-Level\,2}{}^2 + C_{L-Level\,2}{}^2 + D_{L-Level\,2}{}^2 + PMA^2 + PEA^2} \pm B$$

$$NTSP_{Level\,2} = -52.6\ in. + \left(\frac{1.645}{2}\right)\sqrt{\begin{matrix}7.3544\ in.^2 + 0.7183\ in.^2 + 2.3859\ in.^2 \ldots \\ +1.8400\ in.^2 + 0.5000\ in.^2\end{matrix}} \pm 0$$

$$NTSP_{Level\,2} = -46.0235\ in.$$

The current setpoints in the CPS Operational Requirements Manual (Outputs 5.7.1 and 5.7.3) are ≥ -45.5 Inches, which is conservative, being further from the Analytical Limit than -46.0235 inches calculated above. The methodolgy of Reference 6.1 established symmetrical As-Found and As-Left tolerances about the NTSP and Reset, thus the recommendation is to utilize an NTSP of -45.5 Inches and delete the "≥" sign. Therefore:

$NTSP_{Level\,2}$ = -45.5 inches

8.1.2 Calculation of the Level 8 NTSP ($NTSP_{Level\ 8}$)

From Input 4.9.2, the Analytical Limit (AL) for Reactor Vessel Water Level – High, Level 8 is 56.4 inches. From Input 4.8, the Analytical Limit (AL) for the Wide Range Reactor Vessel Water Level 8 is 60 inches. Per the Technical Specification Basis for Section 3.3.5.1, Item 3.c (Reference 6.3), the Reactor Vessel Water Level–High, Level 8 Function is not assumed in the accident and transient analyses. Based upon input from GE (Attachment 5), the higher value of 60 inches will be used in calculation of the Level 8 Allowable Value.

Substituting into the equation for an increasing setpoint where:

$AL_{Level\ 8}$	= +60.0 inches		Input 4.8
Process Span	= 220 inches		Input 4.9.1
PMA	= ± 1.84 inches		Section 7.7
PEA	= ± 0.500 inches		Section 7.8
A_L	= ± 3.3429% Span	(2σ)	Section 7.4.3
	= ± 3.3429% Span * 220 inches		
	= ± 7.3544 inches		
C_L	= ± 0.3265% Span	(2σ)	Section 7.5.4
	= ± 0.3265% Span * 220 inches		
	= ± 0.7183 inches		
D_L	= ± 1.0845% Span	(2σ)	Section 7.6.3
	= ± 1.0845% Span * 220 inches		
	= ± 2.3859 inches		
B	= 0		

$$NTSP_{Level\ 8} = AL_{Level\ 8} - \left(\frac{1.645}{N}\right)\sqrt{A_{L-Level\ 8}{}^2 + C_L{}^2 + D_L{}^2 + PMA^2 + PEA^2} \pm B$$

$$NTSP_{Level\ 8} = 60.0\ in. - \left(\frac{1.645}{2}\right)\sqrt{\begin{matrix}7.3544\ in.^2 + 0.7183\ in.^2 + 2.3859\ in.^2 \ldots \\ +1.8400\ in.^2 + 0.5000\ in.^2\end{matrix}} \pm 0$$

$$NTSP_{Level\ 8} = 53.4235\ in.$$

The current setpoint in the CPS Operational Requirements Manual (Output 5.7.2) Attachment 2-12 Table 7 Item 2.e, is ≤ 52.0 Inches, which is more conservative than the setpoint calculated above. The methodolgy of Reference 6.1 established symmetrical As-Found and As-Left tolerances about the NTSP and Reset, thus the recommendation is to utilize an NTSP of +52.0 Inches and delete the "≤" sign. Therefore:

$NTSP_{Level\ 8}$ = +52.0 inches

8.2 Calculation of As-Found Values

From Section 7.3.6:

The loop As-Found Tolerance (AFT) will be calculated as follows:

$$AFT_L = \pm(N)\sqrt{\left(\frac{C_L}{n}\right)^2 + \left(\frac{D_L}{n}\right)^2} \qquad (2\sigma)$$

Where:

D_L = Loop devices' drift value, as defined in Section 7.3.1
C_L = Loop devices' calibration effect, as defined in Section 7.3.1

$$AFT_i = \pm(N)\sqrt{\left(\frac{ALT_i}{n}\right)^2 + \left(\frac{D_i}{n}\right)^2 + \left(\frac{C_i}{n}\right)^2} \qquad (2\sigma)$$

Where:

ALT_i = device's As-Left Tolerance
D_i = device's drift value
C_i = errors of M&TE used to calibrate the device

8.2.1 Calculating Level Transmitter As-Found Tolerance (AFT_{LT}):

Substituting into the equation for AFT_i where:

Process Span	= 220 inches		Input 4.9.1
ALT_{LT}	= ±0.2500% span	(2σ)	Section 7.5.1
D_{LT}	= ±0.9677 % span	(2σ)	Section 7.6.1
C_{LT}	= ±0.1232 % span	(3σ)	Section 7.5.2.1

$$AFT_{LT} = \pm N\sqrt{\left(\frac{ALT_{LT}}{n}\right)^2 + \left(\frac{C_{LT}}{n}\right)^2 + \left(\frac{D_{LT}}{n}\right)^2}$$

$$AFT_{LT} = \pm 2\sqrt{\left(\frac{0.25\%\ Span}{2}\right)^2 + \left(\frac{0.1232\ \%\ Span}{3}\right)^2 + \left(\frac{0.9677\ \%\ Span}{2}\right)^2}$$

AFT_{LT} = ± 1.0028% Span (2σ)

8.2.2 ATM As-Found Tolerance (AFT_{ATM}):

Substituting into the equation for AFT_i where:

ALT_{ATM}	= ±0.2500% span	(2σ)	Section 7.5.1
D_{ATM}	= ±0.4895% span	(2σ)	Section 7.6.2
C_{ATM}	= ±0.1510 % span	(3σ)	Section 7.5.2.2

$$AFT_{ATM} = \pm N\sqrt{\left(\frac{ALT_{ATM}}{n}\right)^2 + \left(\frac{D_{ATM}}{n}\right)^2 + \left(\frac{C_{ATM}}{n}\right)^2}$$

$$AFT_{ATM} = \pm 2\sqrt{\left(\frac{0.25\%\ Span}{2}\right)^2 + \left(\frac{0.4895\ \%\ Span}{2}\right)^2 + \left(\frac{0.1510\ \%\ Span}{3}\right)^2}$$

AFT_{ATM} = ±0.5588% Span (2σ)

8.2.3 Loop As-Found Tolerance (AFT_L):

Per Section 7.2, a single transmitter and trip unit with 2 outputs generates the Level 2 and Level 8 trips. Therefore a single loop As-Found Tolerance (ALT_L) is representative of both trip functions.

Substituting into the equation for AFT_L where:

C_L	= ± 0.3265% Span	(2σ)	Section 7.5.4
D_L	= ± 1.0845% Span	(2σ)	Section 7.6.3

$$AFT_L = \pm N\sqrt{\left(\frac{C_L}{n}\right)^2 + \left(\frac{D_L}{n}\right)^2}$$

$$AFT_L = \pm 2\sqrt{\left(\frac{.3265\%\ Span}{2}\right)^2 + \left(\frac{1.0845\%\ Span}{2}\right)^2}$$

AFT_L = ±1.1326% Span (2σ)

Per Assumption 2.13, Cold Calibrated Span = 155.0 inwc.

AFT_L = ± 1.1326% Span * 155 inwc
AFT_L = ± 1.7555 inwc (2σ)

Rounded to the precision used in the calibration procedures (Inputs 4.12.2 through 4.12.5):

AFT_L = ± 1.8 inwc (2σ)

Converting AFT_L to "inches" for use in Sections 8.3 and 8.4:

Per Input 4.9.1, Process Span = 220 inches
Per Assumption 2.13, Cold Calibrated Span = 155.0 inwc.
Therefore:
AFT_L = ± 1.8 inwc * (220 inches / 155 inwc)
AFT_L = ± 2.5548 inches

Rounding to the precision of NTSP in Section 8.1:
AFT_L = ± 2.6 inches (2σ)

8.3 Calculation of the Allowable Value (AV):

The Allowable Value may be calculated for an increasing trip as follows:

$$\mathbf{AV_{(INC)} \leq NTSP + AFT_L}$$

The Allowable Value may be calculated for a decreasing trip as follows:

$$\mathbf{AV_{(DEC)} \geq NTSP - AFT_L}$$

8.3.1 Calculation of the Reactor Water Level – Low Low, Level 2 Allowable Value ($AV_{Level\ 2}$)

Substituting into the equation for a decreasing setpoint where:

$NTSP_{Level\ 2}$	= -45.5 inches	Section 8.1.1
AFT_L	= 2.6 inches	Section 8.2.3
$AV_{Level\ 2}$	$\geq NTSP_{Level\ 2} - AFT_L$ ≥-45.5 inches – 2.6 inches	
$AV_{Level\ 2}$	**≥ -48.1 inches**	**(2σ)**

8.3.2 Calculation of the Reactor Water Level – High, Level 8 Allowable Value ($AV_{Level\ 8}$)

Substituting into the equation for a increasing setpoint where:

$NTSP_{Level\ 8}$	= 52.0 inches	Section 8.1.2
AFT_L	= 2.6 inches	Section 8.2.3
$AV_{Level\ 2}$	$\leq NTSP_{Level\ 8} + AFT_L$ ≤ 52.0 inches + 2.6 inches	
$AV_{Level\ 8}$	**≤ 54.6 inches**	**(2σ)**

8.4 Calculation of Reset Value

The trip reset value is selected to prevent overlap with the acceptable NTSP tolerance band, and also to prevent interference with normal plant operations. The maximum reset value is calculated as follows for the decreasing trip function, using the largest loop tolerance:

$$\textbf{Reset} = \textbf{NTSP} + \textbf{AFT}_{\textbf{L}}$$

The minimum reset value is calculated as follows for the increasing trip function, using the largest loop tolerance:

$$\textbf{Reset} = \textbf{NTSP} - \textbf{AFT}_{\textbf{L}}$$

From Inputs 4.12.1, 4.12.3, 4.12.4 and 4.12.6, the existing differncial between trip and reset is 6.6 inches. This is a difference of 3%, which equals the standard differential used for ATMs at CPS. A larger reset differential is more conservative (i.e., moves the process further away from the Analytic Limit before allowing a reset condition). The 6.6 inch existing reset differntial will be conservatively added to the NTSP in lieu of the smaller 2.5 inch AFT_L. this differential to the NTSP determines the existing reset value, therefore:

The maximum reset value is calculated as follows for the increasing and decreasing trip functions, using the largest loop tolerance:

$$\textbf{Reset}_{\textbf{(Dec)}} = \textbf{NTSP} + \textbf{6.6 inches}$$

$$\textbf{Reset}_{\textbf{(Inc)}} = \textbf{NTSP} - \textbf{6.6 inches}$$

Reset for Reactor Vessel Water Level – Low Low, Level 2 ($Reset_{Level\ 2}$) is:

$$Reset_{Level\ 2} = NTSP_{Level\ 2} + 6.6 \text{ inches}$$
$$= -45.5 \text{ inches} + 6.6 \text{ inches}$$

$$\textbf{Reset}_{\textbf{Level 2}} = \textbf{-38.9 inches}$$

Reset for Reactor Vessel Water Level – High Level 8 ($Reset_{Level\ 8}$) is:

$$Reset_{Level\ 8} = NTSP_{Level\ 8} - 6.6 \text{ inches}$$
$$= 52.0 \text{ inches} - 6.6 \text{ inches}$$

$$\textbf{Reset}_{\textbf{Level 8}} = \textbf{45.4 inches}$$

9.0 CONCLUSIONS

The scaling for the RPV Level Trip functions are addressed in Attachment 1 to this calculation. A "Results Summary" is included in Attachment 2 to this calculation.

9.1 RPV Level – Low Low, Level 2

Section 8.1.1 of this calculation determined the minimum NTSP to be -46.0235 inches, demonstrating the design NTSP value of –45.5 inches given in Table 1 of Input 4.9.2 is conservative. The ≥ symbol will be dropped from the ORM (Outputs 5.7.1 and 5.7.3) as this calculation establishes a symmetrical As-Found tolerance.

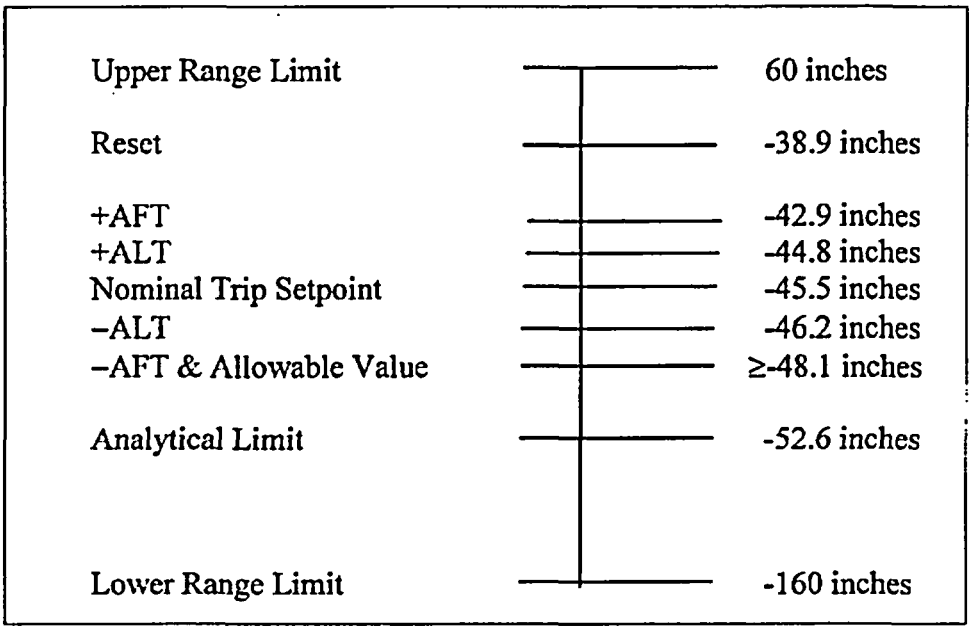
$$\mathbf{NTSP_{Level\,2} = -45.5\ inches}$$

This design calculation provides the basis for establishing the Tech. Spec. Allowable Value at ≥ –48.1 inches, demonstrating the "Tech Spec Limit" value of –47.7 inches given in Table 1 of Input 4.9.2 is conservative. The calculated value is selected to prevent overlap between the AFT_L and AV.

$$\mathbf{AV_{Level\,2} \geq -48.1\ inches}$$

The relationship between the Allowable Value, NTSP and Reset setting values for the Loop and ATM is not directly proportional. This is due to the existence of a 20 BTU sub-cooled region in the reactor vessel. The Loop and ATM input values calculated in Attachment 1 shall be used when calibrating those devices. Interpolation between input and output spans would result in incorrect AV, NTSP and Reset setting values.

FIGURE 1 RPV Level – Low Low, Level 2



9.2 RPV Level – High, Level 8

Section 8.1.2 of this calculation determined the maximum NTSP to be +53.4235 inches, demonstrating the design value of +52.0 inches given in Table 1 of Input 4.9.2 is conservative. The ≤ symbol will be dropped from the ORM (Output 5.7.2) as this calculation establishes a symmetrical As-Found tolerance.

$$\mathbf{NTSP_{Level\ 8} = +52.0\ inches}$$

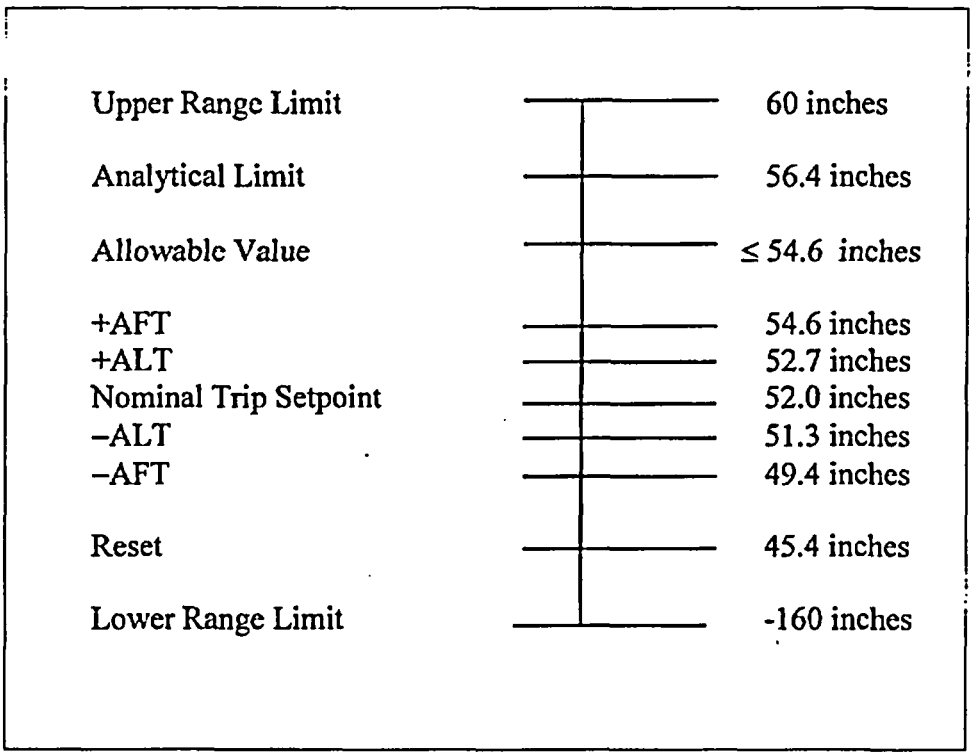
This design calculation provides the basis for establishing the Tech. Spec. Allowable Value at ≤ 54.6 inches, demonstrating the "Tech Spec Limit" value of ≤ 54.2 inches given in Table 1 of Input 4.9.2 is conservative. The calculated value is selected to prevent overlap between the AFT_L and AV.

$$\mathbf{AV_{Level\ 8} \leq +54.6\ inches}$$

The scaling for the RPV High Level 8 Trip function is addressed in Attachment 1 to this calculation. A "Results Summary" is included in Attachment 2 to this calculation.

The relationship between the Allowable Value, NTSP and Reset setting values for the Loop and ATM is not directly proportional. This is due to the existence of a 20 BTU sub-cooled region in the reactor vessel. The Loop and ATM input values calculated in Attachment 1 shall be used when calibrating those devices. Interpolation between input and output spans would result in incorrect AV, NTSP and Reset setting values.

FIGURE 2 RPV Level – High, Level 8



SCALING OF RPV LEVEL 2 AND LEVEL 8 (WR) INSTRUMENT LOOPS (1B21N073C, D, G & H)

1.0 LEVEL TRANSMITTER SCALING

1.1 TRANSMITTER SPECIFIC INFORMATION

EIN: 1B21N073C, D, G & H

Manufacturer: Rosemount Inc.
Model No.: 1153DB5PC
Input: -160 to + 60 inches
Output: 1-5 Vdc

Process Range

Min (p)	Max (P)	Units
p = -160	P = +60	inches

Transmitter Output Range

Min(o)	Max(O)	Units
o=1	O=5	Vdc

1.2 THEORY

As described in Input 4.11.4, the collapsed water level in the vessel annulus is determined by measuring the differential pressure between the two reactor vessel nozzles. The general equation provided to determine this differential pressure is Equation 3-1 of Input 4.11.4 and is:

$$\Delta P = \upsilon_{68}[h_w/\upsilon_w + h_s/\upsilon_s + \Delta h_d/\upsilon_d + \Delta h_{rb}/\upsilon_{rb}]$$

For wide range measurement, transmitter calibration includes 20 BTU/lbm subcooling of vessel water below the narrow range variable leg nozzle to account for the subcooling of vessel inventory due to the injection of colder feedwater. Per Section 3.0 of Input 4.11.4, the equation (EQN 3-3) for determination of differential pressure (ΔP) wide range instruments is:

$$\Delta P = \nu_{68} [h_{w1} (1/\nu_{w1} - 1/\nu_s) + h_{w2} (1/\nu_{w2} - 1/\nu_s) + H/\nu_s + \Delta h_d/\nu_d + \Delta h_{rb}/\nu_{rb}]$$

Where:

h_{w1} = height of saturated vessel water column above the variable leg nozzle (VLN.ELEV).

h_{w2} = height of subcooled vessel water column above the variable leg nozzle (VLN.ELEV).

H = elevation differential between the condensing chamber (CCELEV.COLD) and the variable leg nozzle (VLN.ELEV).
= $h_{w1} + h_{w2} + h_s$

Δh_d = drywell sensing line drop differential
= $h_d$var - $h_d$ref

Δh_{rb} = reactor building sensing line drop differential
= VLP.ELEV – RLP.ELEV

υ_{68} = specific volume of water at standard temperature, 68°F and 1 atmosphere pressure (ST&P); 0.01604537 ft^3/lbm

υ_{w1} = specific volume of saturated vessel water at vessel temperature and pressure

υ_{w2} = specific volume of vessel water subcooled from saturation 20 BTU/lbm at vessel temperature and pressure

υ_s = specific volume of vessel steam at vessel pressure and temperature

υ_d = specific volume of instrument line water at drywell temperature and vessel pressure

υ_{rb} = specific volume of instrument (reference/variable) line water (compressed) at reactor building temperature and vessel pressure

1.3 PHYSICAL INFORMATION

The physical arrangement of instrument installations varies slightly. The physical installation information for each of the 4 instrument installations is provided in Tables 1A and 1B below.

Table 1A

Instrument	1B21-N073C, 1B21-N073G		
Condensing Chamber	1B21-D004C		
TERM	**ELEV (ft) Note 1**	**Conversion**	**ELEV (inches above vessel zero)**
CCELEV.COLD (Note 2)	793.49'	(793.49'-744.0')*12"/'-(1.375"/2)	593.22"
VLN.ELEV (N12/160°)	773.82'	(773.82'-744.0')*12"/'	357.84"
RLP.ELEV (1MD-130)	790'-9" 790.75'	(790.75'-744')*12"/'	561.00"
VLP.ELEV (1MD-136)	770'-9 1/8" 770.76'	(770.76'-744.0')*12"/'	321.12"
SUB.ELEV (Note 3)	786.42'	(786.42'-744.0')*12"/'	509.04"
TCH.ELEV (Note 4)	N/A	N/A	N/A
LI0.ELEV.COLD (Note 5)	-	-	520.62"
Vessel Zero (Note 6)	744.0'	(744.0'-744.0')*12"/'	0.0"

Table 1B

Instrument	1B21-N073D, 1B21-N073H		
Condensing Chamber	1B21-D004D		
TERM	**ELEV (ft) Note 1**	**Conversion**	**ELEV (inches above vessel zero)**
CCELEV.COLD (Note 2)	793.47'	(793.47'-744.0')*12"/'-(1.375"/2)	592.98"
VLN.ELEV (N12/342°)	773.82'	(773.82'-744.0')*12"/'	357.84"
RLP.ELEV (1MD-131)	791'-1 3/16" 791.10'	(791.10'-744')*12"/'	565.19"
VLP.ELEV (1MD-137)	770'-9 5/8" 770.8'	(770.8'-744.0')*12"/'	321.60"
SUB.ELEV (Note 3)	786.42'	(786.42'-744.0')*12"/'	509.04"
TCH.ELEV (Note 4)	N/A	N/A	N/A
LI0.ELEV.COLD (Note 5)	-	-	520.62"
Vessel Zero (Note 6)	744.0'	(744.0'-744.0')*12"/'	0.0"

Table 1A and 1B Notes:

1. Drywell wall penetration elevations (RLP.ELEV and VLP.ELEV) are from Input 4.10.1. The condensing chamber (CC.ELEV) and vessel nozzle (VLN.ELEV) elevations were obtained from the Homer Chastain survey data and the associated CWRs (Input 4.10.2) rather than CWRs, as the Homer Chastain survey data is considered more recent and more reliable.
2. Per Inputs 4.4.6 & 4.4.7, the piping connecting the condensate pot to the reactor vessel is Schedule 160, 1" Stainless Steel, SMLS pipe. According to Reference 6.7, the outside diameter of 1"-Sch. 160 pipe is nominally 1.315". The centerline elevation of the condensing chambers were determined from the elevation of the top of the "Instrument ref. Leg Pipe", referred to as "ELEV. E" in Attachment 3 of Input 4.10.1, less 0.6575 inches (OD / 2 = 1.315 / 2 = 0.6575 inches
3. SUB.ELEV = Narrow Range Level Tap Elevation Per Input 4.11.4. Tap elevation per Input 4.10.2.
4. Per Input 4.11.4, only those transmitters attached to condensing chamber 1B21-D004B experience an elevated temperature at elevations above 576".
5. Instrument Zero (520.62") is from Input 4.11.4.
6. Vessel Zero (744.0') is from Input 4.11.4.

CCELEV.COLD = centerline elevation of the condensing chamber inlet while cold

LIMIN = minimum indication for a given level instrument

LIMAX = maximum indication for a given level instrument

LISPAN = the difference between LIMAX and LIMIN (LIMAX – LIMIN)

LI0. ELEV = water level instrument zero, except fuel zone. Instrument zero is 15 inches above the bottom of the dryer skirt. The TAF/FZ is the top of active fuel for the fuel zone level instruments.
= 520.62"

LIMAX.ELEV = elevation equivalent of the instrument maximum span
= LI0.ELEV + LIMAX

LIMIN.ELEV = elevation equivalent of the instrument minimum span
= LI0.ELEV + LIMIN

RLP.ELEV = reference leg penetration (drywell penetration) elevation

SUB.ELEV = elevation under which it is assumed that reactor coolant is subcooled. This elevation is the elevation of the narrow range variable leg nozzle.

TCH.ELEV = elevation in the drywell above which the drywell temperature is higher

Vessel Invert = elevation of the interior vessel floor at the Reactor Pressure Vessel "RPV" bottom head.

Vessel Zero = a reference point inside the RPV bottom head. The vessel zero is 0.71 inches above the vessel invert.
= 744.00'

VLN.ELEV = variable leg nozzle (RPV penetration) elevation while cold

VLP.ELEV = variable leg penetration (RPV penetration) elevation

1.4 CALCULATION

Since the elevation of condensate chambers and drywell wall penetrations of the Channel C and G transmitters are different than for the Channel D and H transmitters, the results of the head correction and scaling calculations will differ slightly. The following calculation (Channels C and G) demonstrates the techniques used. The results for all four (4) Channels are presented in Table 2 at the end of this section.

From Section 1.2 above:

$$\Delta P = \nu_{68} [h_{w1} (1/\nu_{w1} - 1/\nu_s) + h_{w2} (1/\nu_{w2} - 1/\nu_s) + H/\nu_s + \Delta h_d/\nu_d + \Delta h_{rb}/\nu_{rb}]$$

This calculation will determine the differential pressure (ΔP) with the water level in the reactor at the minimum (LIMIN) and maximum (LIMAX) limits of the instruments range. Rewriting the equation above:

$$\Delta P_{min} = \nu_{68}\,[h_{w1min}\,(1/\nu_{w1} - 1/\nu_s) + h_{w2min}\,(1/\nu_{w2} - 1/\nu_s) + H/\nu_s + \Delta h_d/\nu_d + \Delta h_{rb}/\nu_{rb}]$$

$$\Delta P_{max} = \nu_{68}\,[h_{w1max}\,(1/\nu_{w1} - 1/\nu_s) + h_{w2max}\,(1/\nu_{w2} - 1/\nu_s) + H/\nu_s + \Delta h_d/\nu_d + \Delta h_{rb}/\nu_{rb}]$$

Deriving each term:

From Section 1.2 above:

LIMIN = -160 inches
LIMAX = +60 inches
LISPAN = LIMAX – LIMIN
= +60 inches – (-160 inches)
= 220 inches

From Table 1A above:

LI0.ELEV = 520.62 inches
VLN.ELEV = 357.84 inches

Therefore:

LIMAX.ELEV = 520.62 inches + 60 inches
= 580.62 inches

LIMIN.ELEV = 520.62 inches +(–160 inches)
= 360.62 inches

Per Input 4.11.4, the thermal expansion correction factor for the reactor vessel at 1025 psig and 549.3°F is 3.727E-03 in/in (c = 0.003727 in/in).

From Section 3.0 of Input 4.11.4, h_{w2} is the height of subcooled vessel water column above the variable leg nozzle (corrected for vessel growth).

h_{w2max} = (1 + c) • (SUB.ELEV.COLD – VLN.ELEV.COLD)
= (1+0.003727)•(509.04 inches – 773.82 inches)
= 151.76 inches

hw2max.ELEV = h_{w2max} + VLN.ELEV.COLD
= 151.76 inches + 357.84 inches
= 509.60 inches

From Input 4.11.4, h_{w1} is the height of saturated vessel water column above the variable leg nozzle (VLN.ELEV). Therefore:

Since LIMAX.ELEV (580.62 inches) is greater than hw2max.ELEV (509.60"):

h_{w2max} = 151.76 inches

h_{w1max} = LIMAX.ELEV – hw2max.ELEV
= 580.62 inches – 509.60 inches
= 71.02 inches

Since LIMIN.ELEV (360.62 inches) is less than hw2max.ELEV (509.60"):

h_{w2min} = (1 + c) • (LIMIN.ELEV – VLN.ELEV)
= (1.003727) • (360.62 inches – 357.84 inches)
= 2.79 inches

h_{w1min} = LIMIN.ELEV – hw2max.ELEV
= 360.62 inches – 509.60 inches
= - 148.98 inches

When RPV Level is below hw2max.ELEV there is no water in the Saturated Water region, by definition therefore:

h_{w1min} = 0 inches

From Input 4.11.4:

H = [1+c] * [CCELEV.COLD – VLN.ELEV] – IDCCSIP/2

The centerline elevation of the condensing chambers was determined from the elevation of the top of the pipe connecting the RPV and the condensate pot, referred to as "ELEV. E" in Attachment 3 of Input 4.10.2, less 0.6765 inches (Assumption 2.12). Therefore, "CCELEV.COLD – ID/2" is replaced by CCELEV.COLD from Table 1A.

Rewriting the equation:

H = [1+c] * [CCELEV.COLD – VLN.ELEV]
= [1+0.003727] * [593.22 inches – 357.84 inches]
= 236.26 inches

From Input 4.11.4:

$h_d var$ = [1+c] * VLN.ELEV – VLP.ELEV
= [1+0.003727] * 357.84 inches – 321.12 inches
= 38.05 inches

$h_d ref$ = [1+c] * CCELEV.COLD – IDCCSIP/2 – RLP. ELEV

The centerline elevation of the condensing chambers was determined from the elevation of the top of the pipe connecting the RPV and the condensate pot, referred to as "ELEV. E" in Attachment 3 of Input 4.10.2, less 0.6765 inches (Assumption 2.12). Therefore, "CCELEV.COLD – ID/2" is replaced by CCELEV.COLD from Table 1A.

Rewriting the equation:

$h_d ref1$ = [1+c] * CCELEV.COLD – RLP. ELEV
= [1+0.003727] * 593.22 inches – 561.00 inches
= 34.43 inches

Δh_d = $h_d var$ - $h_d ref1$
= 38.05 inches – 34.43 inches
= 3.62 inches

From Input 4.11.4:

Δh_{rb} = VLP.ELEV – RLP.ELEV
= 321.12 inches – 561.00 inches
= -239.88 inches

From Section 1.2:

v_{68} = 0.01604537 ft^3/lbm

Per Input 4.11.4, vessel conditions are 1025 psig (1039.7 psia), 549.3°F, saturated above nozzle N13, and subcooled 20 BTU/lbm below N13. From steam tables (Ref. 6.6) for saturated steam and water:

v_{wl} = 0.02173445 ft^3/lbm
v_s = 0.426947 ft^3/lbm
h_{fwl} = 548.597 BTU/lbm
T = 549.326°F

To determine the specific volume of sub-cooled water below N13 (v_{w2}) it is necessary to subtract 20 BTU/lbm from $h_{f@549.326°F}$, then determine the corresponding specific volume for compressed water at 1025 psig.

$h_{fvw2} = h_{fwl} - 20$ BTU/lbm
= 548.597 BTU/lbm – 20 BTU/lbm
= 528.597 BTU/lbm

Calculate v_{w2} from steam tables (Ref. 6.6) using h_{fvw2} @1039.7 psia:

v_{w2} = 0.02123649 ft^3/lbm

Per Input 4.11.4, the temperatures in the drywell and containment are 135°F and 80°F, respectively. From steam tables (Ref. 6.6):

v_d = Specific Volume of water at 1039.7 psia and 135°F
v_d = 0.01621815 ft^3/lbm

v_{rb} = Specific Volume of water at 1039.7 psig and 80°F
v_{rb} = 0.01602092 ft^3/lbm

Solving for ΔP_{min} and ΔP_{max}:

$\Delta P_{min} = v_{68} [h_{w1min} (1/v_{w1} - 1/v_s) + h_{w2min} (1/v_{w2} - 1/v_s) + H/v_s + \Delta h_d/v_d + \Delta h_{rb}/v_{rb}]$
= 0.01604537 ft^3/lbm * [0 * (1/0.02173445 ft^3/lbm – 1/0.42697 ft^3/lbm) + 2.79 inches * (1/0.02123649 ft^3/lbm – 1/0.42697 ft^3/lbm) + (236.26 inches / 0.42697 ft^3/lbm) + (3.62 inches / 0.01621815 ft^3/lbm) + (-239.88 inches / 0.01602092 ft^3/lbm)]
= -225.78 inwc

$\Delta P_{max} = v_{68} [h_{w1max} (1/v_{w1} - 1/v_s) + h_{w2max} (1/v_{w2} - 1/v_s) + H/v_s + \Delta h_d/v_d + \Delta h_{rb}/v_{rb}]$
= 0.01604537 ft^3/lbm * [71.02 * (1/0.02173445 ft^3/lbm – 1/0.42697 ft^3/lbm) + 151.76 inches * (1/0.02123649 ft^3/lbm – 1/0.42697 ft^3/lbm) + (236.26 inches / 0.42697 ft^3/lbm) + (3.62 inches / 0.01621815 ft^3/lbm) + (-239.88 inches / 0.01602092 ft^3/lbm)]
= -69.06 inwc

As noted in Section 7.4.1, the transmitter is a Rosemount 1153DB5PC, which per Input 4.2.1 has a static pressure correction of +0.75% of input per 1000 psi. Thus, the correction factor (CF) is determined as,

CF = (1025 psig/1000 psi) x 0.0075 = 0.00769

Applying the correction factor to ΔP_{min} and ΔP_{max}:

Span Corrected Lower Range Limit $= \Delta P_{min} / (1+CF)$
$= -225.78$ inwc $/ (1+0.00769)$
$= -224.1$ inwc

Span Corrected Upper Range Limit $= \Delta P_{max} / (1+CF)$
$= -69.06$ inwc $/ (1+0.00769)$
$= -68.5$ inwc

Determining Cold Calibration span (CC Span):

CC Span = | (Span Corrected Upper Range Limit – Span Corrected Lower Range Limit) |

Substituting from above:

CC Span = |(-68.5 inwc – (-224.1 inwc)|
CC Span = 155.6 inwc

The calculated result of Cold Calibrated Span verifies Assumption 2.12 as conservative. Assuming a CC Span (155 inwc) that is smaller than the actual CC Span (155.6 inwc) results in a slightly larger turn-down ratio and therefore slightly larger transmitter uncertainty.

Results for 1B21N073C,D,G and H are presented in Table 2.

Table 2

Instrument / Term	1B21-N073C&G	1B21-N073D&H
Operating Press	1025 psia	
CCELEV.COLD	593.22 inches	592.98 inches
VLN.ELEV	357.84 inches	357.84 inches
RLP.ELEV	561.00 inches	565.19 inches
VLP.ELEV	321.12 inches	321.60 inches
SUB.ELEV	509.04 inches	509.04 inches
TCH.ELEV	N/A	
LI0.ELEV.COLD	520.62 inches	
Vessel Zero	744.0 feet	
LIMAX	60 inches	
LIMIN	-160 inches	
LISPAN	220 inches	
C	0.003727 in/in	

Instrument Term	1B21-N073C&G	1B21-N073D&H
h_{w1}min	0.00 inches	0.00 inches
h_{w2}min	2.79 inches	2.79 inches
h_{w1}max	71.02 inches	71.02 inches
h_{w2}max	151.76 inches	151.76 inches
H	236.26 inches	236.02 inches
$h_d$var	38.05 inches	37.57 inches
$h_d$ref1	34.43 inches	30.01 inches
$h_d$ref2	N/A	
Δh_d	3.62 inches	7.57 inches
Δh_{rb}	-239.88 inches	-243.59 inches
ν_{68}	0.01604537 ft^3/lbm	
ν_{w1}	0.02173445 ft^3/lbm	
ν_{w2}	0.02123649 ft^3/lbm	
ν_s	0.42697 ft^3/lbm	
ν_{d1}	0.01621815 ft^3/lbm	
ν_{d2}	N/A	
ν_{rb}	0.01602092 ft^3/lbm	
ΔPmin	-225.78 inwc	-225.60 inwc
ΔPmax	-69.06 inwc	-68.88 inwc
CF	0.00769	
Span Corrected Calibrated Range Lower Limit	-224.1 inwc	-223.9 inwc
Span Corrected Calibrated Range Upper Limit	-68.5 inwc	-68.4 inwc
Cold Calibrated Span	155.6 inwc	155.5 inwc

Determining the cardinal point values for cold calibration of the level transmitters.

Per Inputs 4.12.1 through 4.12.5, cardinal points are at 0%, 25%, 50%, 75%, and 100% span.

Per Attachment 1 Section 1.1, Transmitter Output Range:
0% = 1.0 Vdc
100% = 5.0 Vdc

From Attachment 1 Section 1.4, Transmitter Span Corrected Range Limits:
0% = -224.1 inwc
100% = -68.5 inwc

Interpolating for calibration cardinal points (inwc):
Cardinal Point = % span * (-68.5 inwc - (-224.1 inwc)) + (-224.1 inwc)

0% = 0% * (-68.5 inwc - (-224.1 inwc)) + (-224.1 inwc)
= -224.1 inwc

25% = 25% * (-68.5 inwc - (-224.1 inwc)) + (-224.1 inwc)
= -185.2 inwc

50% = 50% * (-68.5 inwc - (-224.1 inwc)) + (-224.1 inwc)
= -146.3 inwc

75% = 75% * (-68.5 inwc - (-224.1 inwc)) + (-224.1 inwc)
= -107.4 inwc

100% = 100% * (-68.5 inwc - (-224.1 inwc)) + (-224.1 inwc)
= -68.5 inwc

The calibration cardinal points for all level transmitters, rounded to existing calibration procedure precision are presented Table 3.

TABLE 3

Instrument	1B21-N073C & 1B21-N073G	1B21-N073D & 1B21-N073H
% Span	Calibration Pressure	
0%	-224.1 inwc	-223.9 inwc
25%	-185.2 inwc	-185.0 inwc
50%	-146.3 inwc	-146.1 inwc
75%	-107.4 inwc	-107.3 inwc
100%	-68.5 inwc	-68.4 inwc

Interpolating for calibration cardinal points (Vdc):
Cardinal Point = % span * (5.0 Vdc – 1.0 Vdc) + 1.0 Vdc

0% = 0% * (5.0 Vdc – 1.0 Vdc) + 1.0 Vdc
= 1.0 Vdc

25% = 25% * (5.0 Vdc – 1.0 Vdc) + 1.0 Vdc
= 2.0 Vdc

50% = 50% * (5.0 Vdc – 1.0 Vdc) + 1.0 Vdc
= 3.0 Vdc

75% = 75% * (5.0 Vdc – 1.0 Vdc) + 1.0 Vdc
= 4.0 Vdc

100% = 100% * (5.0 Vdc – 1.0 Vdc) + 1.0 Vdc
= 5.0 Vdc

2.0 ANALOG TRIP MODULE SCALING

2.1 ANALOG TRIP MODULE SPECIFIC INFORMATION

EIN: 1B21N673C, D, G & H (RPV Level – Low low, Level 2)
1B21N674C & D (RPV Level – High, Level 8)

Manufacturer: GE.
Model No.: 147D8505G001
Input: 1.000 - 5.000 Vdc
Output: discrete trip signal

Input Range

Min (p)	Max (P)	Units
p = 1	P = 5	Vdc

2.2 LOOP SCALING INFORMATION

The cold calibration values for setpoints (inwc) derived in Section 8.1 of the uncertainty calculation are determined by substituting the Level 2 and Level 8 setpoints for "$h_w$min" then recalculating "ΔPmin" and "Span Corrected Calibrated Range Lower Limit" as illustrated in Attachment 1,Section 1.4.

Where:

$AV_{Level\ 2}$ = AV is calculated value from Section 8.3.1

$AV_{Level\ 8}$ = AV is calculated value from Section 8.3.2

$NTSP_{Level\ 2}$ = NTSP is calculated value from Section 8.1.1

$NTSP_{Level\ 8}$ = NTSP is calculated value from Section 8.1.2

$Reset_{Level\ 2}$ = Reset is calculated value from Section 8.4

$Reset_{Level\ 8}$ = Reset is calculated value from Section 8.4

h_wAVLevel 2 = height of vessel water column above the variable leg nozzle (VLN.ELEV) at Level 2 Allowable Value

h_wAVLevel 8 = height of vessel water column above the variable leg nozzle (VLN.ELEV) at Level 8 Allowable Value

h_wLevel 2 = height of vessel water column above the variable leg nozzle (VLN.ELEV) at Level 2

h_wLevel 8 = height of vessel water column above the variable leg nozzle (VLN.ELEV) at Level 8

h_wLevel 2 Reset = height of vessel water column above the variable leg nozzle (VLN.ELEV) at Level 2 Reset

h_wLevel 8 Reset = height of vessel water column above the variable leg nozzle (VLN.ELEV) at Level 8 Reset

$\Delta P\text{-}AV_{Level2}$ = differential pressure on transmitter with RPV water level at Level 2 Allowable Value

$\Delta P\text{-}AV_{Level8}$ = differential pressure on transmitter with RPV water level at Level 8 Allowable Value

ΔP_{Level2} = differential pressure on transmitter with RPV water level at Level 2

ΔP_{Level8} = differential pressure on transmitter with RPV water level at Level 8

$\Delta P_{Level2Reset}$ = differential pressure on transmitter with RPV water level at Level 2 Reset

$\Delta P_{Level8Reset}$ = differential pressure on transmitter with RPV water level at Level 8 Reset

Span Corrected Level 2 Setpoint = differential pressure at $NTSP_{Level\ 2}$ corrected for span.

Span Corrected Level 8 Setpoint = differential pressure at $NTSP_{Level\ 8}$ corrected for span.

Span Corrected Level 2 AV = differential pressure at $AV_{Level\ 2}$ corrected for span.

Span Corrected Level 8 AV = differential pressure at $AV_{Level\ 8}$ corrected for span.

Span Corrected Level 2 Reset = differential pressure at $Reset_{Level\ 2}$ corrected for span.

Span Corrected Level 8 Reset = differential pressure at $Reset_{Level\ 8}$ corrected for span.

Calculating RPV Level – Low Low, Level 2 Trip Unit Scaling:

Per Section 8.3.1

$AV_{Level\ 2}$ = -48.1 inches

Per Section 8.1.1:

$NTSP_{Level\,2}$ = -45.5 inches

Per Section 8.4:

$Reset_{Level\,2}$ = -38.9 inches

From Table 1A:

LI0.ELEV = 520.62 inches

VLN.ELEV = 357.84 inches

Therefore:

$AV_{Level\,2}$.ELEV = 520.62 inches + (-48.1 inches)
= 472.52 inches

$NTSP_{Level\,2}$.ELEV = 520.62 inches + (-45.5 inches)
= 475.12 inches

$Reset_{Level\,2}$.ELEV = 520.62 inches + (-38.9 inches)
= 481.72 inches

From Section 3.0 of Input 4.11.4, h_{w2} is the height of subcooled vessel water column above the variable leg nozzle (corrected for vessel growth).

$$h_{w2} = (1 + c) \bullet (SUB.ELEV.COLD - VLN.ELEV.COLD)$$

The equation from Input 4.11.4 is used for calculating the calibration end points, and must be modified to accommodate setpoints (i.e. NTSP, AV, Reset) below the subcooling elevation (SUB.ELEV.COLD).

IF Setpoint.ELEV is ≥ 509.60 inches (h_{w2max}.ELEV):

h_{w2} = h_{w2max}
= 151.76 inches

IF setpoint is < 509.60 inches:

h_{w2} = (1 + c) • (Setpoint.ELEV – VLN.ELEV)

Where Setpoint.ELEV is the NTSP, AV or Reset elevation expressed in inches above Vessel Zero.

From Section 3.0 of Input 4.11.4, h_{w1} is the height of saturated vessel water column above the variable leg nozzle (VLN.ELEV).

$h_{w1} = h_{wmax} - h_{w2}$
where h_{wmax} is the point of interest, i.e. NTSP, AV, or Reset

Once again it is necessary to modify the Input 4.11.4 equation. The definition of h_{w1} is only valid if level is higher than the top of the sub-cooled region,

IF Setpoint.ELEV is <509.6 inches (h_{w2} + VLN.ELEV),
THEN h_{w1} = 0 inches.

IF Setpoint.ELEV is ≥ 509.6 inches
THEN h_{w1} = Setpoint.ELEV – VLN.ELEV – h_{w2}
Where h_{w2} has previously been defined as 151.76 inches

Substituting:
h_{w1} = Setpoint.ELEV – 357.84 inches – 151.76 inches
= Setpoint.ELEV – 509.60 inches

Therefore:

Since $AV_{Level\,2}$.ELEV (472.52 inches) is less than h_{w2max}.ELEV (509.60"):

$h_{w2}(AV_{Level\,2})$ = (1 + c) • ($AV_{Level\,2}$.ELEV – VLN.ELEV)
= (1 + 0.003727) • (472.52 inches – 357.84 inches)
= 115.11 inches

$h_{w1}(AV_{Level\,2})$ = 0 inches

Since $NTSP_{Level\ 2}$.ELEV (475.12 inches) is less than h_{w2max}.ELEV (509.60"):

$h_{w2}(NTSP_{Level\ 2}) = (1 + c) \bullet (NTSP_{Level\ 2}.ELEV - VLN.ELEV)$
$= (1 + 0.003727) \bullet (475.12 \text{ inches} - 357.84 \text{ inches})$
$= 117.72 \text{ inches}$

$h_{w1}(NTSP_{Level\ 2}) = 0 \text{ inches}$

Since $Reset_{Level\ 2}$.ELEV (481.72 inches) is less than h_{w2max}.ELEV (509.60"):

$h_{w2}(Reset_{Level\ 2}) = (1 + c) \bullet (Reset_{Level\ 2}.ELEV - VLN.ELEV)$
$= (1 + 0.003727) \bullet 481.72 \text{ inches} - 357.84 \text{ inches}$
$= 124.34 \text{ inches}$

$h_{w1}(Reset_{Level\ 2}) = 0 \text{ inches}$

From Attachment 1, Section 1.4:

$$\Delta P = \nu_{68} [h_{w1} (1/\nu_{w1} - 1/\nu_s) + h_{w2} (1/\nu_{w2} - 1/\nu_s) + H/\nu_s + \Delta h_d/\nu_d + \Delta h_{rb}/\nu_d]$$

Substituting "$h_{w1}(NTSP_{Level\ 2})$" for "h_{w1}" and "$h_{w2}(NTSP_{Level\ 2})$" for "h_{w2}":

$$\Delta P_{Level2} = \nu_{68} [h_{w1}(NTSP_{Level\ 2}) * (1/\nu_{w1} - 1/\nu_s) + h_{w2}(NTSP_{Level\ 2}) * (1/\nu_{w2} - 1/\nu_s) + H/\nu_s + \Delta h_d/\nu_d + \Delta h_{rb}/\nu_{rb}]$$

$= 0.01604537 \text{ ft}^3/\text{lbm} * [0 \text{ inches} * (1/0.02173445 \text{ ft}^3/\text{lbm} - 1/0.42697 \text{ ft}^3/\text{lbm}) + 117.72 \text{ inches} * (1/0.02123649 \text{ ft}^3/\text{lbm} - 1/0.42697 \text{ ft}^3/\text{lbm}) + (236.26 \text{ inches} / 0.42697 \text{ ft}^3/\text{lbm}) + (3.62 \text{ inches} / 0.01621815 \text{ ft}^3/\text{lbm}) + (-239.88 \text{ inches} / 0.01602092 \text{ ft}^3/\text{lbm})]$

$= -143.27 \text{ inwc}$

Substituting "$h_{w1}(Reset_{Level\,2})$" for "h_{w1}" and "$h_{w2}(Reset_{Level\,2})$" for "h_{w2}":

$\Delta P_{Level2Reset} = v_{68}\,[h_{w1}(Reset_{Level\,2}) * (1/v_{w1} - 1/v_s) + h_{w2}(Reset_{Level\,2}) * (1/v_{w2} - 1/v_s) + H/v_s + \Delta h_d/v_d + \Delta h_{rb}/v_{rb}]$

$= 0.01604537\ ft^3/lbm * [0\ inches * (1/0.02173445\ ft^3/lbm - 1/0.42697\ ft^3/lbm) + 124.34\ inches * (1/0.02123649\ ft^3/lbm - 1/0.42697\ ft^3/lbm) + (236.26\ inches / 0.42697\ ft^3/lbm) + (3.62\ inches / 0.01621815\ ft^3/lbm) + (-239.88\ inches / 0.01602092\ ft^3/lbm)]$

$= -138.51$ inwc

Substituting "$h_{w1}(AV_{Level\,2})$" for "h_{w1}" and "$h_{w2}(AV_{Level\,2})$" for "h_{w2}":

$\Delta P\text{-}AV_{Level2} = v_{68}\,[h_{w1}(AV_{Level\,2}) * (1/v_{w1} - 1/v_s) + h_{w2}(AV_{Level\,2}) * (1/v_{w2} - 1/v_s) + H/v_s + \Delta h_d/v_d + \Delta h_{rb}/v_{rb}]$

$= 0.01604537\ ft^3/lbm * [0\ inches * (1/0.021739\ ft^3/lbm - 1/0.42697\ ft^3/lbm) + 115.11\ inches * (1/0.021247\ ft^3/lbm - 1/0.42697\ ft^3/lbm) + (236.26\ inches / 0.42697\ ft^3/lbm) + (3.62\ inches / 0.01621815\ ft^3/lbm) + (-239.88\ inches / 0.01602092\ ft^3/lbm)]$

$= -145.14$ inwc

Applying the correction factor to ΔP_{Level2}:

Span Corrected Level 2 Setpoint $= \Delta P_{Level2} / (1+CF)$
$= -143.27$ inwc $/ (1+0.00769)$
$= -142.2$ inwc

Span Corrected Level 2 Reset $= \Delta P_{Level2Reset} / (1+CF)$
$= -138.51$ inwc $/ (1+0.00769)$
$= -137.5$ inwc

Span Corrected Level 2 AV $= \Delta P\text{-}AV_{Level2} / (1+CF)$
$= -145.14$ inwc $/ (1+0.00769)$
$= -144.0$ inwc

Calculating RPV Level – High, Level 8 Trip Unit Scaling:
Per Section 8.3.2

$AV_{Level\ 8}$ = 54.6 inches

Per Section 8.1.2:

$NTSP_{Level\ 8}$ = 52.0 inches

Per Section 8.4:

$Reset_{Level\ 8}$ = 45.4 inches

From Table 1A:

LI0.ELEV = 520.62 inches
VLN.ELEV = 357.84 inches

Therefore:

$AV_{Level\ 8}$.ELEV = 520.62 inches + (54.6 inches)
= 575.22 inches

$NTSP_{Level\ 8}$.ELEV = 520.62 inches + (52.0 inches)
= 572.62 inches

$Reset_{Level\ 8}$.ELEV = 520.62 inches + (45.4 inches)
= 566.02 inches

Since $AV_{Level\ 8}$.ELEV (575.22 inches) is greater than h_{w2max}.ELEV (509.60"):

$h_{w2}(AV_{Level\ 8})$ = 151.76 inches

$h_{w1}(AV_{Level\ 8})$ = $AV_{Level\ 8}$.ELEV – h_{w2max}.ELEV
= 575.22 inches – 509.60 inches
= 65.62 inches

Since $NTSP_{Level\ 8}$.ELEV (572.62 inches) is greater than h_{w2max}.ELEV (509.60"):

$h_{w2}(NTSP_{Level\ 8})$ = 151.76 inches

$h_{w1}(NTSP_{Level\ 8})$ = $NTSP_{Level\ 8}$.ELEV – h_{w2max}.ELEV
= 572.62 inches – 509.60 inches
= 63.02 inches

Since $Reset_{Level\ 8}$.ELEV (566.02 inches) is greater than h_{w2max}.ELEV (509.60"):

$h_{w2}(Reset_{Level\ 8}) = 151.76$ inches

$h_{w1}(Reset_{Level\ 8}) = Reset_{Level\ 8}.ELEV - h_{w2max}.ELEV$
$= 566.02 \text{ inches} - 509.60 \text{ inches}$
$= 56.42$ inches

From Attachment 1, Section 1.4:

$\Delta P = \nu_{68} [h_{w1} (1/\nu_{w1} - 1/\nu_s) + h_{w2} (1/\nu_{w2} - 1/\nu_s) + H/\nu_s + \Delta h_d/\nu_d + \Delta h_{rb}/\nu_{rb}]$

Substituting "$h_{w1}(NTSP_{Level\ 8})$" for "h_{w1}" and "$h_{w2}(NTSP_{Level\ 8})$" for "h_{w2}":

$\Delta P_{Level8} = \nu_{68} [h_{w1}(NTSP_{Level\ 8}) * (1/\nu_{w1} - 1/\nu_s) + h_{w2}(NTSP_{Level\ 8}) * (1/\nu_{w2} - 1/\nu_s) + H/\nu_s + \Delta h_d/\nu_d + \Delta h_{rb}/\nu_{rb}]$
$= 0.01604537 \text{ ft}^3/\text{lbm} * [63.02 \text{ inches} * (1/0.02173445 \text{ ft}^3/\text{lbm} - 1/0.42697 \text{ ft}^3/\text{lbm}) + 151.76 \text{ inches} * (1/0.02123649 \text{ ft}^3/\text{lbm} - 1/0.42697 \text{ ft}^3/\text{lbm}) + (236.26 \text{ inches} / 0.42697 \text{ ft}^3/\text{lbm}) + (3.62 \text{ inches} / 0.01621815 \text{ ft}^3/\text{lbm}) + (-239.88 \text{ inches} / 0.01602092 \text{ ft}^3/\text{lbm})]$
$= -74.67$ inwc

Substituting "$h_{w1}(Reset_{Level\ 8})$" for "h_{w1}" and "$h_{w2}(Reset_{Level\ 8})$" for "h_{w2}":

$\Delta P_{Level8Reset} = \nu_{68} [h_{w1}(Reset_{Level\ 8}) * (1/\nu_{w1} - 1/\nu_s) + h_{w2}(Reset_{Level\ 8}) * (1/\nu_{w2} - 1/\nu_s) + H/\nu_s + \Delta h_d/\nu_d + \Delta h_{rb}/\nu_{rb}]$
$= 0.01604537 \text{ ft}^3/\text{lbm} * [56.42 \text{ inches} * (1/0.02173445 \text{ ft}^3/\text{lbm} - 1/0.42697 \text{ ft}^3/\text{lbm}) + 151.76 \text{ inches} * (1/0.02123649 \text{ ft}^3/\text{lbm} - 1/0.42697 \text{ ft}^3/\text{lbm}) + (236.26 \text{ inches} / 0.42697 \text{ ft}^3/\text{lbm}) + (3.62 \text{ inches} / 0.01621815 \text{ ft}^3/\text{lbm}) + (-239.88 \text{ inches} / 0.01602092 \text{ ft}^3/\text{lbm})]$
$= -79.29$ inwc

Substituting "$h_{w1}(AV_{Level\ 8})$" for "h_{w1}" and "$h_{w2}(AV_{Level\ 8})$" for "h_{w2}":

$\Delta P\text{-}AV_{Level8} = \nu_{68} [h_{w1}(AV_{Level\ 8}) * (1/\nu_{w1} - 1/\nu_s) + h_{w2}(AV_{Level\ 8}) * (1/\nu_{w2} - 1/\nu_s) + H/\nu_s + \Delta h_d/\nu_d + \Delta h_{rb}/\nu_{rb}]$

$= 0.01604537\ ft^3/lbm * [65.62\ inches * (1/0.02173445\ ft^3/lbm - 1/0.42697\ ft^3/lbm) + 151.76\ inches * (1/0.02123649\ ft^3/lbm - 1/0.42697\ ft^3/lbm) + (236.26\ inches / 0.42697\ ft^3/lbm) + (3.62\ inches / 0.01621815\ ft^3/lbm) + (-239.88\ inches / 0.01602092\ ft^3/lbm)]$

$= -72.85$ inwc

Applying the correction factor to ΔP_{Level8}:

Span Corrected Level 8 Setpoint $= \Delta P_{Level8} / (1+CF)$
$= -74.67$ inwc $/ (1+0.00769)$
$= -74.1$ inwc

Span Corrected Level 8 Reset $= \Delta P_{Level8Reset} / (1+CF)$
$= -79.29$ inwc $/ (1+0.00769)$
$= -78.7$ inwc

Span Corrected Level 8 AV $= \Delta P\text{-}AV_{Level8} / (1+CF)$
$= -72.85$ inwc $/ (1+0.00769)$
$= -72.3$ inwc

Table 4 provides the calculated Span Corrected and intermediate values for all channels of instrumentation.

Table 4

Instrument / Term	1B21-N673C 1B21-N673G 1B21-N674C	1B21-N673D 1B21-N673H 1B21-N674D
$NTSP_{Level\ 8}$	52.00	
$NTSP_{Level\ 8}$.ELEV	572.62	
$Reset_{Level\ 8}$	45.40	
$Reset_{Level\ 8}$.ELEV	566.02	
$AV_{Level\ 8}$	54.60	
$AV_{Level\ 8}$.ELEV	575.22	
$NTSP_{Level\ 2}$	-45.50	
$NTSP_{Level\ 2}$.ELEV	475.12	
$Reset_{Level\ 2}$	-38.90	
$Reset_{Level\ 2}$.ELEV	481.72	
$AV_{Level\ 2}$	-48.10	
$AV_{Level\ 2}$.ELEV	472.52	
$h_{w1}(NTSP_{Level\ 8})$	63.02 inches	63.02 inches
$h_{w2}(NTSP_{Level\ 8})$	151.76 inches	151.76 inches
$h_{w1}(Reset_{Level\ 8})$	56.42 inches	56.42 inches
$h_{w2}(Reset_{Level\ 8})$	151.76 inches	151.76 inches
$h_{w1}(AV_{Level\ 8})$	65.62 inches	65.62 inches
$h_{w2}(AV_{Level\ 8})$	151.76 inches	151.76 inches
$h_{w1}(NTSP_{Level\ 2})$	0.00 inches	0.00 inches
$h_{w2}(NTSP_{Level\ 2})$	117.72 inches	151.76 inches
$h_{w1}(Reset_{Level\ 2})$	0.00 inches	0.00 inches
$h_{w2}(Reset_{Level\ 2})$	124.34 inches	151.76 inches
$h_{w1}(AV_{Level\ 2})$	0.00 inches	0.00 inches
$h_{w2}(AV_{Level\ 2})$	115.11 inches	151.76 inches
ΔP_{Level8}	-74.67 inwc	-74.49 inwc
$\Delta P_{Level8Reset}$	-79.29 inwc	-79.11 inwc
$\Delta P\text{-}AV_{Level8}$	-72.85 inwc	-72.66 inwc
ΔP_{Level2}	-143.27 inwc	-143.08 inwc
$\Delta P_{Level2Reset}$	-138.51 inwc	-138.33 inwc
$\Delta P\text{-}AV_{Level2}$	-145.14 inwc	-144.96 inwc
Span Corrected Level 8 Reset	-78.7 inwc	-78.5 inwc
Span Corrected Level 8 Setpoint	-74.1 inwc	-73.9 inwc
Span Corrected Level 8 AV	-72.3 inwc	-72.1 inwc
Span Corrected Level 2 Reset	-137.5 inwc	-137.3 inwc
Span Corrected Level 2 Setpoint	-142.2 inwc	-142.0 inwc
Span Corrected Level 2 AV	-144.0 inwc	-143.9 inwc

1B21N073C,D,G,H CALIBRATION INFORMATION

- Per Inputs 4.12.1, 4.12.3, 4.12.4 and 4.12.6, transmitter calibration input is measured in "inwc" and output is monitored in "Vdc".
- Per Section 1.1 of Attachment 1, output span of the level transmitter is 4 Vdc (5 Vdc – 1 Vdc)
- Per Section 7.5.1 of the uncertainty calculation $ALT_{LT} = \pm 0.2500\%$ Span. Therefore;
  $ALT_{LT} = \pm 0.25\%$ Span * 4 Vdc
  $ALT_{LT} = \pm 0.010$Vdc (rounded down to 3 decimal places to agree with the calibration procedures)
- Per Section 8.2.1 of the uncertainty calculation $AFT_{LT} = \pm 1.0028\%$ Span.
  $AFT_{LT} = \pm 1.0028\%$ Span * 4 Vdc
  $AFT_{LT} = \pm 0.040$ Vdc (rounded down to 3 decimal places to agree with the calibration procedures)

Cal. Pt.	Input Pressure (inwc)		Output (volts DC)	
	1B21-N073C 1B21-N073G	1B21-N073D 1B21-N073H	AFT (±0.040 Vdc)	ALT (±0.010 Vdc)
0%	-224.1 inwc	-223.9 inwc	1.000 (0.960 to 1.040)	1.000 (0.990 to 1.010)
25%	-185.2 inwc	-185.0 inwc	2.000 (1.940 to 2.040)	2.000 (1.990 to 2.010)
50%	-146.3 inwc	-146.1 inwc	3.000 (2.940 to 3.040)	3.000 (2.990 to 3.010)
75%	-107.4 inwc	-107.3 inwc	4.000 (3.940 to 4.040)	4.000 (3.990 to 4.010)
100%	-68.5 inwc	-68.4 inwc	5.000 (4.940 to 5.040)	5.000 (4.990 to 5.010)

1B21-N673C,D,G,H & 1B21N674C,D ATM CALIBRATION INFORMATION

- Per Inputs 4.12.1, 4.12.3, 4.12.4 and 4.12.6, ATM calibration input is measured in "IN Water" and output is monitored by trip and reset action of the ATM.
- Per Input 4.9.1, Process Span = 220 inches
- Per Section 7.5.1 of the uncertainty calculation $ALT_{ATM} = \pm 0.2500\%$ Span.

  $ALT_{ATM} = \pm 0.25\%$ Span * 220 inches
  $ALT_{ATM} = \pm 0.5$ inches (rounded down to 1 decimal places to agree with the calibration procedures)

- Per Section 8.2.2 of the uncertainty calculation $AFT_{ATM} = \pm 0.5588\%$ Span.

  $AFT_{ATM} = \pm 0.5588\%$ Span * 220 inches
  $AFT_{ATM} = \pm 1.2$ inches (rounded down to 1 decimal places to agree with the calibration procedures)

1B21N673C, D and 1B21N673G, H Trip #1 ATM Calibration

Cal. Pt.	Input	Output	
	inches	AFT	ALT
		(±1.2 inches)	(±0.5 inches)
AV	≥ –48.1	≥ –48.1 inches	≥ -48.1 inches
Setpoint	–45.5	–45.5 inches (–42.2 to –44.6)	–45.5 inches (–45.0 to –46.0)
Reset	–38.9	–38.9 inches (–37.7 to –40.1)	–38.9 inches (–38.4 to –39.4)

1B21N673C, D Trip #2 ATM Calibration (1B21-N674C, D)

Cal. Pt.	Input	Output	
	Inches	AFT	ALT
		(±1.2 inches)	(±0.5 inches)
AV	≤54.6	<54.6 inches	<54.6 inches
Setpoint	52.0	52.0 inches (48.8 to 53.2)	52.0 inches (51.5 to 52.5)
Reset	45.4	45.4 inches (44.2 to 46.6)	45.4 inches (44.9 to 45.9)

1B21-N073C,D,G,H, 1B21-N673C,D,G,H Trip #1 and Trip #2 LOOP CALIBRATION INFORMATION

- Per Inputs 4.12.1, 4,12.3, 4.12.4 and 4.12.6, ATM calibration input is measured in "inwc" and output is monitored by trip and reset action of the ATM.
- Per Assumption 2.13 Cold Calibrated Span = 155 inwc.
- Per Section 7.5.1 of the uncertainty calculation $ALT_L = \pm 0.5$ inwc.
- Per Section 8.2.3 of the uncertainty calculation $AFT_L = \pm 1.8$ inwc.

1B21N073C(G) and 1B21N673C(G) Trip #1 Loop Calibration

Cal. Pt.	Input	Output	
	Inwc	AFT	ALT
		(±1.8 inwc)	(± 0.5 inwc)
AV	≥-144.0	≥ -144.0 inwc	≥ -144.0 inwc
Setpoint	-142.2	-142.2 inwc (-140.4 to –144.0)	-142.2 inwc (-141.7 to –142.7)
Reset	-137.5	-137.5 inwc (-135.7 to –139.3)	-137.5 inwc (-137.0 to –138.0)

1B21N073D(H) and 1B21N673D(H) Trip #1 Loop Calibration

Cal. Pt.	Input	Output	
	inwc	AFT	ALT
		(±1.8 inwc)	(± 0.5 inwc)
AV	≥-143.9	≥ -143.9 inwc	≥ -143.9 inwc
Setpoint	-142.0	-142.0 inwc (-140.2 to –143.8)	-142.0 inwc (-141.5 to –142.5)
Reset	-137.3	-137.3 inwc (-135.5 to –139.1)	-137.3 inwc (-136.8 to –137.8)

1B21N073C and 1B21N673C Trip #2 (1B21-N674C) Loop Calibration

Cal. Pt.	Input	Output	
	inwc	AFT	ALT
		(±1.8 inwc)	(± 0.5 inwc)
AV	≤ -72.3	≤ -72.3 inwc	≤ -72.3 inwc
Setpoint	-74.1	-74.1 inwc (-72.3 to –75.9)	-74.1 inwc (-73.6 to –74.6)
Reset	-78.7	-78.7 inwc (-76.9 to –80.5)	-78.7 inwc (-78.2 to –79.2)

1B21N073D and 1B21N673D Trip #2 (1B21-N674D) Loop Calibration

Cal. Pt.	Input	Output	
	inwc	AFT	ALT
		(±1.8 inwc)	(± 0.5 inwc)
AV	≤ -72.1	≤ -72.1 inwc	≤ -72.1 inwc
Setpoint	-73.9	-73.9 inwc (-72.1 to –75.7)	-73.9 inwc (-73.4 to –74.4)
Reset	-78.5	-78.5 inwc (-76.7 to –80.3)	-78.5 inwc (-78.0 to –79.0)

DEPT/DIV	CALCULATION NO. IP-C-0094	REVISION 0	SHEET
C/NSED	ATTACHMENT 2	VOLUME A	1 of 2

RESULTS SUMMARY

The following tables list the applicable results of this calculation:

Primary Sensor Scaling/Calibration					
Primary Sensor	Calibration Span				
	0%	25%	50%	75%	100%
1B21N073C & G	-224.1 inwc	-185.2 inwc	-146.3 inwc	-107.4 inwc	-68.5 inwc
1B21N073D & H	-223.9 inwc	-185.0 inwc	-146.1 inwc	-107.3 inwc	-68.4 inwc

Individual Component Setting Tolerances		
Component EIN	As-Found	As-Left
1B21N073C,D,G,H	± 0.040 Vdc	± 0.010 Vdc
1B21N673C,D,G,H (Trip #1 and #2)	± 1.2 inches	± 0.5 inches

Loop Calibration - Trip Setpoint, Reset and Setting Tolerances				
Component EIN	Setpoint	Reset	As-Found	As-Left
1B21N673C	-142.2 inwc	-137.5 inwc	± 1.8 inwc	± 0.5 inwc
1B21N673D	-142.0 inwc	-137.3 inwc		
1B21N673G	-142.2 inwc	-137.5 inwc		
1B21N673H	-142.0 inwc	-137.3 inwc		
1B21N674C	-74.1 inwc	-78.7 inwc		
1B21N674D	-73.9 inwc	-78.5 inwc		

Loop Calibration - Allowable Value	
Component EIN	Allowable Value
1B21N673C	≥ -144.0 inwc
1B21N673D	≥ -143.9 inwc
1B21N673G	≥ -144.0 inwc
1B21N673H	≥ -143.9 inwc
1B21N674C	≤ -72.3 inwc
1B21N674D	≤ -72.1 inwc

M&TE Used In Calculation (if specified in calculation)			
Manufacturer	Model Number	Range	Total Accuracy (Eng. Units)
Heise	HQS-2 or equivalent	0 – 300 inwc	±0.1173 inwc Temp band of (20°F to 120°F)
Fluke	45 (Slow) (or equivalent)	1-5 Volts (span)	±0.004 Vdc
Precision Resistor	NA	250 Ω	0.02 Ω

FSAR/Technical Specification Setpoints		
Component EIN	Allowable Value / Design Setpoint	FSAR/Technical Specification Section
1B21N673C,D,G,H	≥ -48.1 inches -45.5 inches	Tech. Spec. Tables: 3.3.5.1-1 Item 3.a 3.3.6.1-1 Item 2.e ORM Tables: Attachment 2-8 Table 5 Item 3.a Attachment 2-12 Table 7 Item 2.e
1B21N674C,D	≤ 54.6 inches 52.0 inches	Tech. Spec. Tables: 3.3.5.1-1 Item 3.c ORM Tables: Attachment 2-8 Table 5 Item 3.c

HEISE HQS-2 M&TE DATA SHEETS

EIN:	PG1512
NOUN NAME:	Digital Pressure Module
MANUFACTURER:	Heise
MODEL NO.:	HQS-2
SERIAL NO.:	16359
RANGE:	0 to 300 inwc
ACCURACY:	± *0.09 inwc*
ENVIRONMENTAL LIMITATIONS:	Operating ambient temperature is limited to 20°F to 120°F without corrections. Contact the Cal Lab for corrections if ambient temperature is outside the above specified range.
NOTE:	This pressure module must be used in a Heise Digital Indicator assembly, model number ST-2H, or equivalent. The assembly supplies operating power and a digital readout for the pressure module. The Digital Indicator Assembly has voltage and current functions which are not certified for use for quantitative data.

Approved by: _____ 10/15/00

HEISE HQS-2 M&TE DATA SHEETS

11/03/99 10:21 ☎1 800 287 4000 THERMO CENSE ⓪004/005

LIST PRICES APPLYING TO BULLETIN ST2H-1

HEISE® — DIGITAL PRESSURE INDICATORS

Effective June 15, 1999

ST2H/PS-1A/99
Page 3 of 4

HQS-2: QUICK SELECT PRESSURE MODULES

Gauge and Absolute (All ranges include 316SS isolation, except where indicated by "**")

psi	Inches Water	Inches Mercury	mm Mercury	kPa	Bar Kg/Cm²	mBar cmH₂O	mmH₂O	Accuracy† ±0.025%	±0.05%	±0.1%
5*	100*	10*	250*	25*	1	250*	3000*	Gauge Pressure		
10	150*	20	500	40*	1.5	300*	5000*	650.00	600.00	550.00
15	250	30	750	60	2.5	400*	10,000	[2]	[1]	[1]
30	300	50	1000	100	4	500*				
50	500	100	1500	160	6	600				
60	1000	200	3000	250	10	1000				
100		300	5000	400	16	1500				
150		500		600		2000				
200				1000		2500				
250						4000		Absolute Pressure		
300						5000		725.00	675.00	625.00
				mPa		6000		[2]	[1]	[1]
				1		10,000				
				1.6						
500		1000		2.5	25			Gauge Pressure		
600				4.0	40			750.00	700.00	650.00
1000				6.0	60			[2]	[1]	[1]
1500				10	100					
2000				16	150					
2500				25	250					
3000				40	400			Absolute Pressure		
5000				60	600			825.00	775.00	725.00
6000								[2]	[1]	[1]
7500										
10,000								–	–	790.00

psi	Inches Water	Inches Mercury	mm Mercury	kPa	Bar kg/cm²	mBar cmH₂O	mmH₂O	Accuracy† ±0.025%	±0.05%	±0.1%
Vacuum										
5*		10*	250*	25*	0.25*	250*	3000*			
10		20	500	40*	0.4*	400*	5000*	725.00	675.00	625.00
15		30	750	60	0.6	600		[2]	[1]	[1]
				100	1.0	1000				
Compound										
±5	±100*	±10	±300	±25*	±0.25*	±250*	±3000*			
±10	±250	±20	±500	±40*	±0.40*	±400*	±6000			
±15	±400	±30	±750	±60	±0.60	±600	±10,000	725.00	675.00	625.00
−15/30		−30/60	−750/1500	±100	±1.0	±1000		[2]	[1]	[1]
−15/60		−30/100	−750/3000	−100/200	−1/2	−1000/2000				
				−100/400	−1/4	−1000/4000				

*Non-isolated; for clean dry gas only.

†Maximum includes nonlinearity, nonrepeatability and hysteresis.

HQS-2 OPTIONS

Enhanced Calibration (no additional temperature error throughout operating range of 20-120°F)	100.00
Non-Standard Ranges	115.00
G ¼ British Standard Fitting	30.00
Flush Port (isolated sensors only)	95.00
Welded VCR Connection (with standard finish on gland)	85.00
Oxygen Cleaning (isolated sensors only)	115.00

Reference: Bulletin ST2H-1

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DRESSER INSTRUMENT
A Halliburton Company

10" 150 1000
30 psi 200 1350
50 psi 500 1500"
1000"

HEISE HQS-2 M&TE DATA SHEETS

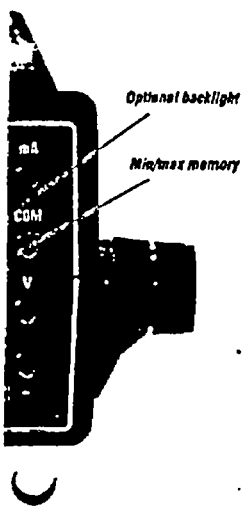
HEISE MODEL ST-2H INDICATOR SPECIFICATIONS

Standard Display: Alphanumeric LCD, 0.37-inch height, 2 lines, 16 characters/line.
Optional Display: Backlit LCD alphanumeric with 2 lines and 16 characters/line.
Display Resolution: ±0.002% of span with damping 1 part in 50,000 (max).
Display Update Rate: 100 ms.
Engineering Units: psi, in.H_2O, in.Hg, ftSW, bar, mbar, kPa, MPa, mmHg, cmH_2O, mmH_2O and kpcm^2 and any single user-programmable engineering unit.
Damping: Programmable averaging from zero through 16 consecutive readings.

TEMPERATURE SPECIFICATIONS

Standard Operating Range: 32° to 120°F (0 to 49°C).

Compensated Range: 20° to 120°F (-7° to +49°C).
Reference Temperature: 70 ±3°F.
Standard Temperature Effect: ±0.004% of span per degree Fahrenheit over the compensated range.
Optional: Quick-Select modules are available calibrated to maintain rated accuracy over the 20° to 120°F (-7° to +49°C) compensated temperature range.
Storage Limits: -4°F to +158°F (-20° to +70°C).



ELECTRICAL SPECIFICATIONS

Electrical Sourcing Specification:
24 Vdc at 25mA.
Electrical Measurement Specification:

Input (volts)	Accuracy
0/10 Vdc	±0.025% F.S.
0/30 Vdc	±0.10% F.S.
Input (mA)	**Accuracy**
0/20 mA	±0.03% F.S.
0/50 mA	±0.05% F.S.

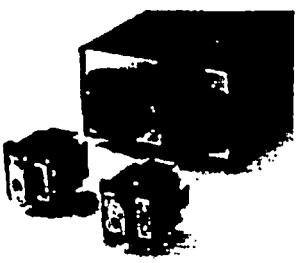
Auto-ranging 10/30 Vdc & 20/50mA
Temperature Effects Electrical Measurement: ±0.001% of span per °F over the compensated range.

INTERFACE AND DATA LOGGING

RS232 Serial Interface: with 9-pin D type at 300, 1200, 2400, 9600 baud.
Field Calibration: Calibration module and proper pressure and electrical standards are required.
Optional Data Logging capacity:
Standard measurements: 714 records.
Date/time stamped measurements: 384 records.
Optional Certification Generation Firmware: Stores 10 complete sets of calibration data including 10 "as found" and 10 "as left" data sets.

MECHANICAL SPECIFICATIONS

Weight: ST-2H Base unit: 3.0 lb (1.4 kg).
Housing: Molded, high-impact ABS case.
Electrical Connections: Standard banana jacks.
Optional Battery Power Supply:
5 "AA" nicads with built-in charger.
External Power Supply: AC adaptor 9 Vdc, 500mA.
Portable Operation: 20 hours with optional backlight off, 2 hours with backlight on.
Warm-up: 5 minutes for rated accuracy (maximum), 30 minutes for complete stability.



HQS Modular Sensor System

ACCESSORIES

AC Adaptors: provide 9 Vdc output.

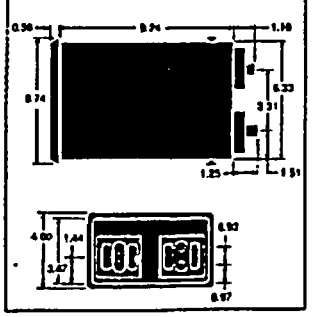
Part Number	Adapts from
831X016-01	110 Vac, 60Hz
831X016-02	100 Vac, 50 Hz
831X016-03	230 Vac, 50 Hz

Calibration Quick-Select Module:
For calibration of base unit electronics.
Part Number: CQS.
System Protection Module: Protects base unit when only one measurement module is required.
Part Number: HQS-XS.
Cable Assembly: Connects base unit to 9-pin female serial port on computer.
Part Number: 838X011-01.
Adapter 9-pin to 25-pin: Serial port connector on computer.
Part Number: 838X012-01.
Hoses: provide 1/8-20 UNF internal fittings. For use with pumps and general process connections.
3 ft hose, *Part Number:* 840X007-01.
5 ft hose, *Part Number:* 840X007-02.
1/8 NPT external fitting adaptor to convert hose connector from 1/8-20 to NPT.
Part Number: 840X006-01.

FOR MORE INFORMATION

Request the following documents:
Temperature Module: HQS-1
Pressure Modules: PTE-1
Pumps: HACC-P
Voltage Adapter: HACC-SM
How to Order: See Price Sheet ST-2H-1 for ordering information.
Contact us at: 203-426-3115.

ST-2H Dimension Drawings



* Ryndtek is a registered trade name of AmeriDetek Corporation.

DEPT/DIV	CALCULATION NO. IP-C-0094	REVISION 0	SHEET
C/NSED	ATTACHMENT 4	VOLUME A	1 of 4

RPV LEVEL SCALING – EXCEL SPREADSHEETS

	A	B	C	D	E	F	G
1	Instrument	1B21-N073C & G					
2	Cond Chamber	1B21-D004C					
3	Operating Presure				1025		
4							
5		feet	inches	cubic feet / lbm	inwc	vdc	
6	CCELEV.COLD	793.49	593.22				
7	VLN.ELEV	773.82	357.84				
8	RLP.ELEV	790.75	561.00				
9	VLP.ELEV	770.76	321.12				
10	SUB.ELEV	786.42	509.04				
11	TCH.ELEV		-8928.00				
12	LI0.ELEV.COLD		520.62				
13	Vessel Zero	744.00					
14							
15	LIMAX		60.00				
16	LIMAX.ELEV		580.62				
17	NTSP Level 8		52.00				
18	NTSP Level 8.ELEV		572.62				
19	Reset Level 8		45.40				
20	Reset Level 8.ELEV		566.02				
21	AV Level 8		54.60	54.20			
22	AV Level 8.ELEV		575.22				
23	NTSP Level 2		-45.50				
24	NTSP Level 2 .ELEV		475.12				
25	Reset Level 2		-38.90				
26	Reset Level 2.ELEV		481.72				
27	AV Level 2		-48.10				
28	AV Level 2.ELEV		472.52				
29	LIMIN		-160.00				
30	LIMIN.ELEV		360.62				
31	LISPAN		220.00				
32							
33	c		0.003727				
34							
35	hw1min		0.00				
36	hw2min		2.79				
37	hw1max		71.02				
38	hw2max		151.76				
39	hw1(NTSPlevel8)		63.02				
40			0.00				
41	hw2(NTSPlevel8)		151.76				
42	hw1(Resetlevel8)		56.42				
43			0.00				
44	hw2(Resetlevel8)		151.76				
45	hw1(AVlevel8)		65.62				
46			0.00				
47	hw2(AVlevel8)		151.76				
48	hw1(NTSPlevel2)		-33.92				
49			0.00				
50	hw2(NTSPlevel2)		117.72				
51	hw1(Resetlevel2)		-27.32				
52			0.00				
53	hw2(Resetlevel2)		124.34				
54	hw1(AVlevel2)		-36.52				
55			0.00				
56	hw2(AVlevel2)		115.11				

RPV LEVEL SCALING – EXCEL SPREADSHEETS

	A	B	C	D	E	F	G
1	Instrument	1B21-N073C & G					
2	Cond Chamber	1B21-D004C					
3	Operating Presure				1025		
4							
5		feet	inches	cubic feet / lbm	inwc	vdc	
57							
58	H		236.26				
59							
60	hdvar		38.05				
61	hdref1		34.43				
62	hdref2						
63	delta-hd		3.62				
64							
65	delta-hrb		-239.88				
66							
67	v68			0.01604537			
68	vw1			0.02173445			
69	vw2			0.02123649			
70	vs			0.42697000			
71	vd			0.01621815			
72	vrb			0.01602092			
73							
74	delta-Pmax				-69.06		
75	delta-P Level 8				-74.67		
76	delta-P Level 8 Reset				-79.29		
77	delta-P AV Level 8				-72.85		
78	delta-P Level 2				-143.27		
79	delta-P Level 2 Reset				-138.51		
80	delta-P AV Level 2				-145.14		
81	delta-Pmin				-225.78		
82							
83	CF				0.00769		
84					inwc	inches	
85	Span Corrected calibrated Range Upper Limit				-68.5	60.000	
86	Span Corrected Level 8 reset				-78.7	45.640	
87	Span Corrected Level 8 Setpoint				-74.1	52.131	
88	Span Corrected AV Level 8				-72.3	54.689	
89	Span Corrected Level 2 reset				-137.5	-37.489	
90	Span Corrected Level 2 Setpoint				-142.2	-44.166	
91	Span Corrected AV Level 2				-144.0	-46.797	
92	Span Corrected calibrated Range Lower Limit				-224.1	-160.000	
93							
94	LT 0%				-224.1	1.000	
95	LT 25%				-185.2	2.000	
96	LT 50%				-146.3	3.000	
97	LT 75%				-107.4	4.000	
98	LT 100%				-68.5	5.000	
99							
100	CC Span				155.60		

RPV LEVEL SCALING – EXCEL SPREADSHEETS

	A	H	I	J	K	L	M	N	O
1	Instrument		1B21-N073D & H						
2	Cond Chamber		1B21-D004D						
3	Operating Presure					1025			
4									
5			feet	inches	cubic feet / lbm	inwc	vdc		
6	CCELEV.COLD		793.47	592.98					
7	VLN.ELEV		773.82	357.84					
8	RLP.ELEV		791.10	565.19					
9	VLP.ELEV		770.80	321.60					
10	SUB.ELEV		786.42	509.04					
11	TCH.ELEV			-8928.00					
12	LI0.ELEV.COLD			520.62					
13	Vessel Zero		744.00						
14									
15	LIMAX			60.00					
16	LIMAX.ELEV			580.62					
17	NTSP Level 8			52.00					
18	NTSP Level 8.ELEV			572.62					
19	Reset Level 8			45.40					
20	Reset Level 8.ELEV			566.02					
21	AV Level 8			54.60					
22	AV Level 8.ELEV			575.22					
23	NTSP Level 2			-45.50					
24	NTSP Level 2 .ELEV			475.12					
25	Reset Level 2			-38.90					
26	Reset Level 2.ELEV			481.72					
27	AV Level 2			-48.10					
28	AV Level 2.ELEV			472.52					
29	LIMIN			-160.00					
30	LIMIN.ELEV			360.62					
31	LISPAN			220.00					
32									
33	c			0.003727					
34									
35	hw1min			0.00					
36	hw2min			2.79					
37	hw1max			71.02					
38	hw2max			151.76					
39	hw1(NTSPlevel8)			63.02					
40				0.00					
41	hw2(NTSPlevel8)			151.76					
42	hw1(Resetlevel8)			56.42					
43				0.00					
44	hw2(Resetlevel8)			151.76					
45	hw1(AVlevel8)			65.62					
46				0.00					
47	hw2(AVlevel8)			151.76					
48	hw1(NTSPlevel2)			-33.92					
49				0.00					
50	hw2(NTSPlevel2)			117.72					
51	hw1(Resetlevel2)			-27.32					
52				0.00					
53	hw2(Resetlevel2)			124.34					
54	hw1(AVlevel2)			-36.52					
55				0.00					
56	hw2(AVlevel2)			115.11					

RPV LEVEL SCALING – EXCEL SPREADSHEETS

	A	H	I	J	K	L	M	N	O
1	Instrument		1B21-N073D & H						
2	Cond Chamber		1B21-D004D						
3	Operating Presure					1025			
4									
5			feet	inches	cubic feet / lbm	inwc	vdc		
57									
58	H			236.02					
59									
60	hdvar			37.57					
61	hdref1			30.01					
62	hdref2								
63	delta-hd			7.57					
64									
65	delta-hrb			-243.59					
66									
67	v68				0.01604537				
68	vw1				0.02173445				
69	vw2				0.02123649				
70	vs				0.42697000				
71	vd				0.01621815				
72	vrb				0.01602092				
73									
74	delta-Pmax					-68.88			
75	delta-P Level 8					-74.49			
76	delta-P Level 8 Reset					-79.11			
77	delta-P AV Level 8					-72.66			
78	delta-P Level 2					-143.08			
79	delta-P Level 2 Reset					-138.33			
80	delta-P AV Level 2					-144.96			
81	delta-Pmin					-225.60			
82									
83	CF					0.00769			
84						inwc	Vdc	mA	Inches
85	Span Corrected calibrated R					-68.4	5.000	20.000	60.000
86	Span Corrected Level 8 res					-78.5	4.739	18.956	45.640
87	Span Corrected Level 8 Set					-73.9	4.857	19.428	52.131
88	Span Corrected AV Level 8					-72.1	4.903	19.614	54.689
89	Span Corrected Level 2 res					-137.3	3.227	12.910	-37.489
90	Span Corrected Level 2 Set					-142.0	3.106	12.424	-44.166
91	Span Corrected AV Level 2					-143.9	3.058	12.233	-46.797
92	Span Corrected calibrated R					-223.9	1.000	4.000	-160.000
93									
94	LT 0%					-223.9	1.000		
95	LT 25%					-185.0	2.000		
96	LT 50%					-146.1	3.000		
97	LT 75%					-107.2	4.000		
98	LT 100%					-68.4	5.000		
99									
100	CC Span					155.50			

DEPT/DIV	CALCULATION NO. IP-C-0094	REVISION 0	SHEET
C/NSED	ATTACHMENT 5	VOLUME A	1 of 1

BASIS FOR LEVEL 8 ANALYTICAL LIMIT

ATTACHMENT A.3-1
REVISION 6

Nuclear Station Engineering Department
P. O. Box 678
Clinton, IL 61727
(217) 935-8881

RECORD OF COORDINATION

Prepared by : Chuck Hallett Date : 05/16/2001 Time : 16:00

File Code number (s): M98-01(05-16)-L

Copies to : Setpoint Calculation IP-C-0094, Rev. 0

Meeting __ Telecon √ Other __

Describe Other : __

Participants Julie Leong, General Electric - Nuclear, San Jose CA & Chuck Hallett CPS

Subject Basis for Wide Range RPV Level 8 Analytical Limit

SUMMARY :

Ms. Leong was asked what GE's justification was for using an Analytical Limit of 60 inches in GE Letter IP-3040 dated 1/23/1987. I told her that a value of 58.4 inches is specified in the Design Spec Data Sheet 22A4622AV.

Ms. Leong stated that the Wide Range Level 8 trip function is used to shut off the High Pressure Core Spray pump and that function was not credited in any Safety-Analysis, but rather was for equipment protection only, in that it would prevent getting water into the steam lines. Her basis for using 60 inches was because that it was the maximum value which would still be "on-scale" (The range is -160 to +60 inches).