Florida Power
CORPORATION

INTEROFFICE CORRESPONDENCE

Nuclear Engineering Design — Office
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SUBJECT: Crystal River Unit 3
Quality Document Transmittal - Analysis/Calculation
File: CALC

TO: Records Management - NR2A

The following analysis/calculation package is submitted as the QA Record copy:

DOCNO (FPC DOCUMENT IDENTIFICATION NUMBER)	REV.	SYSTEM(S)	TOTAL PAGES TRANSMITTED
I-88-0020	7	RC	97

TITLE

RC PRESSURE (WIDE RANGE) LOOP ACCURACY, RC-158-PT and RC-159-PT

KWDS (IDENTIFY KEYWORDS FOR LATER RETRIEVAL)

RC Pressure, Error, Indication, DSS, RECALL, Calculation

DXREF (REFERENCES OR FILES - LIST PRIMARY FILE FIRST)	
SP95-002	
SP-161C	Calculation I-84-0001
SP-120A	Calculation I-92-0003

VEND (VENDOR NAME)	VENDOR DOCUMENT NUMBER (DXREF)	SUPERSEDED DOCUMENTS (DXREF)
FPC/GCI	C-423-5510-043	I-88-0020 Revision 6

TAG		
RC-158-PT	RC-158-PIR	RC-159-PI1
RC-158-PI1	RC-158-PS1	RC-159-PI2
RC-158-PI2	RC-159-PT	RC-159-PS1
RC-158-PY1 thru RC-158-PY7	RC-159-PY1 thru RC-159-PY6	

PART NO.		

COMMENTS (USAGE RESTRICTIONS, PROPRIETARY, ETC.)

This Revision replaces Revision 6 in its entirety.

NOTE:
Use Tag number only for valid tag numbers (i.e., RCV-8, SWV-34, DCH-99), otherwise; use Part number field (i.e., CSC14599, AC1459). If more space is required, write "See Attachment" and list on separate sheet.

DESIGN ENGINEER	DATE	VERIFICATION ENGINEER	DATE	SUPERVISOR, NUCLEAR ENG.	DATE
P.E. Couvillon	5/4/95	Doug Waters	3/23/95	B.K. Ballard	4/13/95

cc: MAR Office (If MAR Related) ☐ Yes ☒ No
MAR/Project File
Mgr. Nucl. Config. Mgt.
File (CALC) - FPES "Original" w/attach
Mgr., Site Nucl. Eng. Serv. w/attach
P.E. Couvillon w/ATTACH.

Plant Document Review Required ☒ Yes ☐ No
Supervisor, Nuclear Document Control w/ Plant Doc. Rev. Eval. and Analysis / Calc. Summary (If Plant Doc. Rev., is Yes)
A/E N/A ☐ Yes ☒ No
(If yes, Transmit w/attach)
G.V. HILDEBRANDT w/ATTACH

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PLANT DOCUMENT REVIEW EVALUATION

DOCUMENT TYPE / NUMBER TO BE EVALUATED

Calculation I-88-0020 Revision 7

PART I

INSTRUCTIONS: Calculations, Document Change Notices, and Plant Equipment Equivalency Replacements have the potential to affect plant documents. The Originator of any of these documents is required to determine which, if any, plant organizations should review the subject document for impact. The Originator should use the best judgment to make this determination based on the nature of the changes. If in doubt as to whether or not a plant organization should review a particular document, it is suggested that the subject organization be contacted.

The Originator is to check the appropriate boxes below and attach to the subject package as follows:

Calculations - Insert behind Analysis/Calculation Transmittal
DCNs - Insert behind DCN page 1
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- ☐ Senior Radiation Protection Engineer
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  - D.E. McPherson for Calibration Data Sheet Revisions
  - Supervisor, Nuclear Training Controls
  - Manager, Nuclear Operations Training

ORIGINATOR / DATE	SUPERVISOR / DATE
P.E. Couvillon 3/11/95	S.K. Balliet 4/12/95

Upon completion of **Part I**, if applicable, attach to the subject document, check "Plant Document Review Required" block, "Yes," and give to Nuclear Engineering Department Support Specialist for distribution.
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Calcs - Distribute with Transmittal Memo, Summary - **PEERE** - Distribute with Attachments - **DCNs** - Distribute with Attachments and Drawings

PART II

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REVIEWING DEPARTMENT

PLANT REVIEW IMPACT EVALUATION: The above referenced document has been reviewed and evaluated as follows:

- ☐ No Action Required
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DOCUMENTS / ACTIONS

REVIEWER / DATE	SUPERVISOR / DATE

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* If the Supervisor or designee acts as the Originator or Reviewer, the applicable "Originator/Reviewer" block should be NA'd.

Florida Power Corporation

ANALYSIS/CALCULATION SUMMARY

DOCUMENT IDENTIFICATION NUMBER	DISCIPLINE	CONTROL NO.	REVISION LEVEL
	I	88-0020	7

TITLE

RC PRESSURE (WIDE RANGE) LOOP ACCURACY, RC-158-PT and RC-159-PT

CLASSIFICATION (CHECK ONE)

[X] Safety Related

[ ] Non Safety Related

MAR/SP/CGWR/PEERE NUMBER/FILE

SP 95-002

VENDOR DOCUMENT NUMBER

C-423-5510-043

	REVISION APPROVALS	ITEMS REVISED
Design Engineer	P.E. Couvillon	Various
Date	3/11/95	
Verification Engineer	George Hildebrandt	
Date/Method*	3/23/95 R	
Supervisor	S. F. Ballard	
Date	4/13/95	

***VERIFICATION METHODS:** R - Design Review; A - Alternate Calculation; T - Qualification Testing

DESCRIBE BELOW IF METHOD OF VERIFICATION WAS OTHER THAN DESIGN REVIEW

PURPOSE SUMMARY

This Revision replaces Revision 6 in its entirety. This revision includes a modified methodology for determining errors compared to the method used in Revision 6.

RESULTS SUMMARY

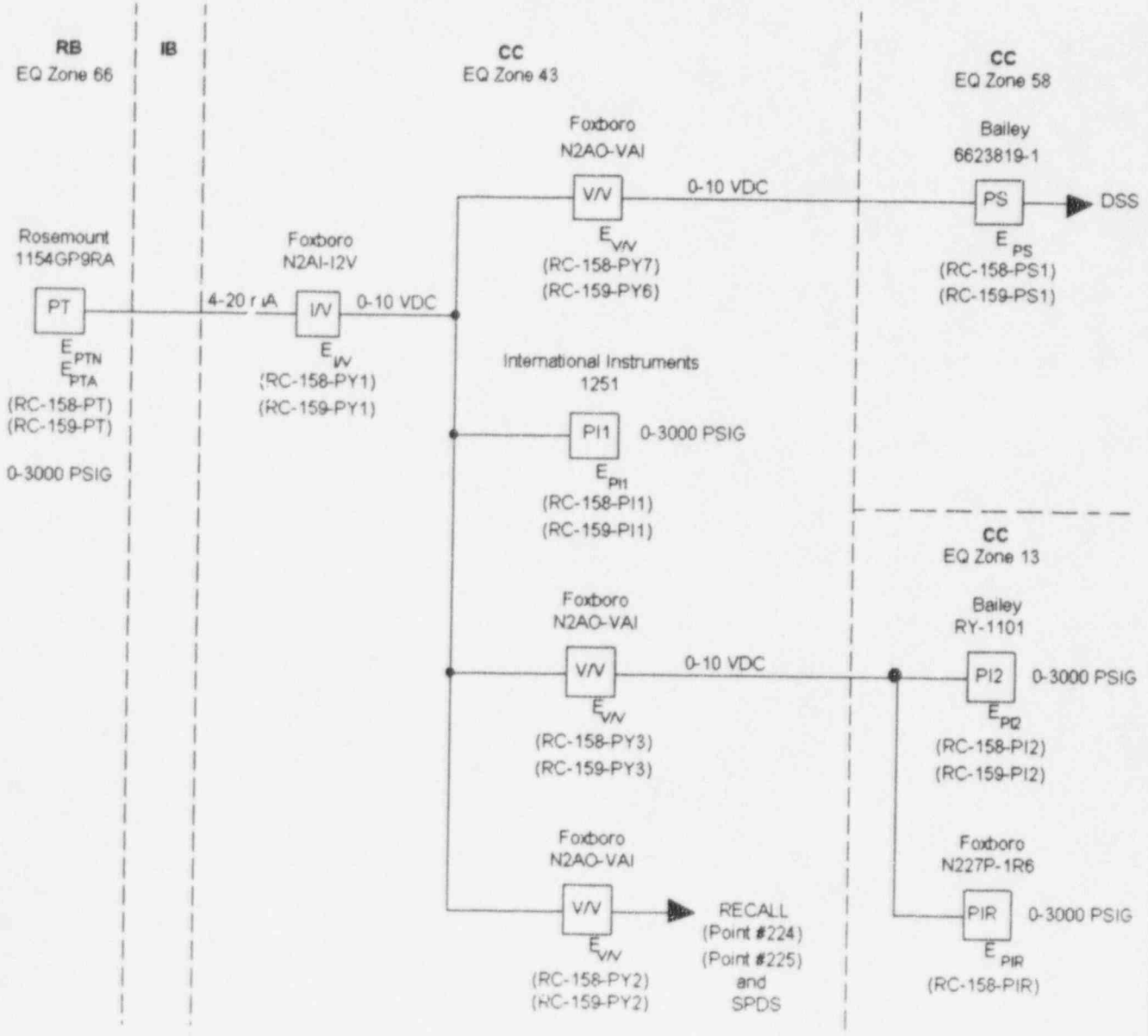
See Section VI "RESULTS/CONCLUSIONS".

DOCUMENT IDENTIFICATION NO.	REVISION	REI/MAR/SP NUMBER/FILE
I-88-0020	7	SP95-002

I. PURPOSE:

The purpose of this calculation is to determine the instrument loop accuracy of the RC Wide Range Pressure loops (transmitters RC-158-PT and RC-159-PT) that provide Control Room indication and recording for Normal and Post-Accident Monitoring (Technical Specification 3.3.17.2.(3) - Reference 2), RECALL/SPDS, Remote Shutdown Indication (Technical Specification 3.3.18.2.(2a) - Reference 2) and input to ATWS.

INSTRUMENT LOOPS



II. DESIGN INPUT (DI):

1. Drawing 205-047 sheet RC-02 (Reference 27) shows the circuit configuration for the RC Wide Range Pressure loops.

2. The Design Basis Document for Post-Accident Monitoring Instrumentation, Section 5/11 (Reference 4), states that the RC Wide Range Pressure indication is a Type A, B and C, Category 1 Reg. Guide 1.97 variable. The RC Wide Range Pressure is indicated (RC-158-PI2 and RC-159-PI2) and recorded (RC-158-PIR) in the Main Control Room, and is on demand in the TSC (Technical Support Center) and the EOF (Emergency Offsite Facility) via RECALL. CMIS states that these are required post-accident for six months (See Attachment 12).

3. Pressure transmitters RC-158-PT and RC-159-PT are located in the Reactor Building.

   (1) Per drawing 308-606 (Reference 31), RC-158-PT is located at the North "Y" Station at an elevation of 103'-11" (± 1") in the Reactor Building.

   (2) Per drawing 308-603 sheet 2 (Reference 30), RC-159-PT is located at the South "Y" Rack at an elevation of 102'-9" (± 4") in the Reactor Building.

   (3) The connections for RC-158-PT and RC-159-PT's sensing lines are shown on drawings 308-601 (Reference 28) and 308-602 (Reference 29), respectively. The connections to the RCS Hot Legs are at an elevation of 167'-2½".

   Per CMIS and REA 94-1210 (Reference 6), RC-158-PT and RC-159-PT are located in EQ Zone 66. Per the Environmental and Seismic Qualification Program Manual (E/SQPM - Reference 7) EQ Zone 66 is "HARSH" and has the following specifications:

Radiation - Normal:	1.4×10^7 rads TID for 40 year dose.
Radiation - Accident:	2.8×10^7 rads TID (40 year TID + 6 months).
Temperature - Normal:	70° to 109°F.
Temperature - LOCA:	110° to 298°F.
Temperature - HELB:	110° to 386°F.

Per drawing 308-601 (Reference 28) and 308-602 (Reference 29), the majority of the sensing lines are routed inside the D-Rings, from the connection point to just below the 119' elevation of the Reactor Building. The area inside the D-Rings is designated as EQ Zone 40 per the E/SQPM (Reference 7) and has the following specifications:

Radiation - Normal:	3.3×10^7 rads TID for 40 year dose.
Radiation - Accident:	6.6×10^7 rads TID (40 year TID + 6 months).
Temperature - Normal:	110° to 149°F.
Temperature - LOCA:	110° to 298°F.
Temperature - HELB:	110° to 386°F.

Calculation I-90-0014 (Reference 14) provides a point specific 10 year radiation dose for Zone 66.

(4) Since RC-158-PT is located at the North "Y" Station in the Reactor Building, it has a 10 year dose rate of 2.1×10^3 rads at an elevation of 104'.

(5) Since RC-159-PT is located at the South "Y" Rack in the Reactor Building, it has a 10 year dose rate of 8.0×10^3 rads at an elevation of 104'.

4. Instrument Data Sheets RC-158-PT (Reference 26.e) and RC-159-PT (Reference 26.n) show that the pressure transmitters are Rosemount Model 1154GP9RA pressure transmitters with a span of 0 to 3,000 psig. The specifications for these transmitters are described in Instruction Manual 1260 (Reference 35). The transmitters have the following specifications (See Attachment 1):

Upper Range Limit (URL):	3,000 psig.
Reference Accuracy:	± 0.75% of calibrated span.
Temperature Effect:	± (0.75% URL + 0.5% span)/100°F.
Drift (Stability):	± 0.2% of upper range limit for 30 months.
Overpressure Effect:	± 0.5% of upper range limit after exposure to 4,500 psig.
Power Supply Effect:	< 0.005% per volt.
Steam Pressure/Temp:	± (2.5% URL + 0.5% span) during and after sequential exposure to steam at the following temperature and pressure, concurrent with chemical spray for the first 24 hours: 420°F, 50 psig for 3 minutes 350°F, 110 psig for 7 minutes 320°F, 75 psig for 8 hours 265°F, 24 psig for 56 hours.

Seismic Effect: ± 0.5% URL after a disturbance defined by a required response spectrum with a ZPA of 7 g's.

Radiation Effect: ± (1.5% URL + 1.0% span) during and after exposure to 55×10^6 rads TID gamma radiation at the centerline per the following dose rate schedule of:
2×10^6 rads/hr for 2 hours,
1.5×10^6 rads/hr for 4 hours,
1×10^6 rads/hr up to 55×10^6 rads TID and an additional 55×10^6 rads TID at a rate of 1×10^6 rads/hr during post-accident operation.

Mounting Position Effect: Effect is superseded by accuracy specifications.

(1) The Temperature Effect is superseded by the Steam Pressure/Temperature Effect during Accident conditions.

(2) Per the Enhanced Design Basis Document for the Reactor Coolant System, Section 6/1 (Reference 5), the RCS pressure is limited to 2750 psig due to the Code Safety Valves and the Reactor Protection System (RPS). Therefore, the overpressure effect for the pressure transmitters will be considered as ± 0.0% since the pressure transmitters will not experience 3,000 psig, because the overpressure limit for the transmitter is it's Upper Range Limit.

(3) Since the conditions required for the Steam Pressure/Temperature effect during Normal operating conditions is not applicable, the Normal Steam Pressure/Temperature effect will be considered as ± 0.0%.

(4) Per Letter LFM90-0006 (Reference 38); "It is not required to apply LOCA + MHE simultaneously to system functions." Thus, a Seismic event (MHE) and a LOCA do not need to be considered to occur simultaneously. Thus, this calculation will only consider the LOCA/HELB effects (Radiation Effect and Steam/Temperature Effect). Therefore, the Seismic effect will be considered as ± 0.0% for Normal and Accident conditions.

(5) Per Letter SNES94-0276 (Reference 39); "...Rosemount has stated that any of these radiation induced errors may be compensated by calibration up to the tested dose from environmental qualification testing or about 110 MRads. Thus, it is shown that compensation of the radiation induced errors by calibration is a viable method up to the qualification level of 110 MRads."

Per the Attachment to Letter SNES94-0276; "The lower the dose rate, the lesser the effect on instrument accuracy. For the lower dose rates (10^4 Rads/hour) it was shown that a TID of less than 1×10^5 Rads resulted in a maximum output shift within the stated accuracy of the transmitter. These results are meant to be an aid in determining effects of radiation on accuracy of Rosemount transmitters."

Since the highest dose rate expected for RC-158-PT and RC-159-PT is 8×10^3 rads for 10 years per Design Input (DI) #3, the total dose rate for 30 months is 2×10^3 rads (8×10^3 rads/10 years x 2.5 years). Therefore, the radiation effect for NORMAL operating conditions will be considered as ± 0.0% since the transmitters receive less than 1×10^4 rads/hour and a 30 month TID of less than 1×10^5 rads.

5. Current to Voltage Converter (I/V) RC-158-PY1, Signal Converter/Isolator (V/V) RC-158-PY2, RC-158-PY3 and RC-158-PY7 are located in Remote Shutdown Auxiliary Equipment Cabinet "A" on the 108′ elevation of the Control Complex.

   Current to Voltage Converter (I/V) RC-159-PY1, Signal Converters/Isolators (V/V) RC-159-PY2, RC-159-PY3 and RC-159-PY6 are located in Remote Shutdown Auxiliary Equipment Cabinet "B" on the 108′ elevation of the Control Complex.

   Pressure Indicators RC-158-PI1 and RC-159-PI1 are located on Remote Shutdown Panel "AB" on the 108′ elevation of the Control Complex.

   Per the E/SQPM (Reference 7), the 108′ elevation of the Control Complex is designated as EQ Zone 43, which is "MILD" and has the following specifications:

Radiation - Normal:	1.75×10^2 rads TID for 40 year dose.
Radiation - Accident:	1.75×10^2 rads TID (40 year TID + 6 months).
Temperature - Normal:	70° to 80°F.

6. Instrument Data Sheets RC-158-PY1 (Reference 26.f) and RC-159-PY1 (Reference 26.o) show that these I/V converters are Foxboro Model N2AI-I2V converters with a 4 to 20 ma input and 0 to 10 VDC output. This Foxboro module also has an isolated 24 VDC transmitter power supply, which is powered from the 30 VDC nest field bus. The specifications for these I/V converters are described in Foxboro Product Specifications PS 2E-1A1-A, which is located in Instruction Manual 586 (Reference 34). The I/Vs have the following specifications (See Attachment 2):

Reference Accuracy:	± 0.25% of output span.
Temperature Effect:	± 0.5% of output span for 45°F change.

7. Instrument Data Sheets RC-158-PY2 (Reference 26.g), RC-158-PY3 (Reference 26.h), which includes RC-158-PY7, RC-159-PY2 (Reference 26.p), and RC-159-PY3 (Reference 26.q), which includes RC-159-PY6 show that these V/V converters are Foxboro Model N2AO-VAI converters with a 0 to 10 VDC input and 0 to 10 VDC output. The specifications for these V/V converters are described in Foxboro Product Specifications PSS 2E-1A1-G and Foxboro Supporting Literature Instruction SI 1-01762, which are located in Instruction Manual 586 (Reference 34). The V/Vs have the following specifications (See Attachment 3):

Reference Accuracy:	± 0.5% of output span.
Temperature Effect:	± 0.5% of output span for 45°F change.

8. Instrument Data Sheets RC-158-PI1 (Reference 26.a), which includes RC-159-PI1 show that the pressure indicators are International Instruments Model 1251WV-B010DCV-B010DCV with a 0 to 10 VDC input for a span of 0 to 3,000 psig. The specifications for this pressure indicator is described in International Instruments Series 1151/1251 bulletin, which is located in Instruction Manual 586 (Reference 34). The pressure indicator has the following specifications (See Attachment 4).

Specified Accuracy:	± 1.5% span for DC ranges.
Repeatability:	± 2% span.
Minor Scale Division:	50 psig.

Per Assumption (A) #6, the SRSS (Square Root of the Sum of the Squares) methodology for the Specified Accuracy and Repeatability will be used to determine the Reference Accuracy.

9. Pressure Switch RC-158-PS1 and RC-159-PS1 are located in ATWS Logic Cabinet on the 124' elevation of the Control Complex.

Per the F/SQPM (Reference 7), the 124' elevation of the Control Complex is designated as EQ Zone 58, which is "MILD" and has the following specifications:

Radiation - Normal:	1.75×10^2 rads TID for 40 year dose.
Radiation - Accident:	1.75×10^2 rads TID (40 year TID + 6 months).
Temperature - Normal:	70° to 80°F.

10. Instrument Data Sheets RC-158-PS1 (Reference 26.d) and RC-159-PS1 (Reference 26.m) show that these pressure switches (signal monitors) are Bailey Model 6623819-1 signal monitors with a 0 to 10 VDC input for a span of 0 to 3,000 psig. The specifications for these signal monitors are described in Bailey Product Instruction E92-74, which is located in Instruction Manual 49 Volume 1B (Reference 33). The signal monitors have the following specifications (See Attachment 5):

Reference Accuracy:	± 0.25% of span.
Temperature Effect:	± 0.25% of span for 100°F.

11. Per FSAR Section 7.5.2.1 (Reference 3), the actuation of DSS (Diverse Scram System) via RC-158-PT and RC-159-PT (RC Wide Range Pressure transmitters) is at a nominal setpoint (Design Setpoint) of 2450 psig.

12. Pressure indicators RC-158-PI2 and RC-159-PI2 and pressure indicating recorder RC-158-PIR are located in the Main Control Room on the 145' elevation of the Control Complex.

    Per the E/SQPM (Reference 7), the 145' elevation of the Control Complex is designated as EQ Zone 13, which is "MILD" and has the following specifications:

Radiation - Normal:	1.75×10^2 rads TID for 40 year dose.
Radiation - Accident:	1.75×10^2 rads TID (40 year TID + 6 months).
Temperature - Normal:	70° to 80°F.

13. Instrument Data Sheets RC-158-PI2 (Reference 26.b) and RC-159-PI2 (Reference 26.l), show that these pressure indicators are Bailey Controls Model RY-1101 with a 0 to 10 VDC input for a span of 0 to 3,000 psig. The specifications for these pressure indicators are described in Bailey Product Instruction E12-9-2, which is located in Instruction Manual 1400 (Reference 36). The pressure indicators have the following specifications (See Attachment 6):

Specified Accuracy:	± 1.0% of span.
Linearity:	± 1.0% of span.
Repeatability:	± 0.5% of span.
Deadband:	± 0.5% of span.
Temperature Effect:	± 0.001% output span/°F.
Power Supply Effect:	± 0.013% output span/volt AC.
Supply Voltage:	118 VAC.
Minor Scale Division:	100 psig.

    Per Assumption (A) #6, the SRSS (Square Root of the Sum of the Squares) methodology will be used to determine the Reference Accuracy.

    (1) RC-158-PI2 and RC-159-PI2 from VBDP-3 Breaker 35 and VBDP-4 Breaker 8, respectively.

Per drawing 206-041 (Reference 44), VBDP-3 is powered from Inverter VBIT-1A or 480V E.S. MCC 3A2 via Regulating Transformer VBTR-4A. Per the Enhanced Design Basis Document (EDBD) for the Class 1E AC System (Reference 42), the regulation associated with VBIT-1A and VBTR-4A is ±2.0%.

Per drawing 206-041 (Reference 44), VBDP-4 is powered from Inverter VBIT-1B or 480V E.S. MCC 3B1 via Regulating Transformer VBTR-4B. Per the Enhanced Design Basis Document (EDBD) for the Class 1E AC System (Reference 42), the regulation associated with VBIT-1B and VBTR-4B is ±2.0%.

Therefore, the voltage supplied to RC-158-PI2 and RC-159-PI2 will be considered as 118 VAC ±2.0%.

14. Instrument Data Sheet RC-158-PIR (Reference 26.c), shows that the pressure indicating recorder is a Foxboro Model N227P-1R6-CS-N/SRC with an 0 to 10 VDC input for a span of 0 to 3,000 psig. The specifications for this pressure indicating recorder are described in Foxboro Product Specifications PSS 9-7C1-A, which is located in Instruction Manual 1524 (Reference 45). The pressure indicating recorders have the following specifications (See Attachment 7):

Indicating Accuracy:	± 0.5% of span.
Recording Accuracy:	± 0.75% of span.
Temperature Effect:	± 0.5% of span/50°F change.
Humidity Influence:	
Indicating:	± 0.3% of span for a change of 50 to 95% relative humidity.
Recording:	+ 0.75% to - 1.5% of span for a change of 50 to 95% relative humidity.
Power Supply Effect:	± 0.1% of span for ±5% change from nominal.
Minor Scale Division:	50 psig (Indicating/Recording).

15. Foxboro Model N2AX-PS9A nest power supplies are used to supply power for the above mentioned Foxboro modules, Rosemount pressure transmitters and pressure indicating recorder. The Specifications for these power supplies are described in Foxboro TI 2AX-151, which is located in Instruction Manual 586 (Reference 34). The power supplies have the following specifications (See Attachment 8):

Output:	+15 VDC at 1.5 amps and -15 VDC at 1.5 amps.
Regulation - Line:	0.2% output voltage change for ±10% change from nominal line voltage.
Regulation - Load:	1.5% output voltage change for load change from 50 to 100%.

(1) Power supply ZZ-1-JY (Reference 26.x) provides power to RC-158-PIR. ZZ-1-JY is powered from VBDP-3 Breaker 2.

(2) Power supply RC-198-J2A (Reference 26.t) provides power to RC-158-PT. RC-198-J2A is powered from VBDP-8 Breaker 3.

(3) Power supply RC-198-J2B (Reference 26.u) provides power to RC-159-PT. RC-198-J2B is powered form VBDP-10 Breaker 3.

For conservatism, the total regulation associated with the power supplies will be considered as ±1.7% (0.2% + 1.5%) for the transmitters and recorder.

16. Foxboro distribution module (terminal block) RC-158-PY4 (Reference 26.i), test modules RC-158-PY5 (Reference 26.j) & RC-159-PY4 (Reference 26.r) and signal generators RC-158-PY6 (Reference 26.k) & RC-159-PY5 (Reference 26.s) will not be considered in this calculation, because the above mentioned modules are only used for distribution or for testing. The modules do not contribute to the loop error.

17. The I&C Design Criteria (Reference 1) and Calculation I-89-0004 (Reference 12) provide the bases for the development of calculations which require the incorporation of Insulation Resistance (IR) effects.

The transmitter loop is not grounded, except at the power source. Therefore, the IR effects are due to conductor-to-conductor current leakage, but will be conservatively evaluated as conductor-to-ground leakage for cables due to the potential of the cables grounding in the field.

18. Per Calculation I-88-0015 (Reference 11), the following is a list of the circuit data for the loop components which are located in "HARSH" environment:

    (1) Sensor: RC-158-PT

        (a) Rosemount Model 1154 transmitter.
        (b) Rosemount conduit seal.
        (c) Circuit number RCR265 (EK-35A, Reel 342).
        (d) Circuit Length - 95 feet.
        (e) 2 splices in circuit RCR265.
        (f) Penetration 129 (PEN-129, previously identified as MTBD-9A).

    (2) Sensor: RC-159-PT

        (a) Rosemount Model 1154 transmitter.
        (b) Rosemount conduit seal.
        (c) Circuit number RCR271 (EK-35A, Reel 341).
        (d) Circuit Length - 360 feet.
        (e) 2 splices in circuit RCR271.
        (f) Penetration 406 (PEN-406, previously identified as MTBD-11B).

19. Per Calculation I-88-0006 (Reference 10), the IR accuracy for Foxboro nest loops is:

    $A_{IR} = + [22.8/(4.8 + (0.016 \times R_p))] \times 100$

    Where R_p is the equivalent parallel resistance of the cable(s), splice(s), connector(s) and/or penetration(s).

    Per Section 6.2.B of the Instrument String Error/Setpoint Determination Methodology (Reference 1): "IR error due to accident environments are considered systematic." These errors are therefore, additive.

20. The cables used in these instrument loops is Bill Of Material (B.O.M.) No. EK-35A, which is a 2 conductor #16 AWG cable. VQP CABL-B365-01 (Reference 17) is used to determine the IR value associated the EK-35A cable. Per Tab I1 of the VQP, all EK-35A cable has the same construction as the BIW (Boston Insulated Wire) Bostrad 7E, whose test data is documented under the VQP.

    The peak temperature in the Reactor Building (RB) is 386°F per Design Input (DI) #3. This temperature peak in the RB lasts approximately 3 minutes before returning to 300°F.

    BIW Bostrad 7E cable was tested under Sandia National Laboratories Report SAND89-1755C, which is included Attachment B2 to Calculation I-89-0004 (Reference 12). Per Conclusion 4.e of the report; "Total thermal lag time was typically 3 minutes for multiconductor cables and 30 seconds for single conductors." Therefore the minimum cable IR of 2.9×10^6 ohms for the 20 foot specimen length, which is listed in Figure 7 of VQP CABL-B365-01 (Reference 17) will be used in this calculation. Therefore, the following information is applicable:

    Specimen Length (L_{SPL}): 20 feet.
    Minimum IR value (R_C): 2.9×10^6 ohms at 300°F.

    The cable IR (R_{CE}) is derived from the cable qualification test specimen IR (R_C), the specimen length (L_{SPL}) and the total length of cable in the HARSH environment (L_{CKT}), in feet. Therefore, the following formula is used:

    $$R_{CE} = (R_C \times L_{SPL})/L_{CKT}$$

21. Based on the Walkdown Packages for transmitters RC-158-PT (Reference 24) and RC-159-PT (Reference 25), the splices in the circuits associated with RC-158-PT and RC-159-PT consists of butt splices with Raychem heat shrink tubing. No VQP were available for the associated penetrations, but no non-standard splice configurations were identified. The splices at the transmitters were identified as having Raychem WCSF-N tubing sleeves; therefore, VQP TERM-R098-04 (Reference 23) which documents the test data associated with Raychem WCSF-N splice sleeves will be used for this calculation.

    Per Tab F5 of the VQP (Wyle Test Report 58442-1), each test circuit consists of three (3) test splices each consisting of a single layer of WCSF-N sleeving. Per Table 1 of the test report, the minimum IR during the simulated LOCA/MSLB test was:

    Cable Splice (R_s): 1.8×10^7 ohms at 314°F (excluding the test specimens that had cable insulation failures).

    Figure 1 of Tab D1, in the above mentioned VQP, describes the thermal lag associated with the Raychem sleeving. The RB temperature profile and the thermal lag associated with the Raychem sleeving cross at approximately 310°F. Therefore, the use of the 1.8×10^7 ohms at 314°F is acceptable.

22. VQP INST-R369-03 (Reference 19) covers Rosemount Model 1154 transmitters. Per Note 1 in Tab D; "Full sequential testing which verifies the design capabilities of these transmitters is dependent on the testing of the 1153 Series D as documented and evaluated in VQP No. INSTR-369-02."

    VQP INST-R369-02 (Reference 18) covers Rosemount Model 1153 Series D transmitters. Tab F, Section II, page II-5 states that the transmitters use a Conax conduit seal during the qualification testing. Per the Walkdown Packages for RC-158-PT (Reference 24) and RC-159-PT (Reference 25), Rosemount 353C conduit seals are used on the transmitters.

    Since VQP INST-R369-02 does not list the IR associated with the Conax conduit seal, and because a Rosemount 353C conduit seal is actually use in the plant configuration, the IR values associated with the Rosemount 353C conduit seal will be used for conservatism.

    VQP PEN-R369-01 (Reference 20) documents the testing of the Rosemount Model 353C conduit seals. Calculation I-88-0003 (Reference 9) documents the IR value of the Rosemount 353C conduit seals as:

    Conduit Seal (R_{SEAL}): 5×10^5 ohms for temperatures up to 420°F, based on the above mentioned VQP.

23. Per CMIS (Attachment 12), Penetration 129 (MTBD-9A) is covered under VQP PEN-C515-04 (Reference 22) and Penetration 406 (MTBD-11B) is covered under VQP PEN-C515-03 (Reference 21). Per Tab B, Section 1.0, VQP PEN-C515-03 does not include the #16 AWG feedthroughs installed at CR3; however, successful Conax testing of similar penetrations and feedthrough assemblies with #16 AWG conductors is found in VQP PEN-C515-04. Therefore, VQP PEN-C515-04 will be used for Penetration 129 and 406.

    Tab D1, Note 3 of VQP PEN-C515-04 states that the test profile envelopes the plant composite profile for the entire test duration except for 16 seconds at the beginning of the test. It also states that the thermal stress imposed by the test is considered to be more severe than the short (16 second) 15°F temperature spike in the plant.

    Tab D1, Note 1 of VQP PEN-C515-04 states that the test contained in Tab F1 is applicable to the penetrations installed at CR3, and Note 9 states that the instrument and thermocouple feedthroughs used at CR3 utilize #14 AWG.

    Tab F1, Section 6.20 describes the DBE testing. IR tests were also performed during the DBE testing and are documented on Data Sheet P in Appendix A. The minimum IR for the #14 AWG conductors during the testing was 2×10^7 ohms (conductor #30 to ground). Leakage current was measured throughout the test and are documented on Data Sheet L of Appendix A. The maximum leakage current for the #14 AWG conductors was 0.12 mA at 536 VAC; therefore, the IR at that point was 4.47×10^6 ohms (536 VAC/0.12 mA). Therefore, for conservatism, the minimum IR value is:

    Penetration (R_{PEN}): 4.47×10^6 ohms for post-accident conditions.

24. The Remote Shutdown equipment is not postulated to be required concurrent with a Design Basis Accident (DBA), per FSAR Section 7.4.6.5 (Reference 3).

25. Per Section 3.0 of Calculation I-83-0001 (Reference 8), RPS High Pressure Trips actuate due to a Start-Up Accident, Rod Withdrawal at Rated Power Operation Accident, Moderator Dilution Accident, Rod Ejection Accident or a Loss of FW & MFW Line Break Accident. Per Section 4.0 of Calculation I-83-0001, only a Small Break LOCA (SBLOCA) has a period of operation (POO), which can cause a harsh environment for the transmitters and circuit components in the Reactor Building prior to actuation. Since a SBLOCA will not result in a RPS trip on High RCS pressure, then the Diverse Scram System (DSS), which actuates on High RCS pressure via RC-158-PT & RC-159-PT, will function during Normal Reactor Building environmental conditions.

    Per FSAR Section 7.5.2.1 (Reference 3), the nominal setpoint for the actuation of DSS is 2450 psig.

26. The "As-Left" tolerances are to be determined from the SRSS of the Reference Accuracy for all of the components in the string. Since "As-Left" tolerances are only used to determine drift between calibrations, only Normal operating condition parameters affect the determination of the tolerances.

27. The "Calibrated" Loop Error will be determined from the summation of the "Calculated" Loop Error plus the "As-Found" tolerances for the components in the loop plus any Margin, if applicable. The "Calibrated" Loop Error is the maximum error that operations could expect after the calibration of the loop.

28. The "As-Found" tolerances are to be determined from the summation of the "As-Left" tolerances plus the SRSS of the Drift of any components and the M&TE error associated with the string.

29. "Partial Loop" tolerances are to be determined from the difference of the Total Loop tolerances ("As-Left" and "As-Found"). "Partial Loop" tolerances are determined to aid in the calibration of loops which include bistables (i.e.: pressure switches).

30. Surveillance Procedure SP-161C (Reference 40) describes the calibration equipment to be used during the calibration of RC-158-PT and RC-159-PT loop components. The procedure presently states that a Fluke 8600 DAM (Digital Multi-Meter) or equivalent, and an Ashcroft 0-3028 psig Test Gauge or equivalent; however, the Fluke Model 8600 DVM are being removed from service at CR3.

    Per the String Calibration Data Sheets from SP-161C for RC-158-PT, the calibration which was performed in April 1994 (Attachment 9), used a Druck DPI-510, 3000 psig (M&TE #TG2362) and a Keithley 197A (M&TE #TI1971).

    Per the Calibration Work Sheet for the Druck DPI-510 Pressure Controller/Calibrator, M&TE #TG2362, with range 0 to 3000 psig (Attachment 10), the Druck DPI is calibrated to the following specifications:

    Accuracy (MTE_{DP}) equals ±0.15% of Full Scale for pressure. Since the Full Scale of the Druck DPI is the same as the span of the transmitters (3,000 psig):

    MTE_{DP} = **± 0.15% span**

    Accuracy (MTE_{DI}) equals ±(0.05% + 1 digit) for the 20 ma range, where 1 digit equals 0.01 mA. Therefore,

    MTE_{DI} = **± 0.1% span**

    Per the Calibration Work Sheet for the Keithley 197A Digital Multimeter, M&TE #TI1971 (Attachment 11), and Instruction Manual 1981 (Reference 37), the Keithley 197A is calibrated to the following specifications:

    Accuracy (MTE_V) equals ±(0.015% input + 3 counts) for 20 VDC range with a resolution of 100×10^{-6} Volts; therefore:

    $$\begin{aligned} MTE_V &= \pm [(0.00015 \times 10 \text{ Volts}) + (3 \times 100 \times 10^{-6})] \\ &= \pm [0.0015 + 0.0003] \\ &= \pm 0.0018 \text{ volts} \\ &= \pm (0.0018 \text{ volts}/10 \text{ volt span}) \times 100\% \\ &= \textbf{± 0.018\% span} \end{aligned}$$

    Accuracy (MTE_I) equals ±(0.1% input + 15 counts) for 20 mA range with a resolution of 100×10^{-9} amps; therefore:

    $$\begin{aligned} MTE_I &= \pm [(0.001 \times 20 \times 10^{-3} \text{ Amps}) + (15 \times 100 \times 10^{-9})] \\ &= \pm [(2.0 \times 10^{-5}) + (1.5 \times 10^{-6})] \\ &= \pm 2.15 \times 10^{-5} \text{ Amps} \\ &= \pm (2.15 \times 10^{-5} \text{ Amps}/16 \text{ mA span}) \times 100\% \\ &= \textbf{± 0.134\% span} \end{aligned}$$

31. Surveillance Procedure SP-161C (Reference 40) has the following "As-Left" and "As-Found" tolerances:

Loop End Device	AS-LEFT	AS-FOUND
RC-158-PI1	±50 PSIG	±75 PSIG
RC-158-PS1	±20 PSIG	±20 PSIG
RC-158-PI2	±50 PSIG	±75 PSIG
RECALL #224 (RC-158-PT)	±25 PSIG	±50 PSIG
RC-158-PIR (Chart)	±30 PSIG	±50 PSIG
RC-158-PIR (Indicator)	±25 PSIG	±50 PSIG
RC-159-PI1	±50 PSIG	±75 PSIG
RC-159-PS1	±20 PSIG	±20 PSIG
RC-159-PI2	±50 PSIG	±75 PSIG
RECALL #225 (RC-159-PT)	±25 PSIG	±50 PSIG

32. SP-120A (Reference 41), provides for the 6 month functional testing of the DSS portion of the ATWS circuitry. SP-120A checks/calibrates just the pressure switches and has the following "As-Left" and "As-Found" tolerances:

Device	AS-LEFT	AS-FOUND
RC-158-PS1	-0.025 VDC (7.5 psig)	-0.025 VDC (7.5 psig)
RC-159-PS1	-0.025 VDC (7.5 psig)	-0.025 VDC (7.5 psig)

33. Per Section 7.1.C of the Instrument String Error/Setpoint Determination Methodology (Reference 1); "The accuracies of calibrating instruments for any one calibration are considered dependent errors and are added algebraically."

34. Per Calculation I-94-0012 (Reference 16), the error associated with RECALL/SPDS is ±0.366% of Full Scale Range (20 VDC or 4096 counts).

35. Industry standard and the NRC, via Reg. Guide 1.105 (Reference 43), have accepted a minimum level of random error probability of 95% (2 sigma) for instrument error analysis. Since some manufacturer data presented can reflect 2 sigma data, this calculation will be considered 2 sigma. This will ensure that the calculation does not have a level of confidence, which is not justified; therefore, the results of the calculation will be conservative in nature.

36. The following method will be used to determine the overall error for component(s) and/or loop(s) that has Positive (+) and/or Negative (-) Biases:

    (1) Positive Biases will be added to the SRSS of the Positive random errors, while ignoring Negative Biases.

    (2) Negative Biases will be added to the SRSS of the Negative random errors, while ignoring Positive Biases.

III. ASSUMPTIONS (A):

1. Assume that modules, indicators and recorders located in EQ Zones 13, 43 and 58 are calibrated at 70°F (minimum temperature for the Zones). Since 80°F is the maximum temperature for these Zones, a 10°F change will be used in the calculation. This will ensure that any temperature effects are conservatively calculated.

2. Assume that the pressure transmitters located in EQ Zone 66 are calibrated at 70°F (minimum temperature for this Zone). This will ensure that any temperature effects are conservatively calculated.

3. It is assumed that the test equipment referenced under Design Input (DI) #30 will be used in the future to calibrate RC-158-PT and RC-159-PT loops.

   (1) The transmitters are calibrated using the Druck DPI-510. Therefore, the M&TE error for the pressure transmitter is:

   $MTE_{PT} = \pm (MTE_{DP} + MTE_{DI})$ DI30

   $= \pm (0.15 + 0.1)$

   $= \pm 0.25\%$ span

   (2) The pressure switch is calibrated using one (1) Keithley 197A for voltage. Therefore, per Design Input (D) #30, the M&TE required is:

   $MTE_{PS} = \pm (MTE_{V})$

   $= \pm 0.018\%$ span

   (3) The Pressure Switch Loop is to be calibrated by calibrating the pressure transmitter, then inputting the transmitter current values (measured via a Keithley 197A for current) into the I/V while monitoring the voltage input to the pressure switch. Therefore, per Design Input (DI) #30 and Assumption 3.1, the MTE required is:

   $MTE_{PSL} = \pm (MTE_{DP} + MTE_{DI} + MTE_{I} + MTE_{V})$

   $= \pm (0.15 + 0.1 + 0.134 + 0.018)$

   $= \pm 0.402\%$ span

(4) The other Loops are to be calibrated by calibrating the pressure transmitter, then inputting the transmitter current values (measured via a Keithley 197A for current) into the I/V while monitoring the indicators, recorders, etc.

$$MTE_{OL} = \pm (MTE_{DP} + MTE_{DI} + MTE_{I})$$

$$= \pm (0.15 + 0.1 + 0.134)$$

$$= \pm 0.384\% \text{ span}$$

4. For components where a drift term is not specified, it is assumed that any drift present is bounded by the Reference Accuracy of the device.

5. The Control Complex is considered a Controlled Environment; therefore, no significant changes in humidity will be considered.

6. Per Section 6.3.A of I&C Design Criteria (Reference 1);

> "Accuracy as identified in a vendor specification is usually assumed to be Reference Accuracy. .....Reference Accuracy includes the combined effects of conformity (linearity), hysteresis and repeatability."

Where conformity (linearity), hysteresis and repeatability values are less than the specified accuracy, the above statement is to be considered true. For conservatism, where conformity (linearity), hysteresis and/or repeatability values are equal to or greater than the specified accuracy, then the value(s) will be combined via the SRSS method with the specified accuracy term to determine the Reference Accuracy value.

IV. REFERENCES:

1. I&C Design Criteria - Instrument String Error/Setpoint Determination Methodology, Revision 1.

2. Technical Specifications 3.3.17.2.(3) and 3.3.18.2.(2a), Amendment 150.

3. FSAR Sections 7.4.6.5 and 7.5.2.1, Revision 21.

4. Design Basis Document (DBD) for Post-Accident Monitoring Instrumentation (Section 5/11), Revision 2.

5. Enhanced Design Basis Document (EDBD) for the Reactor Coolant System (Section 6/1), Revision 3.

6. Request for Engineering Assistance (REA) 94-1210.

7. Environmental and Seismic Qualification Program Manual (E/SQPM), Revision 7.

8. Calculation I-83-0001, "Calculation for Statistical Errors, Crystal River 3 RPS", Revision 4.

9. Calculation I-88-0003, "Insulation Resistance of Rosemount Conduit Seal", Revision 3.

10. Calculation I-88-0006, "IR Accuracy, 4-20 mA (Foxboro Nest)", Revision 4.

11. Calculation I-88-0015, "Selection of Circuit Data for IR Accuracy Calculations", Revision 6.

12. Calculation I-89-0004, "Instrument Loop and Insulation Resistance (IR) Accuracy Calculation", Revision 5.

13. Calculation I-89-0028, "DSS/AMSAC MFW Flow Loop Error", Revision 7.

14. Calculation I-90-0014, "EQ Zone 66 Normal 10 Year Radiation Levels", Revision 2.

15. Calculation I-90-1014, "ATWS DSS/AMSAC Setpoint/Tolerances", Revision 3.

16. Calculation I-94-0012, "Computer Instrument Accuracy", Revision 1.

17. Vendor Qualification Package (VQP) CABL-B365-01, "Boston Insulated Wire Bostrad 7E Instrumentation & Control Cable", Revision 2.

18. Vendor Qualification Package (VQP) INST-R369-02, "Rosemount Model 1153 D Transmitters", Revision 3.

19. Vendor Qualification Package (VQP) INST-R369-03, "Rosemount Model 1154 Transmitters", Revision 4.

20. Vendor Qualification Package (VQP) PEN-R369-01, "Rosemount Model 353C Conduit Seals", Revision 2.

21. Vendor Qualification Package (VQP) PEN-C515-03, "Conax P/N 2325-7870 Electrical Penetration Assembly (Trixial)", Revision 2.

22. Vendor Qualification Package (VQP) PEN-C515-04, "Conax P/N 2325-7867/7868 Electrical Penetration Assembly", Revision 3.

23. Vendor Qualification Package (VQP) TERM-R098-04, "Raychem NPKC, NPKP, and NPKS Transition Splice Assemblies", Revision 2.

24. Walkdown Package for RC-158-PT, dated 4/10/93.

25. Walkdown Package for RC-159-PT, dated 7/1/92.

26. Instrument Data Sheets:

    a. RC-158-PI1, Revision 3
    b. RC-158-PI2, Revision 3
    c. RC-158-PIR, Revision 3
    d. RC-158-PS1, Revision 2
    e. RC-158-PT, Revision 4
    f. RC-158-PY1, Revision 2
    g. RC-158-PY2, Revision 2
    h. RC-158-PY3, Revision 2
    i. RC-158-PY4, Revision 2
    j. RC-158-PY5, Revision 1
    k. RC-158-PY6, Revision 1
    l. RC-159-PI2, Revision 4
    m. RC-159-PS1, Revision 2
    n. RC-159-PT, Revision 5
    o. RC-159-PY1, Revision 2
    p. RC-159-PY2, Revision 2
    q. RC-159-PY3, Revision 2
    r. RC-159-PY4, Revision 1
    s. RC-159-PY5, Revision 1
    t. RC-198-J2A, Revision 2
    u. RC-198-J2B, Revision 2
    v. RC-198-J3A, Revision 2
    w. RC-198-J3B, Revision 2
    x. ZZ-1-JY, Revision 1

27. Drawing 205-047 sheet RC-02, Revision 7.

28. Drawing 308-601, Revision 10.

29. Drawing 308-602, Revision 11.

30. Drawing 308-603 sheet 2, Revision 1.

31. Drawing 308-606, Revision 15.

32. 1967 ASME Steam Tables, Second Edition.

33. Instruction Manual 49 Volume 1B, Revision 15.

34. Instruction Manual 586, Revision 6.

35. Instruction Manual 1260, Revision 7.

36. Instruction Manual 1400, Revision 1.

37. Instruction Manual 1981, Revision 0.

38. Letter LFM90-0006, dated 1/29/90 - "Licensing Interpretation Seismic and LOCA".

39. Letter SNES94-0276, dated 9/12/94 - "Response to NRA94-0694 on RPS Instruments".

40. Surveillance Procedure SP-161C, "Remote Shutdown Instrumentation Calibration", Revision 11.

41. Surveillance Procedure SP-120A, "ATWS DSS Functional Test", Revision 2.

42. Enhanced Design Basis Document (EDBD) for the Class 1E AC System (Section 4/1), Revision 2.

43. Reg. Guide 1.105, "Instrument Setpoints for Safety-Related Systems", Revision 2.

44. Drawing 206-041, Revision 15.

45. Instruction Manual 1524, Revision 4

46. Calculation I-84-0001, "CR-3 SPDS Saturation Curve Errors", Revision 7.

47. Calculation I-88-0014, "Selection of Instrument Loops in a Harsh Environment for IR", Revision 7.

48. Calculation I-89-0001, "DSS/AMSAC Trip Response Times", Revision 3.

49. Calculation I-89-0009, "Allowable Instrument Loop Indication Accuracies", Revision 4.

50. Calculation I-92-0003, "Instrument Error for HPI Flow Verification", Revision 0.

51. Request for Engineering Assistance (REA) 95-0056.

52. Request for Engineering Assistance (REA) 95-0243.

V. DETAILED CALCULATION:

This calculation will evaluate the instrument loop accuracies associated with the RCS Wide Range pressure transmitters (RC-158-PT and RC-159-PT) during Normal and Accident conditions.

COMPONENT ERRORS:

Process Error:

Per Design Input (DI) #3, the majority of the sensing lines associated with RC-158-PT and RC-159-PT are routed through EQ Zone 40, which has the following temperature ranges:

Temperature - Normal: 110° to 149°F.
Temperature - LOCA: 110° to 298°F.
Temperature - HELB: 110° to 386°F.

The water in the wet leg of the pressure transmitter is at the same temperature as the Reactor Building inside the D-Rings. Per the E/SQPM (Reference 7) the temperature in EQ Zone 40 is between 130° and 149°F a majority of the time; therefore, 140°F will be used as the average Normal sense line temperature. In addition, the normal operating pressure of the RCS is 2155 psig per EDBD for the Reactor Coolant System (Reference 5).

Per Design Input (DI) #3, the change in elevation between the tap connections for the transmitters and the location of the transmitters is 63.29 feet (167.21' - 103.92') for RC-158-PT and 64.46 feet (106.21' - 102.75') for RC-159-PT.

Per Table 3 of the 1967 ASME Steam Tables (Reference 32); Specific Volume of water at 140°F and at 2200 psia (2185.3 psig) is 0.01618 ft^3/lbm and the Specific Volume of water at 140°F and at 2100 psia (2085.3 psig) is 0.01619 ft^3/lbm. Since the difference between the Specific Volume is minimal and because the actual operating pressure is closer to 2200 psia, the Specific Volume at 2200 psia will be used in this calculation. Thus, the Weight Density is 61.805 lbm/ft^3 (1/0.01618 ft^3/lbm). Therefore, the following corrections are required for the calibration of the transmitters:

RC-158-PT:

(61.805 lbm/ft^3) x (1 ft^2/144 in^2) = 0.429 lbm/(in^2-ft)

[0.429 lbm/(in^2-ft)] x (63.29 ft) = **27.2 psig**

TRANSMITTER SCALING = 27.2 psig (0%) to 3027.2 psig (100%)

NOTE: The transmitter is not to be calibrated above its Upper Range Limit (URL) of 3000 psig.

RC-159-PT:

$(61.805\ lbm/ft^3) \times (1\ ft^2/144\ in^2) = 0.429\ lbm/(in^2\text{-}ft)$

$[0.429\ lbm/(in^2\text{-}ft)] \times (64.46\ ft) =$ **27.7 psig**

TRANSMITTER SCALING = 27.7 psig (0%) to 3027.7 psig (100%)

NOTE: The transmitter is not to be calibrated above its Upper Range Limit (URL) of 3000 psig.

Although the HELB temperature peaks at 386°F post-accident, it returns to 313°F within the first 2 minutes. Since this temperature envelopes the LOCA conditions (298°F), 310°F will be used to determine the maximum error due to density change. The hotter, less dense post-accident condition in the sense lines will lower the indicated pressure. Per Table 3 of the 1967 ASME Steam Tables, the Specific Volume of water at 310°F between 80 psia (65.3 psig) and 2200 psia (2185.3 psig) is between 0.01755 ft^3/lbm and 0.01739 ft^3/lbm. Therefore, the Weight Density is between 56.98 lbm/ft^3 (1/0.01755 ft^3/lbm) and 57.50 lbm/ft^3 (1/0.01739 ft^3/lbm). For conservatism, a Weight Density of 56.98 lbm/ft^3 will be used for this calculation.

The change in pressure for the sense lines of the pressure transmitters is related to the change in sense line density as follows.

$$A_{SENSE\text{-}LINE} = [(d_{T2} - d_{T1})/(144\ in^2/1\ ft^2)] \times [L/span] \times 100\%$$

where d_{T1} and d_{T2} is the Weight Density of the sense lines are 140°F and 310°F, respectively and L is the length of the sense line.

Therefore, the effect on the transmitters' span is as follows:

RC-158-PT:

$$A_{SENSE\text{-}LINE} = [(56.98 - 61.805)/144] \times [63.29/3000] \times 100\%$$
$$= [-0.0335] \times [0.0211] \times 100\%$$
$$= \textbf{-0.07\% span}$$

RC-159-PT:

$$A_{SENSE\text{-}LINE} = [(56.98 - 61.805)/144] \times [64.46/3000] \times 100\%$$
$$= [-0.0335] \times [0.0215] \times 100\%$$
$$= \textbf{-0.07\% span}$$

Device PT: Rosemount 1154GP9RA pressure transmitter DI4

Span = 3,000 psig

URL = 3,000 psig (Upper Range Limit)

Normal Conditions (E_{PTN})

E_{REF} = Reference Accuracy = ± 0.25%

E_T = Temperature Effect = ± (0.75% URL + 0.5% span)/100°F A2

= ± [(0.75 x 3000 + 0.5 x 3000)/3000] x (109° - 70°)/100°F
= ± [(2250 + 1500)/3000] x 0.39
= ± (1.25) x (0.39)
= ± 0.49% span

E_{OP} = Overpressure Effect = ± 0.0% DI4.2

E_{PSE} = Power Supply Effect = ± 0.005% span/volt

= ± [0.005 span/volt x (0.017 x 24 volts)] DI5 & 15
= ± [0.005 x 0.408]
= ± 0.002% span
This effect will be ignored because it is negligible compared to the other effects.

$E_{P/T}$ = Steam Pressure/Temperature Effect = ± 0.0% DI4.3

E_S = Seismic Effect = ± 0.0% DI4.4

E_{RAD} = Radiation Effect = ± 0.0% DI4.5

$E_{PTN} = \pm [(E_{REF})^2 + (E_T)^2]^{½}$

$= \pm [(0.25)^2 + (0.49)^2]^{½}$
$= \pm [(0.0625) + (0.2401)]^{½}$
$= \pm [0.3026]^{½}$
= **± 0.55% span**

Accident Conditions (E_{PTA})

E_{REF} = Reference Accuracy = ± 0.25%

E_T = Temperature Effect = ± 0.0% DI4.1

E_{OP} = Overpressure Effect = ± 0.0% DI4.2

E_{PSE} = Power Supply Effect = ± 0.005% span/volt

= ± [0.005 span/volt x (0.017 x 24 volts)] DI6 & 15
= ± [0.005 x 0.408]
= ± 0.002% span
This effect will be ignored because it is negligible compared to the other effects.

$E_{P/T}$ = Steam Pressure/Temperature Effect = ± (2.5% URL + 0.5% span)

= ± (2.5 x 3000 psig) + (0.5 x 3000 psig)]/3000 psig
= ± 3.0% span

E_S = Seismic Effect = ± 0.0% DI4.4

E_{RAD} = Radiation Effect = ± (1.5% URL + 1.0% span)

= ± [(1.5 x 3000 psig) + (1.0 x 3000 psig)]/3000 psig
= ± 2.5% span

$E_{PTA} = \pm [(E_{REF})^2 + (E_{P/T})^2 + (E_{RAD})^2]^{1/2}$

$= \pm [(0.25)^2 + (3.0)^2 + (2.5)^2]^{1/2}$
$= \pm [(0.0625) + (9.0) + (6.25)]^{1/2}$
$= \pm [15.3125]^{1/2}$
$= \pm 3.91\%$ span

Device I/V: Foxboro N2AI-I2V Current-to-Voltage Converter ($E_{I/V}$) DI6

E_{REF} = Reference Accuracy = ± 0.25% span

E_T = Temperature Effect = ± 0.5% span/45°F

= ± (0.5/45°F) x (10°F)
= ± 0.11% span A1

$E_{I/V}$ = $\pm [(E_{REF})^2 + (E_T)^2]^{1/2}$

= $\pm [(0.25)^2 + (0.11)^2]^{1/2}$
= $\pm [(0.0625) + (0.0121)]^{1/2}$
= $\pm [0.0746]^{1/2}$
= **± 0.27% span**

Device V/V: Foxboro N2AO-VAI Signal Converter/Isolator ($E_{V/V}$) DI7

E_{REF} = Reference Accuracy = ± 0.5% span

E_T = Temperature Effect = ± 0.5% span/45°F

= ± (0.5/45°F) x (10°F)
= ± 0.11% span A1

$E_{V/V}$ = $\pm [(E_{REF})^2 + (E_T)^2]^{1/2}$

= $\pm [(0.5)^2 + (0.11)^2]^{1/2}$
= $\pm [(0.25) + (0.0121)]^{1/2}$
= $\pm [0.2621]^{1/2}$
= **± 0.51% span**

Device PI1: International Instruments 1251 indicator (E_{PI1}) DI8

E_{REF} = Reference Accuracy

= ± [(Specified Accuracy)^2 + (Repeatability)^2]^{½} A6

= ± [(1.5)^2 + (2.0)^2]^{½}
= ± [(2.25) + (4.0)]^{½}
= ± [6.25]^{½}
= ± 2.5% span.

E_{SC} = Scale Error = ± ½ minor scale division

= ± [(0.5 x 50 psig)/3000 psig] x 100%
= ± 0.83% span

E_{PI1} = ± [(E_{REF})^2 + (E_{SC})^2]^{½}

= ± [(2.5)^2 + (0.83)^2]^{½}
= ± [(6.25) + (0.6889)]^{½}
= ± [6.9389]^{½}
= **± 2.63% span**

Device PS: Bailey 6623819-1 switch (signal monitor) (E_{PS}) DI10

E_{REF} = Reference Accuracy = ± 0.25% span

E_T = Temperature Effect = ± 0.25% span/100°F

= ± (0.25/100°F) x 10°F A1
= ± 0.025% span

E_{PS} = ± [(E_{REF})^2 + (E_T)^2]^{½}

= ± [(0.25)^2 + (0.025)^2]^{½}
= ± [(0.0625) + (0.0006)]^{½}
= ± [0.0631]^{½}
= **± 0.25% span**

Device PI2: Bailey RY-1101 pressure indicator (E_{PI2}) DI13

E_{REF} = Reference Accuracy

= ± [(Specified Accuracy)^2 + (Linearity)^2 + (Repeatability)^2 + (Deadband)^2]^{½} A6

= ± [(1.0)^2 + (1.0)^2 + (0.5)^2 + (0.5)^2]^{½}
= ± [(1.0) + (1.0) + (0.25) + (0.25)]^{½}
= ± [2.5]^{½}
= ± 1.58% span.

E_T = Temperature Effect = ± 0.001% span/°F

= ± (0.001/°F) x 10°F A1
= ± 0.01% span

E_{SC} = Scale Error = ± ½ minor scale division

= ± [(0.5 x 100 psig)/3000 psig] x 100%
= ± 1.67% span

E_{PSE} = Power Supply Effect = ± 0.013% span/volt

= ± [0.013% span/volt x (0.02 x 118 volts)] DI13
= ± [0.013 x 2.36]
= ± 0.031% span

E_{PI2} = ± [(E_{REF})^2 + (E_T)^2 + (E_{SC})^2 + (E_{PSE})^2]^{½}

= ± [(1.58)^2 + (0.01)^2 + (1.67)^2 + (0.031)^2]^{½}
= ± [(2.4964) + (0.0001) + (2.7889) + (0.001)]^{½}
= ± [5.2864]^{½}
= **± 2.30% span**

Device PIR: Foxboro N227P-1R6 recorder

Recording (E_{PIRR}) DI14

E_{REFR} = Recording Reference Accuracy = ± 0.75% span

E_T = Temperature Effect = ± 0.5% span/50°F

= ± (0.5/50°F) x 10°F
= ± 0.1% span A1

E_H = Humidity Influence = ± 0.0% span A5

E_{PSE} = Power Supply Effect = ± 0.1% span

E_{SCR} = Recording Scale Error = ± ½ minor scale division

= ± [(0.5 x 50 psig)/3000 psig] x 100%
= ± 0.83% span

$E_{PIRR} = \pm [(E_{REFR})^2 + (E_T)^2 + (E_{PSE})^2 + (E_{SCR})^2]^{½}$

$= \pm [(0.75)^2 + (0.1)^2 + (0.1)^2 + (0.83)^2]^{½}$
$= \pm [(0.5625) + (0.01) + (0.01) + (0.6889)]^{½}$
$= \pm [1.2714]^{½}$
$= \pm 1.13\%$ span

Indicating (E_{PIRI}) DI14

E_{REFI} = Indicating Reference Accuracy = ± 0.5% span

E_T = Temperature Effect = ± 0.5% span/50°F

= ± (0.5/50°F) x 10°F
= ± 0.1% span A1

E_H = Humidity Influence = ± 0.0% span A5

E_{PSE} = Power Supply Effect = ± 0.1% span

E_{SCI} = Recording Scale Error = ± ½ minor scale division

= ± [(0.5 x 50 psig)/3000 psig] x 100%
= ± 0.83% span

E_{PIRI} = $\pm [(E_{REFI})^2 + (E_T)^2 + (E_{PSE})^2 + (E_{SCI})^2]^{½}$

= $\pm [(0.5)^2 + (0.1)^2 + (0.1)^2 + (0.83)^2]^{½}$
= $\pm [(0.25) + (0.01) + (0.01) + (0.6889)]^{½}$
= $\pm [0.9589]^{½}$
= **± 0.98% span**

RECALL/SPDS:

E_{RCALL} = RECALL Reference Accuracy = ±0.366% FSR DI34

= ± (0.366%) x (20 VDC/10 VDC)
= **± 0.732% span**

IR Errors:

A_{IR} = + [22.8/(4.8 + (0.016 x R_p))] x 100 DI19

$1/R_p$ = $1/R_{CE} + 2/R_S + 1/R_{SEAL} + 1/R_{PEN}$

R_{CE} = Cable IR = $(R_C \times L_{SPL})/L_{CKT}$ DI20

RC-158-PT IR Error:

L_{CKT} for RCR265 is 95 feet. DI18

R_{CE} = (2.9 x 10^6 ohms x 20 feet)/95 feet
= 6.11 x 10^5 ohms

R_S = 1.8 x 10^7 ohms DI21

R_{SEAL} = 5 x 10^5 ohms DI22

R_{PEN} = 4.47 x 10^6 ohms DI23

$1/R_p$ = $(1/6.11 \times 10^5) + (2/1.8 \times 10^7) + (1/5 \times 10^5) + (1/4.47 \times 10^6)$
= 3.97 x 10^{-6}

R_p = $(1/3.97 \times 10^{-6})$
= 2.52 x 10^5 ohms

A_{IR} = $[22.8/(4.8 + (0.016 \times 2.52 \times 10^5))] \times 100$
= $[22.8/(4.03 \times 10^3)] \times 100$
= **0.56% span**

RC-159-PT IR Error:

L_{CKT} for RCR271 is 360 feet. DI18

R_{CE} = (2.9 x 10^6 ohms x 20 feet)/360 feet
= 1.61 x 10^5 ohms

R_S = 1.8 x 10^7 ohms DI21

R_{SEAL} = 5 x 10^5 ohms DI22

R_{PEN} = 4.47 x 10^6 ohms DI23

$1/R_p$ = $(1/1.61 \times 10^5) + (2/1.8 \times 10^7) + (1/5 \times 10^5) + (1/4.47 \times 10^6)$
= 8.55 x 10^{-6}

R_p = $(1/8.55 \times 10^{-6})$
= 1.17 x 10^5 ohms

A_{IR} = $[22.8/(4.8 + (0.016 \times 1.17 \times 10^5))] \times 100$
= $[22.8/(1.88 \times 10^3)] \times 100$
= **1.21% span**

LOOP ERRORS:

Remote Shutdown Indication (E_{RSI}) DI24

$$E_{RSI} = \pm [(E_{PTN})^2 + (E_{I/V})^2 + (E_{PI1})^2]^{1/2}$$

$$= \pm [(0.55)^2 + (0.27)^2 + (2.63)^2]^{1/2}$$
$$= \pm [(0.3025) + (0.0729) + (6.9169)]^{1/2}$$
$$= \pm [7.2923]^{1/2}$$
$$= \textbf{± 2.70\% span} = (2.70\% \times 3000 \text{ psig}) = \textbf{± 81.0 psig}$$

DSS Pressure Switch (Signal Monitor) (E_{DSS}) DI25

$$E_{DSS} = \pm [(E_{PTN})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{PS})^2]^{1/2}$$

$$= \pm [(0.55)^2 + (0.27)^2 + (0.51)^2 + (0.25)^2]^{1/2}$$
$$= \pm [(0.3025) + (0.0729) + (0.2601) + (0.0625)]^{1/2}$$
$$= \pm [0.6980]^{1/2}$$
$$= \textbf{± 0.84\% span} = (0.84\% \times 3000 \text{ psig}) = \textbf{± 25.2 psig}$$

Output to RECALL/SPDS (Normal - E_{RCN}; Accident - E_{RCA})

$$E_{RCN} = \pm [(E_{PTN})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{RCALL})^2]^{1/2}$$

$$= \pm [(0.55)^2 + (0.27)^2 + (0.51)^2 + (0.732)^2]^{1/2}$$
$$= \pm [(0.3025) + (0.0729) + (0.2601) + (0.5358)]^{1/2}$$
$$= \pm [1.1713]^{1/2}$$
$$= \pm 1.08\% \text{ span} = (1.08\% \times 3000 \text{ psig}) = \pm 32.4 \text{ psig}$$

RC-158-PT:

$$E_{RCA} = + [(E_{PTA})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{RCALL})^2]^{1/2} + A_{IR} \quad \text{DI36}$$

$$= + [(3.91)^2 + (0.27)^2 + (0.51)^2 + (0.732)^2]^{1/2} + 0.56$$
$$= + [(15.2881) + (0.0729) + (0.2601) + (0.5358)]^{1/2} + 0.56$$
$$= + [16.1569]^{1/2} + 0.56$$
$$= + 4.02 + 0.56$$
$$= + 4.58\% \text{ span} = (+4.58\% \times 3000 \text{ psig}) = +137.4 \text{ psig}$$

$$= - [(E_{PTA})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{RCALL})^2]^{1/2} - A_{SENSE\text{-}LINE} \quad \text{DI36}$$

$$= - [(3.91)^2 + (0.27)^2 + (0.51)^2 + (0.732)^2]^{1/2} - 0.07$$
$$= - [(15.2881) + (0.0729) + (0.2601) + (0.5358)]^{1/2} - 0.07$$
$$= - [16.1569]^{1/2} - 0.07$$
$$= - 4.02 - 0.07$$
$$= - 4.09\% \text{ span} = (-4.09\% \times 3000 \text{ psig}) = -122.7 \text{ psig}$$

RC-159-PT:

$$E_{RCA} = + [(E_{PTA})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{RCALL})^2]^{1/2} + A_{IR} \quad \text{DI36}$$

$$= + [(3.91)^2 + (0.27)^2 + (0.51)^2 + (0.732)^2]^{1/2} + 1.21$$
$$= + [(15.2881) + (0.0729) + (0.2601) + (0.5358)]^{1/2} + 1.21$$
$$= + [16.1569]^{1/2} + 1.21$$
$$= + 4.02 + 1.21$$
$$= + 5.23\% \text{ span} = (+5.23\% \times 3000 \text{ psig}) = +156.9 \text{ psig}$$

$$= - [(E_{PTA})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{RCALL})^2]^{1/2} - A_{SENSE\text{-}LINE} \quad \text{DI36}$$

$$= - [(3.91)^2 + (0.27)^2 + (0.51)^2 + (0.732)^2]^{1/2} - 0.07$$
$$= - [(15.2881) + (0.0729) + (0.2601) + (0.5358)]^{1/2} - 0.07$$
$$= - [16.1569]^{1/2} - 0.07$$
$$= - 4.02 - 0.07$$
$$= - 4.09\% \text{ span} = (-4.09\% \times 3000 \text{ psig}) = -122.7 \text{ psig}$$

Control Room Indication (Normal - E_{PIN}; Accident - E_{PIA})

$$E_{PIN} = \pm [(E_{PTN})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{PI2})^2]^{1/2}$$

$$= \pm [(0.55)^2 + (0.27)^2 + (0.51)^2 + (2.3)^2]^{1/2}$$
$$= \pm [(0.3025) + (0.0729) + (0.2601) + (5.29)]^{1/2}$$
$$= \pm [5.9255]^{1/2}$$
$$= \mathbf{\pm 2.43\% \text{ span}} = (2.43\% \times 3000 \text{ psig}) = \mathbf{\pm 72.9 \text{ psig}}$$

RC-158-PT:

$$E_{PIA} = + [(E_{PTA})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{PI2})^2]^{1/2} + A_{IR} \quad \text{DI36}$$

$$= + [(3.91)^2 + (0.27)^2 + (0.51)^2 + (2.3)^2]^{1/2} + 0.56$$
$$= + [(15.2881) + (0.0729) + (0.2601) + (5.29)]^{1/2} + 0.56$$
$$= + [20.9111]^{1/2} + 0.56$$
$$= + 4.57 + 0.56$$
$$= \mathbf{+ 5.13\% \text{ span}} = (+5.13\% \times 3000 \text{ psig}) = \mathbf{+153.9 \text{ psig}}$$

$$= - [(E_{PTA})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{PI2})^2]^{1/2} - A_{SENSE\text{-}LINE} \quad \text{DI36}$$

$$= - [(3.91)^2 + (0.27)^2 + (0.51)^2 + (2.3)^2]^{1/2} - 0.07$$
$$= - [(15.2881) + (0.0729) + (0.2601) + (5.29)]^{1/2} - 0.07$$
$$= - [20.9111]^{1/2} - 0.07$$
$$= - 4.57 - 0.07$$
$$= \mathbf{- 4.64\% \text{ span}} = (-4.64\% \times 3000 \text{ psig}) = \mathbf{-139.2 \text{ psig}}$$

RC-159-PT:

$$E_{PIA} = + [(E_{PTA})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{PI2})^2]^{1/2} + A_{IR} \quad \text{DI36}$$

$$= + [(3.91)^2 + (0.27)^2 + (0.51)^2 + (2.3)^2]^{1/2} + 1.21$$
$$= + [(15.2881) + (0.0729) + (0.2601) + (5.29)]^{1/2} + 1.21$$
$$= + [20.9111]^{1/2} + 1.21$$
$$= + 4.57 + 1.21$$
$$= \mathbf{+ 5.78\% \text{ span}} = (+5.78\% \times 3000 \text{ psig}) = \mathbf{+173.4 \text{ psig}}$$

$$= - [(E_{PTA})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{PI2})^2]^{1/2} - A_{SENSE\text{-}LINE} \quad \text{DI36}$$

$$= - [(3.91)^2 + (0.27)^2 + (0.51)^2 + (2.3)^2]^{1/2} - 0.07$$
$$= - [(15.2881) + (0.0729) + (0.2601) + (5.29)]^{1/2} - 0.07$$
$$= - [20.9111]^{1/2} - 0.07$$
$$= - 4.57 - 0.07$$
$$= \mathbf{- 4.64\% \text{ span}} = (-4.64\% \times 3000 \text{ psig}) = \mathbf{-139.2 \text{ psig}}$$

Control Room Recording (Normal - E_{PRRN}; Accident - E_{PRRA})

$$E_{PRRN} = \pm [(E_{PTN})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{PIRR})^2]^{1/2}$$

$$= \pm [(0.55)^2 + (0.27)^2 + (0.51)^2 + (1.13)^2]^{1/2}$$
$$= \pm [(0.3025) + (0.0729) + (0.2601) + (1.2769)]^{1/2}$$
$$= \pm [1.9124]^{1/2}$$
$$= \pm 1.38\% \text{ span} = (1.38\% \times 3000 \text{ psig}) = \pm 41.4 \text{ psig}$$

RC-158-PT:

$$E_{PRRA} = + [(E_{PTA})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{PIRR})^2]^{1/2} + A_{IR} \quad \text{DI36}$$

$$= + [(3.91)^2 + (0.27)^2 + (0.51)^2 + (1.13)^2]^{1/2} + 0.56$$
$$= + [(15.2881) + (0.0729) + (0.2601) + (1.2769)]^{1/2} + 0.56$$
$$= + [16.8980]^{1/2} + 0.56$$
$$= + 4.11 + 0.56$$
$$= + 4.67\% \text{ span} = (+4.67\% \times 3000 \text{ psig}) = +140.1 \text{ psig}$$

$$= - [(E_{PTA})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{PIRR})^2]^{1/2} - I_{SENSE-LINE} \quad \text{DI36}$$

$$= - [(3.91)^2 + (0.27)^2 + (0.51)^2 + (1.13)^2]^{1/2} - 0.07$$
$$= - [(15.2881) + (0.0729) + (0.2601) + (1.2769)]^{1/2} - 0.07$$
$$= - [16.8980]^{1/2} - 0.07$$
$$= - 4.11 - 0.07$$
$$= - 4.18\% \text{ span} = (-4.18\% \times 3000 \text{ psig}) = -125.4 \text{ psig}$$

Control Room Recorder Indicating (Normal - E_{PIRN}; Accident - E_{PIRA})

$$E_{PIRN} = \pm [(E_{PTN})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{PIRI})^2]^{1/2}$$

$$= \pm [(0.55)^2 + (0.27)^2 + (0.51)^2 + (0.98)^2]^{1/2}$$
$$= \pm [(0.3025) + (0.0729) + (0.2601) + (0.9604)]^{1/2}$$
$$= \pm [1.5959]^{1/2}$$
$$= \pm 1.26\% \text{ span} = (1.26\% \times 3000 \text{ psig}) = \pm 37.8 \text{ psig}$$

RC-158-PT:

$$E_{PIRA} = + [(E_{PTA})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{PIRI})^2]^{1/2} + A_{IR} \quad \text{DI36}$$

$$= + [(3.91)^2 + (0.27)^2 + (0.51)^2 + (0.98)^2]^{1/2} + 0.56$$
$$= + [(15.2881) + (0.0729) + (0.2601) + (0.9604)]^{1/2} + 0.56$$
$$= + [16.5815]^{1/2} + 0.56$$
$$= + 4.07 + 0.56$$
$$= + 4.63\% \text{ span} = (+4.63\% \times 3000 \text{ psig}) = +138.9 \text{ psig}$$

$$= - [(E_{PTA})^2 + (E_{I/V})^2 + (E_{V/V})^2 + (E_{PIRI})^2]^{1/2} - A_{SENSE-LINE} \quad \text{DI36}$$

$$= - [(3.91)^2 + (0.27)^2 + (0.51)^2 + (0.98)^2]^{1/2} - 0.07$$
$$= - [(15.2881) + (0.0729) + (0.2601) + (0.9604)]^{1/2} - 0.07$$
$$= - [16.5815]^{1/2} - 0.07$$
$$= - 4.07 - 0.07$$
$$= - 4.14\% \text{ span} = (-4.14\% \times 3000 \text{ psig}) = -124.2 \text{ psig}$$

"AS-LEFT" TOLERANCES:

DI26

Pressure Transmitters (AL_{PT})

$AL_{PT} = \pm (PT\text{-}E_{REF})$

DI4

$= \pm$ 0.25% span = (0.25% x 3000 psig) = $\pm$ 7.5 psig
$= \pm$ [(0.25%/100%) x 16 mA] = $\pm$ 0.04 mA

Per the Calibration Data Sheets for RC-158-PT (Attachment 13) and RC-159-PT (Attachment 14), the currently used "As-Left" tolerance for calibrating RC-158-PT is $\pm$ 0.04 mA. Since the calculated tolerance is the same as currently used, the "As-Left" tolerance for the pressure transmitters will remain at $\pm$ 0.04 mA. Therefore:

AL_{PT} = **$\pm$ 0.25% span = $\pm$ 7.5 psig = $\pm$ 0.04 mA**

Pressure Switch (AL_{PS})

$AL_{PS} = \pm (PS\text{-}E_{REF})$

DI10

$= \pm$ 0.25% span = (0.25% x 3000 psig) = $\pm$ 7.5 psig
$= \pm$ [(0.25%/100%) x 10 VDC] = $\pm$ 0.025 VDC

Per Design Input (DI) #32, the "As-Left" tolerance currently used in SP-120A for the DSS (RC-158-PSI and RC-159-PSI) is - 0.025 VDC. The new setpoint associated with DSS will be provided with a positive and negative tolerance instead of just a negative tolerance. Therefore:

AL_{PS} = **$\pm$ 0.25% span = $\pm$ 7.5 psig = 0.025 VDC**

Remote Shutdown Indication (AL_{RSI})

$$AL_{RSI} = \pm [(PT-E_{REF})^2 + (I/V-E_{REF})^2 + (PI1-E_{REF})^2]^{1/2}$$

$$= \pm [(0.25)^2 + (0.25)^2 + (2.5)^2]^{1/2}$$
$$= \pm [(0.0625) + (0.0625) + (6.25)]^{1/2}$$
$$= \pm [6.375]^{1/2}$$
$$= \pm 2.52\% \text{ span} = (2.52\% \times 3000 \text{ psig}) = \pm 75.6 \text{ psig}$$

Since RC-158-PI1 and RC-159-PI1 can only be read to 25 psig (½ minor division), and because the calculated tolerance is close to a ½ minor division point, the "As-Left" tolerance for the Remote Shutdown Indication will be rounded down to 75 psig or 2.50%.

Per Design Input (DI) #31, the "As-Left" tolerance currently used in SP-161C for the Remote Shutdown Indication (RC-158-PI1 and RC-159-PI1) is ± 50 psig. Based on past experiences of being able to calibrate the indicator loop to the tighter tolerance of ± 50 psig and to remove additional conservatisms, which could affect the ability of the operator using the indicator, an "As-Left" tolerance of ± 50 psig will be used. Therefore:

AL_{RSI} = **± 1.67% span = ± 50 psig**

DSS Pressure Switch (Signal Monitor) (AL_{DSS})

$$AL_{DSS} = \pm [(PT-E_{REF})^2 + (I/V-E_{REF})^2 + (V/V-E_{REF})^2 + (PS-E_{REF})^2]^{1/2}$$

$$= \pm [(0.25)^2 + (0.25)^2 + (0.5)^2 + (0.25)^2]^{1/2}$$
$$= \pm [(0.0625) + (0.0625) + (0.25) + (0.0625)]^{1/2}$$
$$= \pm [0.4375]^{1/2}$$
$$= \pm 0.66\% \text{ span} = (0.66\% \times 3000 \text{ psig}) = \pm 19.8 \text{ psig}$$
$$= \pm 0.066 \text{ VDC } [(0.66\%/100\%) \times 10 \text{ VDC}]$$

Per Design Input (DI) #31, the "As-Left" tolerance currently used in SP-161C for the DSS (RC-158-PS1 and RC-159-PS1) is ± 20 psig. Since the calculated value is so close to the currently used value for the pressure switch loop, the tolerance of ± 20 psig will continue to be used. Therefore:

AL_{DSS} = **± 0.667% span = ± 20 psig**

Output to RECALL/SPDS (AL_{RCN})

$$AL_{RCN} = \pm [(PT\text{-}E_{PEF})^2 + (I/V\text{-}E_{REF})^2 + (V/V\text{-}E_{REF})^2 + (E_{RCALL})^2]^{1/2}$$

$$= \pm [(0.25)^2 + (0.25)^2 + (0.5)^2 + (0.732)^2]^{1/2}$$
$$= \pm [(0.0625) + (0.0625) + (0.25) + (0.5358)]^{1/2}$$
$$= \pm [0.9108]^{1/2}$$
$$= \pm 0.95\% \text{ span} = (0.95\% \times 3000 \text{ psig}) = \pm 28.5 \text{ psig}$$

Per Design Input (DI) #31, the "As-Left" tolerance currently used in SP-161C for the RECALL/SPDS is ± 25 psig. Based on past experiences of being able to calibrate RECALL/SPDS loop to the tighter tolerance of ± 25 psig and to remove additional conservatisms, which could affect the ability of the operator using RECALL/SPDS, an "As-Left" tolerance of ± 25 psig will be used. Therefore:

AL_{RCN} = **± 0.83% span = ± 25 psig**

Control Room Indication (AL_{PI})

$$AL_{PI} = \pm [(PT\text{-}E_{REF})^2 + (I/V\text{-}E_{REF})^2 + (V/V\text{-}E_{REF})^2 + (PI2\text{-}E_{REF})^2]^{1/2}$$

$$= \pm [(0.25)^2 + (0.25)^2 + (0.5)^2 + (1.58)^2]^{1/2}$$
$$= \pm [(0.0625) + (0.0625) + (0.25) + (2.4964)]^{1/2}$$
$$= \pm [2.8714]^{1/2}$$
$$= \pm 1.7\% \text{ span} = (1.7\% \times 3000 \text{ psig}) = \pm 51.0 \text{ psig}$$

Since RC-158-PI2 and RC-159-PI2 can only be read to 50 psig (½ minor division), the "As-Left" tolerance for the Control Room Indicator will be rounded down to 50 psig or 1.67%.

Per Design Input (DI) #31, the "As-Left" tolerance currently used in SP-161C for the Control Room Indication (RC-158-PI2 and RC-159-PI2) is ± 50 psig. Based on past experiences of being able to calibrate the indicator loop to the tolerance of ± 50 psig and because the calculated "As-Left" tolerance is the same as currently used in the procedure, an "As-Left" tolerance of ± 50 psig will be used. Therefore:

AL_{PI} = **± 1.67% span = ± 50 psig**

Control Room Recording (AL_{CRR})

$$AL_{CRR} = \pm [(PT\text{-}E_{REF})^2 + (I/V\text{-}E_{REF})^2 + (V/V\text{-}E_{REF})^2 + (PIR\text{-}E_{REF})^2]^{1/2}$$

$$= \pm [(0.25)^2 + (0.25)^2 + (0.5)^2 + (0.75)^2]^{1/2}$$
$$= \pm [(0.0625) + (0.0625) + (0.25) + (0.5625)]^{1/2}$$
$$= \pm [0.9375]^{1/2}$$
$$= \pm 0.968\% \text{ span} = (0.968\% \times 3000 \text{ psig}) = \pm 29.05 \text{ psig}$$

Since RC-158-PIR Recordings can only be read to 25 psig (½ minor division), the "As-Left" tolerance for the Control Room Indicator will be rounded down to 25 psig or 0.83%.

Per Design Input (DI) #31, the "As-Left" tolerance currently used in SP-161C for the Control Room Recording (RC-158-PIR) is ± 30 psig. Because the recorder can only be read to 25 psig increments, the existing tolerance will need to be changed to ± 25 psig. Therefore:

AL_{CRR} = **± 0.83% span = ± 25 psig**

Control Room Recorder Indicating (AL_{CIR})

$$AL_{CIR} = \pm [(PT\text{-}E_{REF})^2 + (I/V\text{-}E_{REF})^2 + (V/V\text{-}E_{REF})^2 + (PIR\text{-}E_{REF})^2]^{1/2}$$

$$= \pm [(0.25)^2 + (0.25)^2 + (0.5)^2 + (0.5)^2]^{1/2}$$
$$= \pm [(0.0625) + (0.0625) + (0.25) + (0.25)]^{1/2}$$
$$= \pm [0.6250]^{1/2}$$
$$= \pm 0.79\% \text{ span} = (0.79\% \times 3000 \text{ psig}) = \pm 23.7 \text{ psig}$$

Since PIR Indicator can only be read to 25 psig (½ minor division), the "As-Left" tolerance for the Control Room Indicator will be rounded up to 25 psig or 0.83%.

Per Design Input (DI) #31, the "As-Left" tolerance currently used in SP-161C for the Control Room Recorder Indicator (RC-158-PIR) is ± 25 psig. Based on past experiences of being able to calibrate the indicator to the tolerance of ± 25 psig and because the calculated "As-Left" tolerance is the same as currently used in the procedure, an "As-Left" tolerance of ± 25 psig will be used. Therefore:

AL_{CIR} = **± 0.83% span = ± 25 psig**

"AS-FOUND" TOLERANCES:

DI28

The only component which has a specified Drift is the Rosemount transmitter; therefore, the only drift term in the following calculations will be the drift associated with the transmitters ($PT\text{-}E_{SB}$).

Pressure Transmitters (AF_{PT})

$AF_{PT} = \pm \{AL_{PT} + [(PT\text{-}E_{SB})^2 + (MTE_{PT})^2]^{½}\}$ DI4 & A3.1

$= \pm \{(0.25) + [(0.2)^2 + (0.25)^2]^{½}\}$
$= \pm \{(0.25) + [(0.04) + (0.0625)]^{½}\}$
$= \pm \{(0.25) + [0.1025]^{½}\}$
$= \pm \{(0.25) + (0.32)\}$
$= \pm$ 0.57% span = (0.57% x 3000 psig) = ± 17.1 psig
$= \pm$ [(0.57%/100%) x 16 mA] = 0.09 mA

Per the Calibration Data Sheets for RC-158-PT (Attachment 13) and RC-159-PT (Attachment 14), the currently used "As-Found" tolerance for calibrating RC-158-PT and RC-159-PT is ±0.05 mA. Based on past calibrations, the transmitters have been able to meet to the tighter tolerance of ± 0.05 mA. Thus, to remove additional conservatisms, the "As-Found" tolerance for the transmitters will remain at ± 0.05 mA. Therefore:

AF_{PT} = **± 0.313% span ~ ± 9.4 psig = ± 0.05 mA**

Pressure Switch (AF_{PS})

$AF_{PS} = \pm \{(AL_{PS}) + [(MTE_{PS})^2]^{½}\}$ A3.2

$= \pm \{(0.25) + [(0.018)^2]^{½}\}$
$= \pm \{(0.25) + (0.0018)\}$
$= \pm$ 0.25% span = (0.25% x 3000 psig) = ± 7.5 psig
$= \pm$ [(0.25%/100%) x 10 VDC] = 0.025 VDC

Per Design Input (DI) #32, the "As-Found" tolerance currently used in SP-120A for the DSS (RC-158-PS1 and RC-159-PS1) is - 0.025 VDC. The new setpoint associated with DSS will be provided with a positive and negative tolerance instead of just a negative tolerance. Therefore:

AF_{PS} = **± 0.25% span = ± 7.5 psig = 0.025 VDC**

Remote Shutdown Indication (AF_{RSI})

$$AF_{RSI} = \pm \{(AL_{RSI}) + [(PT-E_{SB})^2 + (MTE_{OL})^2]^{1/2}\} \qquad \text{DI4 \& A3.4}$$

$$= \pm \{(1.67) + [(0.2)^2 + (0.384)^2]^{1/2}\}$$
$$= \pm \{(1.67) + [(0.04) + (0.1475)]^{1/2}\}$$
$$= \pm \{(1.67) + [0.1875]^{1/2}\}$$
$$= \pm \{(1.67) + (0.43)\}$$
$$= \pm 2.10\% \text{ span} = (2.10\% \times 3000 \text{ psig}) = \pm 63.0 \text{ psig}$$

Since RC-158-PI1 and RC-159-PI1 can only be read to 25 psig (½ minor division), and because the calculated tolerance is close to a ½ minor division point, the "As-Found" tolerance for the Remote Shutdown Indication will be rounded up to 75 psig or 2.50%.

Per Design Input (DI) #31, the "As-Found" tolerance currently used in SP-161C for the Remote Shutdown Indication (RC-158-PI1 and RC-159-PI1) is ± 75 psig. Since the calculated tolerance is the same as the tolerance currently used, the "As-Found" tolerance will remain ± 75 psig. Therefore:

AF_{RSI} = **± 2.50% span = ± 75 psig**

DSS Pressure Switch (Signal Monitor) (AF_{DSS})

$$AF_{DSS} = \pm ((AL_{DSS}) + [(PT\text{-}E_{SB})^2 + (MTE_{PSL})^2]^{1/2}) \qquad \text{DI4 \& A3.3}$$

$= \pm \{(0.667) + [(0.2)^2 + (0.402)^2]^{1/2}\}$
$= \pm \{(0.667) + [(0.04) + (0.1616)]^{1/2}\}$
$= \pm \{(0.667) + [0.2016]^{1/2}\}$
$= \pm \{(0.667) + (0.45)\}$
$= \pm$ 1.12% span = (1.12% x 3000 psig) = ± 33.6 psig
$= \pm$ [(1.12%/100%) x 10 VDC] = ± 0.112 VDC

Per Design Input (DI) #31, the "As-Found" tolerance currently used in SP-161C for the DSS (RC-158-PS1 and RC-159-PS1) is ± 20 psig. Based on past experiences the pressure switch loop is capable of being calibrated to the tolerance of ± 20 psig. However, to provide additional Engineering Margin the calculated "As-Found" tolerance will be used in this calculation, which will determine the plant setpoint. Therefore, the "As-Found" value in the procedure will remain at ± 20 psig, but the calculation will use ± 33.6 ("As-Found" + Margin). Therefore:

AF_{DSS} = **± 20 psig = ± 0.667% span**

DSS Margin = **± 13.6 psig =± 0.453% span**

Output to RECALL/SPDS (AF_{RCN})

$$AF_{RCN} = \pm \{(AL_{RCN}) + [(PT\text{-}E_{SB})^2 + (MTE_{OL})^2]^{1/2}) \qquad \text{DI4 \& A3.4}$$

$= \pm \{(0.83) + [(0.2)^2 + (0.384)^2]^{1/2}\}$
$= \pm \{(0.83) + [(0.04) + (0.1475)]^{1/2}\}$
$= \pm \{(0.83) + [0.1875]^{1/2}\}$
$= \pm \{(0.83) + (0.43)\}$
$= \pm$ 1.26% span = (1.26% x 3000 psig) = ± 37.8 psig

Per Design Input (DI) #31, the "As-Found" tolerance currently used in SP-161C for the RECALL/SPDS is ± 50 psig. However, the calculated "As-Found" is ± 37.8 psig. Therefore, the calculated "As-Found" tolerance will be used in the calculation and procedure. The tighter tolerance of ± 37.8 psig will remove additional conservatisms, which could affect the ability of the operator using RECALL/SPDS. Therefore:

AF_{RCN} = **± 1.26% span = ± 37.8 psig**

Control Room Indication (AF_{PI})

$$AF_{PI} = \pm ((AL_{PI}) + [(PT\text{-}E_{SB})^2 + (MTE_{OL})^2]^{1/2}) \qquad \text{DI4 \& A3.4}$$

$$= \pm ((1.67) + [(0.2)^2 + (0.384)^2]^{1/2})$$
$$= \pm ((1.67) + [(0.04) + (0.1475)]^{1/2})$$
$$= \pm ((1.67) + [0.1875]^{1/2})$$
$$= \pm ((1.67) + (0.43))$$
$$= \pm 2.10\% \text{ span} = (2.10\% \times 3000 \text{ psig}) = \pm 63.0 \text{ psig}$$

Since RC-158-PI2 and RC-159-PI2 can only be read to 50 psig (½ minor division), and because the calculated tolerance is close to a ½ minor division point, the "As-Found" tolerance for the Control Room Indication will be rounded down to 50 psig or 1.67%.

Per Design Input (DI) #31, the "As-Found" tolerance currently used in SP-161C for the Control Room Indication (RC-158-PI2 and RC-159-PI2) is ± 75 psig. Because the indicator can only be read to 50 psig increments, the existing "As-Found" tolerance will be changed to ± 50 psig. Therefore:

AF_{PI} = **± 1.67% span = ± 50 psig**

Control Room Recording (AF_{CRR})

$$AF_{CRR} = \pm ((AL_{CRR}) + [(PT\text{-}E_{SB})^2 + (MTE_{OL})^2]^{1/2}) \qquad \text{DI4 \& A3.4}$$

$$= \pm ((0.83) + [(0.2)^2 + (0.384)^2]^{1/2})$$
$$= \pm ((0.83) + [(0.04) + (0.1475)]^{1/2})$$
$$= \pm ((0.83) + [0.1875]^{1/2})$$
$$= \pm ((0.83) + (0.43))$$
$$= \pm 1.26\% \text{ span} = (1.26\% \times 3000 \text{ psig}) = \pm 37.8 \text{ psig}$$

Since RC-158-PIR can only be read to 25 psig (½ minor division), and because the calculated tolerance is close to a ½ minor division point, the "As-Found" tolerance for the Control Room Indication will be rounded up to 50 psig or 1.67%.

Per Design Input (DI) #31, the "As-Found" tolerance currently used in SP-161C for the Control Room Recording (RC-158-PIR) is ± 50 psig. Since the calculated tolerance is the same as the tolerance currently used by the procedure, the "As-Found" tolerance will remain ± 50 psig. Therefore:

AF_{CRR} = **± 1.67% span = ± 50 psig**

Control Room Recorder Indicating (AF_{CIR})

$$AF_{CIR} = \pm ((AL_{CIR}) + [(PT-E_{SB})^2 + (MTE_{OL})^2]^{1/2}) \qquad \text{DI4 \& A3.4}$$

$$= \pm \{(0.83) + [(0.2)^2 + (0.384)^2]^{1/2}\}$$
$$= \pm \{(0.83) + [(0.04) + (0.1475)]^{1/2}\}$$
$$= \pm \{(0.83) + [0.1875]^{1/2}\}$$
$$= \pm \{(0.83) + (0.43)\}$$
$$= \pm 1.26\% \text{ span} = (1.26\% \times 3000 \text{ psig}) = \pm 37.8 \text{ psig}$$

Since RC-158-PIR Indicator can only be read to 25 psig (½ minor division), and because the calculated tolerance is close to a ½ minor division point, the "As-Found" tolerance for the Control Room Indication will be rounded up to 50 psig or 1.67%.

Per Design Input (DI) #31, the "As-Found" tolerance currently used in SP-161C for the Control Room Recorder Indicator (RC-158-PIR) is ± 50 psig. Since the calculated tolerance is the same as the tolerance currently used in the procedure, the "As-Found" tolerance will remain ± 50 psig will be used. Therefore:

AF_{CIR} = **± 1.67% span = ± 50 psig**

CALIBRATED LOOP ERRORS:

DI27

Remote Shutdown Indication (CE_{RSI})

$CE_{RSI} = \pm [(E_{RSI}) + (AF_{RSI})]$

$= \pm [(2.70) + (2.50)]$
$= \pm 5.20\%$ span $= (5.20\% \times 3000$ psig$) = \pm 156.0$ psig

DSS Pressure Switch (Signal Monitor) (CE_{DSS})

$CE_{DSS} = \pm [(E_{DSS}) + (AF_{DSS}) + (DSS\ Margin)]$

$= \pm [(0.84) + (0.667) + (0.453)]$
$= \pm 1.96\%$ span $= [(1.96\%) \times (3000$ psig$)] = \pm 58.8$ psig

Since DSS actuates on increasing pressure at a Design Basis Setpoint of 2450 psig, per Design Input (DI) #11, the actual setpoint is to be set below 2450 psig. Therefore, the setpoint for DSS actuation will be as follows:

Setpoint = FSAR Value - CE_{DSS}

= 2450 psig - 58.8 psig
= 2391.2 psig = 7.9707 VDC = [(2391.2 psi/3000 psi) x 10 VDC]

= 7.97 VDC (Setpoint rounded down for ease of setting)

= 2391.0 psig = [(7.97 VDC/10 VDC) x 3000 psig]

Therefore,

CE_{DSS} = (2450 psig - 2391.0 psig) = 59.0 psig
= [(59.0 psig/3000 psig) x 100%] = 1.97%

Output to RECALL/SPDS (Normal - CE_{RCN}, Accident - CE_{RCA})

$CE_{RCN} = \pm [(E_{RCN}) + (AF_{RCN})]$

$= \pm [(1.08) + (1.26)]$
$= \pm 2.34\%$ span = (2.34% x 3000 psig) = **± 70.2 psig**

RC-158-PT:

$CE_{RCA} = \pm [(E_{RCA}) + (AF_{RCN})]$

$= + [(4.58) + (1.26)]$
$= + 5.84\%$ span = (+5.84% x 3000 psig) = **+175.2 psig**

$= - [(4.09) + (1.26)]$
$= - 5.35\%$ span = (-5.35% x 3000 psig) = **-160.5 psig**

RC-159-PT:

$CE_{RCA} = \pm [(E_{RCA}) + (AF_{RCN})]$

$= + [(5.23) + (1.26)]$
$= + 6.49\%$ span = (+6.49% x 3000 psig) = **+194.7 psig**

$= - [(4.09) + (1.26)]$
$= - 5.35\%$ span = (-5.35% x 3000 psig) = **-160.5 psig**

Control Room Indication (Normal - CE_{PIN}, Accident - CE_{PIA})

CE_{PIN} = $\pm$ [(E_{PIN}) + (AF_{PI})]

= $\pm$ [(2.43) + (1.67)]
= **$\pm$ 4.10% span** = (4.10% x 3000 psig) = **$\pm$ 123.0 psig**

RC-158-PT:

CE_{PIA} = $\pm$ [(E_{PIA}) + (AF_{PI})]

= + [(5.13) + (1.67)]
= **+ 6.80% span** = (+6.80% x 3000 psig) = **+204.0 psig**

= - [(4.64) + (1.67)]
= **- 6.31% span** = (-6.31% x 3000 psig) = **-189.3 psig**

RC-159-PT:

CE_{PIA} = $\pm$ [(E_{PIA}) + (AF_{PI})]

= + [(5.78) + (1.67)]
= **+ 7.45% span** = (+7.45% x 3000 psig) = **+223.5 psig**

= - [(4.64) + (1.67)]
= **- 6.31% span** = (-6.31% x 3000 psig) = **-189.3 psig**

Control Room Recording (Normal - CE_{RN}, Accident - CE_{RA})

$CE_{RN} = \pm [(E_{PRRN}) + (AF_{CRR})]$

$= \pm [(1.38) + (1.67)]$
$= \pm 3.05\%$ span = (3.05% x 3000 psig) = **± 91.5 psig**

RC-158-PT:

$CE_{RA} = \pm [(E_{PRRA}) + (AF_{CRR})]$

$= + [(4.67) + (1.67)]$
$= + 6.34\%$ span = (+6.34% x 3000 psig) = **+190.2 psig**

$= - [(4.18) + (1.67)]$
$= - 5.85\%$ span = (-5.85% x 3000 psig) = **-175.5 psig**

Control Room Recorder Indicating (Normal - CE_{RIN}, Accident - CE_{RIA})

$CE_{RIN} = \pm [(E_{PIRN}) + (AF_{CIR})]$

$= \pm [(1.26) + (1.67)]$
$= \pm 2.93\%$ span = (2.93% x 3000 psig) = **± 87.9 psig**

RC-158-PT:

$CE_{RIA} = \pm [(E_{PIRA}) + (AF_{CIR})]$

$= + [(4.63) + (1.67)]$
$= + 6.30\%$ span = (+6.30% x 3000 psig) = **+189.0 psig**

$= - [(4.14) + (1.67)]$
$= - 5.81\%$ span = (-5.81% x 3000 psig) = **-174.3 psig**

PARTIAL LOOP TOLERANCE: (Loop Error - Bistable) DI29

Partial Loop Error is the difference between the Total Loop Error and the Bistable (Pressure Switch) Error.

Partial Loop "As-Left" Tolerance (PL_{AL-PS})

$PL_{AL-PS} = \pm (AL_{DSS} - AL_{PS})$

$= \pm$ (20 psig - 7.5 psig)
$= \pm$ 12.5 psig = [(12.5 psig/3000 psig) x 100%] = ± 0.417% span
$= \pm$ [(0.417%/100%) x 10 VDC] = ± 0.0417 VDC

For ease of setting and to ensure that the sum of the Partial Loop errors do not exceed the Total Loop error, the tolerance will be rounded down to ± 0.041 VDC. Therefore:

PL_{AL-PS} = **± 0.041 VDC = ± 0.41% span = ± 12.3 psig**

Partial Loop "As-Found" Tolerance (PL_{AF-PS})

$PL_{AF-PS} = \pm (AF_{DSS} - AF_{PS})$

$= \pm$ (20 - 7.5)
$= \pm$ 12.5 psig = [(12.5 psig/3000 psig) x 100%] = ± 0.417% span
$= \pm$ [(0.417%/100%) x 10 VDC] = ± 0.0417 VDC

For ease of setting and to ensure that the sum of the Partial Loop errors do not exceed the Total Loop error, the tolerance will be rounded down to ± 0.041 VDC. Therefore:

PL_{AF-PS} = **± 0.041 VDC = ± 0.41% span = ± 12.3 psig**

VI. RESULTS/CONCLUSIONS:

The following Tables list the applicable results of this calculation.

TABLE I
FSAR/Technical Specification Setpoints

END DEVICE	DESIGN SETPOINT	FSAR/TECHNICAL SPECIFICATION SECTION
RC-158-PS1	2450 PSIG	FSAR SECTION 7.5.2.1
RC-159-PS1	2450 PSIG	FSAR SECTION 7.5.2.1

TABLE II
Transmitter Scaling/Calibration

TRANSMITTER	SCALING CORRECTION	CALIBRATION SPAN 0%	CALIBRATION SPAN 100%
RC-158-PT	27.2 PSIG	27.2 PSIG	3027.2 PSIG
RC-159-PT	27.7 PSIG	27.7 PSIG	3027.7 PSIG

NOTE: The pressure transmitters are not be calibrated above their Upper Range Limit of 3000 psig.

TABLE III
Transmitter Setting Tolerances

TRANSMITTER	AS-LEFT (± % SPAN, mA, PSIG)	AS-FOUND (± % SPAN, mA, PSIG)
RC-158-PT	±0.25% SPAN, 0.04 mA, 7.5 PSIG	±0.313% SPAN, 0.05 mA, 9.4 PSIG
RC-159-PT	±0.25% SPAN, 0.04 mA, 7.5 PSIG	±0.313% SPAN, 0.05 mA, 9.4 PSIG

TABLE IV
Pressure Switch Setting Tolerances

PRESSURE SWITCH	NORMAL CALIBRATED SETPOINT (VDC, PSIG*)	AS-LEFT (± VDC, PSIG)	AS-FOUND (± VDC, PSIG)
RC-158-PS1 (DSS)	7.97 VDC, 2418.2 PSIG	±0.025 VDC, 7.5 PSIG	±0.025 VDC, 7.5 PSIG
RC-159-PS1 (DSS)	7.97 VDC, 2418.7 PSIG	±0.025 VDC, 7.5 PSIG	±0.025 VDC, 7.5 PSIG

* The pressure switch setting is 2391.0 psig plus the Scaling Correction for each transmitter.

TABLE V
Total Loop Tolerances

LOOP END DEVICE	ENGINEERING MARGIN (% SPAN, PSIG)	CALIBRATED LOOP ERROR (% SPAN, PSIG)	LOOP AS-LEFT (± % SPAN, PSIG)	LOOP AS-FOUND (± % SPAN, PSIG)
RC-158-PS1	0.453%, 13.6 PSIG	1.97%, 59.0 PSIG	±0.667% SPAN, 20.0 PSIG	±0.667% SPAN, 20.0 PSIG
RC-159-PS1	0.453%, 13.6 PSIG	1.97%, 59.0 PSIG	±0.667% SPAN, 20.0 PSIG	±0.667% SPAN, 20.0 PSIG

TABLE VI
Partial Loop Tolerance (Transmitter to Input of Bistable)

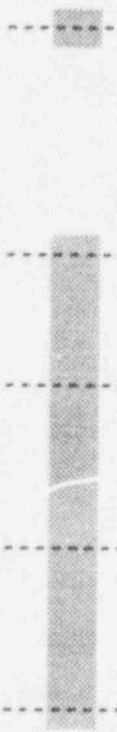
LOOP END DEVICE	LOOP - PRESSURE SWITCH AS-LEFT (± VDC, PSIG)	LOOP - PRESSURE SWITCH AS-FOUND (± VDC, PSIG)
RC-158-PS1 (DSS)	±0.041 VDC, 12.3 PSIG	±0.041 VDC, 12.3 PSIG
RC-159-PS1 (DSS)	±0.041 VDC, 12.3 PSIG	±0.041 VDC, 12.3 PSIG

TABLE VII
Total Loop Errors

END DEVICE	NORMAL CALIBRATED LOOP ERROR (± % SPAN, PSIG)	POST-ACCIDENT CALIBRATED LOOP ERROR (+,- % SPAN) (+,- PSIG)	LOOP AS-LEFT (± PSIG)	LOOP AS-FOUND (± PSIG)
RC-158-PI1 (Remote Shutdown)	±5.20%, 156.0 PSIG	N/A	±50	±75
RC-159-PI1 (Remote Shutdown)	±5.20%, 156.0 PSIG	N/A	±50	±75
RC-158-PI2 (Control Room)	±4.10%, 123.0 PSIG	+6.80, -6.31% +204.0, -189.3 PSIG	±50	±50
RC-159-PI2 (Control Room)	±4.10%, 123.0 PSIG	+7.45%, -6.31% +223.5, -189.3 PSIG	±50	±50
RC-158-PIR (Recording-158)	±3.05%, 91.5 PSIG	+6.34%, -5.85% +190.2, -175.5 PSIG	±25	±50
RC-158-PIR (Indicating-158)	±2.93%, 87.9 PSIG	+6.30%, -5.81% +189.0, -174.3 PSIG	±25	±50
RECALL/SPDS (RC-158-PT)	±2.34%, 70.2 PSIG	+5.84%, -5.35% +175.2, -160.5 PSIG	±25	±37.8
RECALL/SPDS (RC-159-PT)	±2.34%, 70.2 PSIG	+6.49%, -5.35% +194.7, -160.5 PSIG	±25	±37.8

FIGURE I

ATWS/DSS TRIP DATA



2450.0 psig = ATWS/DSS Design Trip
(FSAR Section 7.5.2.1)

2424.6 psig = Upper Limit of Margin

2411.0 psig = (+) Loop As-Left/As-Found Tolerance

2391.0 psig = Calibrated Setpoint

2371.0 psig = (-) Loop As-Left/As-Found Tolerance

2355.0 psig = RPS Tech Spec HI Press Trip
(Tech. Spec. Section 3.3.1, Table 3.3.1-1)

2155.0 psig = Normal Operating Pressure

NOTE: Pressures given in the above Figure are absolute and are not scaled to the specific transmitter calibration spans.

FIGURE II

ATWS/DSS PRESSURE SWITCH DATA

---------- 2398.5 psig = (+) Switch As-Left/As-Found Tolerance

---------- 2391.0 psig = Calibrated Setpoint

---------- 2383.5 psig = (-) Switch As-Left/As-Found Tolerance

NOTE: Pressures given in the above Figure are absolute and are not scaled to the specific transmitter calibration spans.

VII. ATTACHMENTS:

1. Specifications for Rosemount 1154GP9RA transmitters from Instruction Manual 1260, Revision 7 (4 pages).

2. Foxboro Product Specification PSS 2E-1A1-A from Instruction Manual 586, Revision 5 (1 page).

3. Foxboro Product Specification PSS 2E-1A1-G and Foxboro Supporting Literature Instruction SI 1-01762 from Instruction Manual 586, Revision 5 (3 pages).

4. International Instruments Series 1151/1251 bulletin from Instruction Manual 586, Revision 5 (2 pages).

5. Bailey Product Instruction E92-74 from Instruction Manual 49 Volume 1B, Revision 14 (2 pages).

6. Bailey Product Instruction E12-9-2 from Instruction Manual 1400, Revision 1, (2 pages).

7. Foxboro Product Specification PSS 9-7C1-A (1 page).

8. Foxboro Technical Information TI 2AX-151 from Instruction Manual 586, Revision 5 (2 pages).

9. String Calibration Data Sheet from SP-161C for RC-158-PT dated April 1994 - SEEK Reel 7389, Frame 1017 (6 pages).

10. Calibration Work Sheet for Druck DPI-510 Pressure Controller/Calibrator, M&TE #TG2362 - SEEK Reel 7242, Frame 0386 (2 pages).

11. Calibration Work Sheet for Keithley 197A Digital Multimeter, M&TE #TI1971 - SEEK Reel 7366, Frame 0914 (4 pages).

12. CMIS Printouts for MTBD-9A, MTBD-11B, RC-158-PT, RC-159-PT, RCR265 and RCR271, dated 11/17/94 (5 pages).

13. Calibration Data Sheet for RC-158-PT, Revision 4 (1 page).

14. Calibration Data Sheet for RC-159-PT, Revision 4 (1 page).

Section 4
SPECIFICATIONS AND REFERENCE DATA

NUCLEAR SPECIFICATIONS

(Qualified to IEEE Std. 323-1974 and IEEE Std. 344-1975 per Rosemount Report D8400102)

Radiation

Accuracy within ±(1.5% of upper range limit + 1.0% of span) during and after exposure to 55 megarads TID gamma radiation at the centerline per the following dose rate schedule: 2 megarads/hr for 2 hours, 1.5 megarad/hr for 4 hours, 1 megarad/hr up to 55 megarads TID and an additional 55 megarads TID at a rate of 1 megarad/hr during post-accident operation.

Range Code 0: ±(2.25% of upper range limit + 1.0% of span)

Seismic

Accuracy within ±0.5% of upper range limit after a disturbance defined by a required response spectrum with a ZPA of 7 g's.

Range Code 0: ±0.75% of upper range limit.

Steam Pressure/Temperatures

Accuracy within ±(2.5% of upper range limit + 0.5% of span) during and after sequential exposure to steam at the following temperatures and pressures, concurrent with chemical spray for the first 24 hours:

420 °F, 50 psig for 3 minutes

350 °F, 110 psig for 7 minutes

320 °F, 75 psig for 8 hours

265 °F, 24 psig for 56 hours

Range Code 0: ±(3.75% of upper range limit + 0.5% of span).

Chemical Spray

Composition is 0.28 molar boric acid, 0.064 molar sodium thiosulfate, and sodium hydroxide as required to make an initial pH of 11.0 and a subsequent pH ranging from 8.5 to 11.0. Chemical spray is sprayed at a rate of 0.25 gal/min/ft^2.

Post DBE Operation

Accuracy at reference conditions shall be within ±2.5% of upper range limit (3.75% for Range 0) after exposure to DBE as described above for one year following DBE.

Quality Assurance Program

In accordance with NQA-1 and 10CFR50, Appendix B.

Nuclear Cleaning

To 1 ppm maximum chloride content.

Hydrostatic Testing

To 150% of maximum working pressure or 2,000 psi, (13.8 MPa), whichever is greater.

Traceability

In accordance with NQA-1 and 10CFR50, Appendix B; chemical and physical material certification of process wetted parts.

Qualified Life

Dependent on ambient temperature at the installation site, as shown in Figure 4-1. Replacing amplifier and calibration circuit boards at the end of their qualified life permits extension of the transmitter's qualified life to the module's qualified life. See Rosemount Report D8400102 for details.

(Values do not include margin.)

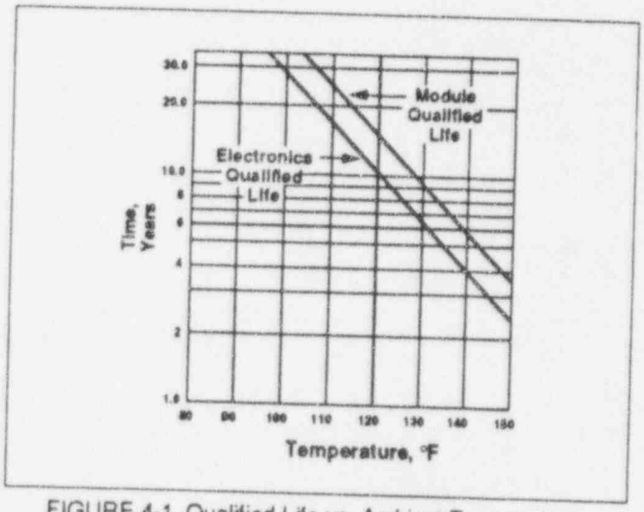


FIGURE 4-1. Qualified Life vs. Ambient Temperature.

PERFORMANCE SPECIFICATIONS

(Zero-based ranges, reference conditions)

Accuracy

±0.25% of calibrated span. Includes combined effects of linearity, hysteresis, and repeatability.

Dead Band

None.

Drift

±0.2% of upper range limit for 30 months.

Temperature Effect

Ranges 4–9: ±(0.75% upper range limit +0.5% span) per 100 °F (55.6 °C) ambient temperature change.

Range 0: ±(1.13% upper range limit +0.5% span) per 100 °F (55.6 °C) ambient temperature change.

Overpressure Effect

Model 1154DP

Maximum zero shift after 2,000 psi (13.8 MPa) overpressure:

±0.25% of upper range limit (Range 4).

±1.0% of upper range limit (Range 5).

±3.0% of upper range limit (Ranges 6 and 7).

±6% of upper range limit (Range 8).

Models 1154GP

Maximum zero shift after 2,000 psi (13.8 MPa) overpressure:

±0.25% of upper range limit (Range 4).

±1.0% of upper range limit (Ranges 5, 6, 7, and 8).

Maximum zero shift after 4,500 psi (31.0 MPa) overpressure:

±0.5% of upper range limit (Range 9).

Maximum zero shift after 6,000 psi (41.34 MPa) overpressure:

±0.25% of upper range limit (Range 0).

Model 1154HP

Maximum zero shift after 3,000 psi (20.68 MPa) overpressure:

±1.0% of upper range limit (Range 4).

±2.0% of upper range limit (Range 5).

±5.0% of upper range limit (Ranges 6 and 7).

Static Pressure Zero Effect

Model 1154DP

±0.2% of upper range limit per 1,000 psi (6.89 MPa) (Ranges 4 and 5).

±0.5% of upper range limit per 1,000 psi (6.89 MPa) (Ranges 6, 7, and 8).

Model 1154HP

±0.66% of upper range limit per 1,000 psi (6.9 MPa) (all ranges).

Static Pressure Span Effect

Is systematic and can be calibrated out for a particular pressure before installation. Correction uncertainty: ±0.5% of reading/1,000 psi.

Power Supply Effect

Less than 0.005% per volt.

Load Effect

No load effect other than the change in voltage supplied to the transmitter.

Mounting Position Effect

No span effect. Zero shift of up to 1.5 inH_2O (372 MPa) (Ranges 4 and 5), which can be calibrated out. For higher ranges, effect is superseded by accuracy specifications.

Response Time

Fixed time constant (63%) at 100 °F (37.8 °C) as follows:

0.5 seconds for Range 4.

0.2 seconds for all other ranges.

Adjustable damping electronics are available that can provide damping of at least 1.2 seconds on Range 4 and 0.8 seconds on all other ranges when adjusted to the maximum position.

FUNCTIONAL SPECIFICATIONS

Service

Liquid, gas, or vapor.

Output

4–20 mA dc.

Power Supply

Design limits (Figure 1-6).

Span and Zero

Continuously adjustable externally.

Zero Elevation and Suppression

Maximum zero elevation: 600% of calibrated span (400% of calibrated span for Range Code 0). Maximum zero suppression: 500% of calibrated span (300% of calibrated span for Range Code 0). Zero elevation and suppression must be such that neither the span nor the upper or lower range value exceed 100% of the upper range limit.

Temperature Limits

Normal Operating Design Limits: 40 to 200 °F (4.4 to 93.3 °C).

Qualified Storage Limits: –40 to 120 °F (–40.0 to 48.9 °C).

Humidity Limits

0–100% relative humidity (NEMA 4X).

Volumetric Displacement

Less than 0.01 in^3 (0.16 cm^3).

Turn-On Time

2 seconds maximum. No warm-up required.

MODELS 1154DP AND 1154HP

Ranges

(4) 0–25 to 0–150 inH_2O (0–6.22 to 0–37.50 kPa).

(5) 0–125 to 0–750 inH_2O (0–31.08 to 0–186.50 kPa).

(6) 0–17 to 0–100 psi (0–0.12 to 0–0.69 MPa).

(7) 0–50 to 0–300 psi (0–0.34 to 0–2.07 MPa).

(8) 0–170 to 0–1,000 psi (D units only)(0–1.17 to 0–6.89 MPa).

Maximum Working Pressure

Static pressure limit.

Static Pressure and Overpressure Limits

Model 1154DP

0.5 psia to 2,000 psig (3.4 kPa to 13.78 MPa) maximum rated static pressure for operation within specifications. 2,000 psig (13.8 MPa) overpressure on either side without damage to the transmitter.

Model 1154HP

0.5 psia to 3,000 psig (3.4 kPa to 20.7 MPa) maximum rated static pressure for operation within specifications. 3,000 psig (20.7 MPa) overpressure on either side without damage to the transmitter.

MODEL 1154GP

Ranges

(4) 0–25 to 0–150 inH_2O (0–6.22 to 0–37.50 kPa).
(5) 0–125 to 0–750 inH_2O (0–31.08 to 0–186.50 kPa).
(6) 0–17 to 0–100 psig (0–0.12 to 0–0.69 MPa).
(7) 0–50 to 0–300 psig (0–0.34 to 0–2.07 MPa).
(8) 0–170 to 0–1,000 psig (0–1.17 to 0–6.89 MPa).
(9) 0–500 to 0–3,000 psig (0–3.45 to 0–20.68 MPa).
(0) 0–1,000 to 0–4,000 psi (0–6.89 to 0–27.56 MPa).

Maximum Working Pressure

Upper range limit.

Overpressure Limits

Operates within specifications from 0.5 psia (3.45 kPa) to upper range limit. Overpressure limit is 2,000 psig (13.8 MPa) (4,500 psig [31.0 MPa] for Range 9) (6,000 psig [41.34 MPa] for Range Code 0) without damage to the transmitter.

PHYSICAL SPECIFICATIONS

ALL MODELS

Materials of Construction

Isolating Diaphragms
316 SST.

Drain/Vent Valves
316 SST.

Process Flanges
316 SST.

Process O-rings
316 SST.

Electronics Housing O-rings
Ethylene propylene.

Fill Fluid
Silicone oil.

Flange Bolts
Plated alloy steel, per ASTM A-540.

Electronics Housing
316 SST.

Process Connections

3/8-inch Swagelok compression fitting, 316 SST (1/4–18 NPT optional).

Electrical Connections

1/2–14 NPT conduit with screw terminals.

Weight

24 lb (10.9 kg) including mounting bracket.

TABLE 4-1. Transmitter Design Specifications.

MODEL
1154 *ALPHALINE* PRESSURE TRANSMITTERS FOR NUCLEAR APPLICATIONS IEEE 323-1974 AND IEEE 344-1975

CODE — PRESSURE MEASUREMENT

DP	Differential Pressure, 2,000 psig (13.8 MPa) Static Pressure Rating
HP	Differential Pressure, 3,000 psig (20.62 MPa) Static Pressure Rating
GP	Gage Pressure

PRESSURE RANGES

CODE	MODEL 1154DP (DIFFERENTAL)	MODEL 1154HP (DIFFERENTIAL)	MODEL 1154GP (GAGE)
4	0-25 to 0-150 inH_2O (0-6.22 to 0-37.50 kPa)	0-25 to 0-150 inH_2O (0-6.22 to 0-37.50 kPa)	0-25 to 0-150 inH_2O (0-6.22 to 0-37.50 kPa)
5	0-125 to 0-750 inH_2O (0-31.08 to 0-186.50 kPa)	0-125 to 0-750 inH_2O (0-31.08 to 0-186.50 kPa)	0-125 to 0-750 inH_2O (0-31.08 to 0-186.50 kPa)
6	0-17 to 0-100 psid (0-0.12 to 0-0.69 MPa)	0-17 to 0-100 psid (0-0.12 to 0-0.69 MPa)	0-17 to 0-100 psig (0-0.12 to 0-0.69 MPa)
7	0-50 to 0-300 psid (0-0.35 to 0-2.07 MPa)	0-50 to 0-300 psid (0-0.35 to 0-2.07 MPa)	0-50 to 0-300 psig (0-0.35 to 0-2.07 MPa)
8	0-170 to 0-1,000 psid (0-1.15 to 0-6.89 MPa)	N/A	0-170 to 0-1,000 psig (0-1.15 to 0-6.89 MPa)
9	N/A	N/A	0-500 to 0-3,000 psig (0-3.45 to 0-20.62 MPa)
0	N/A	N/A	0-1,000 to 0-4,000 psig (0-6.89 to 0-27.56 MPa)

CODE — OUTPUT

R①	Standard 4–20 mA

CODE — FLANGE OPTION

A	Welded 3/8-in. *Swagelok* compression fitting process connection and welded drain/vent valve
B②	1/4–18 NPT process connection and welded drain/vent valve
C②	1/4–18 NPT process connection and drain hole (drain/vent valve not supplied)
D	One Flange Code Option A and one remote seal
E②	One Flange Code Option B and one remote seal
F②	One Flange Code Option C and one remote seal
G	Two remote seals
H	Welded 3/8-in. *Swagelok* compression fittings on both process connection and drain/vent connection
J②	Welded 3/8-in. *Swagelok* compression fitting process connection and 1/4–18 NPT drain hole
L	One Flange Code Option H and one remote seal
M②	One Flange Code Option J and one remote seal

1154 DP 4 R A — TYPICAL MODEL NUMBER

① The Model 1154 with the R Output Code Electronics is also available with adjustable damping. This option is specified by Appending "N0037" to the end of the complete model number. For Example: 1154DP4RAN0037.

② Customer assumes responsibility for qualifying process interfaces on these options. Contact Rosemount Inc. for details.

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STANDARD SPECIFICATIONS

The following specifications apply unless noted otherwise in the individual component listing. All percentage figures are percent of output span.

Dual Converters Two identical independent channels

Output 0 to 10 V dc into 2 kΩ load minimum

Accuracy ±0.5%

Repeatability Less than 0.1%

Ambient Temperature Effect Less than 0.5% for 25°C (45°F) change within normal operating limits of 5 and 50°C (40 and 120°F)

Input Filtering (Current converters) 3 dB down at 10 Hz

Loop Compliance Voltage (Current converters) See Table 1.

Field Connections Screw terminals accept wires from 0.22 mm² to 1.5 mm², or from 24 to 16 AWG

Mounting Two screws retain component in a 2ANU Series nest

Components with Adjustable Range Specific range within calibration limits achieved by jumper position and potentiometer adjustment.

Model	Functional Description	Specifications
2AI-I3V	**Current-to-Voltage Converter** Non-isolated input and non-isolated 30 V dc transmitter power supply.	**Input** 4 to 20 mA **Accuracy** ±0.25% **Zero Adjustment** 7% **Input Resistance** 250 Ω
2AI-I2V	**Current-to-Voltage Converter** Transformer isolated input and isolated 24 V dc transmitter power supply.	**Input** 4 to 20 mA **Accuracy** ±0.25% **Zero Adjustment** 4% **Span Adjustment** 10% **Input Resistance** 40 Ω
2AS-I3I	**Current-to-Voltage Converter** Non-isolated combined with a non-isolated 4 to 20 mA output function. Provides non-isolated 30 V dc transmitter power.	**Input** 4 to 20 mA **Zero Adjustment** 5% **I/V Accuracy** ±0.25% **Input Resistance** 250 Ω **V/I Accuracy** ±0.5% **Input Resistance** 500 kΩ min. **Output Load** 775 Ω max.
2AS-I2I	**Current-to-Voltage Converter** Transformer isolated input combined with an isolated 4 to 20 mA output function. Provides isolated 24 V dc transmitter power.	**Input** 4 to 20 mA **Zero Adjustment** 4% **Span Adjustment** 10% **I/V Accuracy** ±0.25% **Input Resistance** 40 Ω **V/I Accuracy** ±0.5% **Input Resistance** 500 kΩ min. **Output Load** 600 Ω max.
2AI-H2V	**Current-to-Voltage Converter** Transformer isolated input.	**Input** 10 to 50 mA **Zero Adjustment** 5% **Span Adjustment** 7% Requires 40 to 100 V dc transmitter power applied externally or connected to nest field bus via a 2AX + DP10-E Power Distribution Module.

STANDARD SPECIFICATIONS

The following specifications apply unless otherwise noted in the individual component listing. All percentage figures are percent of output span.

Dual Converters Two identical independent channels

Input 0 to 10 V dc into 500 kΩ minimum

Output Load Current converters, see Table 1

Accuracy ±0.5%

Repeatability Less than 0.1%

Ambient Temperature Effect Less than 0.5% for a 25°C (45°F) change within normal operating limits of 5 and 50°C (40 and 120°F)

Field Connections Screw terminals accept wires from 0.5 to 1.5 mm2, or from 22 to 16 AWG

Mounting Two screws retain component in a 2ANU Series nest

Electrical Classification Ordinary locations

Table 1.
Output Load
Voltage to Current Converters

Model	Load (ohms)(4) 30 V dc Field Bus, No Bypass Module
2AO-V3I (Non-Certified)	775(1)
-BGB	775
-CGB	600
-FGB	600
-PGB	775
-AGB	775
-YGB	775
2AO-V5I (Non-Certified)	775(1)
-CGB	600
-FGB	600
2AS-I3I (Non-Certified)	775(1)
-BGB	775
-CGB	775
-FGB	600
-PGB	775
-AGB	775
-YGB	775
2AO-V2I and 2AO-VAI All Versions	600(2)
2AS-I2I (Non-Certified)	600(2)
-CGB	600
-FGB	600
2AO-V2H	400(3)

(1) Non-certified versions of 2AO-V3I, 2AO-V5I and 2AS-I3I can operate with field bus voltage of 24 V dc. Load capability is 540 Ω.

(2) Non-certified versions of 2AO-V2I, 2AO-VAI and 2AS-I2I can utilize an external supply of up to 48 V dc. Load capability is 1800 Ω. Use of bypass module not applicable.

(3) Requires 30 to 100 V dc power applied to load externally or connected to nest field bus via a 2AX + DP10-E power distribution module.

$$\text{Load } R = 20E - 200$$

where E is the supply voltage.
Use of bypass module not applicable to 2AO-V2H.

(4) A bypass module and its associated standby service unit (2AT-SBU) adds resistance to the output of a current converter (not applicable to 2AO-V2H). The above load values must be reduced as follows:

Non-Certified Version	50 Ω
Certified Versions	
CSA, FM	150 Ω
BASEEFA, PTB, SAA, S-Commission	250 Ω

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CUSTOM N-2AO-VAI VOLTAGE-TO-CURRENT CONVERTER MODIFIED TO FUNCTION AS A VOLTAGE-TO-VOLTAGE CONVERTER WITH 0 TO 10 VOLT OUTPUTS (N-ECEP-9206)

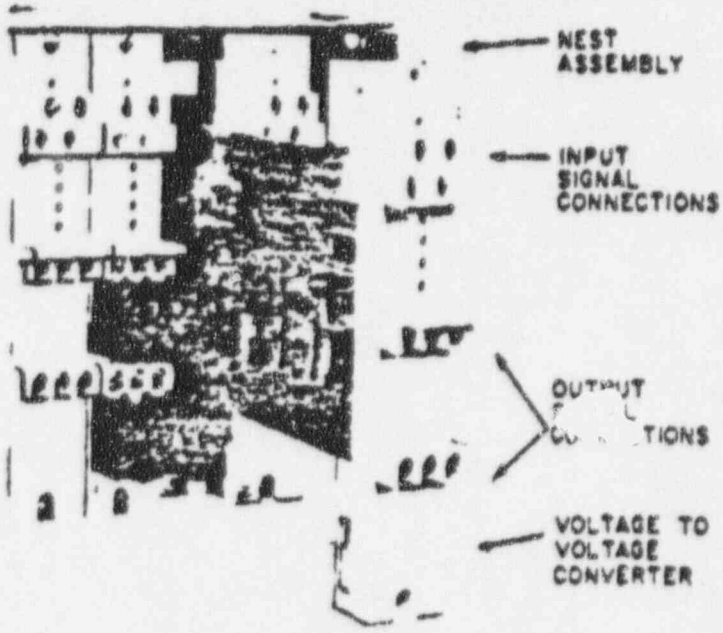

Figure 1

The Model Code N-2AO-VAI modified by N-ECEP-9206 is offered for nuclear Class 1E safety related service based on type testing. The test results are provided in Foxboro documents QOAAA20, Part 1 (seismic) and QOAAB44 (performance). These documents are available for purchase from the Foxboro Company.

General

This N-2AO-VAI Voltage-to-Current Converter has been modified to function as a voltage-to-voltage converter. To accomplish this a 500 Ω ±5%, 2 W resistor is connected externally across each pair of output terminals TC1 and TC2.

The converter slides into the nest assembly and is held by two captive screws on the top and bottom of the front plate. The converter receives its power from the supply bus in the nest assembly. The signal connections and adjustments are made on the front plate.

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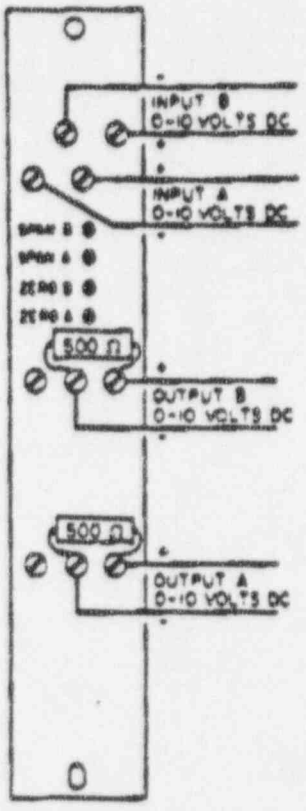

Figure 2

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Wiring

The signal connections are located on the front plate of the converter. The top connections are for Inputs A and B; the lower connections are for Outputs A and B. The input and output signals are 0 to 10 volts dc.

Calibration Procedure

1. Apply 1 volt to Input A and adjust Zero A (R36) for 1 volt ±0.5% at Output A.

2. Apply 10 volts to Input A and adjust Span A (R41) for 10 volts ±0.5% at Output A.

3. Repeat Steps 1 and 2 as required for 0.5% accuracy.

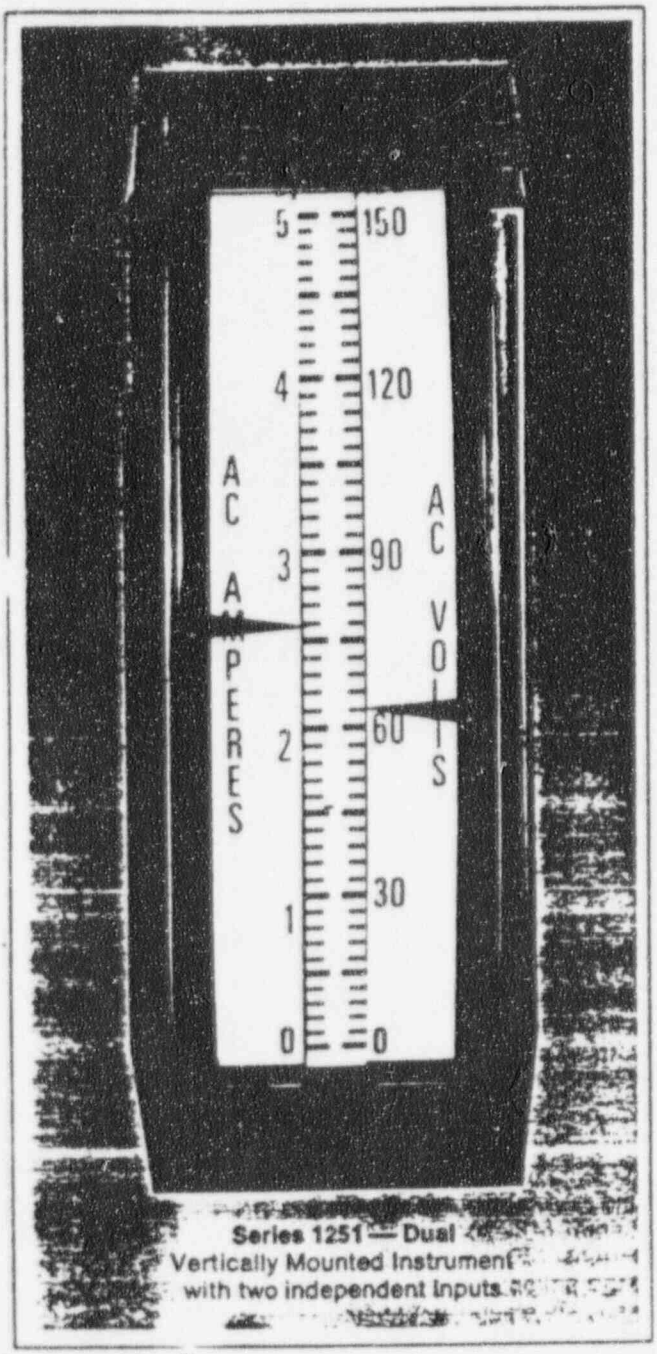
4. Check voltage at Output A for 0.5% accuracy using input voltage of 0 V, 2.5 V, 5 V, and 7.5 V dc.

5. To calibrate Output B, use same procedure as outlined in Steps 1 through 4 using Zero B (R26) and Span B (R9).

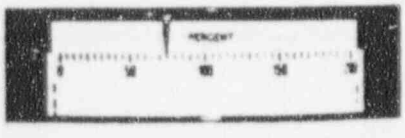
International Instruments
DIVISION OF SIGMA

SERIES
1151/1251

Single-Dual 6" Edgewise Switchboard Instruments



Series 1251 — Dual
Vertically Mounted Instrument with two independent inputs



Series 1151
Single
Horizontally Mounted Instrument

Description

The Series 1151 is a single, edgewise, switchboard class instrument utilizing a patented flat meter movement. The exclusive cantilevered coil construction of the jeweled D'Arsonval movement produces torque to weight ratios (meter efficiency) four times greater than conventional edgewise movements of equivalent size.

The availability of this thin, high performance movement permits the inclusion of two fully independent meters in a single popular case. 1251 is the Series Number for the dual unit.

The case of the Series 1151 or 1251 is made of a self-extinguishing, non-dripping plastic, and the window is Lexan.* An external zero adjustor screw for each movement is located in the front.

Anti-parallax, bi-level scales reduce reading errors on both Series 1151 and Series 1251.

Illuminated instruments are also available.

Exclusive Features

Designed for Nuclear Power Industry
The Series 1151/1251 edgewise, switchboard instruments were initially developed to meet the demanding specifications of the Atomic Energy Commission with respect to seismic qualifications, long-life and high accuracy. The resulting product line is the most rugged and reliable instrument available.

Independent Dual Instruments
Two independent meters can be included in one popular size six inch instrument case. Thus, related functions from a single source can be displayed in a single unit, e.g., specific gravity and temperature, tank level and density, speed and R.P.M. etc.

Additionally, you save three ways with the Series 1251 through:

Lower Initial Cost per Meter
Reduced Panel Space
Less panel fabrication and assembly labor time

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Standard Engineering Legends

ELECTRICAL

AC	DC	Misc.
AC Amperes	DC Amperes	Hertz
AC Kiloamperes	DC Kiloamperes	Horsepower
AC Kilovars	DC Kilovolts	Generator Amps
AC Kilovolts	DC Microamperes	Percent Current
AC Kilowatts	DC Milliamperes	Percent Load
AC Megawatts	DC Millivolts	Phase Angle
AC Milliamperes	DC Volts	Power Factor
AC Millivolts		
AC Vars		
AC Volts		
AC Watts		

TIME

Hours	Minutes	Seconds	Misc.
BBL/HR	BBL/MIN	—	Gallons Per Minute
CFH	CFM	CFS	LBS Per Minute
CPH	CPM	—	Tons Per Hour
FPH	FPM	FPS	LBS/HR x 10^4
GPH	GPM	GPS	LBS/HR
IPH	IPM	IPS	
KPH	KPM	KPS	
LPH	LPM	LPS	
MPH	MPM	—	
PPH	PPM	PPS	
RPH	RPM	RPS	
YPH	YPM	YPS	

TEMPERATURE
Degrees
Deg. C
Deg. F
Deg. K

PRESSURE (VACUUM)
PSI
PSIA
PSID
PSIG
VAC. IN. HG.
VAC. MM. HG.

VOLUME/WEIGHT
Gallons
LBS
LBS Per Gallon
Tons

LEVEL (LENGTH)
Feet
Feet W.C.
Feet Water Level
Inches
Inches W.C.
Level Feet
Level Gallons
Level Inches
Level Percent

MISCELLANEOUS
Percent
Percent Open
Steps/Min.

Specifications

Accuracy: ±1-½% F.S. Value for DC Ranges
±2-½% F.S. Value for AC Ranges

Repeatability: ±2% F.S.

Overload: Sustained—120% for 8 hours
Momentary—10 times rated current

Response Time: 2.5 Secs. Max.

Damping Factor: 5 minimum (Per ASA C39.1)

Hi-Pot: 2600 Volts RMS terminal to case for 1 minute

Temperature (Operating): –20 to 50°C

Shock: 50 G's

Pointer: Triangular type, color–cerise red

Scale: Length—4.5 inches
Marking—black lettering on white background.
Other combinations available.

Standard Movement: Zero left on horizontal or zero bottom on vertical (Zero center, right or top optional)

Mounting: Front of panel with captivated mounting assembly.

Terminals: ¼"-28, ¾" long (Plug-in connector optional)

Materials of Construction: Case—Noryl® Crystal—Lexan®

Finish: Standard—black case Optional—gray case

Weight: Single Movement—2.5 oz. Dual Movement—3.0 oz.

Seismic Qualification: See International Instruments Test Report #SBI-2

Standard Ranges

RANGES	APPROX. RESISTANCE (OHMS)
D.C. Microammeters	
0-100	2300
0-200	1540
0-500	275
D.C. Milliammeters	
0-1	71.0
0-2	14.5
0-3	9.7
0-5	2.7
0-10	1.6
0-50	0.8
0-100	0.5
0-200	0.25
0-500	0.1
0-800	0.062
Suppressed	
1-5	2.20
4-20	1.25
10-50	.8
D.C. Ammeters	
0-1	0.05
0-3	0.0166
0-5	50 MV
0-10	50 MV
0-15	50 MV
Over 15	Require external 50 MV Shunt

RANGES	APPROX. RESISTANCE (OHMS)
D.C. Millivoltmeters	
0-50	12.5
0-100	25.0
D.C. Voltmeters	
0-5	1000 ohms/volt
0-10	sensitivity
0-15	all ranges
0-25	
0-30	
0-50	
0-100	
0-150	
0-200	
0-300	
0-500	
A.C. Milliammeter	
0-1	1000
0-10	125
0-100	10
0-500	2
A.C. Voltmeters	
0-10	1000 ohms/volt
0-50	sensitivity
0-150	all ranges
0-300	
0-500	
A.C. Ammeters	
0-5	

ANALYSIS/CALCULATION
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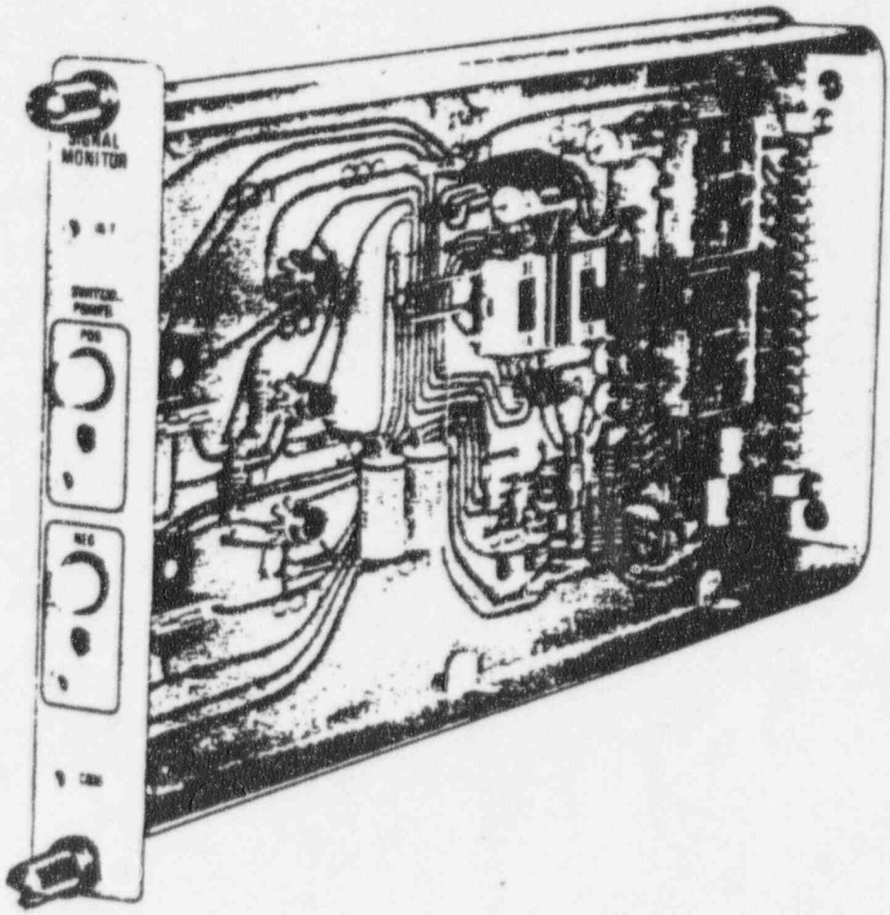
Product Instruction E92-74



ANALYSIS/CALCULATION
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Signal Monitor

Pt. No. 6623819-1

Bailey Babcock & Wilcox

SPECIFICATIONS

Accuracy*	±0.25% of span
Repeatability	±0.1% of span
Hysteresis (switching)	About 0.05% of span
Input signal range	Normal: -10 to +10v DC Reverse: +10 to -10v DC
Input resistance	1 megohm minimum
Source impedance	5000 ohms maximum
Output	Relay contacts (2-Form C contacts per relay). 7 amps @ 28v DC or 115v AC.
Relay time delay	Pull-in: 0.1 seconds Dropout: 0.1 seconds
Ambient temperature range	Normal: 40-140F Limit: 30-160F
Ambient temperature effect	±0.25% of span over ambient temperature range of 40-140F
Positive and negative switch point adjustment range	Positive switch point: ±10v DC Negative switch point: ±10v DC
Power supply	± 24v DC Normal: 22.8 to 25.2v DC Limit: 22 to 26v DC
Current requirement	+24v DC, 80ma -24v DC, 80ma
Power requirement	4 watts
Connector rating	7 amps at 28v DC
Size	1-1/8" x 7" x 11"
Weight	1.19 lbs
Mounting	Designed for plug-in mounting in a standard Bailey electronic systems cabinet (Product Specification G17-10), in a pipe or wall-mounted weatherproof enclosure (Product Specification G17-11), or in a small systems mounting enclosure (Product Specification G17-12).
Checkpoints	Input test jack on front plate permits monitoring of input signal while unit is in service. Lights indicate state of relays.

* As defined by SAMA Standard PMC20.

ROUTINE SERVICING

The Type RY Edgewise indicator under normal operating conditions does not require routine servicing except for periodic cleaning of the scale window. Remove scale window from front mounting frame and dip in hot water to clean. (NOTE: Scale window is metallized, do not rub.) Use a clean, grit-free cloth and soap and water when cleaning the outside cover.

If trouble is traced to the Edgewise Indicator, check for loose or broken wires. Recalibrate the Edgewise Indicator as described under "Adjusting The Indicator For Service". If the Edgewise Indicator still fails to operate correctly, return it to the factory for service or contact a Bailey Service representative (see outside back cover). For schematic, wiring and component location diagrams see Figures 3, 4 and 5.

Removing Indicator Window, Figure 7

1. Pull handle (15) in lower bezel and remove Edgewise Indicator from mounting case.

2. Remove designation plate (20) from module frame (2) by pushing blunt object thru 1/8-inch hole in frame.

3. Remove four screws (45) holding window to front of module frame.

4. Reverse above procedure to install window.

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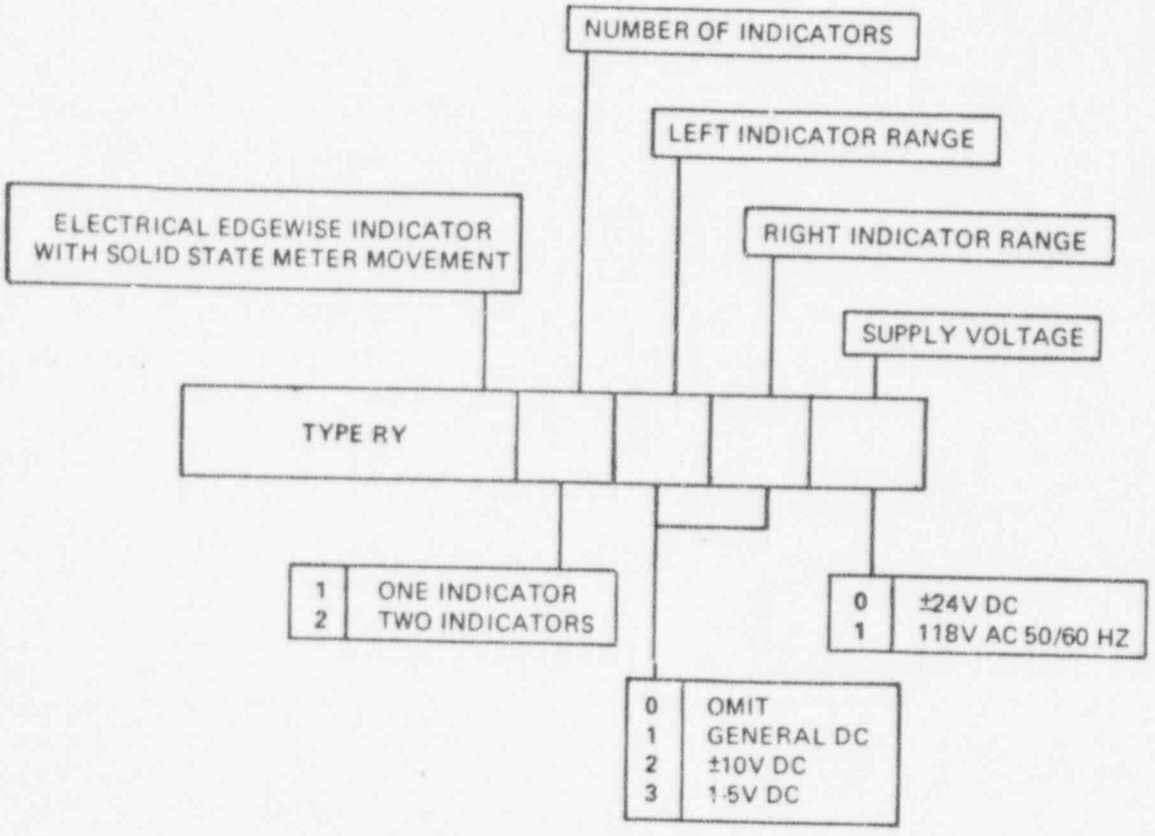
REV 7 SHEET 1 OF 2

EXPLANATION OF NOMENCLATURE



An X in any Nomenclature position indicates that in that respect the unit is special. An X as a suffix to the Nomenclature indicates that the unit includes some special feature not covered by the Nomenclature.

SPECIFICATIONS

Accuracy*	±1.0 of span
Normal Operating* Conditions	Ambient Temperature: 40 to 140F Supply Voltage: AC, 107-127v AC 48-52 Hz or 58-62 Hz. DC, ±22 - ±26v DC Ambient Temperature Effect (amplifier): ±.001% of output span per °F AC Supply Voltage Effect: ±.013 of output span per volt AC Frequency Effect: negligible. DC Supply Voltage Effect: ±0.03% of output span per volt DC. DC variation: ±0.015% of output span per volt DC.
Linearity	±1.0% of output span
Repeatability	±0.5 of output span
Dead Band	±0.5% of output span
Damping Factor	8.3
Step Response	1.60 second
Input Ripple Damping	Will not follow frequencies above 20 Hz
Input Impedance	Greater than 1 megohm
Source Impedance	0 to 2000 ohms (maximum)
Input Voltage Range	Variable (see Table 1)
Input Voltage Span	4v DC minimum, 20v DC maximum (30v DC maximum voltage above ground)
Bias Voltage	0 to −9v DC (max.)
Power Requirement	2.5VA typical, 3.5VA maximum (regulated power supply desirable)

Scale Characteristics	Number of minor divisions: 60 maximum. Number of major divisions: 4, 5, 6, 8, or 10. Number of range figures: 12 maximum. Number of digits per range figure: 2 maximum. Scale length: 5 inches.
Meter Movement	Magnetically shielded 10ma D'Arsonval movement.
Service Legend	Main service legend: 10 characters and spaces per line, 2 lines available. Sub-service legend: 5 characters and spaces per line, 2 lines (3 lines if main service legend is only one line).
Trim Piece	Zinc frosted matte chrome finish; supplied at each end of a grouping of RY indicating and/or RZ push-button modules.
Mounting	Panel or console mounted; two mounting clips supplied with each unit (see Figure 1).
Construction	Module: plug-in design with dust-tight meter movement, positive grip latch, non-magnetic red pointer, and removable designation plate; enclosure: die-cast zinc, platinum-colored.
Connections	Internal connections are made to a card edge connector on rear of unit. Connector is designed for mating with external connector and cable assembly Part No. 6627396-☐☐ LENGTH. Screw terminals are not available.
Enclosure Classification	NEMA 1 (general purpose). **(Indoor)

*As defined by SAMA standard PMC20.

**As defined by National Electrical Manufacturers Association (NEMA) Part ICS1-110-1973.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

REPLACEMENT PARTS

Figures 7 and 8 are parts drawings of the Type RY Indicator and mounting box. These drawings will normally apply to the units furnished. However, there may be individual differences in specific assemblies due to:

a. Design changes made since the printing of this Product Instruction.

b. Special design of equipment furnished to make it suitable for special application.

Therefore, when ordering individual parts, assure receipt of correct replacements by specifying on the order:

1. Complete nomenclature, code number, part number, series label number and S.O. number of equipment for which parts are desired.

2. The Parts Drawing Number on which each part is illustrated.

ANALYSIS/CALCULATION
ECO ID # T-88 0120 ATT # 6
REV 7 SHEET 2 OF 2

CONTROL, MANUAL, AND INDICATOR DISPLAY STATIONS

The N-250 family includes control, manual, and indicator display stations. N-2AX + M Series Output Stations are offered for use in conjunction with N-250H Series stations or for independent use. All are designed for both Class 1E and Class II qualification.

N-250H, N-255H, and N-257H stations, with or without an output station, are panel-mounted by means of individual housings separately specified. Similarly, output stations used independently require individual housings. Up to ten housings of the same model number can occupy a single panel cutout. Further information on mounting is given in the section: "Housings, Models N-2AX + H048, N-2AX + H096, N-2AX + H144." All power and signal connections are made by plug-in cables of the N-2AK Series.

RECORDER DISPLAY STATIONS
N-227 Series

PERFORMANCE SPECIFICATIONS
(Under Reference Operating Conditions)

Indicating Accuracy ±0.5% of span

Repeatability 0.4% of span

Recording Accuracy ±0.75% of span after trim of zero and/or span to match chart rather than indicator scale

FUNCTIONAL SPECIFICATIONS

Number of Pens 1, 2, or 3, as specified

Nominal Pen Speed 5 s to travel from 0 to 100% of scale

Input Signal 0 to 10 V dc

Input Impedance 100 kΩ minimum

Chart
- **Type** Rectilinear, roll
- **Scale Length** 100 mm (4 in)
- **Speed** 20 mm/h, others optional
- **Initial Supply** One 30-day chart with each recorder

Ink
- **Reservoir** Disposable snap-in cartridge with fiber-tip pen provides a 915 mm (3000 ft) ink line (a nominal 3-month supply).
- **Initial Supply** 1 cartridge per pen

Ambient Temperature Influence Less than 0.5% of span for 28°C (50°F) change between 5 and 50°C (40 and 120°F)

Humidity Influence For a change of 50 to 95% relative humidity at maximum wet bulb temperature of 30°C (86°F)
- **Indication** ±0.3% of span
- **Record** +0.75 to -1.5% of span (chiefly chart paper variation)

Power Requirements
- **Supply Voltage** +15 and -15 V dc ±10%
- **Typical Current** 80 mA for 1 pen, 140 mA for 2 pens, 200 mA for 3 pens
- **Chart Drive Supply** 24 V, 50 or 60 Hz, 3 W, 4.2 VA

Supply Voltage Influence Less than 0.1% of span for ±5% change from nominal

Connections 30-pin receptacle for cable connector

Mounting

N-227S Series Each recorder occupies one unit of capacity in an N-202S Series Shelf. Refer to the section "Shelves for Recorders."

N-227P Series Each N-227P Series recorder resides in an individual panel-mounted Model N-2AX + HS1 Housing. The housing is retained in panel by top and bottom screw clamps. A hold-down bracket at rear is fastened to a horizontal framing member supplied by user.

Approximate Mass
- **1-pen Recorder** 2.9 kg (6.5 lb)
- **2-pen Recorder** 3.2 kg (7.0 lb)
- **3-pen Recorder** 3.4 kg (7.5 lb)

Model Codes

N-227P = Housing-mounted Recorder
N-227S = Shelf-mounted Recorder

Number of Pens
-1 = One pen
-2 = Two pens
-3 = Three pens

Supply Frequency
R5 = 50 Hz chart drive
R6 = 60 Hz chart drive

Example: N-227S-2R6

N-2AX + HS1 = Housing for 227P Series Recorder

Qualification Code

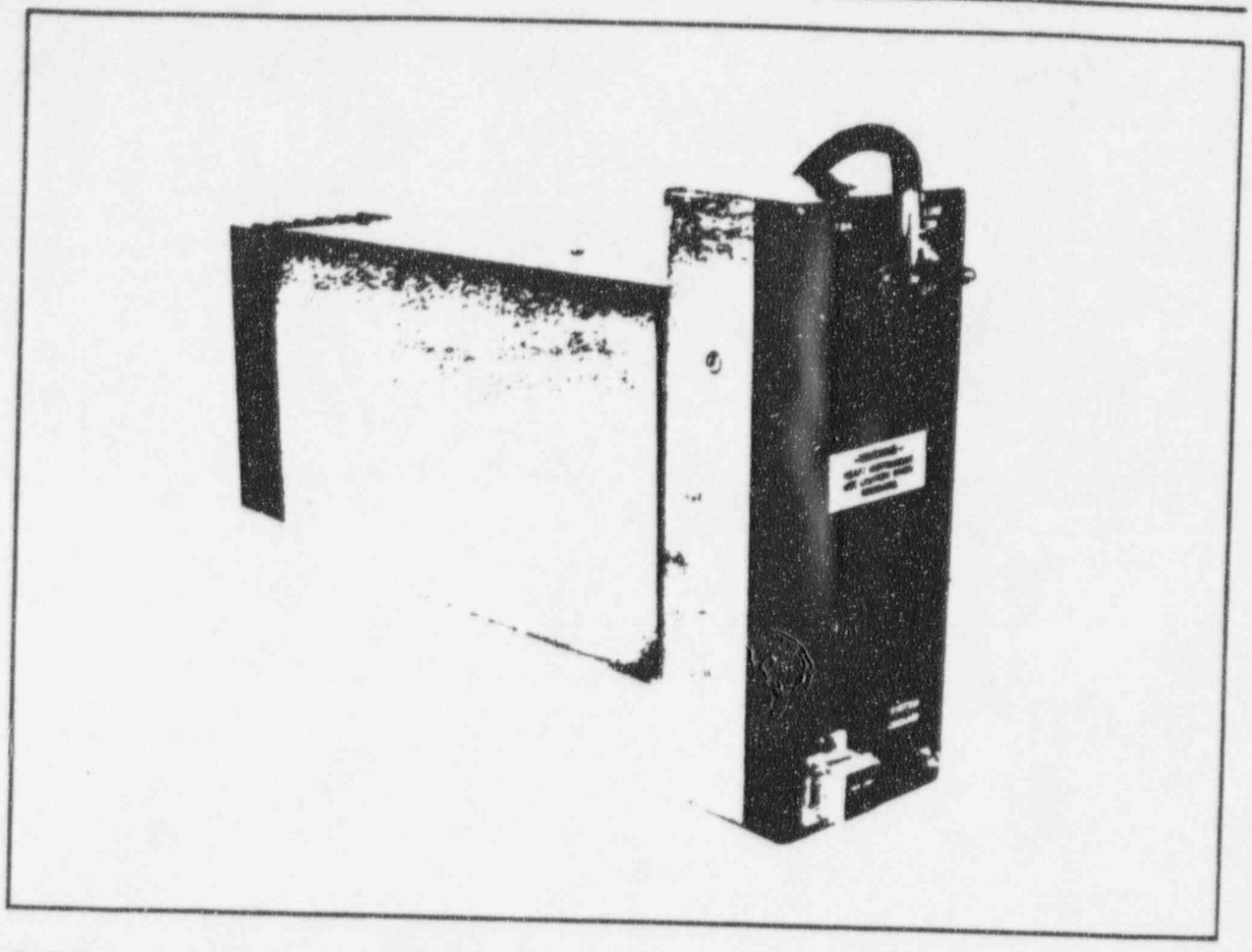
CS-N/SRC = Type-tested for Class 1E qualification per IEEE Standards 323-1974 and 344-1975

CS-N/SRD = Type-tested for Class II (structural integrity) qualification per IEEE Standard 344-1975

ANALYSIS/CALCULATION
DOC ID # I-88-0020 ATT # 7
REV 7 SHEET 1 OF 1

OPTIONAL FEATURE

Alternate Chart Speed 5 mm/h or 10 mm/h



2AX + PS9 SERIES · STYLE B SINGLE NEST dc POWER SUPPLIES

Energize the SPEC 200 system components in one nest

These power supplies mount in a Model 2ANU-P Nest and provide up to 1.5 A of direct current at +15 and -15 V for SPEC 200 system components also mounted in the nest. When applicable, they provide power for transmitters and/or display stations connected to these components.

For high reliability, industrial grade components operated well below normal ratings are used. Overvoltage, overcurrent, and reverse polarity protection is incorporated. Also included are in-line filters for the suppression of radio frequency interference (RFI), voltage surge protection, and a power security turn-off circuit.

An on-off switch, fuse access, and indicating lamps are on the front panel. When the indicating lamps are lit, both the +15 and -15 V outputs are energized.

FOXBORO®

SPECIFICATIONS

Outputs + 15 V (referred to common) at 1.5 A dc, and −15 V (referred to common) at 1.5 A dc

Regulation

Line 0.2% output voltage change for ±10% change from nominal line voltage

Load 1.5% output voltage change for load change from 50 to 100%

Frequency 0.1% output voltage change for frequency change from 47 to 63 Hz

Ripple 20 mV maximum

Power Requirements

Line Voltage 100, 120, 220, or 240 V ac +10% −15%, as specified.

Line Frequency 47 to 63 Hz

Maximum Consumption 100 W or 135 VA at full load

Warm-Up Time 30 minutes

Short Circuit Protection A continuous short circuit on either the + 15 or −15 V output will not damage the supply. Upon removal of the short circuit, the power supply returns to normal operation.

Overvoltage Protection Both outputs are shut off if any power supply failure raises either output above 19 V.

Security Turn Off To assure the predictable response of connected loads, both outputs are shut off upon loss of either output.

Surge Voltage Protection The voltage surges described in IEEE Standard 472-1974 will not affect output if applied to the input power leads, and will not trigger the overvoltage protection circuits if applied to the output connections.

RFI Protection RFI typically produces less than 1% output voltage change for a field strength at the power supply of 15 V/m at frequencies between 410 and 512 MHz.

Electrical Classification Ordinary locations

Mounting Occupies two units of space in a Model 2ANU-P Nest; leaves nine units of space for other system components.

Ambient Temperature

Normal Operating Limits 5 and 50°C (40 and 120°F)

Influence Less than 0.5% output voltage change for 25°C (45°F) change within normal operating limits

Humidity

Normal Operating Limits 10 and 95% relative humidity with a maximum wet bulb temperature of 30°C (86°F)

Influence Less than 0.1% output voltage change for relative humidity changes within normal operating limits

PRINCIPLE OF OPERATION

As illustrated in Figure 1, two identical power supplies are connected to provide + 15 V dc referred to common and −15 V dc referred to common. In each supply, a regulator amplifier varies the voltage drop across a series pass transistor as required to maintain output voltage. The desired value of output voltage is set by the voltage adjust circuit. The overcurrent circuit takes control of the regulator starting at 110% of rated output current. Overload or short circuit current from either output is limited to a value between 1.55 and 1.70 A. Upon removal of the overload or short circuit, normal operation is restored.

The overvoltage protection circuit consists of a zener diode overvoltage detector, a transistor driver, and a silicon controlled rectifier (SCR). The SCR, when fired by an overvoltage condition, shorts the power supply output to common. Shunt diodes protect against externally-applied reverse or forward transients above 20 V.

The + 15, −15, and common leads to the power security turn-off circuit include RFI filters.

STRING CALIBRATION DATA SHEET
STRING # _____
AS-FOUND

SYSTEM: REACTOR COOLANT
INSTRUMENT FUNCTION: S.G. 3A WIDE RANGE PRESSURE
PRIMARY ELEMENT: RC-158-PT
RANGE: 0-3000 PSIG

TEST EQUIPMENT/DUE
T6-2362 3-1-85
II-1971 3-1-85

ANALYSIS/CALCULATION
DOC ID # I-88-0020 ATT # 9
REV 7 SHEET 1 OF 6

INPUT RC-158-PT		DESIRED OUTPUT RC-158-PI-1	INDICATED OUTPUT INC.				
			RC-158-PI-1 (Remote Shutdown Panel)				RC-1
% OF SPAN	PSIG	PSIG	READING	ERROR	N/A	N/A	READ
0	28	0 (-75 to 75)	0	0			
25	778	750 (675-825)	750	0			
50	1528	1500 (1425-1575)	1500	0			
75	2278	2250 (2175-2325)	2250	0			
96.7	2928	2900 (2825-2975)	2900	0			

DEVICE	ACTION	SETPOINT PSIG	ACTUATION POINT	ERROR
RC-158-PS1 **	CDI	2443.2* (2423.2 to 2463.2)	2435.5	7.7

SERVICE DEVICES-ACCURACY

SERVICE DEVICES	SPAN	TOLERANCE	MAX. ERROR
RC-158-PI-1	3000 PSIG	± 75 PSIG	0 PSI
RC-158-PS1	3000 PSIG	± 20 PSIG	7.7 PSI

*Includes 28 PSIG for head pressure.
Parenthesis indicates acceptable range (± 20 PSIG)
Indicated Value is 2615.2 PSIG
**Located in ATWS Logic Cab. Location AA

Calibrated by Initials/Date SZ 1/4/84

Approved by Initials/Date M.T.L 5/3/84

ENCLOSURE 3
(Page 4 of 14)

STRING CALIBRATION DATA SHEET
STRING # _____
AS-FOUND

SYSTEM: REACTOR COOLANT
EQUIPMENT FUNCTION: S.G. 3A WIDE RANGE PRESSURE
PRIMARY ELEMENT: RC-158-PT
RANGE: 0-3000 PSIG

TEST EQUIPMENT/DUE

ANALYSIS/CALCULATION
DOC ID # I-88-002 ATT # 9
REV 7 SHEET 2 OF 6

INPUT RC-158-PT		DESIRED OUTPUT RECALL PT. 224*/ RC-158-PI-2	INDICATED OUTPUT INC.			
			RECALL PT. 224		CONTROL ROOM RC-158-PI-2	
% OF SPAN	PSIG	PSIG	READING	ERROR	READING	ERROR
0	28	0 (-50to50)/(-75to75)	*	*	0	0
25	778	750 (700-800)/(675-825)	↓	↓	750	0
50	1528	1500 (1450-1550)/(1325-1575)			1500	0
75	2278	2250 (2200-2300)/(2175-2325)			2250	0
96.7	2928	2900 (2850-2950)/(2825-2975)			2900	0

SERVICE DEVICES-ACCURACY

SERVICE DEVICES	SPAN	TOLERANCE	MAX. ERROR
RECALL PT. #224*	3000 PSIG	± 50 PSIG	*
RC-158-PI-2	0-3000 PSIG	± 75 PSIG	0 PSI

*NOTE: Recall Point in Main Control Room.

Calibrated by Initials/Date SR 4/1/94

Approved by Initials/Date m.n 5/3/94

* RECALL TO BE REPLACED BY MAR # 91-07-13-03

ENCLOSURE 3
(Page 5 of 14)

STRING CALIBRATION DATA SHEET
STRING # _____
AS-FOUND

SYSTEM: REACTOR COOLANT
EQUIPMENT FUNCTION: S.G. 3A WIDE RANGE PRESSURE
PRIMARY ELEMENT: RC-158-PT
0-3000 PSIG

TEST EQUIPMENT/DUE
T6 - 2362 St. Cont
II - 1711 St. Cont

ANALYSIS/CALCULATION
DOC ID # I-88-002 ATT # 9
REV 7 SHEET 3 OF 6

INPUT RC-158-PT		DESIRED OUTPUT RC-158-PIR	INDICATED OUTPUT INC.			
			RC-158-PIR (PEN)		RC-158-PIR (IND)	
% OF SPAN	PSIG	PSIG	READING	ERROR	READING	ERROR
0	28	0 (-50|+50)	25	25	0	0
25	778	750 (700 - 800)	775	25	750	0
50	1528	1500 (1450 - 1550)	1525	25	1500	0
75	2278	2250 (2200 - 2300)	2250	0	2250	0
96.7	2928	2900 (2850 - 2950)	2900 / 2900	0	2900	0

SERVICE DEVICES-ACCURACY

SERVICE DEVICES	SPAN	TOLERANCE	MAX. ERROR
RC-158-PIR (PEN)	0-3000 PSIG	± 50 PSIG	25 PSI
RC-158-PIR (IND)	0-3000 PSIG	± 50 PSIG	0 PSI

Calibrated by Initials/Date SR 1 4/2/89
Approved by Initials/Date MNI 5/1/89

ENCLOSURE 3
(Page 10 of 14)

STRING CALIBRATION DATA SHEET
STRING # _____
AS-LEFT

[redacted] 3.0, 3A WIDE RANGE PRESSURE
[redacted] RC-158-PT

TEST EQUIPMENT/DUE
TG-2360 SR.CERT.
TI-1971 SR.CERT.

ANALYSIS/CALCULATION
DOC ID # T-88-0020 ATT # 9
REV 7 SHEET 4 OF 6

INPUT RC-158-PT		DESIRED OUTPUT RC-158-PI-1	INDICATED OUTPUT INC.			
			RC-158-PI-1 (Remote Shutdown Panel)			
% OF SPAN	PSIG	PSIG	READING	ERROR	N/A	N/A
0	28	0 (-50 to 50)	0	C		
25	778	750 (700-800)	750	C		
50	1528	1500 (1450-1550)	1500	C		
75	2278	2250 (2200-2300)	2250	C		
100	2928	2900 (2850-2950)	2900	C		

DEVICE	ACTION	SETPOINT PSIG	ACTUATION POINT	ERROR
[redacted] 158-PSI	CDI	2443.2* (2423.2 to 2463.2)	2435.5	--

*Includes 28 PSIG for head pressure.
Parenthesis indicates acceptable range (±20 PSIG)
Indicated value is 2415.2 PSIG
[redacted] ATWS Logic Cab. Location AA

SERVICE DEVICES-ACCURACY

SERVICE DEVICES	SPAN	TOLERANCE	MAX. ERROR
RC-158-PI-1	3000 PSIG	± 50 PSIG	C
RC-158-PSI	3000 PSIG	± 20 PSIG	--

Calibrated by Initials/Date RL 4/20/94

Approved by Initials/Date mm 5/3/94

STRING CALIBRATION DATA SHEET
STRING # _____
AS-LEFT

REACTOR COOLANT
[illegible] FUNCTION: S.G. 3A WIDE RANGE PRESSURE
[illegible] RC-150-PT
0-3000 PSIG

TEST EQUIPMENT/DUE
16-23162 SP.CONT.
II-1721 SP.CONT.

ANALYSIS/CALCULATION
DOC ID # Z-88-0020 ATT # 9
REV 7 SHEET 5 OF 6

RC-150-PT		DESIRED OUTPUT RECALL PT. 224*/ RC-150-PI-2	INDICATED OUTPUT INC.			
			RECALL PT. 224		CONTROL ROOM RC-150-PI-2	
% OF SPAN	PSIG	PSIG	READING	ERROR	READING	ERROR
0	28	0 (-25to25)/(-50to50)	*	*	0	C
25	778	750 (725-775)/(700-800)			750	C
50	1528	1500 (1475-1525)/(1450-1550)			1500	C
75	2278	2250 (2225-2275)/(2200-2300)			2250	C
96.7	2928	2900 (2875-2925)/(2850-2950)			2900	C

SERVICE DEVICES-ACCURACY

SERVICE DEVICES	SPAN	TOLERANCE	MAX. ERROR
RECALL PT. #224*	3000 PSIG	± 25 PSIG	*
RC-150-PI-2	0-3000 PSIG	± 50 PSIG	0 PSI

LABEL TO BE REPLACED BY MAR # 91-07-11-03

*NOTE: Recall Point in Main Control Room.

Calibrated by Initials/Date YL 1/12-/89

Approved by Initials/Date MM 1/5/89

ANALYSIS/CALCULATION
DOC ID # I-88-0020 ATT # 9
REV 7 SHEET 6 OF 6

STRING CALIBRATION DATA SHEET

STRING # ________

AS-LEFT

COOLANT
FUNCTION: S.G. 3A WIDE RANGE PRESSURE
ELEMENT: RC-158-PT
0-3000 PSIG

TEST EQUIPMENT/DUE
TG-2362 SP. CERT.
TE-1971 SP. CERT.

INPUT RC-158-PT		DESIRED OUTPUT RC-158-PIR(PEN)/ RC-158-PIR(IND)	INDICATED OUTPUT INC.			
			RC-158-PIR (PEN)		RC-158-PIR (IND)	
% OF SPAN	PSIS	PSIG	READING	ERROR	READING	ERROR
0	28	0 (-30to30)/(-25to25)	25	25	0	0
25	778	750 (720-780)/(725-775)	775	25	750	0
50	1528	1500 (1470-1530)/(1475-1525)	1525	25	1500	0
75	2278	2250 (2220-2280)/(2225-2275)	2275	25	2250	0
96.7	2928	2900 (2870-2930)/(2875-2925)	2900	0	2900	0

SERVICE DEVICES-ACCURACY

SERVICE DEVICES	SPAN	TOLERANCE	MAX. ERROR
RC-158-PIR (PEN)	0-3000 PSIG	± 30 PSIG	25 PSI
RC-158-PIR (IND)	0-3000 PSIG	± 25 PSIG	0 PSI

Calibrated by Initials/Date SR / 4/20/94

Approved by Initials/Date mm / 5/3/94

04294

31

EXHIBIT 6

CALIBRATION WORK SHEET

TEST EQUIPMENT TAG NO: TG2382 DUE DATE: 08/26/93 DATE: 07/26/93 NO.93-07 368
DESCRIPTION : CALIBRATOR PRESSURE MANUFACTURE : DRUCK
RANGE : 0. - 3000. SERIAL NO. 0683/92-3 MODEL NO. DPI-510

CHECK REASON : RETURNED DAMAGED
CYCLE 08 SPECIAL CERTIFICATION
RECERTIFICATION
NEW EQUIPMENT

_____(J)CALIBRATION SERVICES _____(U)
_____(K)FUNCTIONAL CHECK _____(W)
__/__(M)MANUFACTURER CERT. _____(X)
_____(N)CANNOT LOCATE _____(Y)

PROCEDURE NO. CI 05 IF CALIBRATION SERVICES, R.A. NUMBER REQUIRED : _____
CALIBRATION WORKSHEET NUMBER: 187 ACCURACY: +/-.15% F.S.

DESCRIBE CONDITION: CHECK CALIBRATION FOR MODEL INSTRUMENT UNDER TEST.

RETURN INSTRUMENT TO SERVICE. NOTIFY THE NCL SUPERVISOR IF INSTRUMENT IS OUT-OF-TOLERANCE BEFORE MAKING ADJUSTMENTS.

ORIGINATOR CAL.LAB. DEPT. CALIBRATION LAB

-CALIBRATION LAB USE ONLY-

CERTIFIED PER CI 05 A7 (I)
CALIBRATED PER CI 05 _____(T)
FUNCTIONAL CHECK PER CI 05 _____(W)
REMOVED BY _____(R)
DESCRIBED WORK AS PERFORMED:

OUT-OF-TOLERANCE _____(O)
ADJUSTMENT REQUIRED _____(A)
REPAIR REQUIRED _____(S)
UPDATED, NOT USED _____(°)

OSC: A7 HOURS: 1.0 OSC: B6 HOURS: 1.0 OSC: ___ HOURS: ___

TEST INSTRUMENT CAL. DATE: 11-12-93 DUE DATE: 4-29-94

TEST STANDARDS USED	CAL DATE:	DUE DATE:	COMMENTS: pulled DFC
TG-133	4/13/93	3/5/94	
TS-501	10/9/93	4/5/94	

WMIS NO. NONE

LOCATION 8A

APPROVED BY: _____ DATE: 11-15-93

PAGE 27 OAP-19 DATE 12/30/87 REV. 9

ANALYSIS/CALCULATION
DOC ID # T-88-002P ATT # 10
REV 7 SHEET 1 OF 2

Secondary Standards Lab
FI-05-187

I.D. NUMBER G-2362 CALIBRATION WORKSHEET NUMBER 93-07-363
SERIAL NUMBER 0883/93-3 MODEL NUMBER DPI-510
INSTRUMENT CALIBRATOR PRESSURE
SPECIFICATIONS 0 TO 3000 PSI
ACCURACY +/- .15% OF FS

TEST INSTRUMENTS TO BE USED FOR CALIBRATION	ID NUMBER	DUE DATE
TS-523		
PS-138	TG-133	3/15/94
TS-505	TS-501	4/5/94

NOTE: USE DRY AIR ONLY.

OR EQUIVALENT

STANDARD RANGE	STANDARD INPUT/OUTPUT	AS FOUND INDICATION CODE AT-BG	AS LEFT INDICATION CODE AT-BG	TOLERANCE
PSI	PSI	PSI	PSI	PSI
0 TO 3000	0	0		- 4.5 / 4.5
	500	499.2	Same	495.50 / 504.50
	1000	998.9	as	995.50 / 1004.5
	2000	1998.3	Found	1995.5 / 2004.5
	2500	2497.5		2495.50 / 2504.50

CONNECTIONS ARE MADE AT PTX RETURN AND GROUND (SCREEN) FOR mAMPS.

mAMPS	mAMPS	mAMPS	mAMPS	mAMPS .05%+1DIG
	20	19.99		19.98 / 20.02
	50	49.99		49.974 / 50.026

CONNECTIONS ARE MADE AT SIGINAL POSITIVE AND SIGINAL NEGATIVE FOR mVDC OR PIN 12 + AND PIN 24 -

mVDC	mVDC	mVDC	mVDC	mVDC .05%+1DIG
200	20	19.99		19.98 / 20.02
	50	50.00		49.96 / 50.04
	100	100.00		99.94 / 100.06
	200	200.00		199.89 / 200.11

CALIBRATED BY AT-BG DATE 11-8-93

APPROVED J. Lowe DATE 11-15-93 REVISION 1 DATE 02/12/97

ANALYSIS/CALCULATION
DOC ID # I-88-0020 ATT # 10
REV 7 SHEET 2 OF 2

004892

[redacted]

Procedure No: GT 91-71 CALIBRATION SERVICES, EA or SHOP IS REQUIRED: _____
Calibration WORK SHEET #: 177 Accuracy: +/-SEE MAN.

Originator: CAL LAB DEPT: CALIBRATION LAB

-CALIBRATION LAB USE ONLY-

CERTIFIED PER AY (I)
CALIBRATED PER _____ (T)
FUNCTIONAL CHECK PER _____ (W)
REMOVED BY _____ (R)

OUT-OF-TOLERANCE _____ (O)
ADJUSTMENT REQUIRED _____ (A)
REPAIR REQUIRED _____ (S)
UPDATED, NOT USED _____ (*)
OUT-OF-SERVICE AY (M)

Describe Work Performed: _____

OSC: AY HOURS: .5 /OSC: ___ HOURS: ___ /OSC: ___ HOURS: ___

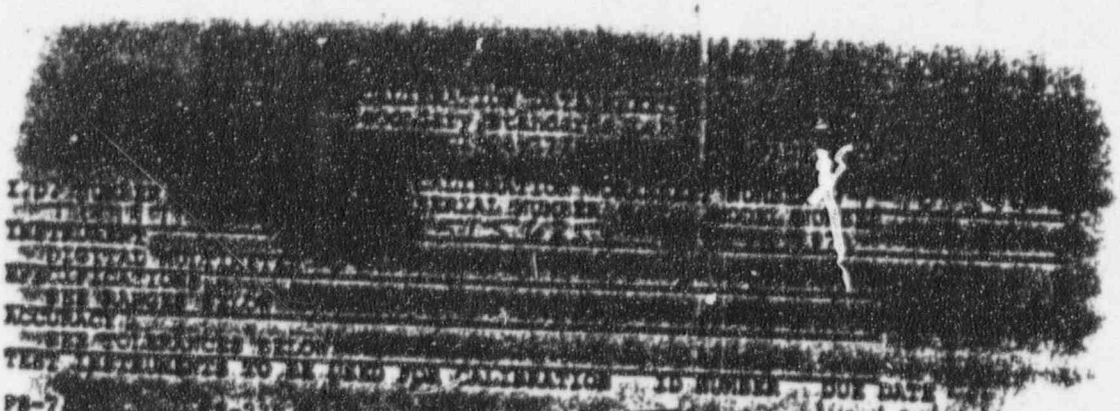
LAST INSTRUMENT CAL DATE: 5/31/94 DUE DATE: 005

LAST STANDARDS USED	CAL DATE	DUE DATE	COMMENTS: TAKEN OUT OF
TS 505	9/23/93	8/25/94	INVENTORY
TS 37A	9/23/93	8/25/94	
TS 470	5/25/94	11/9/94	
TS 7	11/19/93	10/20/94	MMIS No: 52607213
TS 468	4/18/94	8/12/95	Location: WHSE

Approved By: RGMcDonald DATE: 5/31/94

* CP-146 *

ANALYSIS/CALCULATION
DOC ID # I-88-0020 ATT # 11
REV 7 SHEET 1 OF 4



	ID NUMBER	DUE DATE
PS-7	TS 505	9/25/94
PS-10S	TS 37A	8/25/94
PS-15	TS 470	11/9/94
TS-7 OR EQUIVALENT	TS 7	10/20/94
	TS 468	3/12/95

STANDARD RANGE	STANDARD INPUT/OUTPUT	AS FOUND INDICATION CODE AY	AS LEFT INDICATION CODE AY	TOLERANCE
0.TO 200. mVDC	+/- .016% OF INPUT ÷ 2 COUNTS			
mVDC	mVDC	mVDC	mVDC	mVDC
200.	190.	189.998	SAME AS "AS FOUND"	189.967/ 190.033
	-190.	-189.999		-189.967/-190.033
0.TO 2. VDC	+/- .011% OF INPUT ÷ 2 COUNTS			
VDC	VDC	VDC	VDC	VDC
2.	1.9	1.99999		1.89977/ 1.90023
	-1.9	-1.99999		-1.89977/-1.90023
20. TO 1000. VDC	+/- .015% OF INPUT ÷ 2 COUNTS			
VDC	VDC	VDC	VDC	VDC
20.	19.	19.9997		18.9969/ 19.0031
	-19.	-19.9997		-18.9969/-19.0031
200.	190.	199.997		189.969 / 190.031
	-190.	-199.997		-189.969 /-190.031
1000.	1000.	999.87		999.83 / 1000.17
	-1000.	-999.87		-999.83 /-1000.17

CALIBRATED BY AY DATE 5/31/94

APPROVED Reynolds DATE 5/31/94

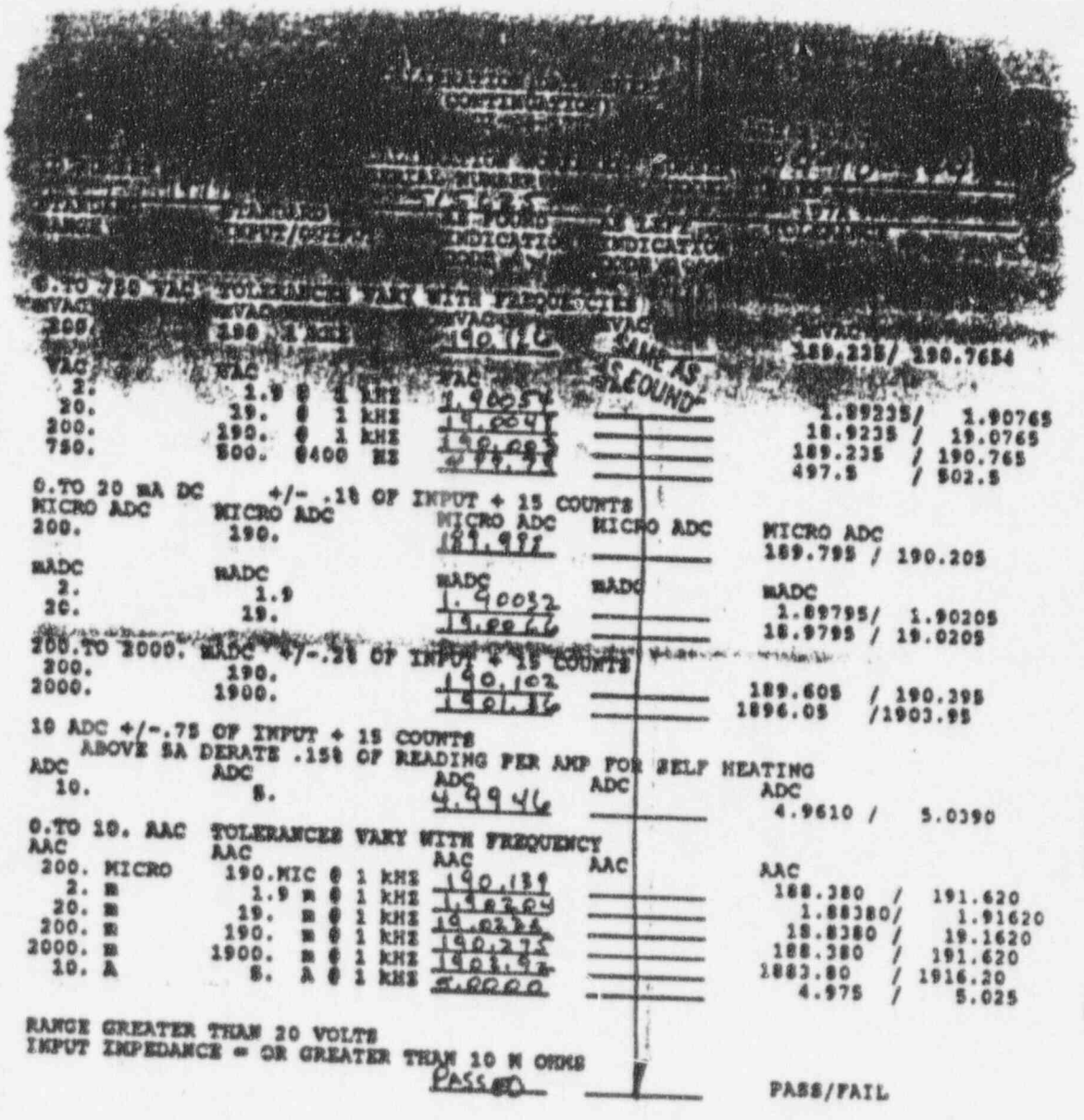
REVISION -1-

DATE 05/30/92

ANALYSIS/CALCULATION

DOC ID # I-BB-0020 ATT # 11

REV 7 SHEET 2 OF 4

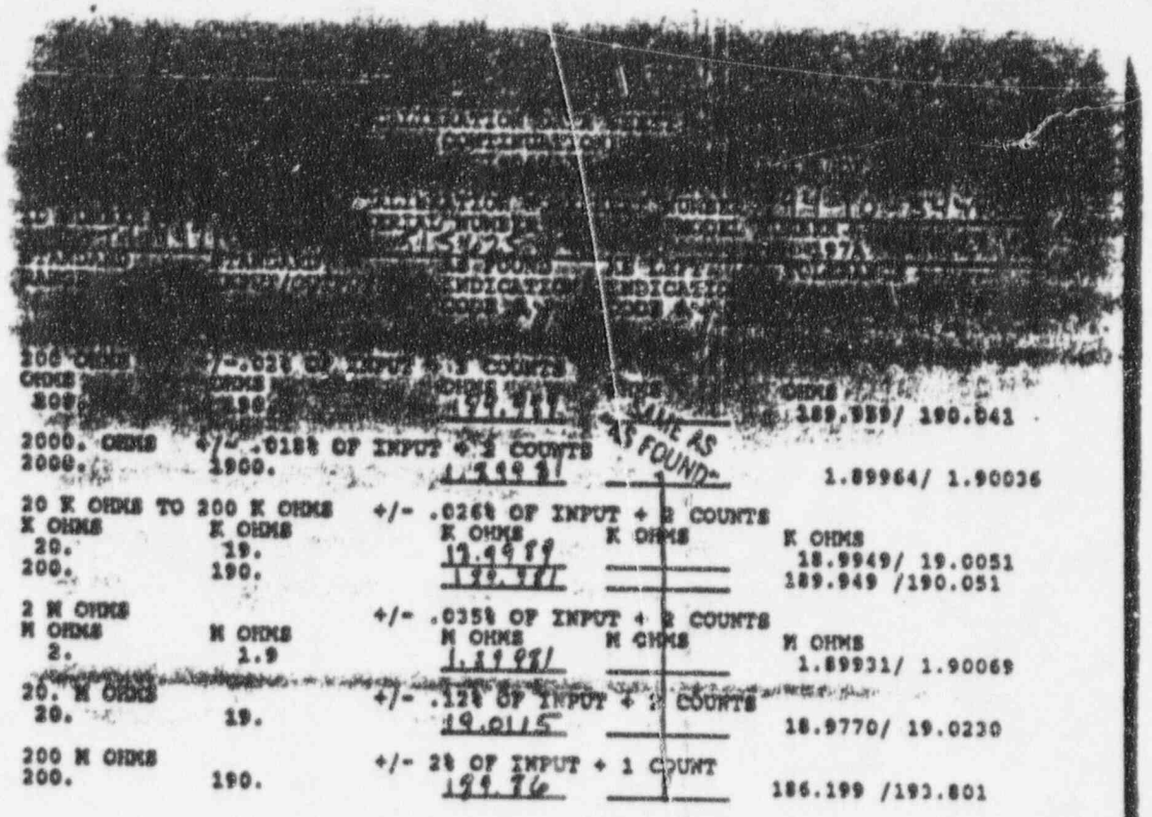


0.TO 750 VAC TOLERANCES VARY WITH FREQUENCY					
VAC	VAC		VAC	VAC	VAC
200.	190. 1 KHZ	190.116	SAME AS FOUND		189.235/ 190.7654
VAC	VAC	VAC			VAC
2.	1.9 @ 1 KHZ	1.90054			1.89235/ 1.90765
20.	19. @ 1 kHZ	19.004			18.9235 / 19.0765
200.	190. @ 1 kHZ	190.083			189.235 / 190.765
750.	500. @400 HZ	499.75			497.5 / 502.5
0.TO 20 mA DC +/- .1% OF INPUT + 15 COUNTS					
MICRO ADC	MICRO ADC	MICRO ADC	MICRO ADC		MICRO ADC
200.	190.	189.991			189.795 / 190.205
mADC	mADC	mADC	mADC		mADC
2.	1.9	1.90052			1.89795/ 1.90205
20.	19.	19.0026			18.9795 / 19.0205
200.TO 2000. mADC +/-.2% OF INPUT + 15 COUNTS					
200.	190.	190.102			189.605 / 190.395
2000.	1900.	190.32			1896.05 /1903.95
10 ADC +/-.75 OF INPUT + 15 COUNTS					
ABOVE 5A DERATE .15% OF READING PER AMP FOR SELF HEATING					
ADC	ADC	ADC	ADC		ADC
10.	5.	4.9946			4.9610 / 5.0390
0.TO 10. AAC TOLERANCES VARY WITH FREQUENCY					
AAC	AAC	AAC	AAC		AAC
200. MICRO	190.MIC @ 1 kHZ	190.139			188.380 / 191.620
2. M	1.9 M @ 1 kHZ	1.90204			1.88380/ 1.91620
20. M	19. M @ 1 kHZ	19.0204			18.8380 / 19.1620
200. M	190. M @ 1 kHZ	190.277			188.380 / 191.620
2000. M	1900. M @ 1 kHZ	1901.92			1883.80 / 1916.20
10. A	5. A @ 1 kHZ	5.0000			4.975 / 5.025
RANGE GREATER THAN 20 VOLTS					
INPUT IMPEDANCE = OR GREATER THAN 10 M OHMS					
		PASSED			PASS/FAIL

ANALYSIS/CALCULATION

DOC ID # I-88-0020 ATT # 11

REV 7 SHEET 3 OF 4



200 OHMS	+/- .01% OF INPUT + 1 COUNTS				
OHMS	OHMS				OHMS
200.	190.	199.981	SAME AS "AS FOUND"		189.959/ 190.041
2000. OHMS	+/- .018% OF INPUT + 2 COUNTS				
2000.	1900.	1.99981			1.89964/ 1.90036
20 K OHMS TO 200 K OHMS	+/- .026% OF INPUT + 2 COUNTS				
K OHMS	K OHMS	K OHMS	K OHMS	K OHMS	
20.	19.	19.9979			18.9949/ 19.0051
200.	190.	199.981			189.949 /190.051
2 M OHMS		+/- .035% OF INPUT + 2 COUNTS			
M OHMS	M OHMS	M OHMS	M OHMS	M OHMS	
2.	1.9	1.99981			1.89931/ 1.90069
20. M OHMS		+/- .12% OF INPUT + 2 COUNTS			
20.	19.	19.9115			18.9770/ 19.0230
200 M OHMS		+/- 2% OF INPUT + 1 COUNT			
200.	190.	199.96			186.199 /193.801

ANALYSIS/CALCULATION

DOC ID # I-88-0020 ATT # 11

REV 7 SHEET 4 OF 4

FOR INFORMATION ONLY

TAG NUMBER / DESIGN REF / FLOPTH	A/P	COMPONENT: EQ ZONE(S) / OPTIME / EQ EVENT(S)	PANEL BOX	CAT CODE KEYS: BLDG ELEV / COL/ROW / SAFETY FUCTION(S) / VQP NUMBER	MFG VENDMODEL NUMBER
RC1	P2	NA 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		02	PEN-C515-04
MTBD-9A		PENETRATION, ELEC	A Q BB EX II QQ	CONX	
IN-PLANT		39	RB 133-1		
AHXA1	A	1 DAY 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		07 11 12	
BS1	A	1 DAY 01		07	
CF2	A	1 DAY 01 02 18		01 03	
CF3	A	1 DAY 01 02 04 18		11	
DH1	A	1 DAY 01 02 03		01 03	
DH2	A	1 DAY 01 02 03		01 03	
DH3	P1	6 MONTH 01		01 03	
DH4	A	1 DAY 02 03		01 03	
DH5	A	1 DAY 01 02 03 06 10 18		06 11	
EF1	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		04 05	
EF3	A	6 MONTH 04 10 18		01	
MU3	A	1 DAY 01 02 04 05 06 09 10 11 12 13 14 15 18		01 03	
MU4	A	1 DAY 02 03		03	
MU5	A	1 DAY 04 05 06 07 08 09 10 11 12 13 15 18		02	
RC1	A	1 DAY 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		02	
RC3	P1	6 MONTH 10		02 05 09	
RG12	A	6 MONTH 01 02 03 04 18		11	
RG17	P1	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RG18	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RG2	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RG3	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RG4	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RG5	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RG6	A	6 MONTH 01 02 03 05 18		11	
RG7	A	6 MONTH 01 02 03 05 18		11	
RP10	P2	NA 01 02 11		01	
RP5	P2	NA 03 05 07 09 12 18		01	
RP6	P2	NA		01	
RP7	P2	NA 11		01	
RP9	P2	NA 01 02 04 06 11 18		01	
					PEN-C515-04
MTBD-9B		PENETRATION, ELEC	A Q BB EX II QQ	CONX	
IN-PLANT		39	RB 133-1		
AHXA1	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		07 11 12	
BS1	A	6 MONTH 01		07	
CF2	A	6 MONTH 01 02 18		01 03	
DH1	A	6 MONTH 01 02 03		01 03	
DH2	A	6 MONTH 01 02 03		01 03	
DH3	A	6 MONTH 01		01 03	
DH4	A	5 DAYS 02 03		01 03	
DH5	A	6 MONTH 01 02 03 06 10 18		06 11	
EF1	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		04 05	
EF2	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		04 05	
EF3	A	6 MONTH 04 10 18		01	
MU3	A	6 MONTH 01 02 04 05 06 09 10 11 12 13 14 15 18		01 03	
MU4	A	5 DAYS 02 03		03	
MU5	A	6 MONTH 04 05 06 07 08 09 10 11 12 13 15 18		02	
RG12	A	6 MONTH 01 02 03 04 18		11	
RG17	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	

ANALYSIS/CALCULATION
DOC ID # TR-88-0020 ATT # 12
REV 7 SHEET 1 OF 5

FOR INFORMATION ONLY

TAG NUMBER / DESIGN REF / FLOPTH	A/P	COMPONENT: EQ ZONE(S) / OPTIME / EQ EVENT(S)	PANEL BOX	CAT CODE KEYS: BLDG ELEV / COL/ROW / SAFETY FUCTION(S) / VQP NUMBER	MFG VENDMODEL NUMBER
EF3	A	6 MONTH 04 10 18		01	
RC1	P2	NA 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		02	
RG4	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RP10	P2	NA 01 02 11		01	
RP5	P2	NA 03 05 07 09 12 15		01	
RP6	P2	NA		01	
RP7	P2	NA 11		01	
RP9	P2	NA 01 02 04 06 11 18		01	
					PEN-C515-04
MTBD-10A		PENETRATION, ELEC	A Q EX QQ		CONX
IN-PLANT		39	RB 133-1		
RG25	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
					PEN-C515-04
MTBD-10B		PENETRATION, ELEC	A Q EX QQ		CONX
IN-PLANT		39	RB 137-5		
RG8	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
					PEN-C515-02
MTBD-11A		PENETRATION, ELEC	A Q EX II QQ		CONX
IN-PLANT		39	RB 140-8		
RG1	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RG30	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 17 18		11	
RG5	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RP1	P2	NA 03 04 07 08 12 13 18		01	
RP4	P2	NA 15		01	
RP7	P2	NA 11		01	
					PEN-C515-03
MTBD-11B		PENETRATION, ELEC	A Q EX II QQ		CONX
IN-PLANT		39	RB 140-8		
RG1	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RG2	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RG3	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RG30	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 17 18		11	
RG4	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RG5	A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RP1	P2	NA 03 04 07 08 12 13 18		01	
RP4	P2	NA 15		01	
RP7	P2	NA 11		01	
					PEN-C515-03
MU-1		LIGHT SOCKET MU-1	B EX QQ		
IN-PLANT		01	AB 95		303-I
MU3	P1	1 HOUR 01 02 04 05 06 09 10 11 12 13 14 15 18		01 03	
MU4	P1	1 HOUR 02 03		03	
MU5	P1	1 HOUR 04 05 06 07 08 09 10 11 12 13 15 18		02	
					CNTL-G080-02
MU-1		CONTROL STATION	B D EX QQ		
IN-PLANT		01	AB 95		303-I
MU3	P1	6 MONTH 01 02 04 05 06 09 10 11 12 13 14 15 18		01 03	
MU4	P1	6 DAYS 02 03		03	
MU5	P1	6 MONTH 04 05 06 07 08 09 10 11 12 13 15 18		02	

ANALYSIS/CALCULATION
DOC ID # T-EE-0020 ATT # 12
REV 7 SHEET 2 OF 5

FOR INFORMATION ONLY

TAG NUMBER / DESIGN REF / FLOPTH	COMPONENT / ZONE(S) / OPERATE / EQ EVENT(S)	PANEL BOX	CAT CODE KEYS / BLDG ELEV / COL/ROW / SAFETY FUCTION(S)	MFG VENDMODEL NUMBER / VQP NUMBER
RG5 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RC-103	TERMINAL BLOCK	RC-103	A EX QQ WW	INST-R369-05
IN-PLANT	40		RB 119	WEMT SAK-4
RG4 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RC-104	TERMINAL BLOCK	RC-104	A EX QQ WW	TERM-W179-06
IN-PLANT	40		RB 119	WEMT SAK-4
RG4 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RC-105	TERMINAL BLOCK	RC-105	A EX QQ WW	TERM-W179-06
IN-PLANT	38		RB 95	WEMT SAK-4
RG4 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RC-106	TERMINAL BLOCK	RC-106	A EX QQ WW	TERM-W179-06
IN-PLANT	40		RB 119	WEMT SAK-4
RG4 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RC-107	TERMINAL BLOCK	RC-107	A EX QQ WW	TERM-W179-06
IN-PLANT	66		RB 95	WEMT SAK-4
RG4 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RC-108	TERMINAL BLOCK	RC-108	A EX QQ WW	TERM-W179-06
IN-PLANT	66		RB 95	WEMT SAK-4
RG4 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RC-158-PT	TRANSMITTER, PRESS		A AR CC EX QQ WW	RO RO 1154GP9RA
IN-PLANT	66		RB 95	INST-R369-03
RG3 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	RO 353C
RC-158-PT	SEAL	RC-158-PT	B EX QQ	PEN-R369-01
IN-PLANT	66		RB 101	RO RO 1154GP9RA
RG3 P1	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	INST-R369-03
RC-159-PT	TRANSMITTER, PRESS		A AR CC EX QQ WW	RO 353C
IN-PLANT	66		RB 95	PEN-R369-01
RG3 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	ENCO BABW2273AM20
RC-159-PT	SEAL	RC-159-PT	B EX QQ	
IN-PLANT	66		RB 66	
RG3 P1	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		11	
RC-160-ME1A	ELEMENT		A EX QQ XX	
IN-PLANT	40		RB 160	

ANALYSIS/CALCULATION
DOC ID # I-88-0020 ATT # /2
REV 7 SHEET 3 OF 5

TAG NUMBER / DESIGN REF / FLOPTH A/P OPTIME	COMPONENT / PANEL BOX / EQ ZONE(S) / EQ EVENT(S)	CAT CODE KEYS / BLDG ELEV / COL/ROW / SAFETY FUNCTION(S) / VQP NUMBER	MFG VENDMODEL NUMBER
RG5 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
			TERM-R098-04
			TERM-R098-02
RCR250	CABLE	A EX QQ	
IN-PLANT	HA		
RG2 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
RG4 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
RG5 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
			CABL-A385-04
RCR250	CABLE TERMINATION RC-48-TE4	B EX QQ	
IN-PLANT	40	RB 165	
RG2 P1	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
RG4 P1	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
RG5 P1	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
			INST-R369-05
RCR250	SPLICE MTBD-11B	A EX QQ	
IN-PLANT	39	RB 140-8	
RG2 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
RG4 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
RG5 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
			TERM-R098-05
			TERM-R098-04
			TERM-R098-04
			TERM-R098-02
RCR250	SPLICE RC-48-TE4	B EX QQ	
IN-PLANT	40	RB 165	
RG2 P1	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
RG4 P1	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
RG5 P1	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
			TERM-R098-04
RCR251	CABLE	A EX QQ	
IN-PLANT	HA		
RG2 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
RG4 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
RG5 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	
			CABL-B386-01
RCR251	SPLICE MTBD-11B	A EX QQ	
IN-PLANT	57	RB 140-8	
RG2 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15	11	
RG4 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15	11	
RG5 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15	11	
			TERM-R098-05
			TERM-R098-04
			TERM-R098-04
			TERM-R098-02
RCR265	CABLE	A EX QQ	
IN-PLANT	HA		
RG3 A	6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	11	

ANALYSIS/CALCULATION
DOC ID # T-88-0020 ATT # JZ
REV 7 SHEET 4 OF 5

FOR INFORMATION ONLY

TAG NUMBER / DESIGN REF / FLOPTH	COMPONENT / EQ ZONE($) / A/P / OPTIME / EQ EVENT($)	PANEL BOX	CAT CODE KEYS / BLDG ELEV	COL/ROW	MFG	VENDMODEL NUMBER / SAFETY FUCTION($) / VOP NUMBER
RCR265 IN-PLANT RG3	CABLE TERMINATION 66 A 6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	RC-158-PT	A EX QQ RB 101 11			CABL-8365-01
RCR265 IN-PLANT RG3	SPLICE 39 A 6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	MTBD-9A	A EX QQ RB 133-1 11			INST-R369-03
RCR265 IN-PLANT RG3	SPLICE 66 A 6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	RC-158-PT	A EX QQ RB 102 11			TERM-R098-04 TERM-R098-02
RCR266 IN-PLANT RG3	CABLE HA A 6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		A EX QQ 11			TERM-R098-04
RCR266 IN-PLANT RG3	SPLICE 17 A 6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	MTBD-9A	A EX QQ RB 133-1 11			CABL-8365-01
RCR271 IN-PLANT RG3	CABLE HA A 6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18		A EX QQ 11			TERM-R098-04 TERM-R098-02
RCR271 IN-PLANT RG3	CABLE TERMINATION 39 A 6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	MTBD-11B	A EX QQ RB 140-B 11			CABL-8365-01
RCR271 IN-PLANT RG3	CABLE TERMINATION 66 A 6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	RC-159-PT	A EX QQ RB 95 11			PEN-C515-03
RCR271 IN-PLANT RG3	SPLICE 66 A 6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	RC-159-PT	A EX QQ RB 95 11			INST-R369-02
RCR271 IN-PLANT RG3	SPLICE 66 A 6 MONTH 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 18	RC-84-JB	A EX QQ RB 95 11			TERM-R098-04 RCHM WCSF-115-N
RCR272	CABLE		A EX QQ			TERM-R098-04

ANALYSIS/CALCULATION
DOC ID # E-88-0020 ATT # 12
REV 7 SHEET 5 OF 5

DESCRIPTION:	REACTOR COOLANT TO STEAM GENERATOR "A" WIDE RANGE	TAG NO.	RC-158-PT
TYPE:	ROSEMOUNT MODEL# 1154 GP9RA		
VENDOR MANUAL:	BOOK# 1280	TEST EQUIPMENT USED ITEM	DUE DATE
LOCATION:	95' REACTOR BLDG. LOCATED AT SECONDARY SHIELD WALL NORTH "Y" STATION		
REMARKS:		DRAWING # 205-047 RC-02, 209-047 RC-12, 306-606 & 868	

ANALYSIS/CALCULATION

DOC ID # I-88-0020 ATT # 13

REV 7 SHEET 1 OF 1

DESIGN CALIBRATION			AS-FOUND CALIBRATION			AS-LEFT CALIBRATION		
%	IN PSIG	OUT MA	READING	ACCEPTABLE RANGE	ERROR	READING	ACCEPTABLE RANGE	ERROR
0	28.0	4.00		3.95 TO 4.05			3.96 TO 4.04	
25	778.0	8.00		7.95 TO 8.05			7.96 TO 8.04	
50	1528.0	12.00		11.95 TO 12.05			11.96 TO 12.04	
75	2278.0	16.00		15.95 TO 16.05			15.96 TO 16.04	
96.7	2928.0	19.47		19.42 TO 19.52			19.43 TO 19.51	

PREPARED BY Dave McPherson DATE 4/5/94

REVIEWED BY Walt Barlow DATE 4/6/94

SUPERVISOR LS Kobelt DATE 4/8/94

CALIBRATED BY DATE

APPROVED BY DATE

FLORIDA POWER CORPORATION
PETERSBURG, FLORIDA
PROJECT CRYSTAL RIVER UNIT 3

REV. 4 ST.

CALIBRATION DATA SHEET

TRANSMITTER

SHEET 1 OF 1

DESCRIPTION:	REACTOR COOLANT TO STEAM GENERATOR "B" WIDE RANGE	TAG NO.	RC-159-PT
TYPE:	ROSEMOUNT MODEL# 1154 GP9RA		
VENDOR MANUAL:	BOOK# 1280	ITEM	TEST EQUIPMENT USED / DUE DATE
LOCATION:	95' REACTOR BLDG. LOCATED AT SECONDARY SHIELD WALL NORTH "Y" STATION		
REMARKS:	ANALYSIS/CALCULATION DOC ID # I-88-0020 ATT # 14 REV 7 SHEET 1 OF 1		DRAWING # 205-047 RC-02, 209-047 RC-12, 308-603

DESIGN CALIBRATION			AS-FOUND CALIBRATION			AS-LEFT CALIBRATION		
%	IN PSIG	OUT MA	READING	ACCEPTABLE RANGE	ERROR	READING	ACCEPTABLE RANGE	ERROR
0	28.0	4.00		3.95 TO 4.05			3.96 TO 4.04	
25	778.0	8.00		7.95 TO 8.05			7.96 TO 8.04	
50	1528.0	12.00		11.95 TO 12.05			11.96 TO 12.04	
75	2278.0	16.00		15.95 TO 16.05			15.96 TO 16.04	
96.7	2928.0	19.47		19.42 TO 19.52			19.43 TO 19.51	

PREPARED BY Dave McPhee	DATE 4/5/94	REVIEWED BY Walt Barlow	DATE 4/6/94
SUPERVISOR LS Kobelt	DATE 3/13/95		
CALIBRATED BY	DATE	APPROVED BY	DATE

FLORIDA POWER CORPORATION
ST. PETERSBURG, FLORIDA
PROJECT CRYSTAL RIVER UNIT 3

REV. 4

CALIBRATION DATA SHEET

TRANSMITTER

SHEET 1 OF 1

SURVEILLANCE REQUIREMENT - 3.3.1.6, (6)
REACTOR PROTECTION SYSTEM
REACTOR BUILDING HIGH PRESSURE

I. SURVEILLANCE PROCEDURE/DEVICES:

A. Surveillance procedure: SP-112.

B. Calibrated device included in the instrument Drift Data analysis:

DEVICE: Pressure Switch
MANUFACTURER: Static "O"-Ring
MODEL: 12N-K5-CM2
RANGE: .25 to 12 psig.
CALIBRATED SPAN: 11.75 psig.
TAG NUMBERS: BS-59-PS, BS-60-PS, BS-61-PS, & BS-62-PS
DEVICE DRIFT VALUE: None Stated

II. NRC GENERIC LETTER 91-04 Analysis Criteria and DRIFT STUDY RESULTS:

1. ***"Confirm that instrument drift as determined by "As-Found" and "As-Left" calibration data from surveillance and maintenance records has not, except on rare occasions, exceeded acceptable limits for a calibration interval."***

Per Refueling interval surveillance procedure, SP-112, "Calibration of the Reactor Protection System", the pressure switches listed above, have not exceeded acceptable "As-Found" surveillance procedure tolerances, for the surveillance intervals investigated, except as described below.

One raw calibration data point for BS-62-PS, on 4/2/94, was found to have exceeded the calibration procedure "As-Found" tolerance in the conservative direction. It is considered a "rare occasion" exception. The raw "As-Found" data has never exceeded the Tech. Spec. limit of 4 psig. Raw calibration data points which have exceeded "As-Found" tolerance: 1 of 16 or 6%.

Outlier Treatment

Raw calibration "As-Found" data which exceeds to acceptance criteria of the surveillance procedure is considered to have some type of failure. Consequently, this data was removed. This is conservative since, by definition, failure of this raw calibration data to meet the surveillance procedure acceptance criteria, identifies this data and the operation of the instrument as "non-normal." Once the drift data has been calculated and the values which did not meet the "As-Found" tolerance have been removed, an "outlier test" was performed on each remaining point. The outliers were identified by performing a statistical "critical values of T" test. The outlier criteria value was determined based on the number of total drift points. Outliers may

SURVEILLANCE REQUIREMENT - 3.3.1.6, (6)
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result from raw calibration data which has exceeded the surveillance procedure "As-Found" tolerance, procedural or personnel errors, M&TE problems, or other deficiencies or failures. A conservative approach for dealing with outliers was utilized in that identified outliers were not removed form the drift data.

2. ***"Confirm that the values of drift for each instrument type, (make, model and range) and application have been determined with a high probability and a high degree of confidence. Provide a summary of the methodology and assumptions used to determine the rate of instrument drift with time based upon historical plant data."***

Standard statistical methodologies were utilized in this DRIFT STUDY. The following references were consulted to establish the techniques used in this evaluation.

1. ISA-S67.04, Part I Standard, Setpoints for Nuclear Safety-Related Instrumentation
2. ISA-S67.04, Part II Recommended Practice, Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation
3. EPRI document TR-103335, "Guidelines for Instrument Calibration Extension/Reduction Programs", Project 2409-21, final Report dated March 1994
4. American Society of Testing and Materials (ASTM) standard E178-1980, (re-approved 1989), "Standard Practice for Dealing With Outlying Observations."
5. ANSI N15.15-1974, American National Standard Assessment of the Assumption of Normality
6. Probability and Statistics 4th Edition, Irwin Miller/John E Freund/Richard A. Johnson

The summary of the EPRI project observations, from section 9, "CONCLUSIONS" is as follows:

A. Instrument drift tends to increase with instrument span.

B. Instrument drift tends to be bounded by a normal distribution.

C. Instrument drift rarely showed any significant indication of time dependency.

D. Instrument Drift Data often showed no bias for the direction of drift.

E. OUTLIER checks are necessary to detect data errors.

The methods utilized in this drift study, can be summarized as follows:

A. Instrument calibration data, ("As-Found" and "As-Left"), is obtained from, (typically), five intervals of the appropriate Refueling interval surveillance procedure. The number of intervals may change if instruments have been replaced with a different type, etc.

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B. A spread sheet computer program, which can be run on a personal computer is utilized for ease of analysis. Florida Power Corporation utilizes Microsoft Excel, running under a Microsoft Windows environment. See the **"SPREAD SHEET FORMAT"** section below for an explanation of the spread sheet data and calculations.

C. The "RAW" "As Found" and "As Left" data is obtained from the associated Refueling interval surveillance procedure, and entered onto the spread sheet.

D. Drift Data information is obtained by subtracting the "As-Left" data from the "As-Found" data from one "As-Found" date to the next. This difference is divided by the calibrated span and the Drift Data is then expressed as a PERCENT OF SPAN.

E. Drift Data is analyzed and the MEAN and STANDARD DEVIATION is determined. "OUTLIER detection by critical values of T" test is performed and if required, the Drift Data OUTLIERs may be excluded from further analysis.

F. Next, the tolerance interval for the data is calculated by multiplying each calculated STANDARD DEVIATION by the appropriate 95%/95% tolerance factor. This factor indicates a 95% level of confidence, that 95% of the instrument Drift Data will be contained within the tolerance interval.

G. The Drift Data is tested to verify the assumption that the data is "NORMAL". Either a D'-test or W-test may be performed. If the Drift Data fails these tests, then a "COVERAGE ANALYSIS" is performed. The Coverage Analysis requires that Drift Data be analyzed to determine if the data is bounded by a normal distribution. A "DATA HISTOGRAM" is plotted, as well as a comparison table of the actual distribution of the Drift Data versus the expected probability distribution to show that the Drift Data is normally bounded.

H. To evaluate time dependency, the Drift Data is charted versus calibration interval, (in months), and also charted versus calibration, ("As-Found"), date. The charts can then be utilized to demonstrate no time dependent trend is observed.

I. If the Drift Data is demonstrated to (1) be "normal" and (2) is not time dependent, then the 95%/95% Tolerance values for the instruments are assumed to envelop the 30-month drift values, hence the projected 30-month drift is the 95%/95% Tolerance values.

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REACTOR PROTECTION SYSTEM
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SPREAD SHEET FORMAT

The surveillance procedure data is arranged in a spread sheet format which displays the following information:

A. Instrument Tag Number/Channel/Descriptor,

B. "As-Found" and "As-Left" calibration dates of the surveillance procedure, which are used to Calculate the calibration "INTERVAL"s,

C. Raw "As-Found" and "As-Left" device data, (voltage, pressure, etc.),

D. "DRIFT DATA", (difference between "As-Found" and "As-Left" data divided by the calibrated SPAN of the instrument, expressed in PERCENT of SPAN),

E. "OUTLIER detection by critical values of T" test,

F. Range, Calibrated Span, "As-Found" and "As-Left" tolerances, Instrument Error/Setpoint calculation number, device setpoint, Technical Specification Limiting Value, etc. is provided for reference.

G. Drift Data statistical information: MEAN, STANDARD DEVIATION, OUTLIER CRITERIA, number of Drift Data points, number of OUTLIERs excluded, 95%/95% "k" value, and the calculated $\pm$ 95%/95% tolerance values.

H. The D'-test or W-test for "normal" data assumption is performed. If the data fails the appropriate test, a Drift Data Histogram and coverage analysis is performed.

I. Drift Data, surveillance interval, "As-Found" dates, $\pm$95%/95% tolerance values, and zero % values are provided for charting.

3. ***"Confirm that the magnitude of instrument drift has been determined with a high probability and a high degree of confidence for a bounding calibration interval of 30 months for each instrument type; make, model number and range) and application that performs a safety function. Provide a list of the channels by Technical Specification section that identifies these instrument applications."***

SURVEILLANCE REQUIREMENT - 3.3.1.6, (6)
REACTOR PROTECTION SYSTEM
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The Drift Data calculations for each Surveillance Requirement, establishes the "±95%/95%" Tolerance Factor. This calculated value indicates a 95% level of confidence, that 95% of the population, (instrument Drift Data), will be within the stated interval.

The RB Pressure HIGH Pressure Switch Drift Data passed the W-TEST, (the data is "normal"), and the associated charts indicate that the Drift Data is neither calibration interval dependent nor time, (age), dependent. In summary, since the Drift Data is "normal" and does not appear to be time dependent, then the 95%/95% Tolerance values can be assumed to envelope the 30-month drift values.

As indicated on page one, the Surveillance Requirement and instruments covered by this analysis, are as follows:

Surveillance Requirement: 3.3.1.6, (6); Reactor Protection System, Initiation - Reactor Building Pressure - HIGH

Surveillance procedure: SP-112.

Technical Specification Allowable Value: ≤ 4 psig.

Surveillance procedure setpoint: 3.34 psig.

Tag Numbers: Channel "A": BS-59-PS,
Channel "B": BS-60-PS,
Channel "C": BS-61-PS,
Channel "D": BS-62-PS

±95%/95% Tolerances:
BS-59,60,61,62-PT
+ 1.4%, + 0.2 psig
- 1.7%, - 0.2 psig

4. *"Confirm that a comparison of the projected instrument drift errors has been made with the values of drift used in the setpoint analysis. If this results in revised setpoints to accommodate larger drift errors, provide proposed Technical Specification changes to update trip setpoints. If the drift errors result in a revised safety analysis to support existing setpoints, provide a summary of the updated analysis conclusions to confirm that the safety limits and safety analysis assumptions are not exceeded."*

SURVEILLANCE REQUIREMENT - 3.3.1.6, (6)
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REACTOR BUILDING HIGH PRESSURE

Engineering has a program in place to upgrade the RPS Instrument Accuracy Calculations to reflect 30 month drift error terms. It is assumed that no change will be required for the Technical Specifications due to the RPS Instrument Accuracy Calculation. The calculation for these pressure switches will provide the required surveillance procedure setpoint and "As-Left" and "As-Found" procedure tolerances, which will include, as required, any effects due to 30-month drift.

The projected 30-month drift terms for the pressure switches have never been exceeded for the surveillance intervals investigated. Hence, since Drift Data is not time dependent, we have a high level of confidence that future Drift Data will be contained within the projected tolerance interval.

5. ***"Confirm that the projected instrument errors caused by drift are acceptable for control of plant parameters to effect a safe shutdown. Licensees must confirm that the instrument errors caused by drift will not affect the capability to achieve safe shutdown."***

The RPS Reactor Building Pressure Switches are utilized for inputs to:

A. RPS REACTOR BUILDING HIGH PRESSURE, (4 psig), Reactor Trip Actuation
B. RPS REACTOR BUILDING HIGH PRESSURE, (4 psig), Alarm

The pressure switches analyzed in this Drift study are not utilized for control of plant parameters, other than the RPS "TRIP" functions. Since in (4) above the 30-month drift term has been found to be acceptable, then the projected drift value will not affect the capability to achieve safe shutdown.

6. ***"Confirm that all conditions and assumptions of the setpoint and safety analysis have been checked and are appropriately reflected in the acceptance criteria of plant surveillance procedures for CHANNEL CHECKS, CHANNEL FUNCTIONAL TESTS and CHANNEL CALIBRATIONS."***

As stated in (4) above, the calculation for these reactor building pressure switches will provide the required surveillance procedure setpoint and "As-Left" and "As-Found" procedure tolerances. The revised "As-Left" and "As-Found" surveillance procedure tolerances, will be incorporated into the appropriate CHANNEL CHECKS, CHANNEL FUNCTIONAL TEST or CHANNEL CALIBRATION surveillance procedures, as required.

SURVEILLANCE REQUIREMENT - 3.3.1.6, (6)
REACTOR PROTECTION SYSTEM
REACTOR BUILDING HIGH PRESSURE

7. ***"Provide a summary description of the program for monitoring and assessing the effects of increased calibration surveillance intervals on instrument drift and its effect on safety.***

The instrument "DRIFT PROGRAM" is an ongoing program which will monitor future surveillance procedure "As-Found" and "As-Left" data, and will incorporate new data into the Drift Study spread sheets with the existing Drift Data. The revised Drift Data MEAN, STANDARD DEVIATION, ± 95%/95% TOLERANCE INTERVALS, etc., will be compared with the existing Drift Data, to ensure the conclusions reached in this report remain valid.

III. DRIFT STUDY SUMMARY:

1. Per Refueling interval surveillance procedure, SP-112, the pressure switches have not exceeded acceptable "As-Found" surveillance procedure tolerances, for the surveillance intervals investigated, except as follows. One raw calibration data point for BS-62-PS, on 4/2/94, was found to have exceeded the calibration procedure "As-Found" tolerance in the conservative direction. It is considered a "rare occasion" exception. The raw "As-Found" data has never exceeded the Tech. Spec. limit of 4 psig. Raw calibration data points which have exceeded "As-Found" tolerance: 1 of 16 or 6%.

2. The attached spread sheets and charts present calculated Drift Data and the associated statistical information using the methods described in the references. The methodology is summarized in section **II.2**, above.

3. The pressure switch Drift Data is considered "normal". The associated charts indicate that the Drift Data for the switches are neither calibration interval dependent nor time, (age), dependent. Hence, the 95%/95% Tolerance values can be assumed to envelop the 30-month drift values.

4. Engineering has a program in place to upgrade the RPS Instrument Accuracy Calculations to reflect 30 month drift error terms. It is assumed that no change will be required for the Technical Specifications due to the RPS Instrument Accuracy Calculation. The calculation for these pressure switches will provide the required surveillance procedure setpoint and "As-Left" and "As-Found" procedure tolerances, which will include, as required, any effects due to 30-month drift.

   The projected 30-month drift terms for the pressure switches have never been exceeded for the surveillance intervals investigated. Hence, since Drift Data is not time dependent,

SURVEILLANCE REQUIREMENT - 3.3.1.6, (6)
REACTOR PROTECTION SYSTEM
REACTOR BUILDING HIGH PRESSURE

we have a high level of confidence that future Drift Data will be contained within the projected tolerance interval.

5. The pressure switches analyzed in this Drift study are not utilized for control of plant parameters, other than the RPS "TRIP" functions. Since in (4) above the 30-month drift term has been found to be acceptable, then the projected drift value will not affect the capability to achieve safe shutdown.

6. As stated in (4) above, the calculation for these reactor building pressure switches will provide the required surveillance procedure setpoint and "As-Left" and "As-Found" procedure tolerances. The revised "As-Left" and "As-Found" surveillance procedure tolerances, will be incorporated into the appropriate CHANNEL CHECKS, CHANNEL FUNCTIONAL TEST or CHANNEL CALIBRATION surveillance procedures, as required.

7. The instrument "DRIFT PROGRAM" is an ongoing program which will monitor future surveillance procedure "As-Found" and "As-Left" data, and will incorporate new data into the Drift Study spread sheets with the existing Drift Data. The revised Drift Data MEAN, STANDARD DEVIATION, ± 95%/95% TOLERANCE INTERVALS, etc., will be compared with the existing Drift Data, to ensure the conclusions reached in this report remain valid.

IV. CONCLUSION:

Based on the above summary, the Surveillance Interval for this Technical Specification calibration requirement can be extended to 30-months.

SP-112

S.R. 3.3.1.6, (6)

BS-59, 60, 61 & 62-PS
Reactor Building HIGH Pressure

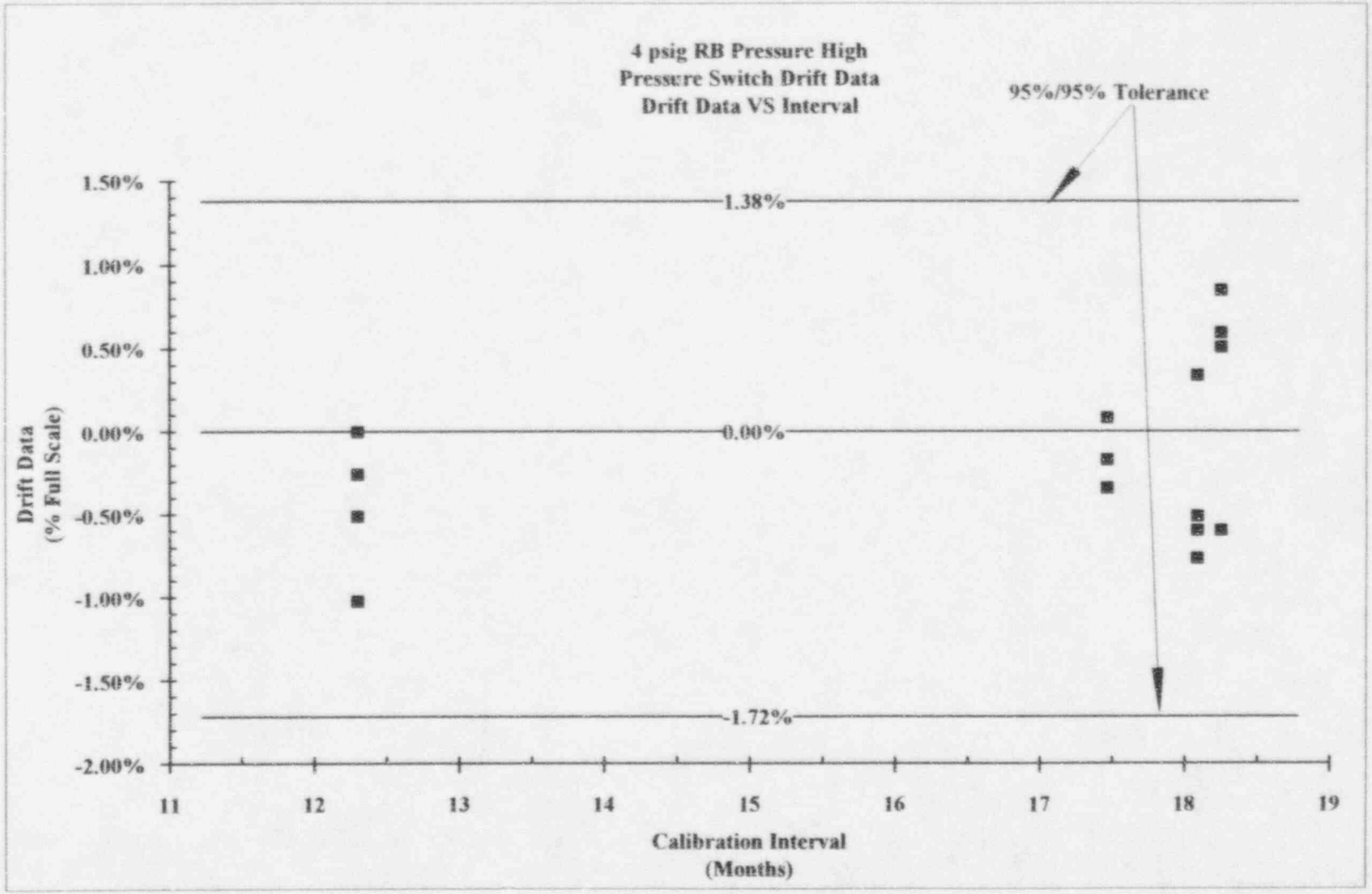
Surveillance Procedure:	SP-112	Calibration	Interval	Trip	Drift Data					
TAG NUMBER		Date	(Months)	Data	Outlier Evaluation					
BS-59-PS	As Left	9/30/88		3.300						
RPS CHANNEL A	As Found	4/3/90	18.1	3.210	-0.77%					
PS CAB. 3A1	As Left	4/3/90		3.320	DATA IS OK					
	As Found	9/16/91	17.5	3.300	-0.17%					
	As Left	11/8/91		3.280	DATA IS OK					
	As Found	3/24/93	18.2	3.350	0.60%					
	As Left	3/24/93		3.350	DATA IS OK					
	As Found	4/2/94	12.3	3.320	-0.26%					
	As Left	4/2/94		3.320	DATA IS OK					
BS-60-PS	As Left	9/30/88		3.350						
RPS CHANNEL B	As Found	4/3/90	18.1	3.290	-0.51%					
PS CAB. 3A2	As Left	4/3/90		3.290	DATA IS OK					
	As Found	9/16/91	17.5	3.250	-0.34%					
	As Left	11/8/91		3.330	DATA IS OK					
	As Found	3/24/93	18.2	3.430	0.85%					
	As Left	3/24/93		3.430	DATA IS OK					
	As Found	4/2/94	12.3	3.310	-1.02%					
	As Left	4/2/94		3.310	DATA IS OK					
BS-61-PS	As Left	9/30/88		3.250						
RPS CHANNEL C	As Found	4/3/90	18.1	3.180	-0.60%					
PS CAB. 3A3	As Left	4/3/90		3.320	DATA IS OK					
	As Found	9/16/91	17.5	3.330	0.09%					
	As Left	11/8/91		3.340	DATA IS OK					
	As Found	3/24/93	18.2	3.400	0.51%					
	As Left	3/24/93		3.400	DATA IS OK					
	As Found	4/2/94	12.3	3.340	-0.51%					
	As Left	4/2/94		3.340	DATA IS OK					
BS-62-PS	As Left	9/30/88		3.340						
RPS CHANNEL D	As Found	4/3/90	18.1	3.380	0.34%					
PS CAB. 3A4	As Left	4/3/90		3.300	DATA IS OK					
	As Found	9/16/91	17.5	3.280	-0.17%					
	As Left	11/8/91		3.270	DATA IS OK					
	As Found	3/24/93	18.2	3.200	-0.60%					
	As Left	3/24/93		3.300	DATA IS OK					
	As Found	4/2/94	12.3	3.080	-1.87%					
	As Left	4/2/94		3.350	OUTLIER					
Pressure Range:	.25 to 12	psig		Mean:	-0.17%		Percent	psig		
Pressure Span:	11.75	psig		Standard Deviation:	0.52%	+95%/95%:	1.4%	0.2		
SP-112 Setpoint:	3.34	psig		Number of Points:	16	-95%/95%:	-1.7%	-0.2		
TS Limiting value:	<=4	psig	Percent	Outliers Excluded:	1	Setpoint Calculation:		183-0001		
SP-112 As Found Tol:	0.19	psig	1.62%	Outlier Criteria:	2.443					
SP-112 As Left Tol:	0.19	psig	1.62%	95%/95% k:	2.954					

DATE: 5/19/95

FILE: 46RBPS.RPS

W-TEST DATA		Coefficients	Sorted Test Data		B terms	# of Pts.	Data	Sorted		
Number of Points:	15	0.5150	-1.87%	0.85%	1.40%	1	-0.77%	-1.87%		
Variance (s^2):	2.60E-05	0.3306	-1.02%	0.60%	0.53%	2	-0.17%	-1.02%		
S^2:	3.64E-04	0.2495	-0.77%	0.51%	0.32%	3	0.60%	-0.77%		
B:	2.57E-02	0.1878	-0.60%	0.34%	0.18%	4	-0.26%	-0.60%		
B^2:	6.60E-04	0.1353	-0.60%	0.09%	0.09%	5	-0.51%	-0.60%		
W = (B^2 / S^2):	1.814	0.0880	-0.51%	-0.17%	0.03%	6	-0.34%	-0.51%		
Critical W @ 95%:	0.881	0.0433	-0.51%	-0.17%	0.01%	7	0.85%	-0.51%		
W Test:	PASS		-0.34%	0.00%	0.00%	8	-1.02%	-0.34%		
CHART DATA						9	-0.60%	0.85%		
Calibration	Drift					10	0.09%	0.60%		
Interval	Data			Zero		11	0.51%	0.51%		
11		1.38%	-1.72%	0.00%		12	-0.51%	0.34%		
18	-0.77%	1.38%	-1.72%	0.00%		13	0.34%	0.09%		
17	-0.17%	1.38%	-1.72%	0.00%		14	-0.17%	-0.17%		
18	0.60%	1.38%	-1.72%	0.00%		15	-0.60%	-0.17%		
12	-0.26%	1.38%	-1.72%	0.00%		16				
18	-0.51%	1.38%	-1.72%	0.00%						
17	-0.34%	1.38%	-1.72%	0.00%						
18	0.85%	1.38%	-1.72%	0.00%						
12	-1.02%	1.38%	-1.72%	0.00%						
18	-0.60%	1.38%	-1.72%	0.00%						
17	0.09%	1.38%	-1.72%	0.00%						
18	0.51%	1.38%	-1.72%	0.00%						
12	-0.51%	1.38%	-1.72%	0.00%						
18	0.34%	1.38%	-1.72%	0.00%						
17	-0.17%	1.38%	-1.72%	0.00%						
18	-0.60%	1.38%	-1.72%	0.00%						
12	0.00%	1.38%	-1.72%	0.00%						
19		1.38%	-1.72%	0.00%						

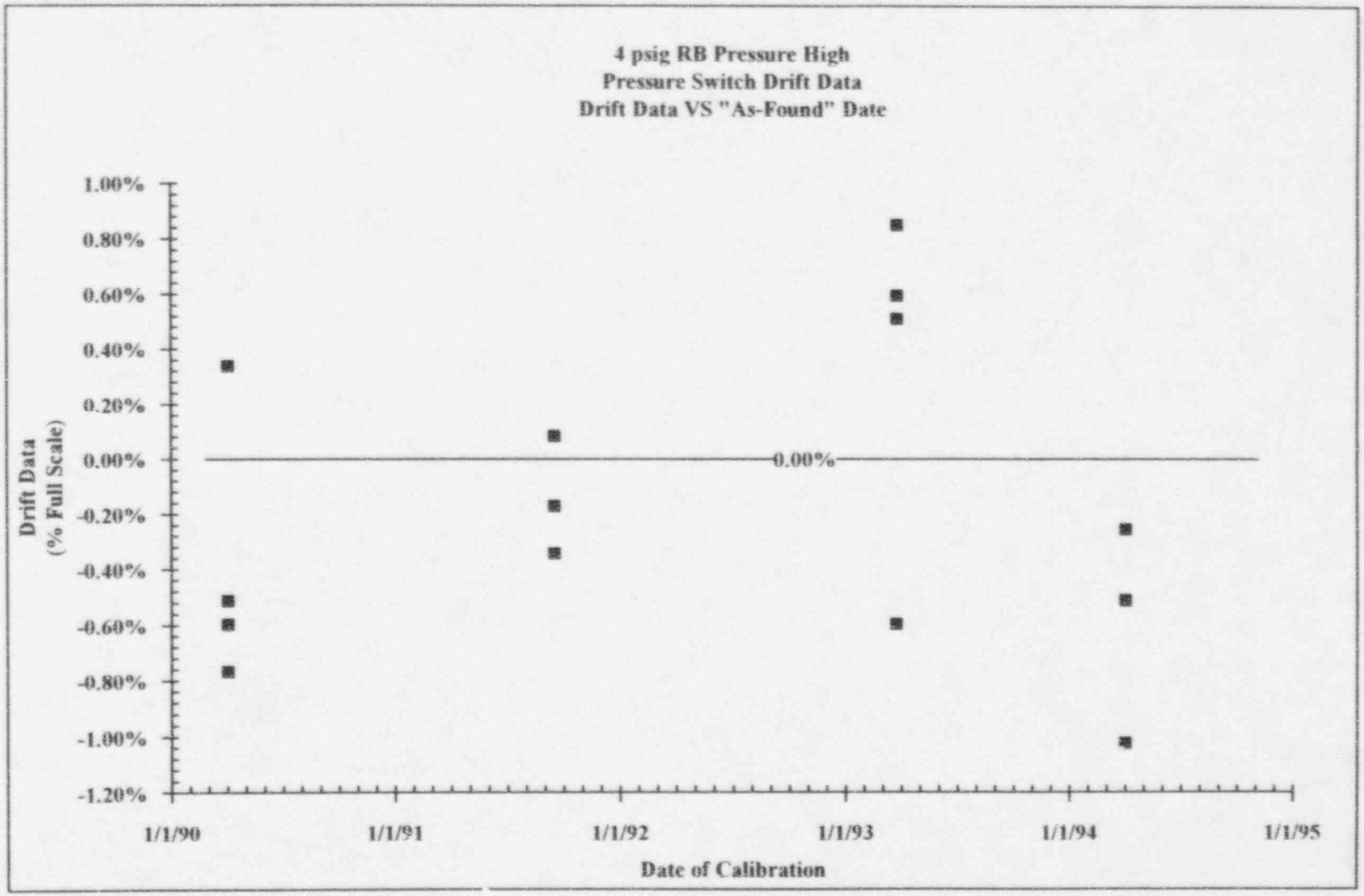
Surveillance Requirement 3.3.1.6, (6)
BS-59, 60, 61 & 62-PS



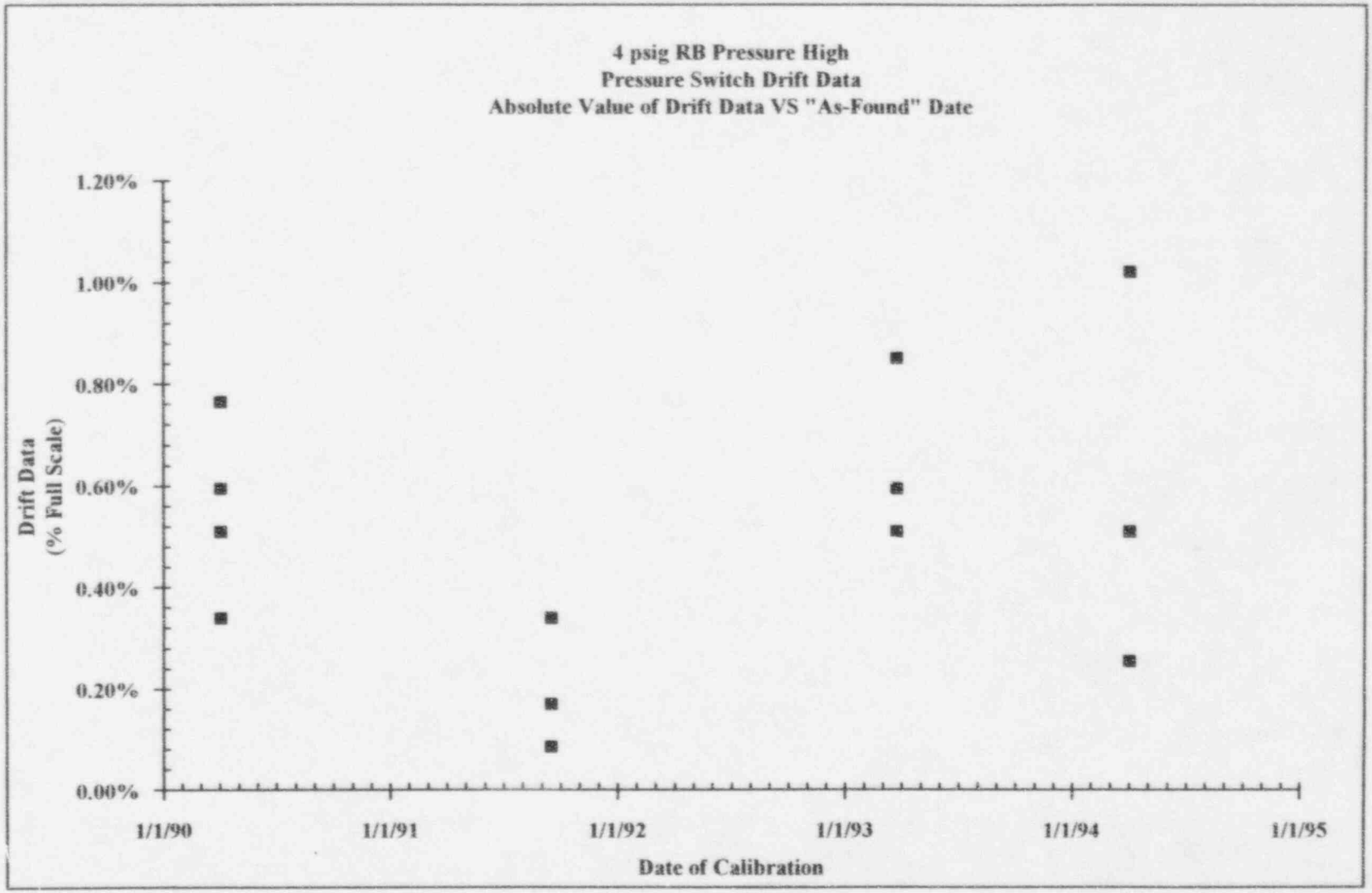
DATE: 4/4/95

FILE:I4#RBPS.RPS|4 PSIG DRIFT DATA VS INTERVAL

Surveillance Requirement 3.3.1.6, (6)
BS-59, 60, 61 & 62-PS



Surveillance Requirement 3.3.1.6, (6)
BS-59, 60, 61 & 62-PS



SURVEILLANCE REQUIREMENT - 3.3.5.3, (1)
ENGINEERED SAFEGUARDS ACTUATION SYSTEM
RCS PRESSURE LOW

I. SURVEILLANCE PROCEDURE/DEVICES:

A. Surveillance procedure: SP-132.

B. Calibrated devices included in the instrument loop Drift Data analysis:

1. **DEVICE:** Pressure Transmitter.
   MANUFACTURER: Rosemount.
   MODEL: 1154GP9RA.
   RANGE: 0 to 3000 psig.
   CALIBRATED SPAN: 0 to 2500 psig.
   TAG NUMBERS: RC-3A-PT3, RC-3A-PT4 & RC-3B-PT3
   DEVICE 30-MONTH DRIFT VALUE: ± 0.2% of URL, (from vendor manual), or (± 0.2% x 3000/2500) = ± 0.24%.

2. **DEVICE:** Buffer Amplifier.
   MANUFACTURER: Bailey Meter Company.
   MODEL: 6621670A1241.
   INPUT SPAN: 1 to 5 volts DC = 0 to 2500 psig
   OUTPUT SPAN: 0 to 10 volts DC = 0 to 2500 psig
   TAG NUMBERS: RC-3A-PY3, RC-3A-PY4-1, RC-3B-PY3
   DEVICE DRIFT VALUE: ± 0.1% Full Scale, (30 days, from B&W Calc. I83-0001, Rev. 4).

3. **DEVICE:** Bistable.
   MANUFACTURER: Bailey Meter Company.
   MODEL: 6621500A1.
   INPUT SPAN: 0 to 10 volts DC = 0 to 2500 psig
   TAG NUMBERS: RC-3-BT1, RC-3-BT2, RC-3-BT3
   DEVICE DRIFT VALUE: ± 0.03% Full Scale, (30 days, from B&W Calc. I83-0001, Rev. 4).

SURVEILLANCE REQUIREMENT - 3.3.5.3, (1)
ENGINEERED SAFEGUARDS ACTUATION SYSTEM
RCS PRESSURE LOW

II. NRC GENERIC LETTER 91-04 Analysis Criteria and DRIFT STUDY RESULTS:

1. ***"Confirm that instrument drift as determined by "As-Found" and "As-Left" calibration data from surveillance and maintenance records has not, except on rare occasions, exceeded acceptable limits for a calibration interval."***

Per Refueling interval surveillance procedure, SP-132, "Engineered Safeguards Channel Calibration", the components listed on the preceding page, have not exceeded acceptable, "As-Found" surveillance procedure tolerances, for the surveillance intervals investigated, except as indicated below.

BISTABLES: For RC-3-BT1, one OUTLIER was identified. The Drift Data of 3/20/90 was identified as an OUTLIER. The raw "As Found" calibration data EXCEEDs the procedure "As Found" tolerance. Hence, this OUTLIER was removed from the data. For RC-3-BT2, one OUTLIER was identified. The Drift Data of 3/20/90 was identified as an OUTLIER. The raw "As Found" calibration data EXCEEDs the procedure "As Found" tolerance. Hence, this OUTLIER was removed from the data. Raw calibration data points which have exceeded "As-Found" tolerance: 2 of 15, or 13%.

TRANSMITTER & BUFFER/AMPLIFIERS: For RC-3A-PT3, the 75% and 100% raw "As-Found" calibration data point for 10/14/88, was found to exceed the calibration procedure "As-Found" tolerance Hence, these OUTLIERs were removed and are considered "rare occasion" exceptions. Once the OUTLIERs were removed from the Drift Data, the 50% Drift Data of 10/15/88 was identified as an OUTLIER. The raw calibration data for this point is within the procedure calibration tolerance, hence this OUTLIER was not removed. (**NOTE:** Transmitter RC-3A-PT3 caused outliers in all drift data studies for both ESAS functions: RCS LOW PRESSURE 1500 psig bistable and RCS LOW-LOW PRESSURE 900 psig bistable). For RC-3A-PT4, the 100% raw "As-Found" calibration data point for 10/15/88, was found to exceed the calibration procedure "As-Found" tolerance Hence, this OUTLIER was removed and is considered a "rare occasion" exception. (**NOTE:** Transmitter RC-3A-PT4 caused outliers in all drift data studies for both ESAS functions: RCS LOW PRESSURE: 1500 and 1700 psig bistables and RCS LOW-LOW PRESSURE: 900 & 500 psig bistables). Raw calibration data points which have exceeded "As-Found" tolerance: 3 of 75 or 4%.

Outlier Treatment

Raw calibration "As-Found" data which exceeds to acceptance criteria of the surveillance procedure is considered to have some type of failure. Consequently, this data was removed. This is conservative since, by definition, failure of this raw calibration data to meet the surveillance procedure acceptance criteria, identifies this data and the operation of the instrument as "non-normal." Once the drift data has been calculated and the values which did

SURVEILLANCE REQUIREMENT - 3.3.5.3, (1)
ENGINEERED SAFEGUARDS ACTUATION SYSTEM
RCS PRESSURE LOW

not meet the "As-Found" tolerance have been removed, an "outlier test" was performed on each remaining point. The outliers were identified by performing a statistical "critical values of T" test. The outlier criteria value was determined based on the number of total drift points. Outliers may result from raw calibration data which has exceeded the surveillance procedure "As-Found" tolerance, procedural or personnel errors, M&TE problems, or other deficiencies or failures. A conservative approach for dealing with outliers was utilized in that identified outliers were not removed form the drift data.

2. ***"Confirm that the values of drift for each instrument type, (make, model and range) and application have been determined with a high probability and a high degree of confidence. Provide a summary of the methodology and assumptions used to determine the rate of instrument drift with time based upon historical plant data."***

Standard statistical methodologies were utilized in this DRIFT STUDY. The following references were consulted to establish the techniques used in this evaluation.

1. ISA-S67.04, Part I Standard, Setpoints for Nuclear Safety-Related Instrumentation
2. ISA-S67.04, Part II Recommended Practice, Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation
3. EPRI document TR-103335, "Guidelines for Instrument Calibration Extension/Reduction Programs", Project 2409-21, final Report dated March 1994
4. American Society of Testing and Materials (ASTM) standard E178-1980, (re-approved 1989), "Standard Practice for Dealing With Outlying Observations."
5. ANSI N15.15-1974, American National Standard Assessment of the Assumption of Normality
6. Probability and Statistics 4th Edition, Irwin Miller/John E Freund/Richard A. Johnson

The summary of the EPRI project observations, from section 9, "CONCLUSIONS" is as follows:

A. Instrument drift tends to increase with instrument span.

B. Instrument drift tends to be bounded by a normal distribution.

C. Instrument drift rarely showed any significant indication of time dependency.

D. Instrument Drift Data often showed no bias for the direction of drift.

E. OUTLIER checks are necessary to detect data errors.

SURVEILLANCE REQUIREMENT - 3.3.5.3, (1)
ENGINEERED SAFEGUARDS ACTUATION SYSTEM
RCS PRESSURE LOW

The methods utilized in this drift study, can be summarized as follows:

A. Instrument calibration data, ("As-Found" and "As-Left"), is obtained from, (typically), five intervals of the appropriate Refueling interval surveillance procedure. The number of intervals may change if instruments have been replaced with a different type, etc.

B. A spread sheet computer program, which can be run on a personal computer is utilized for ease of analysis. Florida Power Corporation utilizes Microsoft Excel , running under a Microsoft Windows environment. See the **"SPREAD SHEET FORMAT"** section below for an explanation of the spread sheet data and calculations.

C. The "RAW" "As Found" and "As Left" data is obtained from the associated Refueling interval surveillance procedure, and entered onto the spread sheet.

D. Drift Data information is obtained by subtracting the "As-Left" data from the "As-Found" data from one "As-Found" date to the next. This difference is divided by the calibrated span and the Drift Data is then expressed as a PERCENT OF SPAN.

E. Drift Data is analyzed and the MEAN and STANDARD DEVIATION is determined. "OUTLIER detection by critical values of T" test is performed and if required, the Drift Data OUTLIERs may be excluded from further analysis.

F. Next, the tolerance interval for the data is calculated by multiplying each calculated STANDARD DEVIATION by the appropriate 95%/95% tolerance factor. This factor indicates a 95% level of confidence, that 95% of the instrument Drift Data will be contained within the tolerance interval.

G. The Drift Data is tested to verify the assumption that the data is "NORMAL". Either a D'-test or W-test may be performed. If the Drift Data fails these tests, then a "COVERAGE ANALYSIS" is performed. The Coverage Analysis requires that Drift Data be analyzed to determine if the data is bounded by a normal distribution. A "DATA HISTOGRAM" is plotted, as well as a comparison table of the actual distribution of the Drift Data versus the expected probability distribution to show that the Drift Data is normally bounded.

H. To evaluate time dependency, the Drift Data is charted versus calibration interval, (in months), and also charted versus calibration, ("As-Found"), date. The charts can then be utilized to demonstrate no time dependent trend is observed.

I. If the Drift Data is demonstrated to (1) be "normal" and (2) is not time dependent, then the 95%/95% Tolerance values for the instruments are assumed to envelop the 30-month drift values, hence the projected 30-month drift is the 95%/95% Tolerance values.

SURVEILLANCE REQUIREMENT - 3.3.5.3, (1)
ENGINEERED SAFEGUARDS ACTUATION SYSTEM
RCS PRESSURE LOW

SPREAD SHEET FORMAT

The surveillance procedure data is arranged in a spread sheet format which displays the following information:

A. Instrument Tag Number/Channel/Descriptor.

B. "As-Found" and "As-Left" calibration dates of the surveillance procedure, which are used to Calculate the calibration "INTERVALs".

C. Raw "As-Found" and "As-Left" device data, (voltage, pressure, etc.).

D. "DRIFT DATA", (difference between "As-Found" and "As-Left" data divided by the calibrated SPAN of the instrument, expressed in PERCENT of SPAN).

E. "OUTLIER detection by critical values of T" test.

F. Range, Calibrated Span, "As-Found" and "As-Left" tolerances, Instrument Error/Setpoint calculation number, device setpoint, Technical Specification Limiting Value, etc. is provided for reference.

G. Drift Data statistical information: MEAN, STANDARD DEVIATION, OUTLIER CRITERIA, number of Drift Data points, number of OUTLIERs excluded, 95%/95% "k" value, and the calculated $\pm$ 95%/95% tolerance values.

H. The D'-test or W-test for "normal" data assumption is performed. If the data fails the appropriate test, a Drift Data Histogram and coverage analysis is performed.

I. Drift Data, surveillance interval, "As-Found" dates, $\pm$95%/95% tolerance values, and zero % values are provided for charting.

3. ***"Confirm that the magnitude of instrument drift has been determined with a high probability and a high degree of confidence for a bounding calibration interval of 30 months for each instrument type, make, model number and range) and application that performs a safety function. Provide a list of the channels by Technical Specification section that identifies these instrument applications."***

The Drift Data calculations for each Surveillance Requirement, establishes the "$\pm$95%/95%" Tolerance Factor. This calculated value indicates a 95% level of confidence, that 95% of the population, (instrument Drift Data), will be within the stated interval.

SURVEILLANCE REQUIREMENT - 3.3.5.3, (1)
ENGINEERED SAFEGUARDS ACTUATION SYSTEM
RCS PRESSURE LOW

The Bistable Drift Data passed the W-TEST, (the data is "normal"), and the associated charts indicate that the Drift Data is neither calibration interval dependent nor time, (age), dependent.

The Loop Drift Data, (Transmitter/Buffer Amp), did not pass the D'-TEST. However, a "COVERAGE ANALYSIS" was performed on the data, including a "DATA HISTOGRAM" chart and also a "NORMAL DISTRIBUTION" comparison. The "Actual" coverage distribution envelopes the "Expected Value", from 0 to 4 sigma. Therefore, for the purposes of this Drift Study, the Drift Data is considered "normal". The associated charts indicate that the Drift Data is neither calibration interval dependent nor time, (age), dependent.

In summary, since the Drift Data is "normal" and does not appear to be time dependent, then the ± 95%/95% Tolerance values are assumed to be the limits of the predicted 30-month drift values.

As indicated on page one, the Surveillance Requirement and instruments covered by this analysis, are as follows:

Surveillance Requirement: 3.3.5.3, (1); ESAS Initiation -- RCS Pressure Low.

Surveillance procedure: SP-132.

Technical Specification Allowable Value: ≤ 1500 psig.

Surveillance Procedure Setpoint: 1540 psig.

Tag Numbers: Channel "1": RC-3A-PT3, RC-3A-PY3 & RC-3A-BT1;
Channel "2": RC-3A-PT4, RC-3A-PY4-1 & RC-3A-BT2;
Channel "3": RC-3B-PT3, RC-3B-PY3 & RC-3-BT3.

±95%/95% Tolerances:

Transmitter &Buffer/Amp	Bistable
+ 0.55%, + 13.7 psig	+ 0.37%, + 9.3 psig
- 0.62%, - 15.4 psig	- 0.36%, - 9.1 psig

4. *"Confirm that a comparison of the projected instrument drift errors has been made with the values of drift used in the setpoint analysis. If this results in revised setpoints to accommodate larger drift errors, provide proposed Technical Specification changes to update trip setpoints. If the drift errors result in a revised safety analysis to support existing setpoints, provide a summary of the updated analysis conclusions to confirm that the safety limits and safety analysis assumptions are not exceeded."*

SURVEILLANCE REQUIREMENT - 3.3.5.3, (1)
ENGINEERED SAFEGUARDS ACTUATION SYSTEM
RCS PRESSURE LOW

Engineering has a program in place to review, revise and upgrade the Instrument Accuracy Calculations, as required, to reflect 30-month drift error terms. It is assumed that no change will be required for the Technical Specifications due to the revision of the ESAS Instrument Accuracy Calculation. The revised calculation for this RCS LOW PRESSURE TRIP function will provide the required surveillance procedure setpoint and "As-Left" and "As-Found" procedure tolerances, which will include, as required, any effects due to 30-month drift.

The projected 30-month drift terms for the low RCS pressure bistables has never been exceeded for the surveillance intervals investigated. The projected 30-month drift terms for the pressure transmitter & buffer/amps have only been exceeded in 2 of 72 Drift Data points, or 2.8% of the total Drift Data points. Hence, since Drift Data is not time dependent, we have a high level of confidence that future Drift Data will be contained within the projected tolerance interval.

5. ***"Confirm that the projected instrument errors caused by drift are acceptable for control of plant parameters to effect a safe shutdown. Licensees must confirm that the instrument errors caused by drift will not affect the capability to achieve safe shutdown."***

Per the instrument error calculation, I89-0014, Rev. 4, the ESAS RC Pressure transmitters are utilized for inputs to:

A. ESAS LOW PRESSURE, (1540 psig), HPI Actuation
B. ESAS LOW-LOW PRESSURE, (540 psig) LPI Actuation
C. ESAS HPI BYPASS PERMIT, (1700 psig).
D. ESAS HPI BYPASS REMOVAL, (1725 psig).
E. ESAS LPI BYPASS PERMIT, (900 psig).
F. ESAS LPI BYPASS REMOVAL, (925 psig).
G. HPI NOT RESET - NOT BYPASSED Alarm, (1640 psig).
H LPI NOT RESET - NOT BYPASSED Alarm, (710 psig).
I. ESAS LPI BYPASS AUTO RESET (1700 psig).
J. LOW RCS PRESSURE Alarm, (1550 psig).
K. CFT ISO VLV NOT CLOSED Alarm, (715 psig).
L. CFT ISO VLV NOT CLOSED Alarm, (700 psig).
M. LTOP EVENT IN PROGRESS Alarm, (500 psig).
N. DHR ACI VLV POSITION Alarm, (200 psig)
O. Pressure recorders & indicators.
P. Reactor Vessel Level, (RCITS).
Q. T-SAT monitors.
R. RCS PRESSURE Outputs to RECALL, Plant Computer, etc.

SURVEILLANCE REQUIREMENT - 3.3.5.3, (1)
ENGINEERED SAFEGUARDS ACTUATION SYSTEM
RCS PRESSURE LOW

The RCS Pressure loop devices analyzed in this Drift study are not utilized for control of plant parameters, other than the ESAS RCS PRESSURE TRIP function. Since in (4) above the 30-month drift term has been found to be acceptable, then the projected drift value will not affect the capability to achieve safe shutdown.

6. ***"Confirm that all conditions and assumptions of the setpoint and safety analysis have been checked and are appropriately reflected in the acceptance criteria of plant surveillance procedures for CHANNEL CHECKS, CHANNEL FUNCTIONAL TESTS and CHANNEL CALIBRATIONS."***

As stated in (4) above, the revised calculation for these RCS Pressure loop devices will provide the required surveillance procedure setpoint and "As-Left" and "As-Found" procedure tolerances. The revised "As-Left" and "As-Found" surveillance procedure tolerances, will be incorporated into the appropriate CHANNEL CHECKS, CHANNEL FUNCTIONAL TEST or CHANNEL CALIBRATION surveillance procedures, as required.

7. ***"Provide a summary description of the program for monitoring and assessing the effects of increased calibration surveillance intervals on instrument drift and its effect on safety.***

The instrument "DRIFT PROGRAM" is an ongoing program which will monitor future surveillance procedure "As-Found" and "As-Left" data, and will incorporate new data into the Drift Study spread sheets with the existing Drift Data. The revised Drift Data MEAN, STANDARD DEVIATION, ± 95%/95% TOLERANCE INTERVALS, etc., will be compared with the existing Drift Data, to ensure the conclusions reached in this report remain valid.

III. DRIFT STUDY SUMMARY:

1. Per Refueling interval surveillance procedure, SP-132, the RCS Pressure components have not exceeded acceptable, "As-Found" surveillance procedure tolerances, for the surveillance intervals investigated, except as indicated below. **BISTABLES:** For RC-3-BT1, one OUTLIER was identified. The Drift Data of 3/20/90 was identified as an OUTLIER. The raw "As Found" calibration data EXCEEDs the procedure "As Found" tolerance. Hence, this OUTLIER was removed from the data. For RC-3-BT2, one OUTLIER was identified. The Drift Data of 3/20/90 was identified as an OUTLIER. The raw "As Found" calibration data EXCEEDs the procedure "As Found" tolerance. Hence, this OUTLIER was removed from the data. Raw calibration data points which have exceeded "As-Found" tolerance: 2 of 15, or 13%. **TRANSMITTER & BUFFER/AMPLIFIERS:** For RC-3A-PT3, the 75% and 100% raw "As-Found"

SURVEILLANCE REQUIREMENT - 3.3.5.3, (1)
ENGINEERED SAFEGUARDS ACTUATION SYSTEM
RCS PRESSURE LOW

calibration data point for 10/14/88, was found to exceed the calibration procedure "As-Found" tolerance Hence, these OUTLIERs were removed and are considered "rare occasion" exceptions. Once the OUTLIERs were removed from the Drift Data, the 50% Drift Data of 10/14/88 was identified as an OUTLIER. The raw calibration data for this point is within the procedure calibration tolerance, hence this OUTLIER was not removed. (**NOTE:** Transmitter RC-3A-PT3 caused outliers in all drift data studies for both ESAS functions: RCS LOW PRESSURE 1500 psig bistable and RCS LOW-LOW PRESSURE 900 psig bistable). For RC-3A-PT4, the 100% raw "As-Found" calibration data point for 10/15/88, was found to exceed the calibration procedure "As-Found" tolerance Hence, this OUTLIER was removed and is considered a "rare occasion" exception. (**NOTE:** Transmitter RC-3A-PT4 caused outliers in all drift data studies for both ESAS functions: RCS LOW PRESSURE 1500 psig bistable and RCS LOW-LOW PRESSURE 900 psig bistable). Raw calibration data points which have exceeded "As-Found" tolerance: 3 of 75 or 4%.

2. The attached spread sheets and charts present calculated Drift Data and the associated statistical information using the methods described in the references. The methodology is summarized in section **II.2**, above.

3. The RCS PRESSURE bistable Drift Data passed the W-TEST and pressure transmitter/buffer amp Drift Data was determined by a "COVERAGE ANALYSIS" to be "normal", and the associated charts indicate that the Drift Data is neither calibration interval dependent nor time, (age), dependent. Hence, then the 95%/95% Tolerance values can be assumed to envelope the 30-month drift values.

4. Engineering has a program in place to review, revise and upgrade the Instrument Accuracy Calculations, as required, to reflect 30-month drift error terms. It is assumed that no change will be required for the Technical Specifications due to the revision of the ESAS Instrument Accuracy Calculation. The revised calculation for this RCS LOW PRESSURE TRIP function will provide the required surveillance procedure setpoint and "As-Left" and "As-Found" procedure tolerances, which will include, as required, any effects due to 30-month drift.

   The projected 30-month drift terms for the low RCS pressure bistables have never been exceeded for the surveillance intervals investigated. The projected 30-month drift terms for the pressure transmitter & buffer/amps have only been exceeded in 2 of 72 Drift Data points, or 2.8% of the total Drift Data points. Hence, since Drift Data is not time dependent, we have a high level of confidence that future Drift Data will be contained within the projected tolerance interval.

5. The RCS Pressure loop devices analyzed in this Drift study are not utilized for control of plant parameters, other than the ESAS RCS PRESSURE TRIP function. Since in (4)

SURVEILLANCE REQUIREMENT - 3.3.5.3, (1)
ENGINEERED SAFEGUARDS ACTUATION SYSTEM
RCS PRESSURE LOW

above the 30-month drift term has been found to be acceptable, then the projected drift value will not affect the capability to achieve safe shutdown.

6. As stated in (4) above, the revised calculation for these RCS Pressure loop devices will provide the required surveillance procedure setpoint and "As-Left" and "As-Found" procedure tolerances. The revised "As-Left" and "As-Found" surveillance procedure tolerances, will be incorporated into the appropriate CHANNEL CHECKS, CHANNEL FUNCTIONAL TEST or CHANNEL CALIBRATION surveillance procedures, as required.

7. The instrument "DRIFT PROGRAM" is an ongoing program which will monitor future surveillance procedure "As-Found" and "As-Left" data, and will incorporate new data into the Drift Study spread sheets with the existing Drift Data. The revised Drift Data MEAN, STANDARD DEVIATION, ± 95%/95% TOLERANCE INTERVALS, etc., will be compared with the existing Drift Data, to ensure the conclusions reached in this report remain valid.

IV. CONCLUSION:

Based on the above summary, the Surveillance Interval for this Technical Specification calibration requirement can be extended to 30-months.

SP-132
RC-3-BT1, RC-3-BT2 RC-3-BT3
1500 psig RC Pressure LOW

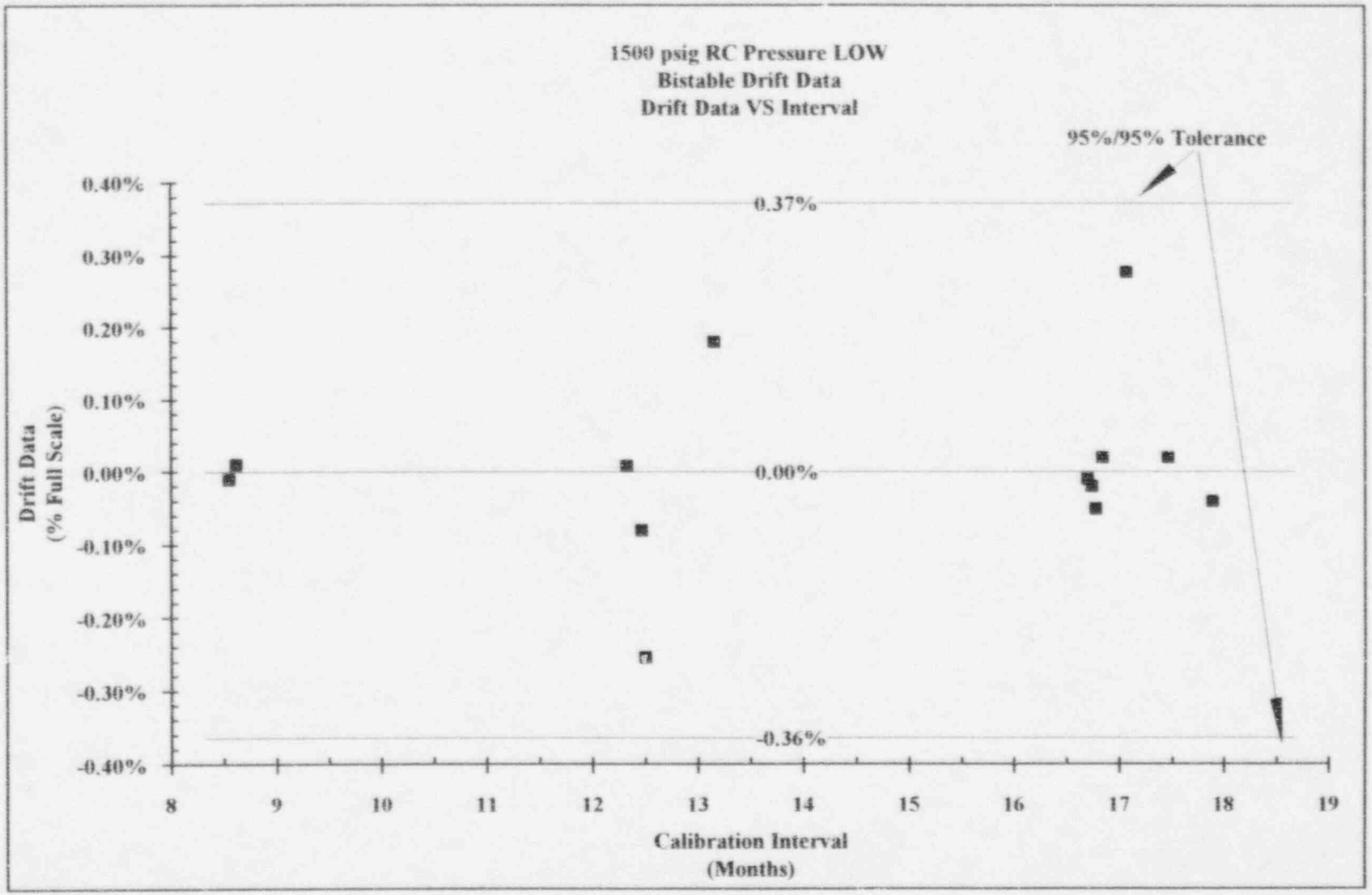
Surv. Procedure:	SP-132	Calibration	Interval	Trip	Drift Data
TAG NUMBER		Date	(Months)	Data	Outlier Evaluation
RC-3-BT1	As Left	10/6/87		6.1594	
RC-3A-PT3	As Found	10/15/88	12.3	6.1602	0.01%
RC-1, TEST CAB. 1	As Left	10/15/88		6.1602	DATA IS OK
	As Found	3/20/90	17.1	**6.2520**	**0.92%**
	As Left	6/1/90		6.1570	**OUTLIER**
	As Found	10/22/91	16.7	6.1560	-0.01%
X moved - Flood MAR -	As Left	6/29/92		6.1610	DATA IS OK
no "As Founds" taken.	As Found	3/16/93	8.5	6.1600	-0.01%
	As Left	3/18/93		6.1600	DATA IS OK
	As Found	9/13/94	17.9	6.1560	-0.04%
	As Left	9/13/94		6.1600	DATA IS OK
RC-3-BT2	As Left	10/1/87		6.1613	
RC-3A-PT4	As Found	10/15/88	12.5	6.1359	-0.25%
RC-2, TEST CAB.2	As Left	10/15/88		6.1633	DATA IS OK
	As Found	3/20/90	17.1	**6.2580**	**0.95%**
	As Left	6/1/90		6.1610	**OUTLIER**
	As Found	10/23/91	16.7	6.1590	-0.02%
X moved - Flood MAR -	As Left	6/29/92		6.1660	DATA IS OK
no "As Founds" taken.	As Found	3/18/93	8.6	6.1670	0.01%
	As Left	3/19/93		6.1670	DATA IS OK
	As Found	4/23/94	13.2	6.1850	0.18%
	As Left	4/23/94		6.1680	DATA IS OK
RC-3-BT3	As Left	10/4/87		6.1518	
RC-3B-PT3	As Found	10/17/88	12.5	6.1438	-0.08%
RC-3, TEST CAB. 3	As Left	10/17/88		6.1603	DATA IS OK
	As Found	3/20/90	17.1	6.1880	0.28%
	As Left	6/1/90		6.1560	DATA IS OK
	As Found	10/24/91	16.8	6.1510	-0.05%
	As Left	10/24/91		6.1590	DATA IS OK
	As Found	3/19/93	16.8	6.1610	0.02%
	As Left	4/1/93		6.1580	DATA IS OK
	As Found	9/14/94	17.5	6.1600	0.02%
	As Left	9/14/94		6.1600	DATA IS OK

SP-132
RC-3-BT1, RC-3-BT2 RC-3-BT3
1500 psig RC Pressure LOW

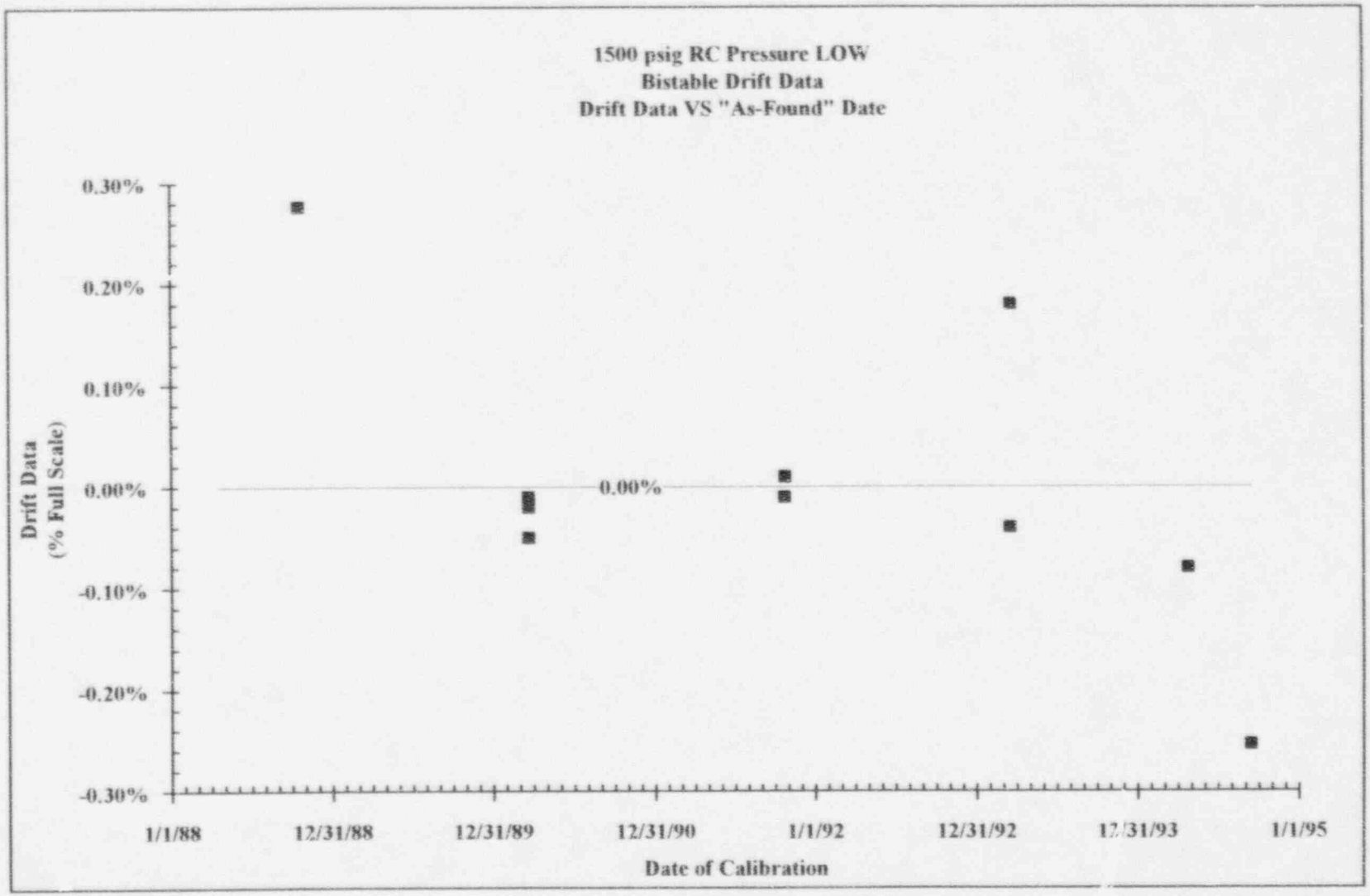
Pressure Range:	0 to 2500	psig	Mean:	0.004%		Percent	Volts DC	psig
Pressure Span:	2500	psig	Standard Deviation:	0.119%	+95%/95%:	0.37%	0.037	9.3
Output Range:	6 to 10	Volts DC	Number of Points:	15	-95%/95%:	-0.36%	-0.036	-9.1
Output Span:	10	Volts DC	Outliers Excluded:	2				
SP-132 Setpoint:	1540	psig	Outlier Criteria:	2.409				
SP-132 Setpoint:	6.160	Volts DC	95%/95% k:	3.081	etpoint Calculation:	I89-0014, Rev. 4		
TS Limiting value:	>=1500	psig	Percent	psig				
SP-132 As Found Tol:	0.06	Volts DC	0.60%	15				
SP-132 As Left Tol:	0.01	Volts DC	0.10%	2.5				

W-TEST DATA		Coefficients	Sorted Test Data		B terms	# of Pts.	Data	Sorted
Number of Points:	13	0.5359	-0.25%	0.28%	0.28%	1	0.01%	-0.25%
Variance (s^2):	1.43E-06	0.3325	-0.08%	0.18%	0.09%	2	-0.01%	-0.08%
S^2:	1.71E-05	0.2412	-0.05%	0.02%	0.02%	3	-0.01%	-0.05%
B:	4.02E-03	0.1707	-0.04%	0.02%	0.01%	4	-0.04%	-0.04%
B^2:	1.62E-05	0.1099	-0.02%	0.01%	0.00%	5	-0.25%	-0.02%
W = (B^2 / S^2):	0.946	0.0539	-0.01%	0.01%	0.00%	6	-0.02%	-0.01%
Critical W @ 95%:	0.859					7	0.01%	0.28%
W Test:	PASS					8	0.18%	0.18%
CHART DATA						9	-0.08%	0.02%
Calibration	Drift					10	0.28%	0.02%
Interval	Data	95%/95% Value		Zero %		11	-0.05%	0.01%
8		0.37%	-0.36%	0.00%		12	0.02%	0.01%
12	0.01%	0.37%	-0.36%	0.00%		13	0.02%	-0.01%
17		0.37%	-0.36%	0.00%		14		
17	-0.01%	0.37%	-0.36%	0.00%		15		
9	-0.01%	0.37%	-0.36%	0.00%				
18	-0.04%	0.37%	-0.36%	0.00%				
12	-0.25%	0.37%	-0.36%	0.00%				
17		0.37%	-0.36%	0.00%				
17	-0.02%	0.37%	-0.36%	0.00%				
9	0.01%	0.37%	-0.36%	0.00%				
13	0.18%	0.37%	-0.36%	0.00%				
12	-0.08%	0.37%	-0.36%	0.00%				
17	0.28%	0.37%	-0.36%	0.00%				
17	-0.05%	0.37%	-0.36%	0.00%				
17	0.02%	0.37%	-0.36%	0.00%				
17	0.02%	0.37%	-0.36%	0.00%				
19		0.37%	-0.36%	0.00%				

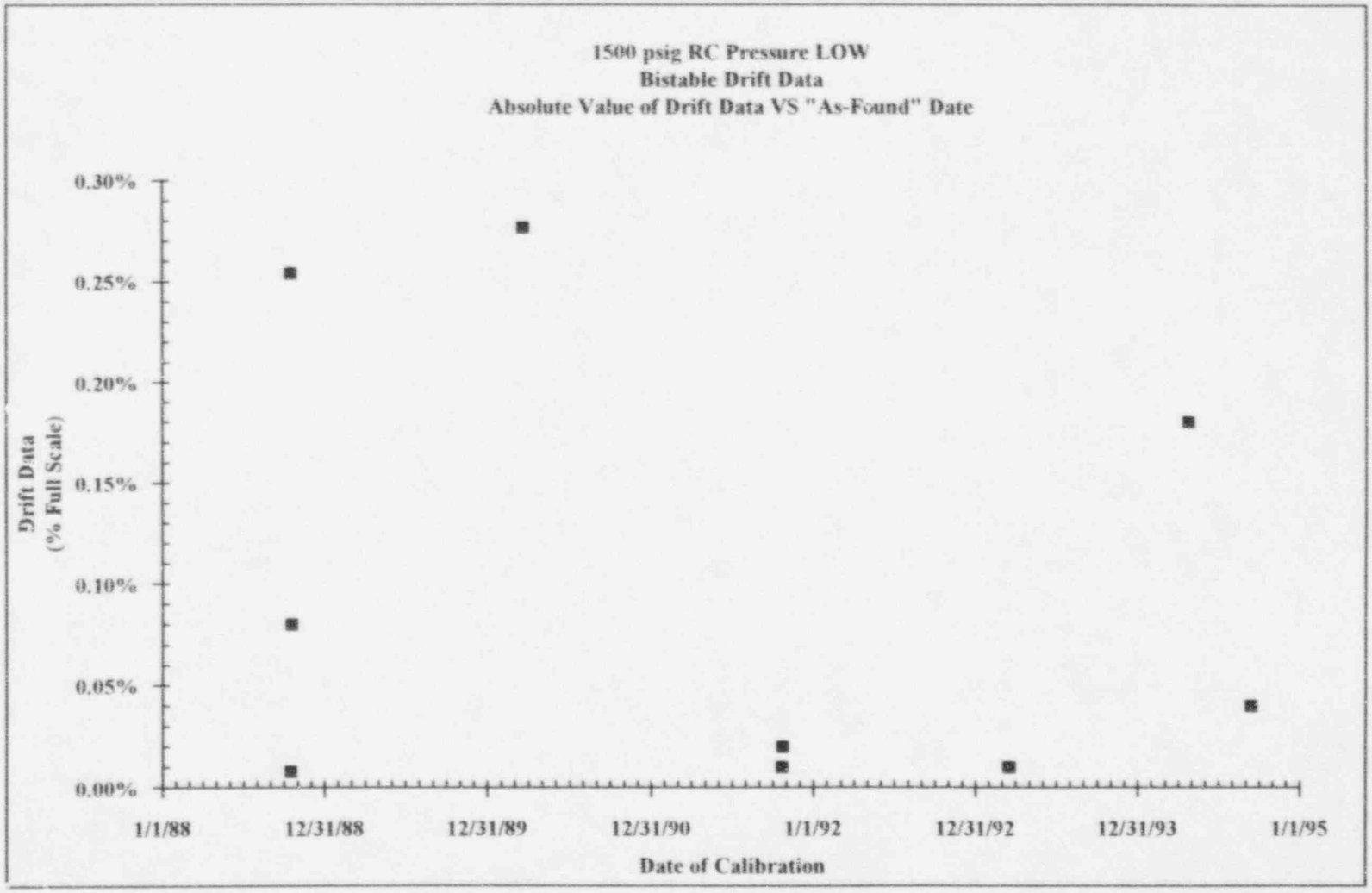
Surveillance Requirement 3.3.5.3, (1)
RC-3-BT1, RC-3-BT2 RC-3-BT3



Surveillance Requirement 3.3.5.3, (1)
RC-3-BT1, RC-3-BT2 RC-3-BT3



Surveillance Requirement 3.3.5.3, (1)
RC-3-BT1, RC-3-BT2 RC-3-BT3



RC-3A-PT3/RC-3A-PY3, RC-3B-PT3/RC-3B-PY3 & RC-3A-PT4/RC-3A-PY4-1

1500 psig RC Pressure LOW

Surveillance Procedure:	SP-132	Calibration	Interval	Five Point Data					Drift Data & Outlier Evaluation				
TAG NUMBER		Date	(Months)	0%	25%	50%	75%	100%	0%	25%	50%	75%	100%
RC-3A-PT3/RC-3A-PY3	As Left	10/6/87		0.0111	2.5172	5.0242	7.5114	10.0054					
RC-1, TEST CAB. 1	As Found	10/14/88	12.3	-0.0047	2.4573	4.9077	**7.3553**	**9.8051**	-0.16%	-0.60%	-1.17%	**-1.56%**	**-2.00%**
1500 PSIG BISTABLE LOOP	As Left	10/15/88		0.0101	2.5114	5.0149	7.5044	10.0153	DATA IS OK	DATA IS OK	OUTLIER	**OUTLIER**	**OUTLIER**
	As Found	3/20/90	17.1	0.0200	2.5100	5.0200	7.5100	10.0100	0.10%	-0.01%	0.05%	0.06%	-0.05%
	As Left	6/1/90		0.0160	2.5090	5.0070	7.5020	10.0070	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
	As Found	10/22/91	16.7	0.0060	2.4830	4.9900	7.4990	9.9990	-0.10%	-0.26%	-0.17%	-0.03%	-0.08%
X moved - Flood MAR ———	As Left	6/29/92		-0.0062	2.5053	5.0003	7.4951	10.0004	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
no "As Founds" taken.	As Found	3/16/93	8.5	-0.0180	2.4850	4.9930	7.5030	9.9820	-0.12%	-0.20%	-0.07%	0.08%	-0.18%
	As Left	3/18/93		-0.0180	2.4850	4.9930	7.5030	9.9820	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
	As Found	9/13/94	17.9	0.0250	2.4780	4.9740	7.4740	9.9820	0.43%	-0.07%	-0.19%	-0.29%	0.00%
	As Left	9/13/94		0.0250	2.4780	4.9740	7.4740	9.9820	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
RC-3A-PT4/RC-3A-PY4-1	As Left	10/1/87		0.0212	2.5147	4.9990	7.4808	9.9816					
RC-2, TEST CAB. 2	As Found	10/15/88	12.5	0.0069	2.4990	4.9864	7.4532	**9.8280**	-0.14%	-0.16%	-0.13%	-0.28%	**-1.54%**
1500 PSIG BISTABLE LOOP	As Left	10/15/88		0.0141	2.5135	5.0155	7.4987	9.9930	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	**OUTLIER**
	As Found	3/20/90	17.1	0.0050	2.4980	4.9850	7.4830	9.9972	-0.09%	-0.15%	-0.31%	-0.16%	0.04%
	As Left	6/1/90		0.0150	2.5080	5.0050	7.5020	9.9900	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
	As Found	10/23/91	16.7	0.0500	2.5490	5.0550	7.5550	10.0440	0.35%	0.41%	0.50%	0.53%	0.54%
X moved - Flood MAR ———	As Left	6/29/92		0.0050	2.5090	5.0040	7.4970	9.9950	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
no "As Founds" taken.	As Found	3/18/93	8.6	-0.0160	2.4890	4.9920	7.4920	9.9840	-0.21%	-0.20%	-0.12%	-0.05%	-0.11%
	As Left	3/19/93		-0.0160	2.4890	4.9920	7.4920	9.9840	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
	As Found	4/23/94	13.2	0.0020	2.4900	4.9890	7.4780	9.9740	0.18%	0.01%	-0.03%	-0.14%	-0.10%
	As Left	4/23/94		0.0010	2.5060	5.0000	7.4950	9.9910	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
RC-3B-PT3/RC-3B-PY3	As Left	10/4/87		0.0011	2.5000	5.0055	7.4917	9.9803					
RC-3, TEST CAB. 3	As Found	10/17/88	12.5	-0.0060	2.4975	4.9964	7.4913	9.9936	-0.07%	-0.02%	-0.09%	0.00%	0.13%
1500 PSIG BISTABLE LOOP	As Left	10/17/88		-0.0051	2.5036	5.0042	7.5024	10.0051	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
	As Found	3/20/90	17.1	-0.0080	2.5020	5.0090	7.5040	10.0020	-0.03%	-0.02%	0.05%	0.02%	-0.03%
	As Left	6/1/90		0.0060	2.5090	5.0240	7.5210	10.0240	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
	As Found	10/24/91	16.8	0.0060	2.5190	5.0380	7.5380	10.0310	0.00%	0.10%	0.14%	0.17%	0.07%
	As Left	10/24/91		-0.0010	2.4980	5.0070	7.5130	10.0020	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
	As Found	3/19/93	16.8	-0.0040	2.5250	5.0360	7.5380	9.9300	-0.03%	0.27%	0.29%	0.25%	-0.72%
	As Left	4/1/93		0.0170	2.5320	5.0320	7.5270	10.0150	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
	As Found	9/14/94	17.5	0.0140	2.5340	5.0300	7.5240	10.0120	-0.03%	0.02%	-0.02%	-0.03%	-0.03%
	As Left	9/14/94		0.0080	2.5110	5.0080	7.5030	9.9930	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK

Pressure Range:	0 to 2500	psig	SP-132	Volts DC	Percent	psig		Mean:	-0.03%		Percent	Volts DC	psig
Pressure Span:	2500	psig	+/- As Found Tol:	0.13	1.30%	32.5		Standard Deviation:	0.25%	+95%/95%:	0.55%	0.055	13.7
Output Range:	0 to 10	volts DC	+/- As Left Tol:	0.04	0.40%	10.0		Number of Points:	75	95%/95%:	-0.62%	-0.062	-15.4
Output Span:	10	volts DC						Outliers Excluded:	3	95%/95% k:	2.299		
Setpoint Calculation:	189-0014, Rev. 4							Outlier Criteria:	3.107				

RC-3A-PT3/RC-3A-PY3, RC-3B-PT3/RC-3B-PY3 & RC-3A-PT4/RC-3A-PY4-1

1500 psig RC Pressure LOW

D' TEST DATA		i	T terms	i	T terms	# of Pts.	Data	Sorted	# of Pts.	Data	Sorted		
n = Number of Points:	72	1	4.14E-01	37	-1.50E-04	1	-0.16%	-1.17%	37	-0.31%	-0.03%		
(n +1) / 2:	36.5	2	2.48E-01	38	-4.50E-04	2	0.10%	-0.72%	38	0.50%	-0.03%		
Variance (s^2):	6.42E-06	3	2.01E-01	39	-7.50E-04	3	-0.10%	-0.60%	39	-0.12%	-0.03%		
S^2:	4.56E-04	4	9.91E-02	40	-1.05E-03	4	-0.12%	-0.31%	40	-0.03%	-0.03%		
S:	2.13E-02	5	9.13E-02	41	-1.31E-03	5	0.43%	-0.29%	41	-0.09%	-0.03%		
T:	3.25E+00	6	8.42E-02	42	-1.37E-03	6	-0.14%	-0.28%	42	0.05%	-0.02%		
D' = T / S:	152.22	7	7.67E-02	43	-1.30E-03	7	-0.09%	-0.26%	43	0.14%	-0.02%		
D'1:	166.60	8	5.99E-02	44	-1.20E-03	8	0.35%	-0.21%	44	0.29%	-0.02%		
D'2:	174.90	9	5.58E-02	45	-1.19E-03	9	-0.21%	-0.20%	45	-0.02%	-0.01%		
D' Test:	FAIL	10	5.30E-02	46	-3.80E-04	10	0.18%	-0.20%	46	0.06%	0.00%		
		11	4.85E-02	47	0.00E+00	11	-0.07%	-0.19%	47	-0.05%	0.00%		
		12	4.51E-02	48	0.00E+00	12	-0.03%	-0.18%	48	0.08%	0.00%		
		13	3.99E-02	49	1.25E-03	13	0.00%	-0.17%	49	-0.29%	0.01%		
		14	3.56E-02	50	2.16E-03	14	-0.03%	-0.16%	50	-0.28%	0.02%		
		15	3.38E-02	51	2.90E-03	15	-0.03%	-0.16%	51	-0.16%	0.02%		
		16	3.22E-02	52	6.51E-03	16	-0.60%	-0.16%	52	0.53%	0.04%		
		17	3.02E-02	53	7.92E-03	17	-0.01%	-0.15%	53	-0.05%	0.05%		
		18	2.65E-02	54	8.92E-03	18	-0.26%	-0.14%	54	-0.14%	0.05%		
		19	2.45E-02	55	1.04E-02	19	0.20%	-0.14%	55	0.00%	0.06%		
		20	2.08E-02	56	1.37E-02	20	-0.07%	-0.13%	56	0.02%	0.07%		
		21	1.86E-02	57	1.62E-02	21	-0.16%	-0.12%	57	0.17%	0.08%		
		22	1.71E-02	58	2.13E-02	22	-0.15%	-0.12%	58	0.25%	0.10%		
		23	1.48E-02	59	2.25E-02	23	0.41%	-0.11%	59	-0.03%	0.10%		
		24	1.25E-02	60	3.13E-02	24	-0.20%	-0.10%	60	-0.05%	0.13%		
		25	1.15E-02	61	3.43E-02	25	0.01%	-0.10%	61	-0.08%	0.14%		
		26	9.56E-03	62	4.34E-02	26	-0.02%	-0.09%	62	-0.18%	0.17%		
		27	8.64E-03	63	4.77E-02	27	-0.02%	-0.09%	63	0.00%	0.18%		
		28	6.80E-03	64	6.88E-02	28	0.10%	-0.08%	64	0.04%	0.25%		
		29	5.47E-03	65	7.69E-02	29	0.27%	-0.07%	65	0.54%	0.27%		
		30	4.62E-03	66	8.55E-02	30	0.02%	-0.07%	66	-0.11%	0.29%		
		31	3.85E-03	67	1.07E-01	31	-1.17%	-0.07%	67	-0.10%	0.35%		
		32	2.39E-03	68	1.29E-01	32	0.05%	-0.05%	68	0.13%	0.41%		
		33	1.75E-03	69	1.40E-01	33	-0.17%	-0.05%	69	-0.03%	0.43%		
		34	7.75E-04	70	1.67E-01	34	-0.07%	-0.03%	70	0.07%	0.50%		
		35	4.50E-04	71	1.83E-01	35	-0.19%	-0.03%	71	-0.72%	0.53%		
		36	1.50E-04	72	1.92E-01	36	-0.13%	-0.03%	72	-0.03%	0.54%		

RC-3A-PT3/RC-3A-PY3, RC-3B-PT3/RC-3B-PY3 & RC-3A-PT4/RC-3A-PY4-1

1500 psig RC Pressure LOW

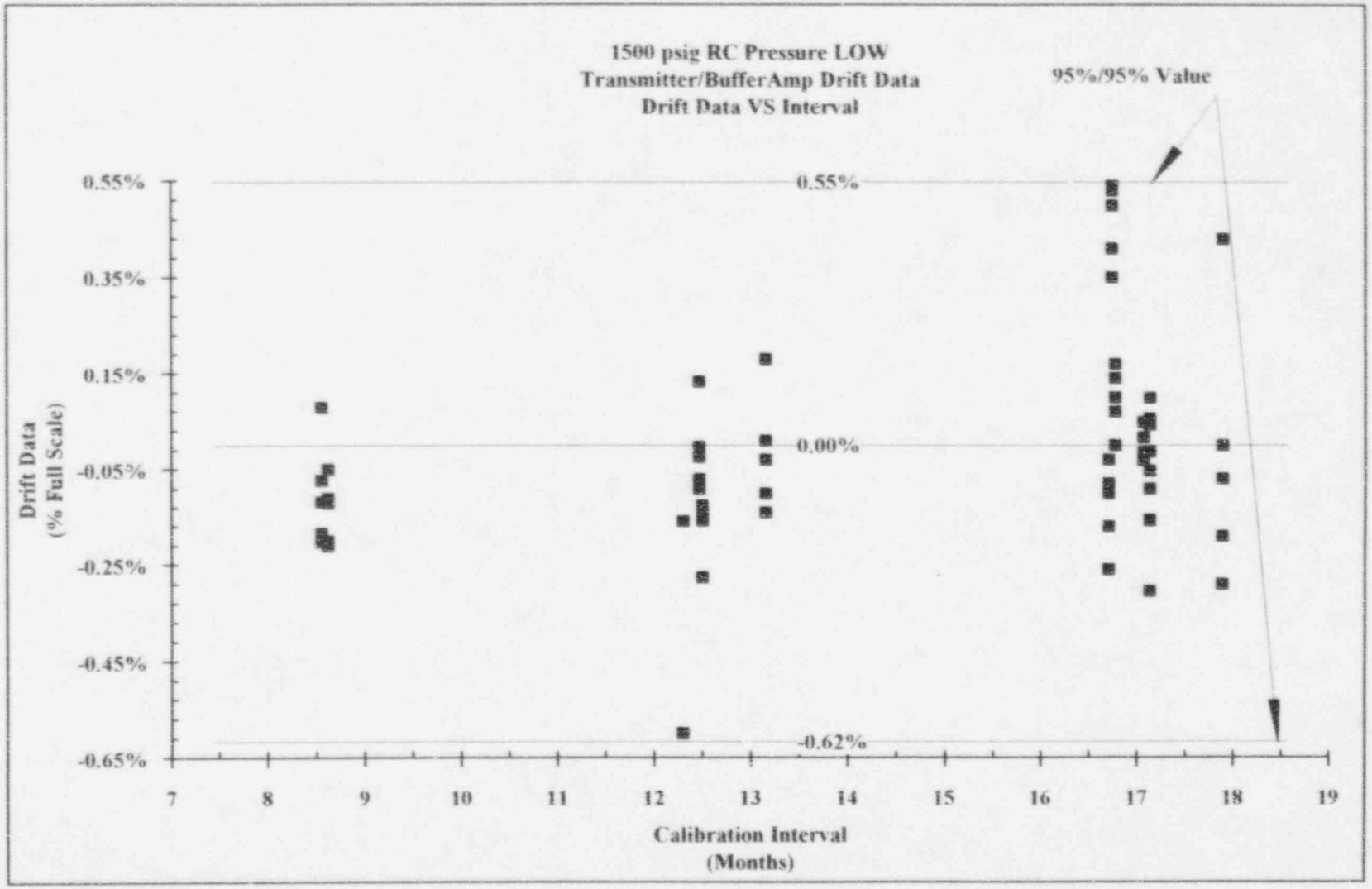
CHART DATA													
Calibration	Five Point Drift Data												
Interval	0%	25%	50%	75%	100%	95%/95% Value		Zero					
8						0.55%	-0.62%	0.00%					
12	-0.16%	-0.60%	-1.17%			0.55%	-0.62%	0.00%					
17	0.10%	-0.01%	0.05%	0.06%	-0.05%	0.55%	-0.62%	0.00%					
17	-0.10%	-0.26%	-0.17%	-0.03%	-0.08%	0.55%	-0.62%	0.00%					
9	-0.12%	-0.20%	-0.07%	0.08%	-0.18%	0.55%	-0.62%	0.00%					
18	0.43%	-0.07%	-0.19%	-0.29%	0.00%	0.55%	-0.62%	0.00%					
12	-0.14%	-0.16%	-0.13%	-0.28%		0.55%	-0.62%	0.00%					
17	-0.09%	-0.15%	-0.31%	-0.16%	0.04%	0.55%	-0.62%	0.00%					
17	0.35%	0.41%	0.50%	0.53%	0.54%	0.55%	-0.62%	0.00%					
9	-0.21%	-0.20%	-0.12%	-0.05%	-0.11%	0.55%	-0.62%	0.00%					
13	0.18%	0.01%	-0.03%	-0.14%	-0.10%	0.55%	-0.62%	0.00%					
12	-0.07%	-0.02%	-0.09%	0.00%	0.13%	0.55%	-0.62%	0.00%					
17	-0.03%	-0.02%	0.05%	0.02%	-0.03%	0.55%	-0.62%	0.00%					
17	0.00%	0.10%	0.14%	0.17%	0.07%	0.55%	-0.62%	0.00%					
17	-0.03%	0.27%	0.29%	0.25%	-0.72%	0.55%	-0.62%	0.00%					
17	-0.03%	0.02%	-0.02%	-0.03%	-0.03%	0.55%	-0.62%	0.00%					
19						0.55%	-0.62%	0.00%					

RC-3A-PT3/RC-3A-PY3, RC-3B-PT3/RC-3B-PY3 & RC-3A-PT4/RC-3A-PY4-1

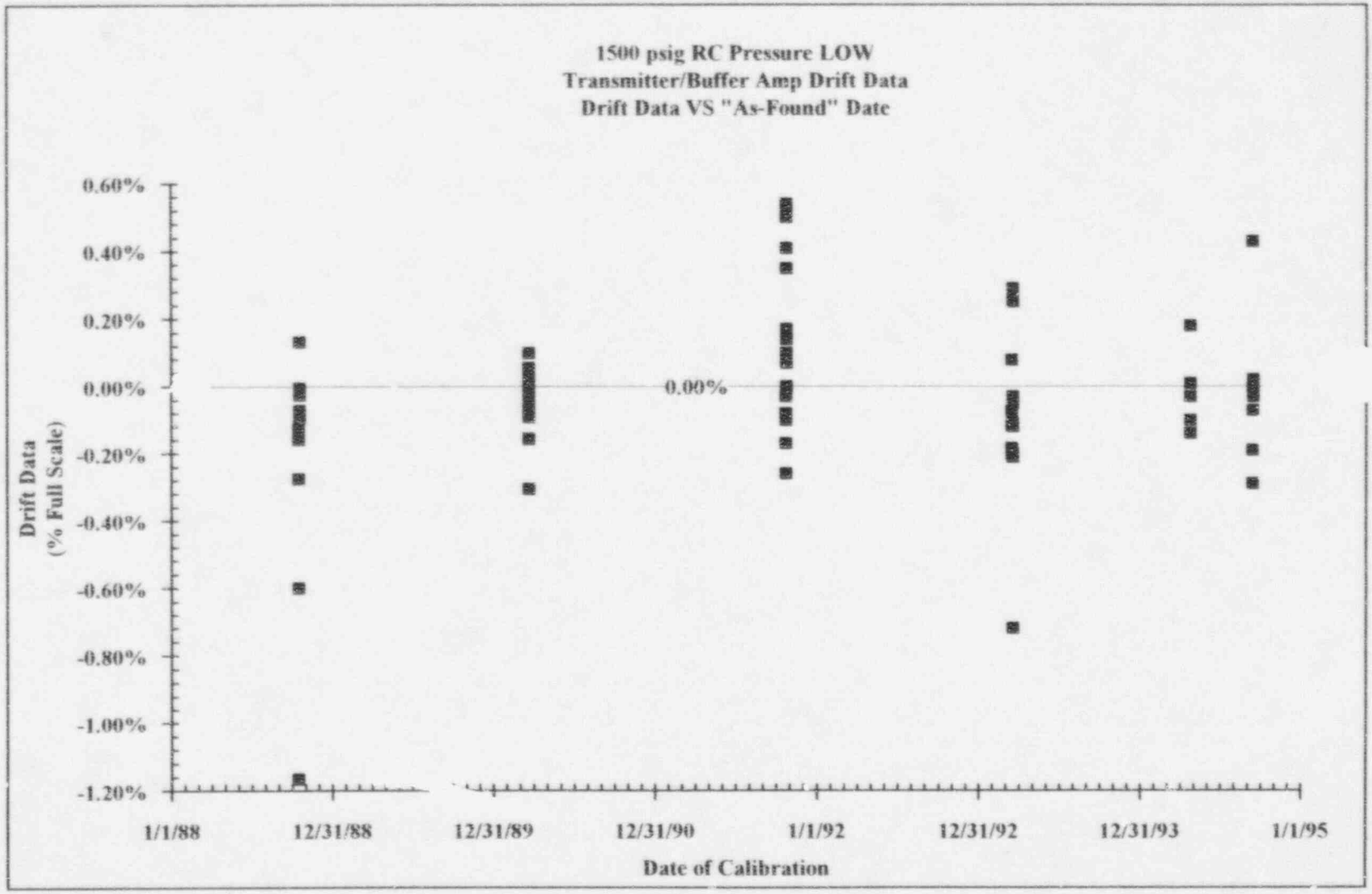
1500 psig RC Pressure LOW

HISTOGRAM DATA						Bin	Frequency		Probability for t sigma	Observed Proportion			
-4.000	-1.05%	0%	0.053	0%		-1.05%	0		0%	25.35%			
-3.750	-0.98%	0%	0.139	0%		-0.98%	0		19.74%	45.07%			
-3.500	-0.92%	0%	0.345	0%		-0.92%	0		38.29%	67.61%			
-3.250	-0.86%	0%	0.801	0%		-0.86%	0		54.67%	78.87%			
-3.000	-0.79%	0%	1.750	0%		-0.79%	0		68.27%	84.51%			
-2.750	-0.73%	1%	3.590	0%		-0.73%	1		86.64%	90.14%			
-2.500	-0.67%	0%	6.920	0%		-0.67%	0		**95.45%**	**95.77%**			
-2.250	-0.60%	1%	12.531	1%		-0.60%	1		98.76%	98.59%			
-2.000	-0.54%	0%	21.316	1%		-0.54%	0		99.73%	100.00%			
-1.750	-0.48%	0%	34.063	2%		-0.48%	0		99.95%	100.00%			
-1.500	-0.41%	0%	51.134	3%		-0.41%	0		99.9994%	100.00%			
-1.250	-0.35%	3%	72.111	5%		-0.35%	2		**Expected Value**	**Actual**			
-1.000	-0.29%	3%	95.531	6%		-0.29%	2						
-0.750	-0.22%	8%	118.890	8%		-0.22%	6						
-0.500	-0.16%	17%	138.997	9%		-0.16%	12						
-0.250	-0.10%	11%	152.658	10%		-0.10%	8						
0.000	-0.03%	25%	157.504	10%		-0.03%	18						
0.250	0.03%	8%	152.658	10%		0.03%	6						
0.500	0.09%	6%	138.997	9%		0.09%	4						
0.750	0.16%	3%	118.890	8%		0.16%	2						
1.000	0.22%	3%	95.531	6%		0.22%	2						
1.250	0.28%	1%	72.111	5%		0.28%	1						
1.500	0.35%	1%	51.134	3%		0.35%	1						
1.750	0.41%	3%	34.063	2%		0.41%	2						
2.000	0.47%	3%	21.316	1%		0.47%	2						
2.250	0.54%	1%	12.531	1%		0.54%	1						
2.500	0.60%	0%	6.920	0%		0.60%	0						
2.750	0.66%	0%	3.590	0%		0.66%	0						
3.000	0.73%	0%	1.750	0%		0.73%	0						
3.250	0.79%	0%	0.801	0%		0.79%	0						
3.500	0.85%	0%	0.345	0%		0.85%	0						
3.750	0.92%	0%	0.139	0%		0.92%	0						
4.000	0.98%	0%	0.053	0%		0.98%	0						
		100%	1579	100%			71						

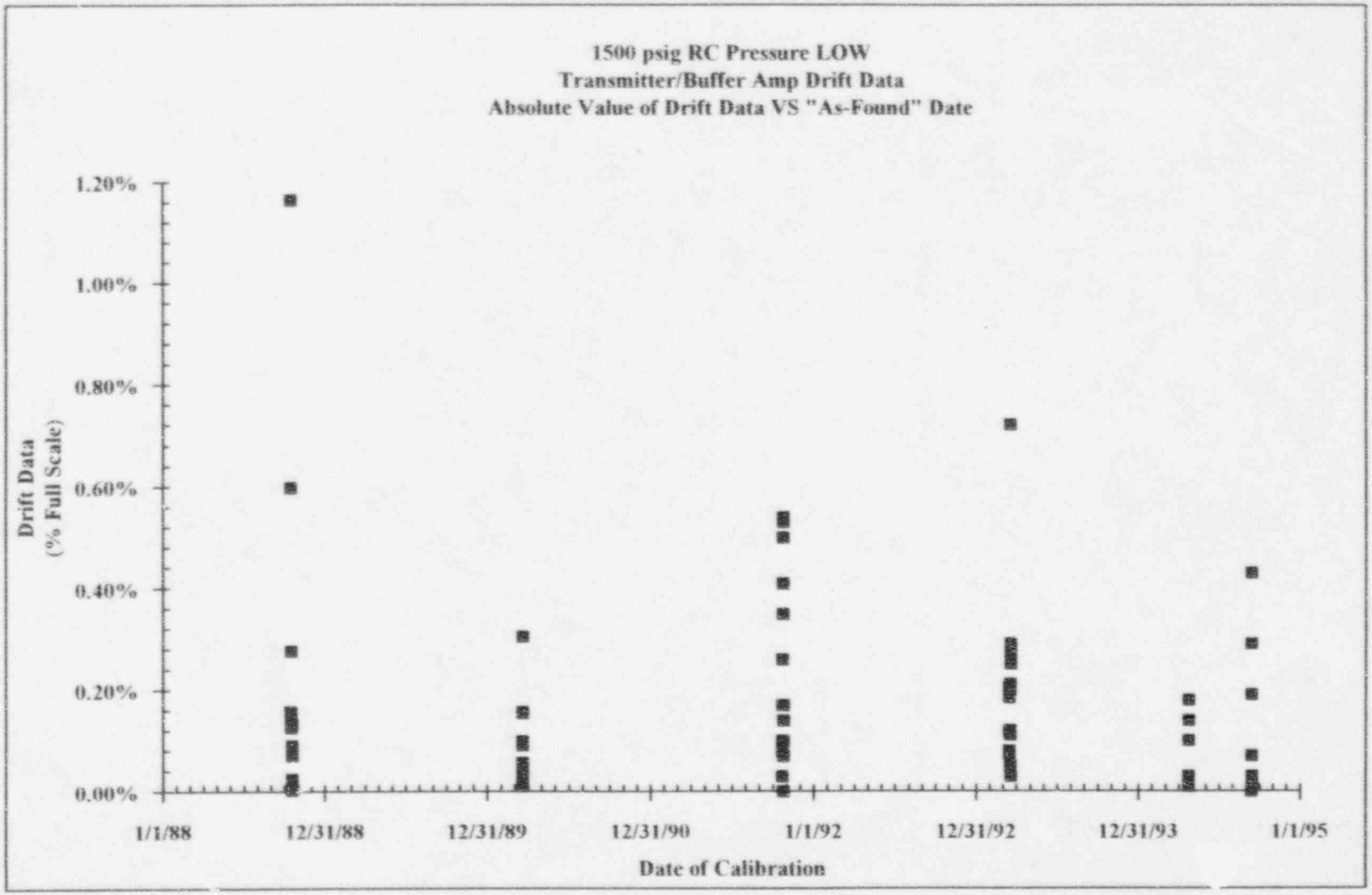
Surveillance Requirement 3.3.5.3, (1)
RC-3A-PT3/RC-3A-PY3, RC-3B-PT3/RC-3B-PY3 & RC-3A-PT4/RC-3A-PY4-1



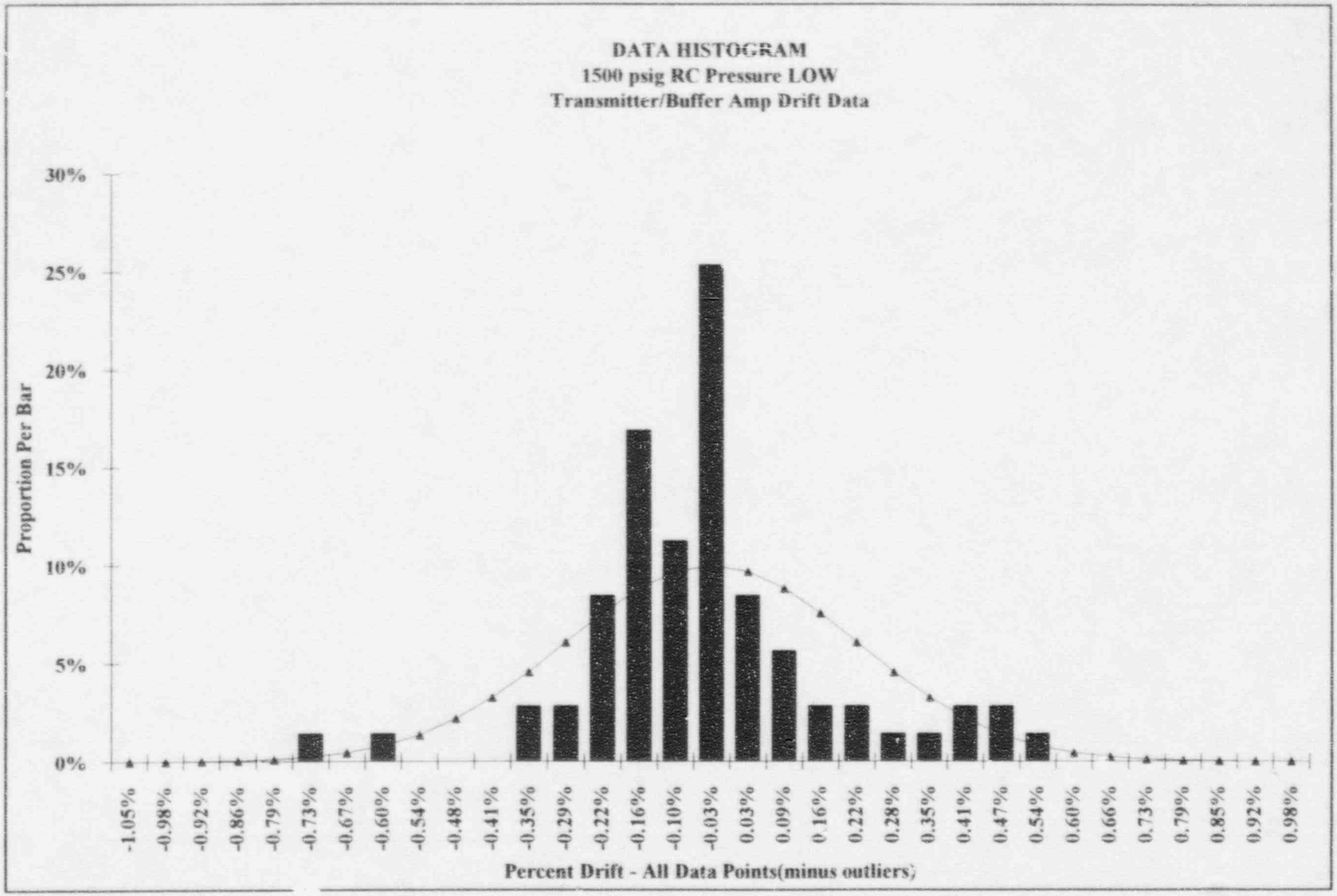
Surveillance Requirement 3.3.5.3, (1)
RC-3A-PT3/RC-3A-PY3, RC-3B-PT3/RC-3B-PY3 & RC-3A-PT4/RC-3A-PY4-1



Surveillance Requirement 3.3.5.3, (1)
RC-3A-PT3/RC-3A-PY3, RC-3B-PT3/RC-3B-PY3 & RC-3A-PT4/RC-3A-PY4-1



Surveillance Requirement 3.3.5.3, (1)
RC-3A-PT3/RC-3A-PY3, RC-3B-PT3/RC-3B-PY3 & RC-3A-PT4/RC-3A-PY4-1



SURVEILLANCE REQUIREMENT - 3.3.17.2. (3)
POST ACCIDENT MONITORING
RCS PRESSURE (WIDE RANGE)

I. SURVEILLANCE PROCEDURE & DEVICES:

A. Surveillance procedure: SP-161C.

B. Calibrated devices included in the individual instrument Drift Data analysis:

1. **DEVICE:** Pressure Transmitter
   MANUFACTURER: Rosemount
   MODEL: 1154GP9RA
   RANGE: 0 to 3000 psi
   SPAN: 0 to 3000 psi
   TAG NUMBERS: RC-158-PT & RC-159-PT
   DEVICE 30-MONTH DRIFT VALUE: ± 0.2% URL. (Upper Range Limit), for 30 months, from vendor manual; or $\pm (3000/3000 \times 0.2\%^2)^{1/2}$ or ± 0.2%).

2. **DEVICE:** Current To Voltage Converter
   MANUFACTURER: Foxboro
   MODEL: 2AI-I2V
   INPUT SPAN: 4 to 20 mA DC
   OUTPUT SPAN: 0 to 10 volts DC
   TAG NUMBERS: RC-158-PY-1 & RC-159-PY1
   DEVICE DRIFT VALUE: None Stated

3. **DEVICE:** Voltage Buffer
   MANUFACTURER: Foxboro
   MODEL: N2A0-VAI
   INPUT SPAN: 0 to 10 volts DC
   OUTPUT SPAN: 0 to 10 volts DC
   TAG NUMBERS: RC-158-PY3 & RC-159-PY3
   DEVICE DRIFT VALUE: None Stated

4. **DEVICE:** Pressure Indicator
   MANUFACTURER: Bailey
   MODEL: RY
   INPUT SPAN: 0 to 10 volts DC
   INDICATING RANGE: 0 to 3000 psig
   TAG NUMBERS: RC-158-PI-2 & RC-159-PI-2
   DEVICE DRIFT VALUE: None Stated

SURVEILLANCE REQUIREMENT - 3.3.17.2, (3)
POST ACCIDENT MONITORING
RCS PRESSURE (WIDE RANGE)

5. **DEVICE:** Pressure Recorder
MANUFACTURER: Foxboro
MODEL: N227P-1R6-CS-N/SRC
INPUT SPAN: 0 to 10 volts DC
INDICATING RANGE: 0 to 3000 psig
TAG NUMBERS: RC-158-PIR
DEVICE DRIFT VALUE: None Stated

II. NRC GENERIC LETTER 91-04 Analysis Criteria and DRIFT STUDY RESULTS:

1. ***"Confirm that instrument drift as determined by "As-Found" and "As-Left" calibration data from surveillance and maintenance records has not, except on rare occasions, exceeded acceptable limits for a calibration interval."***

`Per Refueling interval surveillance procedure, SP-161C, "Remote Shutdown Instrument Calibration", the components listed on the preceding page have not exceeded acceptable "As-Found" surveillance procedure tolerances, for the surveillance intervals investigated.

INDICATOR LOOP: Three OUTLIERs were identified. However, the OUTLIERs do not exceed the "As-Found" procedure tolerance. Hence, these OUTLIERS are ACCEPTABLE and will not be removed from the Drift Data. Raw calibration data points which have exceeded "As-Found" tolerance: 0 of 40.

RECORDER LOOP: No OUTLIERs were identified. Raw calibration data points which have exceeded "As-Found" tolerance: 0 of 25.

2. ***"Confirm that the values of drift for each instrument type, (make, model and range) and application have been determined with a high probability and a high degree of confidence. Provide a summary of the methodology and assumptions used to determine the rate of instrument drift with time based upon historical plant data."***

Standard statistical methodologies were utilized in this DRIFT STUDY. The following references were consulted to establish the techniques used in this evaluation.

1. ISA-S67.04, Part I Standard, Setpoints for Nuclear Safety-Related Instrumentation
2. ISA-S67.04, Part II Recommended Practice, Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation
3. EPRI document TR-103335, "Guidelines for Instrument Calibration Extension/Reduction Programs", Project 2409-21, final Report dated March 1994

SURVEILLANCE REQUIREMENT - 3.3.17.2, (3)
POST ACCIDENT MONITORING
RCS PRESSURE (WIDE RANGE)

4. American Society of Testing and Materials (ASTM) standard E178-1980, (re-approved 1989), "Standard Practice for Dealing With Outlying Observations."
5. ANSI N15.15-1974, American National Standard Assessment of the Assumption of Normality
6. Probability and Statistics 4th Edition, Irwin Miller/John E Freund/Richard A. Johnson

The summary of the EPRI project observations, from section 9, "CONCLUSIONS" is as follows:

A. Instrument drift tends to increase with instrument span.

B. Instrument drift tends to be bounded by a normal distribution.

C. Instrument drift rarely showed any significant indication of time dependency.

D. Instrument Drift Data often showed no bias for the direction of drift.

E. OUTLIER checks are necessary to detect data errors.

The methods utilized in this drift study, can be summarized as follows:

A. Instrument calibration data, ("As-Found" and "As-Left"), is obtained from, (typically), five intervals of the appropriate Refueling interval surveillance procedure. The number of intervals may change if instruments have been replaced with a different type, etc.

B. A spread sheet computer program, which can be run on a personal computer is utilized for ease of analysis. Florida Power Corporation utilizes Microsoft Excel, running under a Microsoft Windows environment. See the **"SPREAD SHEET FORMAT"** section below for an explanation of the spread sheet data and calculations.

C. The "RAW" "As Found" and "As Left" data is obtained from the associated Refueling interval surveillance procedure, and entered onto the spread sheet.

D. Drift Data information is obtained by subtracting the "As-Left" data from the "As-Found" data from one "As-Found" date to the next. This difference is divided by the calibrated span and the Drift Data is then expressed as a PERCENT OF SPAN.

E. Drift Data is analyzed and the MEAN and STANDARD DEVIATION is determined. "OUTLIER detection by critical values of T" test is performed and if required, the Drift Data OUTLIERs may be excluded from further analysis.

SURVEILLANCE REQUIREMENT - 3.3.17.2, (3)
POST ACCIDENT MONITORING
RCS PRESSURE (WIDE RANGE)

F. Next, the tolerance interval for the data is calculated by multiplying each calculated STANDARD DEVIATION by the appropriate 95%/95% tolerance factor. This factor indicates a 95% level of confidence, that 95% of the instrument Drift Data will be contained within the tolerance interval.

G. The Drift Data is tested to verify the assumption that the data is "NORMAL". Either a D'-test or W-test may be performed. If the Drift Data fails these tests, then a "COVERAGE ANALYSIS" is performed. The Coverage Analysis requires that Drift Data be analyzed to determine if the data is bounded by a normal distribution. A "DATA HISTOGRAM" is plotted, as well as a comparison table of the actual distribution of the Drift Data versus the expected probability distribution to show that the Drift Data is normally bounded.

H. To evaluate time dependency, the Drift Data is charted versus calibration interval, (in months), and also charted versus calibration, ("As-Found"), date. The charts can then be utilized to demonstrate no time dependent trend is observed.

I. If the Drift Data is demonstrated to (1) be "normal" and (2) is not time dependent, then the 95%/95% Tolerance values for the instruments are assumed to envelop the 30-month drift values, hence the projected 30-month drift is the 95%/95% Tolerance values.

SPREAD SHEET FORMAT

The surveillance procedure data is arranged in a spread sheet format which displays the following information:

A. Instrument Tag Number/Channel/Descriptor,

B. "As-Found" and "As-Left" calibration dates of the surveillance procedure, which are used to Calculate the calibration "INTERVAL"s,

C. Raw "As-Found" and "As-Left" device data, (voltage, pressure, etc.),

D. "DRIFT DATA", (difference between "As-Found" and "As-Left" data divided by the calibrated SPAN of the instrument, expressed in PERCENT of SPAN),

E. "OUTLIER detection by critical values of T" test,

SURVEILLANCE REQUIREMENT - 3.3.17.2, (3)
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F. Range, Calibrated Span, "As-Found" and "As-Left" tolerances, Instrument Error/Setpoint calculation number, device setpoint, Technical Specification Limiting Value, etc. is provided for reference.

G. Drift Data statistical information: MEAN, STANDARD DEVIATION, OUTLIER CRITERIA, number of Drift Data points, number of OUTLIERs excluded, 95%/95% "k" value, and the calculated ± 95%/95% tolerance values.

H. The D'-test or W-test for "normal" data assumption is performed. If the data fails the appropriate test, a Drift Data Histogram and coverage analysis is performed.

I. Drift Data, surveillance interval, "As-Found" dates, ±95%/95% tolerance values, and zero % values are provided for charting.

3. ***"Confirm that the magnitude of instrument drift has been determined with a high probability and a high degree of confidence for a bounding calibration interval of 30 months for each instrument type, (make, model number and range) and application that performs a safety function. Provide a list of the channels by Technical Specification section that identifies these instrument applications."***

The Drift Data calculations for each Surveillance Requirement, establishes the "±95%/95%" Tolerance Factor. This calculated value indicates a 95% level of confidence, that 95% of the population, (instrument Drift Data), will be within the stated interval.

INDICATOR LOOP: The RC Wide Range Pressure Indicators Drift Data, did not pass the W-TEST. However, a "COVERAGE ANALYSIS" was performed on the data, including a "DATA HISTOGRAM" chart and also a "NORMAL DISTRIBUTION" comparison.

A review of the Drift Data Histogram, indicates a high "kurtosis", (large peak), at 0% drift, (27 of 40 Drift Data points), which virtually assure that the data will fail a normality test.

The "Actual" coverage distribution envelopes the "Expected Value", from 0 to 1.5 sigma. However, the "Actual" Histogram distribution is slightly smaller than the "Expected Value", at 2 sigma, (90% vs 95.45%, a difference two Drift Data points). The "Actual" again envelopes the "Expected" at 3.5 sigma, (100% vs 99.95%) and above. For the purposes of this Drift Study, the Drift Data will be considered "normal".

RECORDER LOOP: The RC Wide Range Pressure Recorder Drift Data, passed the W-TEST, (the data is "normal"), and the associated charts indicate that the Drift Data is neither calibration interval dependent nor time, (age), dependent.

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POST ACCIDENT MONITORING
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In summary, the Drift Data for both indicators and recorder is considered "normal" and does not appear to be time dependent.

As indicated on page one, the Surveillance Requirement and instruments covered by this analysis, are as follows:

Surveillance Requirement: 3.3.17.2, (3); Post Accident Monitoring -- RCS Pressure - Wide Range.

Surveillance procedure: SP-161C.

Technical Specification Allowable Value: None, since this is Post Accident Monitoring instrumentation only.

Surveillance Procedure Setpoint: No setpoints are associated with this Post Accident Monitoring Instrumentation.

Tag Numbers: RC-158-PT, RC-158-PY-1, RC-158-PY3 & RC-158-PI-2 & RC-158-PIR
RC-159-PT, RC-159-PY1, RC-159-PY3, RC-159-PI-2

±95%/95% Tolerances:

RC-158/159-PI-2	RC-158-PIR
+ 0.70%, 20.9 psig	+ 1.32%, 39.5 psig
- 0.61%, -18.4 psig	- 1.07%, -32.0 psig

4. *"Confirm that a comparison of the projected instrument drift errors has been made with the values of drift used in the setpoint analysis. If this results in revised setpoints to accommodate larger drift errors, provide proposed Technical Specification changes to update trip setpoints. If the drift errors result in a revised safety analysis to support existing setpoints, provide a summary of the updated analysis conclusions to confirm that the safety limits and safety analysis assumptions are not exceeded."*

These Post Accident Monitoring, (PAM), indicators have no setpoints, hence no setpoint analysis changes will be required.

The projected 30-month drift terms for the recorder has never been exceeded in the intervals investigated. The projected 30-month drift terms for the indicators has only been exceeded by 3 of 40 or 7.5% of the total Drift Data points. Note that the three Drift Data points were identified as OUTLIERs, but were not removed from the Drift Data because the points did not exceed allowable "As-Found" tolerances. Hence, since Drift Data is not time dependent,

SURVEILLANCE REQUIREMENT - 3.3.17.2, (3)
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we have a high level of confidence, that future Drift Data will be contained within the projected tolerance interval.

5. *"Confirm that the projected instrument errors caused by drift are acceptable for control of plant parameters to effect a safe shutdown. Licensees must confirm that the instrument errors caused by drift will not affect the capability to achieve safe shutdown."*

Per the Instrument Accuracy Calculation, (I88-0020, Rev. 7), and FPC drawing, 205-047 RC-02, the RCS Wide Range Pressure loops input to:

A. RCS Wide Range Pressure Recorder at MCB (RC-158-PT loop only).
B. RCS Wide Range Pressure Indicators at MCB.
C. RCS Wide Range Pressure Indicators at RSP.
D. RCS Wide Range Pressure to RECALL.
E. RCS Wide Range Pressure to ATWS-DSS.

With the exception of the outputs to ATWS-DSS, all the above functions are recording and indication only. Per the methodology utilized in the revised Instrument Accuracy Calculation, a new ATWS-DSS setpoint has been provided, and will be incorporated into the associated surveillance procedures, as required. Hence, the 30-month drift value will not affect the capability to achieve safe shutdown.

6. *"Confirm that all conditions and assumptions of the setpoint and safety analysis have been checked and are appropriately reflected in the acceptance criteria of plant surveillance procedures for CHANNEL CHECKS, CHANNEL FUNCTIONAL TESTS and CHANNEL CALIBRATIONS."*

Engineering has revised and upgraded the Instrument Accuracy Calculation, (I88-0020, Rev. 7), for these PAM devices. The majority of string devices have no 30-month drift error terms. However, revised "As-Left" and "As-Found" calibration tolerances and the revised ATWS-DSS setpoints will be incorporated into the appropriate CHANNEL CHECK, CHANNEL FUNCTIONAL TEST and CHANNEL CALIBRATION surveillance procedures, as required.

7. *"Provide a summary description of the program for monitoring and assessing the effects of increased calibration surveillance intervals on instrument drift and its effect on safety.*

The instrument "DRIFT PROGRAM" is an ongoing program which will monitor future surveillance procedure "As-Found" and "As-Left" data, and will incorporate new data into the Drift Study spread sheets with the existing Drift Data. The revised Drift Data MEAN, STANDARD DEVIATION, ± 95%/95% TOLERANCE INTERVALS, etc., will be

compared with the existing Drift Data, to ensure the conclusions reached in this report remain valid.

III. DRIFT STUDY SUMMARY:

1. Per Refueling interval surveillance procedure, SP-161C, the PAM instruments have not exceeded acceptable, "As-Found" surveillance procedure tolerances.

   INDICATOR LOOP: Three OUTLIERs were identified. However, the OUTLIERs do not exceed the "As-Found" procedure tolerance. Hence, these OUTLIERS are ACCEPTABLE and will not be removed from the Drift Data. Raw calibration data points which have exceeded "As-Found" tolerance: 0 of 40.

   RECORDER LOOP: No OUTLIERs were identified. Raw calibration data points which have exceeded "As-Found" tolerance: 0 of 25.

2. The attached spread sheets and charts present calculated Drift Data and the associated statistical information using the methods described in the references. The methodology is summarized in section **II.2**, above.

3. The pressure indicators and the pressure recorder Drift Data is considered "normal". The associated charts indicate that the Drift Data for both indicator and recorder is neither calibration interval dependent nor time, (age), dependent. Hence, the 95%/95% Tolerance values can be assumed to envelop the 30-month drift values.

4. These Post Accident Monitoring indicators have no setpoints, hence no setpoint analysis changes will be required. The projected 30-month drift terms for the recorder has never been exceeded in the intervals investigated. The projected 30-month drift terms for the indicators has only been exceeded by 3 of 40 or 7.5% of the total Drift Data points. Note that the three Drift Data points were identified as OUTLIERs, but were not removed from the Drift Data because the points did not exceed allowable "As-Found" tolerances. Hence, since Drift Data is not time dependent, we have a high level of confidence, that future Drift Data will be contained within the projected tolerance interval.

5. With the exception of the outputs to ATWS-DSS, all the above functions are recording and indication only. Per the methodology utilized in the revised Instrument Accuracy Calculation, a new ATWS-DSS setpoint has been provided, and will be incorporated into the associated surveillance procedures, as required. Hence, the 30-month drift value will not affect the capability to achieve safe shutdown.

SURVEILLANCE REQUIREMENT - 3.3.17.2, (3)
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6. Engineering has revised and upgraded the Instrument Accuracy Calculation, (I88-0020, Rev. 7), for these PAM devices. The majority of string devices have no 30-month drift error terms. However, revised "As-Left" and "As-Found" calibration tolerances and the revised ATWS-DSS setpoint will be incorporated into the appropriate CHANNEL CHECK, CHANNEL FUNCTIONAL TEST and CHANNEL CALIBRATION surveillance procedures, as required.

7. The instrument "DRIFT PROGRAM" is an ongoing program which will monitor future surveillance procedure "As-Found" and "As-Left" data, and will incorporate new data into the existing Drift Study spread sheets. The revised Drift Data will be compared with the existing Drift Data, to ensure the conclusions reached in this report remain valid.

IV. CONCLUSION:

Based on the above summary, the Surveillance Interval for this Technical Specification calibration requirement can be extended to 30-months.

SP-161C

RC-158/159-PI-2

RC PRESSURE INDICATION – WIDE RANGE

SP-161C		Calibration	Interval	Five Point Data					Drift Data & Outlier Evaluation				
TAG NUMBER		Date	(Months)	0%	25%	50%	75%	100%	0%	25%	50%	75%	100%
RC-158-PI-2	As Left	9/2/89		0	750	1500	2275	3000					
RC-158-PT Replaced 9-89	As Found	3/30/90	6.9	0	750	1500	2250	3000	0.00%	0.00%	0.00%	**-0.83%**	0.00%
	As Left	5/27/90		0	750	1500	2250	3000	DATA IS OK	DATA IS OK	DATA IS OK	**OUTLIER**	DATA IS OK
4-20-94 As-Found & As-Left	As Found	11/7/91	17.4	0	760	1520	2275	3000	0.00%	0.33%	0.67%	**0.83%**	0.00%
Data Taken at 96.7% Vs	As Left	11/7/91		0	750	1500	2260	3000	DATA IS OK	DATA IS OK	DATA IS OK	**OUTLIER**	DATA IS OK
100%. Data Extrapolated To	As Found	6/29/92	7.7	0	745	1505	2255	3000	0.00%	-0.17%	0.17%	-0.17%	0.00%
100% To Be Consistent	As Left	6/29/92		5	745	1505	2255	3000	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
With Previous Data	As Found	4/5/93	9.2	0	750	1500	2250	3000	-0.17%	0.17%	-0.17%	-0.17%	0.00%
	As Left	4/5/93		0	750	1500	2250	3000	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
	As Found	4/20/94	12.5	0	750	1500	2250	3000	0.00%	0.00%	0.00%	0.00%	0.00%
	As Left	4/20/94		0	750	1500	2250	3000	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
RC-159-PI-2	As Left	5/27/90		0	725	1490	2250	3000					
RC-159-PT Replaced 5-90	As Found	11/7/91	17.4	0	750	1500	2250	3000	0.00%	**0.83%**	0.33%	0.00%	0.00%
4-20-94 As-Found & As-Left	As Left	11/7/91		0	750	1500	2250	3000	DATA IS OK	**OUTLIER**	DATA IS OK	DATA IS OK	DATA IS OK
Data Taken at 96.7% Vs	As Found	4/5/93	16.9	0	750	1500	2250	3000	0.00%	0.00%	0.00%	0.00%	0.00%
100%. Data Extrapolated To	As Left	4/5/93		0	750	1500	2250	3000	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
100% To Be Consistent	As Found	4/20/94	12.5	0	750	1500	2250	3000	0.00%	0.00%	0.00%	0.00%	0.00%
With Previous Data	As Left	4/20/94		0	750	1500	2250	3000	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
RC-158/159-PI-2 Range:	0 to 3000	**psig**						**Mean:**	0.04%		**Percent**	**psig**	
Span:	3000	**psig**						**Standard Deviation:**	0.27%	**+95%/95%:**	0.70%	20.9	
SP-161C As Found Tol.:	75	**psig**	2.50%					**Number of Points:**	40	**-95%/95%:**	-0.61%	-18.4	
SP-161C As Left Tol.:	50	**psig**	1.67%					**Outliers Excluded:**	0				
Loop Accuracy Calculation:	**188-0020, Rev. 7**							**Outlier Criteria:**	2.856				
								95%/95% k:	2.445				

RC-158/159-P1-2

RC PRESSURE INDICATION -- WIDE RANGE

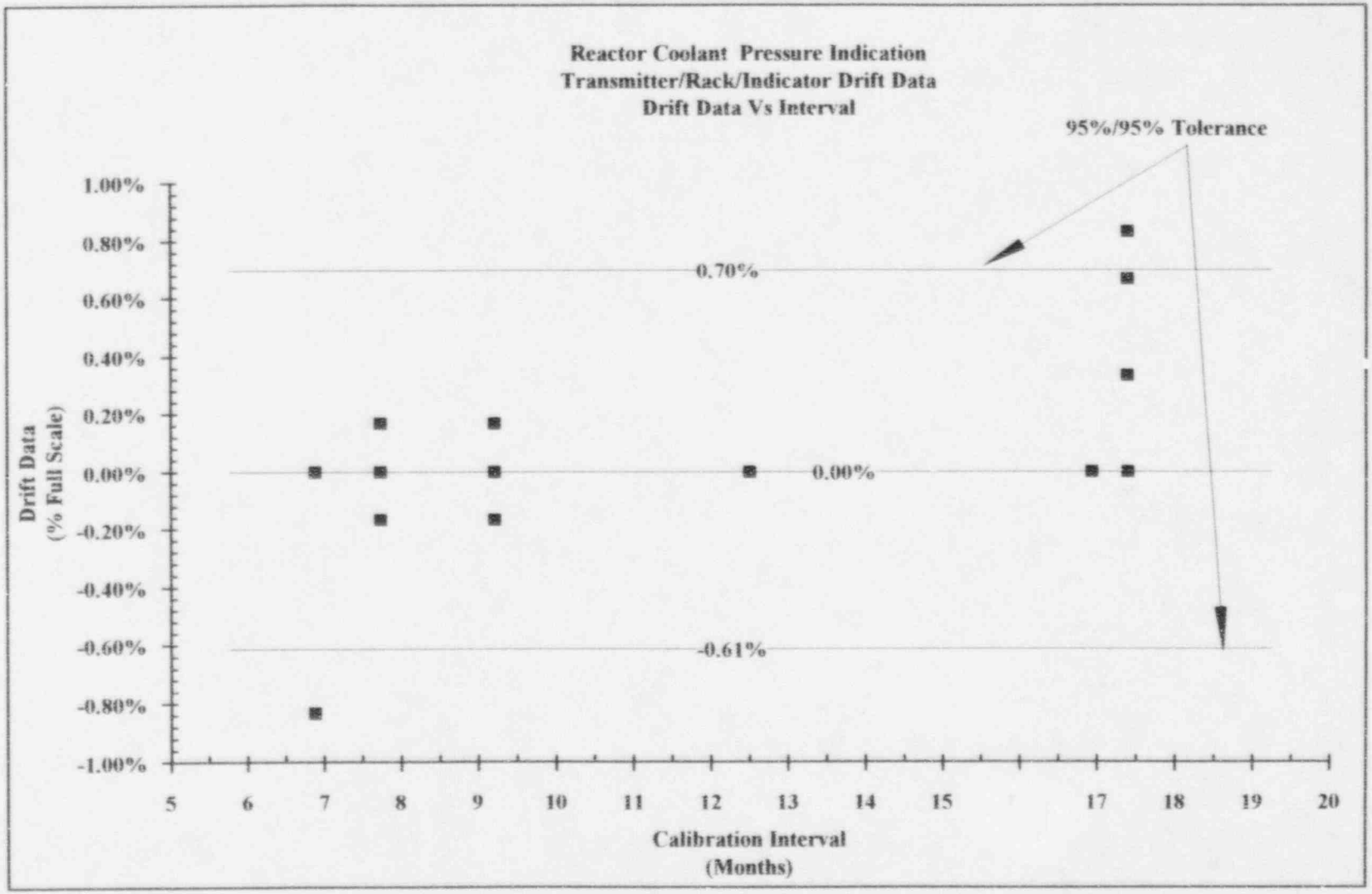
W-TEST DATA		Coefficients	Sorted Test Data		B terms	# of Pts.	Data	Sorted	# of Pts.	Data	Sorted
Number of Points:	40	0.3964	-0.83%	0.83%	0.66%	1	0.00%	-0.83%	21	0.00%	0.83%
Variance (s^2):	7.19E-06	0.2737	-0.17%	0.83%	0.27%	2	0.00%	-0.17%	22	0.33%	0.83%
S^2:	2.80E-04	0.2368	-0.17%	0.67%	0.20%	3	0.00%	-0.17%	23	0.00%	0.67%
B:	1.41E-02	0.2098	-0.17%	0.33%	0.10%	4	-0.17%	-0.17%	24	0.00%	0.33%
B^2:	1.99E-04	0.1878	-0.17%	0.33%	0.09%	5	0.00%	-0.17%	25	-0.83%	0.33%
W = (B^2 / S^2):	0.712	0.1691	-0.17%	0.17%	0.06%	6	0.00%	-0.17%	26	0.83%	0.17%
Critical W @ 95%:	0.940	0.1526	0.00%	0.17%	0.03%	7	0.00%	0.00%	27	-0.17%	0.17%
W Test:	FAIL	0.1376	0.00%	0.00%	0.00%	8	0.00%	0.00%	28	-0.17%	0.00%
		0.1237	0.00%	0.00%	0.00%	9	0.00%	0.00%	29	0.00%	0.00%
		0.1108	0.00%	0.00%	0.00%	10	0.33%	0.00%	30	0.00%	0.00%
		0.0986	0.00%	0.00%	0.00%	11	-0.17%	0.00%	31	0.00%	0.00%
		0.0870	0.00%	0.00%	0.00%	12	0.17%	0.00%	32	0.00%	0.00%
		0.0759	0.00%	0.00%	0.00%	13	0.00%	0.00%	33	0.00%	0.00%
		0.0651	0.00%	0.00%	0.00%	14	0.83%	0.00%	34	0.00%	0.00%
		0.0546	0.00%	0.00%	0.00%	15	0.00%	0.00%	35	0.00%	0.00%
		0.0444	0.00%	0.00%	0.00%	16	0.00%	0.00%	36	0.00%	0.00%
		0.0343	0.00%	0.00%	0.00%	17	0.00%	0.00%	37	0.00%	0.00%
		0.0244	0.00%	0.00%	0.00%	18	0.67%	0.00%	38	0.00%	0.00%
		0.0146	0.00%	0.00%	0.00%	19	0.17%	0.00%	39	0.00%	0.00%
		0.0049	0.00%	0.00%	0.00%	20	-0.17%	0.00%	40	0.00%	0.00%

Chart Data								
Calibration	Five Point Drift Data					95%/95% Limits		Zero %
Interval	0%	25%	50%	75%	100%			
6						0.70%	-0.61%	0.00%
7	0.00%	0.00%	0.00%	-0.83%	0.00%	0.70%	-0.61%	0.00%
17	0.00%	0.33%	0.67%	0.83%	0.00%	0.70%	-0.61%	0.00%
8	0.00%	-0.17%	0.17%	-0.17%	0.00%	0.70%	-0.61%	0.00%
9	-0.17%	0.17%	-0.17%	-0.17%	0.00%	0.70%	-0.61%	0.00%
12	0.00%	0.00%	0.00%	0.00%	0.00%	0.70%	-0.61%	0.00%
17	0.00%	0.83%	0.33%	0.00%	0.00%	0.70%	-0.61%	0.00%
17	0.00%	0.00%	0.00%	0.00%	0.00%	0.70%	-0.61%	0.00%
12	0.00%	0.00%	0.00%	0.00%	0.00%	0.70%	-0.61%	0.00%
18						0.70%	-0.61%	0.00%

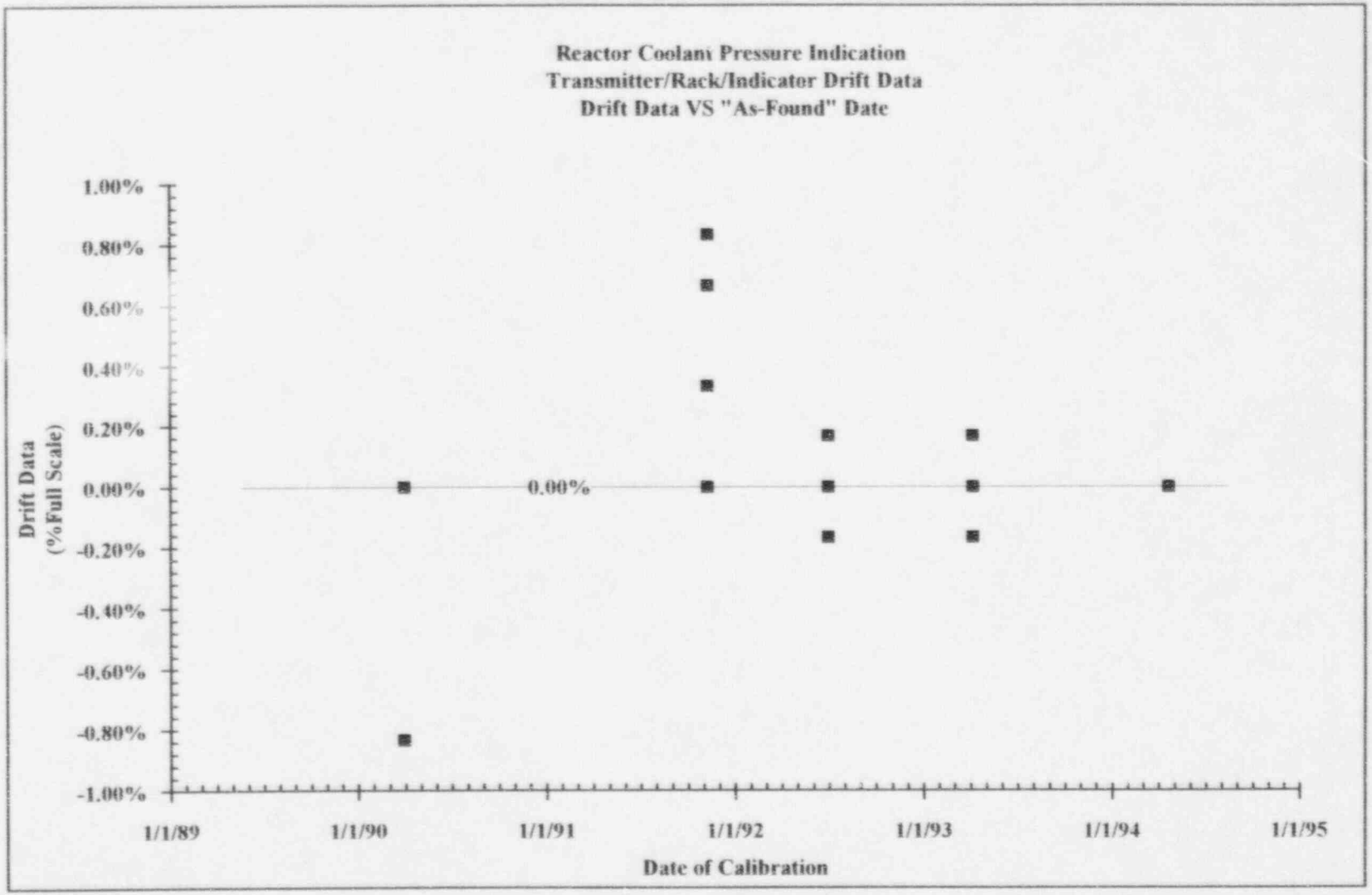
RC PRESSURE INDICATION -- WIDE RANGE

Histogram Data												
						Bin	Frequency		t	Probability for t-sigma	Observed Proportion	
-4.00	-1.03%	0.0%	0.05	0.0%		-1.03%	0		0.000	0%	0.00%	
-3.75	-0.96%	0.0%	0.13	0.0%		-0.96%	0		0.250	19.74%	72.50%	
-3.50	-0.90%	2.5%	0.33	0.0%		-0.90%	1		0.500	38.29%	72.50%	
-3.25	-0.83%	0.0%	0.76	0.1%		-0.83%	0		0.750	54.67%	72.50%	
-3.00	-0.76%	0.0%	1.65	0.1%		-0.76%	0		1.000	68.27%	90.00%	Additional Pts
-2.75	-0.70%	0.0%	3.39	0.2%		-0.70%	0		1.500	86.64%	90.00%	3
-2.50	-0.63%	0.0%	6.54	0.4%		-0.63%	0		**2.000**	**95.45%**	**90.00%**	**97.50%**
-2.25	-0.56%	0.0%	11.84	0.8%		-0.56%	0		2.500	98.76%	92.50%	
-2.00	-0.49%	0.0%	20.14	1.3%		-0.49%	0		3.000	99.73%	97.50%	
-1.75	-0.43%	0.0%	32.18	2.2%		-0.43%	0		3.500	99.95%	100.00%	
-1.50	-0.36%	0.0%	48.31	3.2%		-0.36%	0		4.000	99.9994%	100.00%	
-1.25	-0.29%	0.0%	68.13	4.6%		-0.29%	0			**Expected Value**	**Actual**	
-1.00	-0.23%	12.5%	90.26	6.0%		-0.23%	5					
-0.75	-0.16%	0.0%	112.32	7.5%		-0.16%	0					
-0.50	-0.09%	0.0%	131.32	8.8%		-0.09%	0					
-0.25	-0.03%	67.5%	144.23	9.7%		-0.03%	27					
0.00	0.04%	0.0%	148.81	10.0%		0.04%	0					
0.25	0.11%	5.0%	144.23	9.7%		0.11%	2					
0.50	0.18%	0.0%	131.32	8.8%		0.18%	0					
0.75	0.24%	0.0%	112.32	7.5%		0.24%	0					
1.00	0.31%	5.0%	90.26	6.0%		0.31%	2					
1.25	0.38%	0.0%	68.13	4.6%		0.38%	0					
1.50	0.44%	0.0%	48.31	3.2%		0.44%	0					
1.75	0.51%	0.0%	32.18	2.2%		0.51%	0					
2.00	0.58%	0.0%	20.14	1.3%		0.58%	0					
2.25	0.64%	2.5%	11.84	0.8%		0.64%	1					
2.50	0.71%	0.0%	6.54	0.4%		0.71%	0					
2.75	0.78%	5.0%	3.39	0.2%		0.78%	2					
3.00	0.85%	0.0%	1.65	0.1%		0.85%	0					
3.25	0.91%	0.0%	0.76	0.1%		0.91%	0					
3.50	0.98%	0.0%	0.33	0.0%		0.98%	0					
3.75	1.05%	0.0%	0.13	0.0%		1.05%	0					
4.00	1.11%	0.0%	0.05	0.0%		1.11%	0					
		100.0%	1491.95	100.0%			40					

SP-161C
Surveillance Requirement 3.3.17.2, (3)
RC-158/159-PI-2



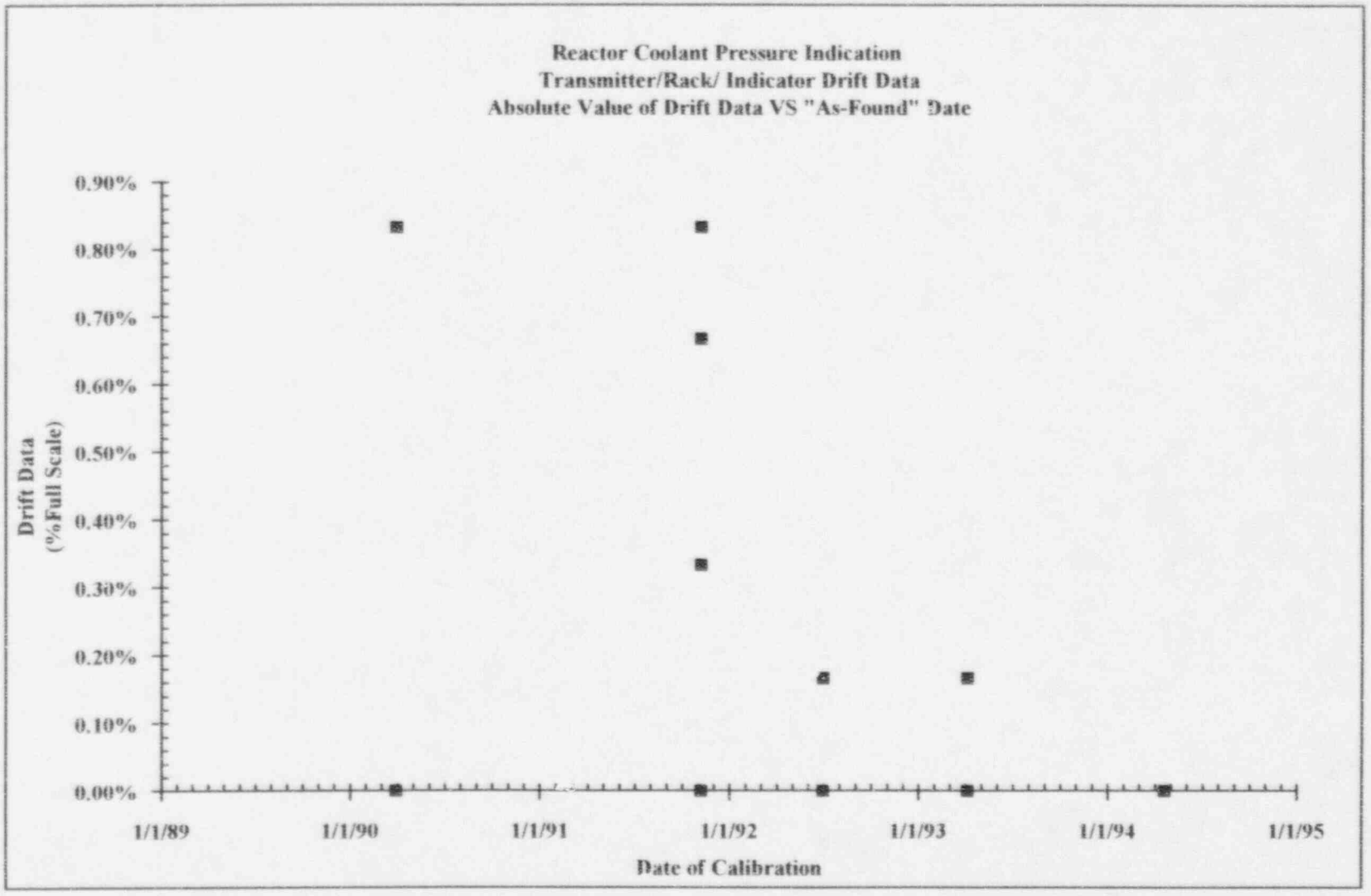
SP-161C
Surveillance Requirement 3.3.17.2, (3)
RC-158/159-PI-2



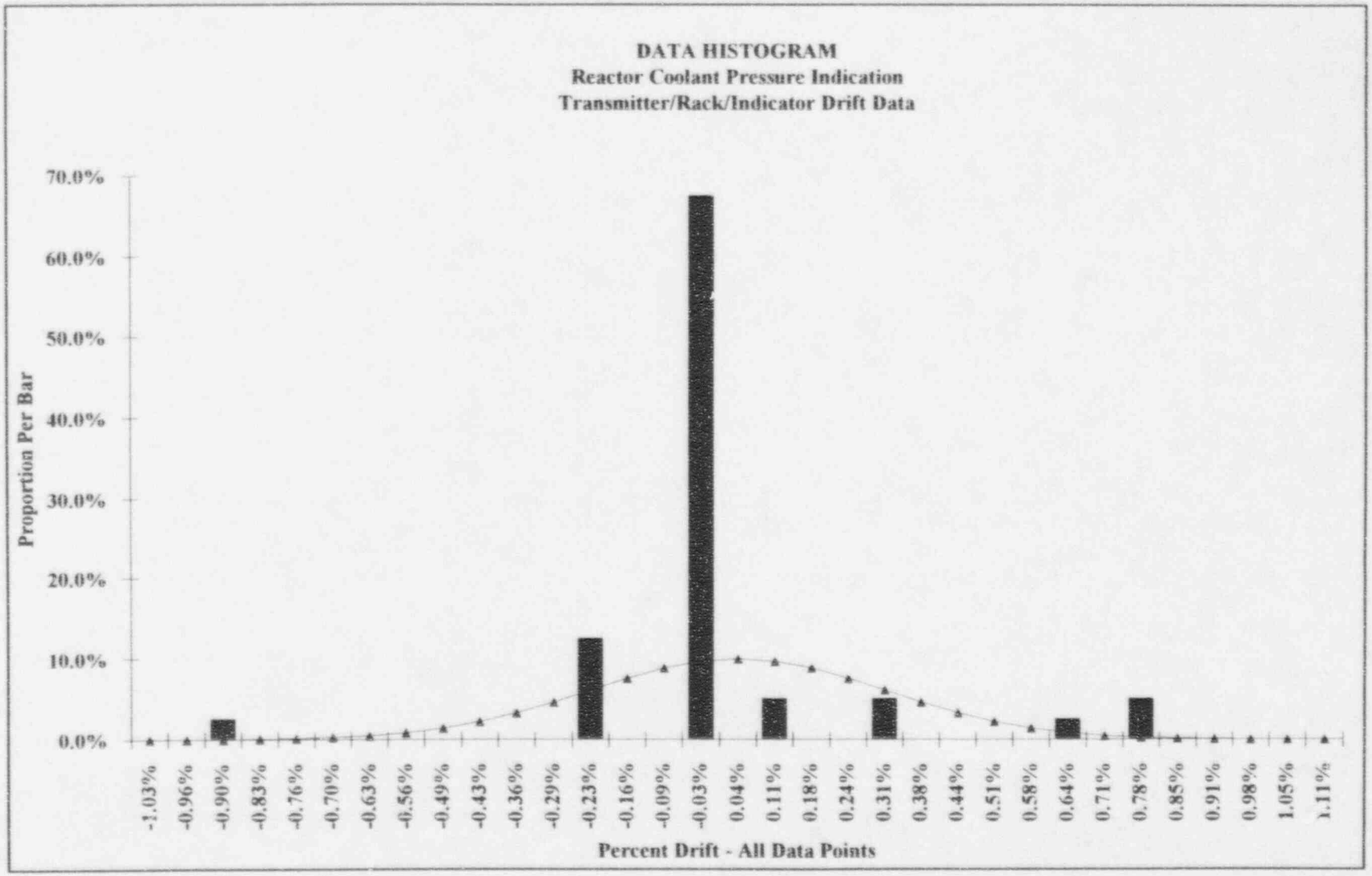
Date: 4/14/95

FILE:[RCPI&PIR.PAM]RC DRIFT DATA VS AF DATE

SP-161C
Surveillance Requirement 3.3.17.2, (3)
RC-158/159-PI-2



SP-161C
Surveillance Requirement 3.3.17.2, (3)
RC-158/159-PI-2



SP-161C
RC-158-PIR
RCS PRESSURE INDICATION -- WIDE RANGE

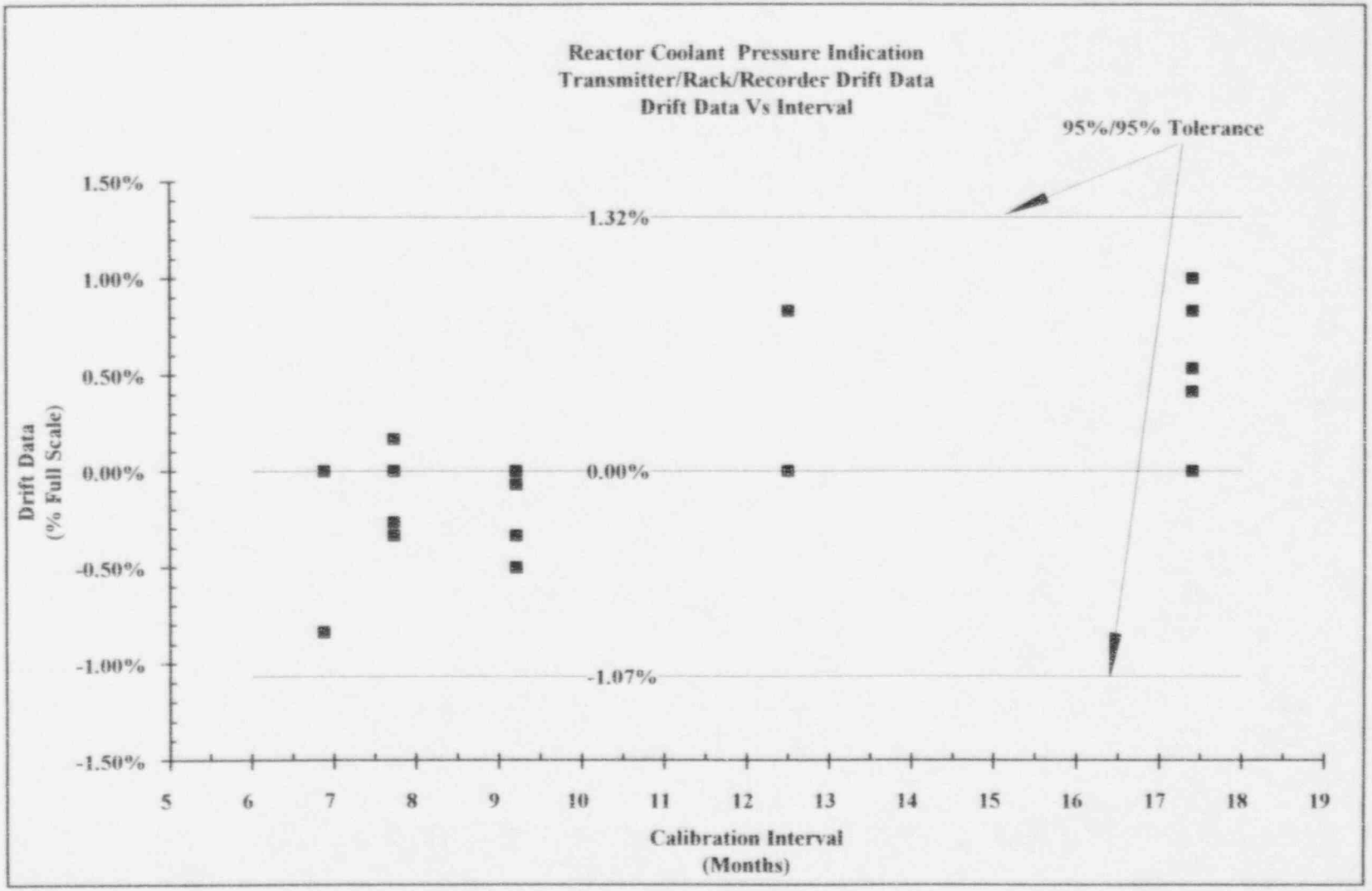
SP-161C		Calibration	Interval	Five Point Data					Drift Data & Outlier Evaluation				
TAG NUMBER		Date	(Months)	0%	25%	50%	75%	100%	0%	25%	50%	75%	100%
RC-158-PIR (PEN)	As Left	9/2/89		0	750	1525	2250	3000					
RC-158-PT Replaced 9-89	As Found	3/30/90	6.9	0	750	1500	2250	3000	0.00%	0.00%	-0.83%	0.00%	0.00%
	As Left	5/27/90		9	757.5	1500	2245	3000	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
4-20-94 As-Found & As-Left	As Found	11/7/91	17.4	25	770	1530	2270	3000	0.53%	0.42%	1.00%	0.83%	0.00%
Data Taken at 96.7% Vs	As Left	11/7/91		10	760	1510	2260	3000	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
100%. Data Extrapolated To	As Found	6/29/92	7.7	2	760	1515	2250	3000	-0.27%	0.00%	0.17%	-0.33%	0.00%
100% To Be Consistent	As Left	6/29/92		2	760	1515	2250	3000	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
With Previous Data.	As Found	4/5/93	9.2	0	750	1500	2250	3000	-0.07%	-0.33%	-0.50%	0.00%	0.00%
	As Left	4/5/93		0	750	1500	2250	3000	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK
	As Found	4/20/94	12.5	25	775	1525	2250	3000	0.83%	0.83%	0.83%	0.00%	0.00%
	As Left	4/20/94		25	775	1525	2275	3000	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK	DATA IS OK

RC-158-PIR (PEN) Range:	0 to 3000	psig						Mean:	0.12%		Percent	psig	
SP-161C As Found Tol.:	50	psig	1.67%					Standard Deviation:	0.45%	+95%/95%:	1.32%	39.5	
SP-161C As Left Tol.:	30	psig	1.00%					Number of Points:	25	-95%/95%:	-1.07%	-32.0	
Loop Accuracy Calculation:	I88-0020, Rev. 7							Outliers Excluded:	0				
								Outlier Criteria:	2.663				
								95%/95% k:	2.631				

W-TEST DATA		Coefficients	Sorted Test Data		B terms	# of Pts.	Data	Sorted	# of Pts.	Data	Sorted		
Number of Points:	25	0.4450	-0.83%	1.00%	0.82%	1	0.00%	-0.83%	14	-0.50%	1.00%		
Variance (s^2):	2.05E-05	0.3069	-0.50%	0.83%	0.41%	2	0.53%	-0.50%	15	0.83%	0.83%		
S^2:	4.91E-04	0.2543	-0.33%	0.83%	0.30%	3	-0.27%	-0.33%	16	0.00%	0.83%		
B:	2.14E-02	0.2148	-0.33%	0.83%	0.25%	4	-0.07%	-0.33%	17	0.83%	0.83%		
B^2:	4.56E-04	0.1822	-0.27%	0.83%	0.20%	5	0.83%	-0.27%	18	-0.33%	0.83%		
W = (B^2 / S^2):	0.929	0.1539	-0.07%	0.53%	0.09%	6	0.00%	-0.07%	19	0.00%	0.53%		
Critical W @ 95%:	0.918	0.1283	0.00%	0.42%	0.05%	7	0.42%	0.00%	20	0.00%	0.42%		
W Test:	PASS	0.1046	0.00%	0.17%	0.02%	8	0.00%	0.00%	21	0.00%	0.17%		
		0.0823	0.00%	0.00%	0.00%	9	-0.33%	0.00%	22	0.00%	0.00%		
		0.0610	0.00%	0.00%	0.00%	10	0.83%	0.00%	23	0.00%	0.00%		
		0.0403	0.00%	0.00%	0.00%	11	-0.83%	0.00%	24	0.00%	0.00%		
		0.0200	0.00%	0.00%	0.00%	12	1.00%	0.00%	25	0.00%	0.00%		
						13	0.17%	0.00%					

Chart Data Calibration Interval	Five Point Drift Data					95%/95% Limits		Zero %					
	0%	25%	50%	75%	100%								
6						1.32%	-1.07%	0.00%					
7	0.00%	0.00%	-0.83%	0.00%	0.00%	1.32%	-1.07%	0.00%					
17	0.53%	0.42%	1.00%	0.83%	0.00%	1.32%	-1.07%	0.00%					
8	-0.27%	0.00%	0.17%	-0.33%	0.00%	1.32%	-1.07%	0.00%					
9	-0.07%	-0.33%	-0.50%	0.00%	0.00%	1.32%	-1.07%	0.00%					
12	0.83%	0.83%	0.83%	0.00%	0.00%	1.32%	-1.07%	0.00%					
18						1.32%	-1.07%	0.00%					

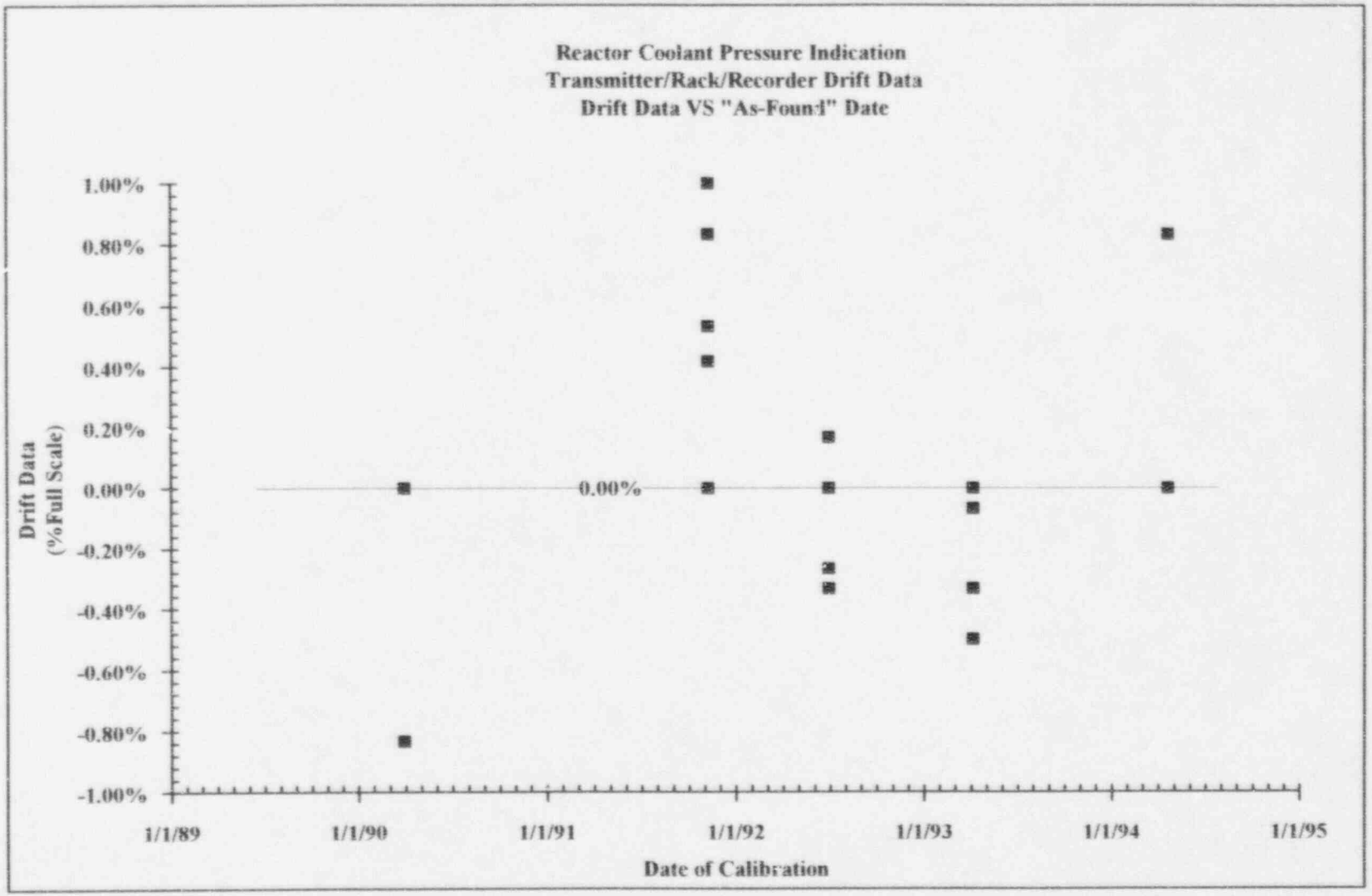
SP-161C
Surveillance Requirement 3.3.17.2, (3)
RC-158-PIR



Date: 4/14/95

FILE:RCPI&PIR.PAM|REC DRIFT DATA VS INTERVAL

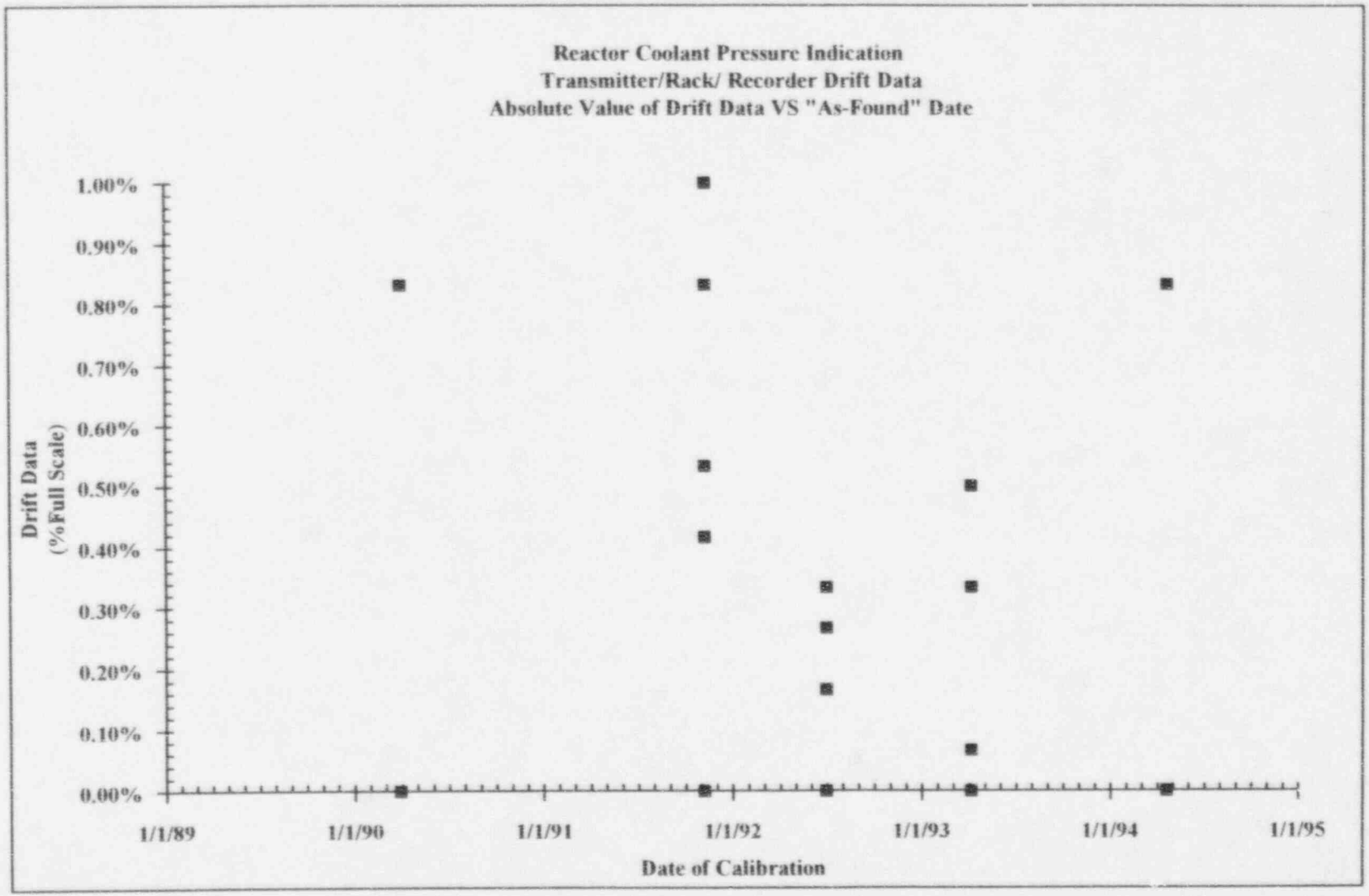
SP-161C
Surveillance Requirement 3.3.17.2, (3)
RC-158-PIR



Date: 6/14/95

FILE:[RCPIN&PIR.PAM]REC DRIFT DATA VS AF DATE

SP-161C
Surveillance Requirement 3.3.17.2, (3)
RC-158-PIR



Date: 4/14/95

FILE:[RCPIS.PIR.PAM]REC ABS DRIFT DATA VS AF DATE