## PMLevyCOLNPEm Resource

**From:** Frando, Frieda [Frieda.Frando@pgnmail.com]
**Sent:** Thursday, June 16, 2011 12:45 PM
**To:** Lingam, Siva
**Subject:** CR-3 EPU LAR Submittal (Part 4 of 5)
**Attachments:** Attachment 8_CR-3 EPU LAR.pdf

**Importance:** High

**Hearing Identifier:** Levy_County_COL_NonPublic
**Email Number:** 4329

**Mail Envelope Properties** (F73C2A86E0FEDF4EB0F0DA72507B1D8D1224E55703)

**Subject:** CR-3 EPU LAR Submittal (Part 4 of 5)
**Sent Date:** 6/16/2011 12:44:54 PM
**Received Date:** 6/16/2011 12:48:30 PM
**From:** Frando, Frieda

**Created By:** Frieda.Frando@pgnmail.com

**Recipients:**
"Lingam, Siva" <Siva.Lingam@nrc.gov>
Tracking Status: None

**Post Office:** WN000075.oak.zone1.progress-energy.com

| **Files** | **Size** | **Date & Time** |
|---|---|---|
| MESSAGE | 3 | 6/16/2011 12:48:30 PM |
| Attachment 8_CR-3 EPU LAR.pdf | 7043654 | |

**Options**
**Priority:** High
**Return Notification:** No
**Reply Requested:** No
**Sensitivity:** Normal
**Expiration Date:**
**Recipients Received:**

PROGRESS ENERGY FLORIDA, INC.

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50-302 /LICENSE NUMBER DPR-72

LICENSE AMENDMENT REQUEST #309, REVISION 0

ATTACHMENT 8

# SAMPLE INSTRUMENTATION SETPOINT CALCULATION

## SAMPLE INSTRUMENTATION SETPOINT CALCULATION

This Attachment is consistent with the guidance provided in Technical Specifications Task Force (TSTF) proposal, TSTF-493, "Clarify Application of Setpoint Methodology for LSSS Functions."

The Crystal River Unit 3 (CR-3) Extended Power Uprate (EPU) does not require revision to any existing Limiting Safety System Setting (LSSS) setpoints. However, the new CR-3 Improved Technical Specifications (ITS) 3.3.19, "Inadequate Core Cooling Monitoring System (ICCMS) Instrumentation," ensures that adequate core protection is provided for a specific range of small break loss of coolant accidents (LOCAs). Therefore, the notes consistent with the intent of TSTF-493, Option A have been added to ITS Surveillance Requirement (SR) 3.3.19.3 (CHANNEL CALIBRATION) for this instrumentation. Associated ITS Bases changes also reflect the addition of these notes. As requested in the notice of availability for TSTF-493, CR-3 is providing a summary calculation demonstrating the plant specific instrument setpoint methodology.

A setpoint calculation of the Reactor Coolant System pressure instrumentation (an input parameter to ICCMS) has been included in this attachment to provide a representative view of the methodology used in developing and maintaining safety-related setpoints at CR-3. The methodology used at CR-3 is primarily based on Instrument Society of America (ISA) Recommended Practice RP67.04, Part II, 1994.

The CR-3 methodology utilizes a graded approach to setpoints, with a more rigorous approach taken for setpoints that are critical for shutting down the reactor, maintaining the reactor in a shutdown configuration and mitigating the effects of accident conditions. The setpoint program establishes four category levels with Category A being the most stringent. Category A calculations meet the 95/95 tolerance limit as identified in Regulatory Guide 1.105, "Setpoints for Safety-Related Instrumentation." The sample setpoint calculation attached, Calculation I-89-0014, "Reactor Coolant Pressure Loop Accuracy for Engineered Safeguards," is a Category A calculation.

This calculation supports multiple setpoint categories. Examples include: Reactor Coolant Pressure instrumentation going to the Low Temperature Overpressure Protection System, and the Reactor Protection System and the Safety Parameter Display System. As such, the level of rigor utilized in the calculation will not be consistent throughout the entire calculation.

Florida Power CORPORATION

# INTEROFFICE CORRESPONDENCE

A-C-XMTL.FRM

| Office | MAC | Telephone |
|---|---|---|
| Design Engineering | NA1E | 3415 |

SUBJECT: Crystal River Unit 3
Quality Record Transmittal - Analysis/Calculation

TO: Records Management j 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-89-0014 | 10 | RC | 94 |

TITLE
RC PRESSURE LOOP ACCURACY FOR ES

FLORIDA POWER CORPORATION
NUCLEAR ENGINEERING DEPARTMENT
CRYSTAL RIVER UNIT 3
REVIEWED AND ACCEPTED BY:
A.T. BARNARD
ENGINEER A.T. Barnard DATE 11/23/99
SUPERVISOR S.E. Bprkofski [signature] DATE 11/23/99

KWDS (IDENTIFY KEYWORDS FOR LATER RETRIEVAL)
Calculation, Insulation Resistance, Setpoint, Accuracy, RC, HPI, LPI, ES

DXREF (REFERENCES OR FILES j LIST PRIMARY FILE FIRST)
SP-132
I-84-0002
MAR 97-02-12-01, MAR 97-02-12-02

| VEND (VENDOR NAME) | VENDOR DOCUMENT NUMBER (DXREF) | SUPERSEDED DOCUMENTS (DXREF) |
|---|---|---|
| FRAMATOME | N/A | I-89-0014 R9, ICA R0, & Rev 9 ATB 11/23/99 |

**TAG**

| | | |
|---|---|---|
| RC-3A-PT3, RC-3A-PT4, RC-3B-PT3 | RC-3A-JX3, RC-3A-JX4, RC-3B-JX3, | RC-3A-PI3, RC-3A-PI2 |
| RC-3A-PY3, RC-3A-PY4-1, RC-3B-PY3 | RC-3A-EB1, RC-3B-EB2, RC-3A-EB2, RC-3A-EB3, RC-3B-EB3 | RC-163A-PY1, RC-163A-PY2<br>RC-154-PR/TR |
| RC-3-BT1, RC-3-BT7, RC-3-BT2 | RC-3A-PS3, RC-3A-PS4, RC-3A-PS5 | RC-3-BT4, RC-3-BT5, RC-3-BT6, RC-3-BT10 |
| RC-3-BT8, RC-3-BT3, RC-3-BT9 | RC-3A-PS6, RC-3A-PS7, RC-3A-PY4 | RC-3-BT11, RC-3-BT12 |

**PART NO.**

| | | |
|---|---|---|
| | | |
| | | |

COMMENTS (USAGE RESTRICTIONS, PROPRIETARY, ETC.)
This calculation incorporates the changes made by HPI MAR 97-02-12-01 and MAR 97-02-12-02 which revised the Low pressure setpoint and modified the RCITS Foxboro module and adds the Signal Monitor/Bypass Alarm setpoints. ~~Attachment 6 of Revision 9 has been deleted.~~ JB 10/29/99 The attachments for this revision remain the same as Revision 9 ICA, Rev. 00.

**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.

**FOR RECORDS MANAGEMENT USE ONLY **
Quality Record Transmittal received and information entered into SEEK.
Entered by: __________________ Date
(Return copy of Quality Record Transmittal to DE Support Specialist.)

| DESIGN ENGINEER W.H. Powell | DATE | VERIFICATION ENGINEER JR Brannon | DATE | SUPERVISOR, DESIGN ENG. L. Lesniak | DATE |
|---|---|---|---|---|---|
| W. Powell | 10/29/99 | J. Brannon | 10/29/99 | L. Lesniak | 11-1-99 |

cc: Nuclear Projects (If MAR/CGWR/PEERE Return to Service Related) ☐ Yes ☒ No
Supervisor, Config. Mgt. Info.
Mgr., Design Engineering (Original) w/attach
Mgr., Radiological Emergency Planning w/attach ☐ Yes ☒ No
D.M. Porter w/ attach

Calculation Review form Part III actions required ☐ Yes ☒ No
(If Yes, send copy of the Calculation to the Responsible Organization(s) identified in Part III on the Calculation Review form.)

NOV 24 1999

Florida Power CORPORATION

# ANALYSIS/CALCULATION SUMMARY

A-C-SUM.FRM

| DOCUMENT IDENTIFICATION NUMBER | DISCIPLINE I | CONTROL NO. 89-0014 | REVISION LEVEL 10 |
|---|---|---|---|

TITLE
RC PRESSURE LOOP ACCURACY FOR ES

CLASSIFICATION (CHECK ONE)
- [x] **Safety Related**
- [ ] **Non Safety Related**

MAR/SP/CGWR/PEERE NUMBER
97-02-12-01 &97-02-12-02

VENDOR DOCUMENT NUMBER

| | APPROVAL SIGNATURES | PRINTED NAME |
|---|---|---|
| **Design Engineer** | | **W.H. Powell** |
| **Date** | | W H Powell 10/29/99 |
| **Verification Engineer** | J Brannon | **Jim Brannon** |
| **Date** | 10/29/99 | |
| **Supervisor** | L. M. Jr | **L. Lesniak** |
| **Date** | 11-1-99 | |

ITEMS REVISED
Items Revised: ES Low Pressure, Bypass Reset and Bypass Permit and Alarm setpoints.

PURPOSE SUMMARY

- RCITS I/V uncertainty has been removed from this calculation. Reason: The RCITS I/V loop uncertainty is no longer required as input to calculation I89-0010 (Reference 60) and the RCITS loop input is not tested in SP-0132 (Reference 37). However, the loop IR effects have been revised to incorporate the MAR 97-02-12-02 (Reference 86) RC-163A-PY1 and RC-163B-PY1 I/V modification to the new Foxboro I/V module.

- The HPI Upgrade project altered the current high pressure injection (HPI) system to improve its reliability and capability to meet its defined functional requirements as well as reduce operator burden during accident scenarios. The change impacts the interfacing system such as the engineered safeguards actuation system (ESAS) by revising the ITS ES RCS Low Pressure setpoint, Bypass Reset and Bypass Permit values. Section I of this calculation summarizes the old and new setpoint values. All setpoint values are summarized on Table IV of Section 2 of this calculation. This revision will incorporate the revised values for the ES RCS Low Pressure Trip, Bypass and Permit and alarm setpoints. The HPI MAR 97-02-12-01 and MAR 97-02-12-02 (References 85 and 86) established the Bypass Reset and Permit setpoints since there are no analytical limits associated with these setpoints.

- This Revision also adds the Signal Monitor and Bypass Alarm setpoint values to Table IV of Section 2.

FLORIDA POWER CORPORATION
NUCLEAR ENGINEERING DEPARTMENT
CRYSTAL RIVER UNIT 3
REVIEWED AND ACCEPTED BY:
A.T. BARNARD
ENGINEER A.T. Barnard DATE 11/23/99
SUPERVISOR S.Z. BARKOFSKI SZ Barkofski DATE 11/23/99

RESULTS SUMMARY
The Revision 9 calculated loop errors have not been changed in this calculation. This calculation applies the existing loop uncertainty errors to the above listed Low Pressure values, assesses the HPI MAR changes for impact on these setpoints and adds the Signal Monitor and Bypass Alarm setpoints.

Florida Power CORPORATION

# CALCULATION REVIEW

ARS 11/24/99

CALC-REV.FRM



CALCULATION NO./REV. 10
I-89-0014 Rev. ~~9 ICA, Rev. 00~~

**PART I - DESIGN ASSUMPTION/INPUT REVIEW: APPLICABLE** ☐ **Yes** ☒ **No**

The following organizations have reviewed and concur with the design assumptions and inputs identified for this calculation:

Systems Engineering _______________ Signature/Date

Nuclear Plant Operations _______________ Signature/Date

OTHER(S)

_______________ _______________ Signature/Date

_______________ _______________ Signature/Date

**PART II - RESULTS REVIEW: APPLICABLE** ☐ **Yes** ☒ **No**

The following organizations have reviewed and concur with the results of this calculation and understand the actions which the organizations must take to implement the results.

System Engineering _______________ Signature/Date

Comments: _______________

Nuclear Plant Operations _______________ Signature/Date

Comments: _______________

Safety Analysis Group ☐ Yes ☐ N/A _______________ Signature/Date

Comments: _______________

Nuclear Plant Maintenance ☐ Yes ☐ N/A _______________ Signature/Date

Comments: _______________

Nuclear Licensed Operator Training ☐ Yes ☐ N/A _______________ Signature/Date

Comments: _______________

Manager, Nuclear Regulatory Compliance ☐ Yes ☐ N/A _______________ Signature/Date

Comments: _______________

Sr. Radiation Protection Engineer ☐ Yes ☐ N/A _______________ Signature/Date

Comments: _______________

Nuclear Plant EOP Group ☐ Yes ☐ N/A _______________ Signature/Date

Comments: _______________

Design Engineering ☐ Yes ☐ N/A _______________ Signature/Date

Comments: _______________

OTHER: ☐ Yes ☐ N/A _______________ Signature/Date

_______________ Signature/Date

Florida Power CORPORATION

# CALCULATION REVIEW



CALCULATION NO./REV.
I-89-0014 Rev. 10

**PART III - CONFIGURATION CONTROL: APPLICABLE** ☐ **Yes** ☒ **No** **PC #** 99-3260 for R9, ICA R0 already addresses configuration control changes

The following is a list of Plant procedures/lesson plans/other documents and Nuclear Engineering calculations which require updating based on calculation results review:

| Document | Date Required | Responsible Organization |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

**Upon completion, generate a Precursor Card in accordance with CP-111 for tracking of actions for any items identified in Part III. If calculations are listed, a copy shall be sent to the original file and the calculation log updated to reflect this impact.**

**PART IV - NUCLEAR ENGINEERING DOCUMENTATION REVIEW**

The responsible Design Engineer must thoroughly review the below listed documents to assess if the calculation requires revision to these documents. If "Yes," the change authorizations must be listed below and issued concurrently with the calculation.

| | | | | | |
|---|---|---|---|---|---|
| Enhanced Design Basis Document | ☐ Yes ☒ No | (TC#) | Vendor Qualification Package | ☐ Yes ☒ No | (VQP#) |
| FSAR | ☐ Yes ☒ No | (Letter#) | Topical Design Basis Doc. | ☐ Yes ☒ No | (TC#) |
| Improved Tech. Specification | ☐ Yes ☒ No | (Letter#) | E&SQPM | ☐ Yes ☒ No | (TC#) |
| Improved Tech. Spec. Bases | ☐ Yes ☒ No | (Letter#) | Other Documents reviewed: | | |
| Config. Mgmt. Info. System | ☐ Yes ☒ No | (CIDP#) | | ☐ Yes ☐ No | (CHANGE DOC. REFERENCE) |
| Design Basis Document | ☐ Yes ☒ No | (TC#) | | ☐ Yes ☐ No | (CHANGE DOC. REFERENCE) |
| Appendix R Fire Study | ☐ Yes ☒ No | (TC#) | | ☐ Yes ☐ No | (CHANGE DOC. REFERENCE) |
| Fire Hazardous Analysis | ☐ Yes ☒ No | (TC#) | | ☐ Yes ☐ No | (CHANGE DOC. REFERENCE) |
| NFPA Code Conformance Document | ☐ Yes ☒ No | (TC#) | | ☐ Yes ☐ No | (CHANGE DOC. REFERENCE) |

**PART V - PLANT REVIEWS/APPROVALS FOR INSTRUMENT SETPOINT CHANGE**

PRC/DNPO approval is required if a setpoint is to be physically changed in the plant through the NEP-213 process

PRC Review Required ☐ Yes ☒ No

PRC Chairman /Date

DNPO Review Required ☐ Yes ☒ No

DNPO /Date

| DESIGN ENGINEER/DATE | DESIGN ENGINEER - PRINTED NAME |
|---|---|
| W.H. Powell 10/29/99 | W.H. Powell |

# CALCULATION VERIFICATION CHECKLIST

**Crystal River Unit 3**

CALVERCL.FRM

Florida Power CORPORATION

CALCULATION NUMBER:
I-89-0014 Rev. 10

| | | YES | NO | N/A |
|---|---|---|---|---|
| 1. | Are inputs, including codes, standards, regulatory requirements, procedures, data, and Engineering methodology correctly selected and applied? | ☒ | ☐ | ☐ |
| 2. | Have assumptions been identified? Are they reasonable and justified? (re: NEP-101) | ☒ | ☐ | ☐ |
| 3. | Are references properly identified, correct, and complete? (re: NEP-101 ) | ☒ | ☐ | ☐ |
| 4. | Have applicable construction and operating experiences been considered? | ☐ | ☐ | ☒ |
| 5. | Was an appropriate Design Analysis/Calculation method used? | ☒ | ☐ | ☐ |
| 6. | In cases where computer software was used, has the program been verified or reverified in accordance with NEP-151 for safety related design applications and/or are inputs, formulas, and outputs associated with spreadsheets accurate? | ☐ | ☐ | ☒ |
| 7. | Is the output reasonable, compared to inputs? | ☒ | ☐ | ☐ |
| 8. | Has technical design information provided (via letter, REA, IOC, or telecon) by other disciplines or programs been verified by that discipline or program? | ☐ | ☐ | ☒ |
| 9. | Has technical design information provided via letter or telecon from an external Engineering Organization or vendor been confirmed and accepted by FPC? | ☐ | ☐ | ☒ |
| 10. | Has atypical equipment/bus alignment been considered in the calculation? | ☐ | ☐ | ☒ |
| 11. | Do the calculation results indicate a non-conforming condition exists? (If "Yes," immediately notify the responsible Supervisor.) | ☐ | ☒ | ☐ |
| 12. | Do the results require a change to other Engineering documents? (If "Yes," have these documents been identified for revision on the Calculation Review Form?) | ☐ | ☒ | ☐ |

# REVIEWER CONCURRENCE FORM
## Crystal River Unit 3

Florida Power CORPORATION

RCF.FRM

**Document Number/Revision Level:** I-89-0014, Rev. 10

**Originator:** A. T. Barnard (Print) A T Barnard (Sign)

Signatures delineated below signify whether the department/organization needs to review the Analysis/Calculation. This determination will be made by the individual department/organization, along with the respective discipline. All blocks must be signed by a representative from the respective department/organization.*

| Department/Organization | Review Required | Signature/Date |
|---|---|---|
| DE Electrical | ☐ Yes ☒ No | N/A** / |
| DE I&C | ☐ Yes ☒ No | N/A** / |
| DE Mechanical | ☐ Yes ☒ No | N/A** / |
| DE Structural | ☐ Yes ☒ No | N/A** / |
| ISI | ☐ Yes ☒ No | N/A** / |
| Licensing | ☐ Yes ☒ No | N/A** / |
| Maintenance | ☐ Yes ☒ No | N/A** / |
| Nuclear Safety Management | ☐ Yes ☒ No | N/A** / |
| Operations | ☐ Yes ☒ No | N/A** / |
| Operations (EOP/AP | ☐ Yes ☒ No | N/A** / |
| Programs All (Identify App."R", EQ, and/or Fire Protection) | ☐ Yes ☒ No | N/A** / |
| Systems Engineering | ☐ Yes ☒ No | N/A** / |
| Training | ☐ Yes ☒ No | N/A** / |
| Other ______ | ☐ Yes ☐ No | N/A** / |
| Other ______ | ☐ Yes ☐ No | N/A** / |

*NOTE: In lieu of signatures by respective departments, the originator may sign for them, based on verbal concurrence (telecons), cc:mail notes, etc.

** The only effect of this revision is to convert an Interim Change to a permanent revision. No changes were made to the calculation. Therefore, the Manager, Design Engineering has waived the requirement for reviewer concurrence.

Florida Power CORPORATION

# INTEROFFICE CORRESPONDENCE

A-C-XMTL.FRM

| Design Engineering | NA1E | 3415 |
|---|---|---|
| Office | MAC | Telephone |

SUBJECT: Crystal River Unit 3
Quality Record Transmittal - Analysis/Calculation
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-89-0014 | 9 ICA, Rev. 00 | RC | 115 |

TITLE
RC PRESSURE LOOP ACCURACY FOR ES

FLORIDA POWER CORPORATION
NUCLEAR ENGINEERING DEPARTMENT
~~CRYSTAL RIVER UNIT 3~~
REVIEWED AND ACCEPTED BY:
ENGINEER A.T. BARNARD A T Barnard DATE 10/5/99
SUPERVISOR S Hildebrandt FOR S.K. Barkotski DATE 10/5/99

KWDS (IDENTIFY KEYWORDS FOR LATER RETRIEVAL)
Calculation, Insulation Resistance, Setpoint, Accuracy, RC, HPI, LPI, ES

DXREF (REFERENCES OR FILES – LIST PRIMARY FILE FIRST)
SP-132
I-84-0002
MAR 97-02-12-01, MAR 97-02-12-02

| VEND (VENDOR NAME) | VENDOR DOCUMENT NUMBER (DXREF) | SUPERSEDED DOCUMENTS (DXREF) |
|---|---|---|
| FRAMATOME | N/A | N/A |

TAG

| | | |
|---|---|---|
| RC-3A-PT3, RC-3A-PT4, RC-3B-PT3 | RC-3A-JX3, RC-3A-JX4, RC-3B-JX3, | RC-3A-PI3, RC-3A-PI2 |
| RC-3A-PY3, RC-3A-PY4-1, RC-3B-PY3 | RC-3A-EB1, RC-3B-EB2, RC-3A-EB2, RC-3A-EB3, RC-3B-EB3 | RC-163A-PY1, RC-163A-PY2<br>RC-154-PR/TR |
| RC-3-BT1, RC-3-BT7, RC-3-BT2 | RC-3A-PS3, RC-3A-PS4, RC-3A-PS5 | RC-3-BT4, RC-3-BT5, RC-3-BT6, RC-3-BT10 |
| RC-3-BT8, RC-3-BT3, RC-3-BT9 | RC-3A-PS6, RC-3A-PS7, RC-3A-PY4 | RC-3-BT11, RC-3-BT12 |

PART NO.

| | | |
|---|---|---|
| | | |
| | | |

COMMENTS (USAGE RESTRICTIONS, PROPRIETARY, ETC.)
This calculation incorporates the changes made by HPI MAR 97-02-12-01 and MAR 97-02-12-02 which revised the Low pressure setpoint and modified the RCITS Foxboro module and adds the Signal Monitor/Bypass Alarm setpoints. Attachment 6 of Revision 9 has been deleted. ~~A sheet denoting the deletion of Attachment 6 has been inserted in place of Attachment 6.~~ 10-5-99

**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.

**FOR RECORDS MANAGEMENT USE ONLY **
Quality Record Transmittal received and information entered into SEEK.
Entered by: ________________ Date
(Return copy of Quality Record Transmittal to DE Support Specialist.)

| DESIGN ENGINEER W.H. Powell DATE | VERIFICATION ENGINEER JR Brannon DATE | SUPERVISOR, DESIGN ENG. DATE |
|---|---|---|
| W Powell 9-23-99 | J Brannon 9/23/99 | [signature] 9-23-99 |

cc: Nuclear Projects (If MAR/CGWR/PEERE Return to Service Related) ☒ Yes ☐ No
✓ Supervisor, Config. Mgt. Info.
Mgr., Design Engineering (Original) w/attach
Mgr., Radiological Emergency Planning w/attach ☐ Yes ☒ No
D.M. Porter w/ attach, W.S. Koleff w/attach, W.S. Chase w/attach

Calculation Review form Part III actions required ☒ Yes ☐ No
(If Yes, send copy of the Calculation to the Responsible Organization(s) identified in Part III on the Calculation Review form.)

G.V. Hildebrandt w/attach
J.D. Hologa w/attach
V. Esquillo w/attach

OCT -6 1999

Florida Power CORPORATION

# ANALYSIS/CALCULATION SUMMARY

A-C-SUM.FRM

| DOCUMENT IDENTIFICATION NUMBER | DISCIPLINE I | CONTROL NO. 89-0014 | REVISION LEVEL 9 ICA, Rev. 00 |
|---|---|---|---|

| TITLE | CLASSIFICATION (CHECK ONE) |
|---|---|
| RC PRESSURE LOOP ACCURACY FOR ES | [X] Safety Related<br>[ ] Non Safety Related |
| | MAR/SP/CGWR/PEERE NUMBER |
| | VENDOR DOCUMENT NUMBER |

| | APPROVAL SIGNATURES | PRINTED NAME |
|---|---|---|
| Design Engineer | W.H. Powell | W.H. Powell |
| Date | 9-23-99 | 09/23/99 |
| Verification Engineer | J. Brannon | Jim Brannon |
| Date | 9-23-99 | |
| Supervisor | L. M. Lesniak | FOR J.R. Paljug |
| Date | 9-23-99 | LM LESNIAK |

ITEMS REVISED

Items Revised: ES Low Pressure, Bypass Reset and Bypass Permit and Alarm setpoints.

PURPOSE SUMMARY

- RCITS I/V uncertainty has been removed from this calculation. Reason: The RCITS I/V loop uncertainty is no longer required as input to calculation I89-0010 (Reference 60) and the RCITS loop input is not tested in SP-0132 (Reference ~~6.12~~ 37 WB 9-23-99). However, the loop IR effects have been revised to incorporate the MAR 97-02-12-02 (Reference 86) RC-163A-PY1 and RC-163B-PY1 I/V modification to the new Foxboro I/V module .

- The HPI Upgrade project will alter the current high pressure injection (HPI) system to improve its reliability and capability to meet its defined functional requirements as well as reduce operator burden during accident scenarios. The change impacts the interfacing system such as the engineered safeguards actuation system (ESAS) by revising the ITS ES RCS Low Pressure setpoint, Bypass Reset and Bypass Permit values. Section I of this calculation summarizes the old and new setpoint values. All setpoint values are summarized on Table IV of Section 2 of this calculation. This revision will incorporate the revised values for the ES RCS Low Pressure Trip, Bypass and Permit and alarm setpoints. The HPI MAR 97-02-12-01 and MAR 97-02-12-02 (References 85 and 86) will establish the Bypass Reset and Permit setpoints since there are no analytical limits associated with these setpoints.

- This Revision also add the Signal Monitor and Bypass Alarm setpoint values to Table IV of Section 2.

FLORIDA POWER CORPORATION
NUCLEAR ENGINEERING DEPARTMENT
CRYSTAL RIVER UNIT 3
REVIEWED AND ACCEPTED BY:

A.I. BARNARD
ENGINEER A.I. Barnard DATE 10/5/99
SUPERVISOR D Hildebrandt DATE 10/5/99
FOR S.K. Barkofski

RESULTS SUMMARY

The Revision 9 calculated loop errors have not been changed in this calculation. This calculation applies the exsiting loop uncertainty errors to the above listed Low Pressure values, assesses the HPI MAR changes for impact on these setpoints and adds the Signal Monitor and Bypass Alarm setpoints.

Florida Power
CORPORATION

Enclosure 5

CHANGE, TEST OR EXPERIMENT EVALUATION

Document No. I-89-0014 Revision No. 09, ICA, Rev. 00

**A. Briefly describe the proposed activity (change, test or experiment):**

Calculation I-89-0014, Revision 09, ICA, Rev. 00 is revising;

1) the ES Reactor Coolant System Pressure – Low (HPI actuation) setpoint from 1540 psig decreasing to 1665 psig decreasing
2) the ES Reactor Coolant System Pressure – Low (HPI actuation) Bypass automatic reset setpoint from 1695 psig increasing to 1795 psig increasing
3) the shutdown bypass permit setpoint for bypass of the ES Reactor Coolant System Pressure – Low HPI actuation trip from 1670 psig decreasing to 1770 psig decreasing
4) the HPI Not Bypassed alarm setpoint from 1640 psig decreasing to 1740 psig decreasing
5) the HPI Not Reset alarm setpoint from 1640 psig increasing to 1740 psig increasing
6) the RC Low Pressure alarm setpoint from 1550 psig decreasing to 1675 psig decreasing

This change is being made to accommodate revision of the ITS Allowable Value for the ES Reactor Coolant System Pressure – Low (HPI actuation) setpoint and revision of the ITS Applicable Mode and Other Specified Conditions requirement for operability of the ES Reactor Coolant System Pressure – Low (HPI actuation) function. These setpoints are being revised based on HPI modifications MAR 97-02-12-01 and MAR 97-02-12-02.

Per MAR 97-02-12-02, the ES Reactor Coolant System Pressure – Low (HPI actuation) setpoint Allowable Value is changing from $\geq$ 1500 psig to $\geq$ 1625 psig. Per Calculation I-89-0014, Revision 9, ICA, Rev.00 the new ES Reactor Coolant System Pressure – Low (HPI actuation) in plant setpoint will be 1665 psig decreasing based on the post MAR ITS allowable value of $\geq$ 1625 psig.

The 10 psi margin between the current in plant HPI actuation setpoint of 1540 psig and the current in plant RC Low Pressure alarm setpoint of 1550 psig will be retained for the post MAR alarm setpoint. Therefore, the new RC Low Pressure alarm setpoint will be 1675 psig decreasing. The RC Low Pressure alarm is an operator aid device only and it has no safety-related function.

Also, per MAR 97-02-12-02, the ITS Applicable Mode and Other Specified Conditions requirement for operability of the ES Reactor Coolant System Pressure – Low (HPI actuation) is changing from $\geq$ 1700 psig to $\geq$1800 psig. The MAR will change the ES Reactor Coolant System Pressure – Low (HPI actuation) Bypass automatic reset setpoint from 1695 psig to 1795 psig to ensure this Applicable Mode and Other Specified Condition requirement is met. The adjustable bistable reset deadband setting of 25 psi is being retained by the MAR setpoint change. This will result in a ES Reactor Coolant System Pressure – Low (HPI actuation) Bypass Permit setpoint of 1770 psig. These setpoint changes have been validated/verified by Calculation I-89-0014, Revision 9, ICA, Rev.00.

The 55 psi margin between the current in plant ES Reactor Coolant System Pressure – Low (HPI actuation) Bypass automatic reset setpoint of 1695 psig increasing and the HPI Not Reset alarm setpoint of 1640 psig increasing will be retained for the post MAR alarm setpoint. Therefore, the new HPI Not Reset alarm setpoint will be 1740 psig increasing.

The current practice of having the HPI Not Bypassed Alarm equal to the HPI Not Reset alarm will be retained. The HPI Not Bypassed alarm actuates on decreasing pressure vice HPI Not Reset Alarm actuating on increasing pressure. Therefore, the new HPI Not Bypassed alarm setpoint will be 1740 psig decreasing. This alarm is an operator aid only and it has no safety-related function.

B. Disposition:

B.1 List the applicable previously approved SA/USQD numbers and titles:

SA/USQD No. 99-0010, Revision 2 HPI Upgrade Project

B.2 Describe how the proposed activity is covered by the approved SA/USQD and whether or not all aspects of this change been addressed in the SA/USQD.

SA/USQD 99-0010 has justified the specific values for the revised ITS ES Reactor Coolant System Pressure - Low HPI actuation trip setpoint and revised ITS Applicable Mode and Other Specified Conditions requirement for operability of the ES Reactor Coolant System Pressure – Low HPI actuation setpoint discussed in Section A above. The conclusions of this discussion remain unchanged by the results of Calculation I-89-0014, Revision 9, ICA, Rev. 00.

The alarm setpoints are operator aids only. The new post MAR alarm setpoints will be based on margins and relationships between existing alarms and actuation setpoints in an effort maintain the preexisting coordination.

| | |
|---|---|
| **NOTE:** | **If the proposed activity is not completely bounded by the approved SA/USQD, either revise the existing SA/USQD or prepare a separate SA/USQD.** |

| | | | |
|---|---|---|---|
| Preparer: | J. R. Brannon / *(Printed Name)* | J Brannon / *(Signature)* | 10/4/99 *(Date)* |
| Reviewer: | W. S. Koleff / *(Printed Name)* | W Koleff / *(Signature)* | 10/4/99 *(Date)* |
| Interpretation Contact: | N/A / | / | |

*(Interpretation Contact for New Procedures or Procedure Revisions Only)*

Florida Power CORPORATION

# INTEROFFICE CORRESPONDENCE

A-C-XMTL.FRM

| Design Engineering | NA1E | 3415 |
|---|---|---|
| Office | MAC | Telephone |

SUBJECT: Crystal River Unit 3
Quality Record Transmittal - Analysis/Calculation

TO: Records Management – SA2A

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

| DOCNO (FPC DOCUMENT IDENTIFICATION NUMBER) | REV. | SYSTEM(S) | TOTAL PAGES TRANSMITTED |
|---|---|---|---|
| I-89-0014 | 9 | RC | 120 |

TITLE
RC PRESSURE LOOP ACCURACY FOR ES

KWDS (IDENTIFY KEYWORDS FOR LATER RETRIEVAL)
Calculation, Insulation Resistance, Setpoint, Accuracy, RC, HPI, LPI, ES

DXREF (REFERENCES OR FILES - LIST PRIMARY FILE FIRST)
SP-132
I-84-0002

| VEND (VENDOR NAME) | VENDOR DOCUMENT NUMBER (DXREF) | SUPERSEDED DOCUMENTS (DXREF) |
|---|---|---|
| FRAMATOME | N/A | I-89-0014, Rev. 8 |

**TAG**

| | | |
|---|---|---|
| RC-3A-PT3, RC-3A-PT4, RC-3B-PT3 | RC-3A-JX3, RC-3A-JX4, RC-3B-JX3, | RC-3A-PI3, RC-3A-PI2 |
| RC-3A-PY3, RC-3A-PY4-1, RC-3B-PY3 | RC-3A-EB1, RC-3B-EB2, RC-3A-EB2, RC-3A-EB3, RC-3B-EB3 | RC-163A-PY1, RC-163A-PY2<br>RC-154-PR/TR |
| RC-3-BT1, RC-3-BT7, RC-3-BT2 | RC-3A-PS3, RC-3A-PS4, RC-3A-PS5 | RC-3-BT4, RC-3-BT5, RC-3-BT6, RC-3-BT10 |
| RC-3-BT8, RC-3-BT3, RC-3-BT9 | RC-3A-PS6, RC-3A-PS7, RC-3A-PY4 | RC-3-BT11, RC-3-BT12 |

**PART NO.**

COMMENTS (USAGE RESTRICTIONS, PROPRIETARY, ETC.)
This calculation incorporates the control complex temperature range change.

**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.

**FOR RECORDS MANAGEMENT USE ONLY **
Quality Record Transmittal received and information entered into SEEK.
Entered by: ________________ Date
(Return copy of Quality Record Transmittal to DE Support Specialist.)

| DESIGN ENGINEER | DATE | VERIFICATION ENGINEER | DATE | SUPERVISOR, DESIGN ENG. L MLESNIAK | DATE |
|---|---|---|---|---|---|
| W.H. Powell WHPowell | 8/9/99 | J.R. Brannon JBrannon | 8-11-99 | L.M. [signature] | 8-11-99 |

cc: Nuclear Projects (If MAR/CGWR/PEERE Return to Service Related) ☐ Yes ☒ No
Supervisor, Config. Mgt. Info.
Mgr., Design Engineering (Original) w/attach
Mgr., Radiological Emergency Planning w/attach ☐ Yes ☒
W.S. Koleff FTI w/attach.
D. Porter (NU47)
W.S. Chase w/Attach
J.D. Hologa w/Attach
V. Esquillo - w/attach.

Calculation Review form Part III actions required ☒ Yes ☐ No
(If Yes, send copy of the Calculation to the Responsible Organization(s) identified in Part III on the Calculation Review form.)
G.V. Hildebrandt w/Attach

FLORIDA POWER CORPORATION
NUCLEAR ENGINEERING DEPARTMENT
CRYSTAL RIVER UNIT 3
REVIEWED AND ACCEPTED BY:
A.T. BARNARD
ENGINEER ATBarnard DATE 8/16/99
SUPERVISOR [signature] DATE 8/31/99
G. Hildebrandt for S. [illegible]

SEP -1 1999

Rev. 5/98 Exhibit 2 NEP-213 (Page 21 of 46)

Florida Power CORPORATION

# ANALYSIS/CALCULATION SUMMARY

A-C-SUM.FRM

| DOCUMENT IDENTIFICATION NUMBER | DISCIPLINE I | CONTROL NO. 89-0014 | REVISION LEVEL 9 |
|---|---|---|---|

TITLE
RC PRESSURE LOOP ACCURACY FOR ES

CLASSIFICATION (CHECK ONE)
- [x] Safety Related
- [ ] Non Safety Related

MAR/SP/CGWR/PEERE NUMBER

VENDOR DOCUMENT NUMBER

| | APPROVAL SIGNATURES | PRINTED NAME |
|---|---|---|
| Design Engineer | W.H. Powell | W.H. Powell |
| Date | 8-9-99 | 08/09/99 |
| Verification Engineer | J. Brannon | J.R. Brannon |
| Date | 8-11-99 | |
| Supervisor | S.M. Jasier for L.M. Lesniak | ~~J.R. Paljug~~ L.M. LESNIAK |
| Date | 8-14-99 | |

ITEMS REVISED
Items Revised: Complete calculation and deleted Attachments 5 & 8

PURPOSE SUMMARY
The purpose of Revision 9 is as follows:

- Incorporate changes from instrument loop components that were identified in Calculation M-97-0020 Rev. 0 (Reference 77) as located in the Control Room complex and could be subjected to revised temperature profiles. The accident and normal ambient temperature ranges that will be applied are as follows;

  Normal = Δ20°F (See Assumption 1)
  Accident = Δ34°F for Zones 13 and 58 (See Assumption 1)

  The Detailed Analysis/Calculation Section of this calculation will be revised to encompass the effects of the above listed temperature ranges as well as the Operational Consideration and Result Conclusion Sections.

- The "I&C Design Criteria For Instrument Loop Uncertainty Calculation" has been recently revised (Rev. ~~3~~ 4 9/31/99) to incorporate a Graded Approach Method for instruments loops components that are calibrated on different time intervals. This new method has been identified as a Split Loop method. This method is detailed in Attachment #5 to the Design Criteria (see DI37 below) and specifies the method to be used for Instrumentation inside containment and outside of containment. This calculation will provide a Category A/B Partial Spilt Loop method. Attachment 5 circuit diagram will be added to the body of calculation and the attachment deleted.

- The previous revision to this calculation added an Attachment 8 which provided a revised estimate of the uncertainty for the signals sent to the T'SAT Meters and the Plant Computer/RECALL/SPDS using the Graded Approach found in the CR3 I&C Design Criteria For Instrumentation Loop Uncertainty Calculations, Revision 2. This attachment will be incorporated into the body of the calculation and the Attachments 5&8 will be deleted.

RESULTS SUMMARY
Calculated loop errors have been revised and detailed in Tables I through VIII. All of the previous setpoints (AL, AF and CE) have been reduced and redefined by applying a new split-loop method. However, the actual HPI/LPI trip setpoints have remained unchanged by adding additional engineering margin to the newly calculated total loop uncertainty (TLU).

FLORIDA POWER CORPORATION
NUCLEAR ENGINEERING DEPARTMENT
CRYSTAL RIVER UNIT 3
REVIEWED AND ACCEPTED BY:
A.T. BARNARD
ENGINEER A.T. Barnard DATE 8/16/99
SUPERVISOR G. Hildebrandt DATE 8/31/99
G. Hildebrandt for S. Barkofski

Florida Power CORPORATION

# CALCULATION REVIEW

CALC-REV.FRM



CALCULATION NO./REV.
I-89-0014 Rev. 9

**PART I - DESIGN ASSUMPTION/INPUT REVIEW: APPLICABLE** ☒ Yes ☐ No

The following organizations have reviewed and concur with the design assumptions and inputs identified for this calculation:

| | | |
|---|---|---|
| Systems Engineering | 8/12/99 | Signature/Date |
| Nuclear Plant Operations | WINBORNE 8/12/99 | Signature/Date |
| OTHER(S): Design Engineering - Mechanical | 8-12-99 RONALD BORYLA | Signature/Date |
| | | Signature/Date |

**PART II - RESULTS REVIEW: APPLICABLE** ☒ Yes ☐ No

The following organizations have reviewed and concur with the results of this calculation and understand the actions which the organizations must take to implement the results.

| Organization | Yes | N/A | Signature/Date | Comments |
|---|---|---|---|---|
| System Engineering | | | 8/12/99 | |
| Nuclear Plant Operations | | | WINBORNE 8/12/99 | |
| Safety Analysis Group | ☒ | ☐ | V.M. ESRUILLO 8/12/1999 | |
| Nuclear Plant Maintenance | ☒ | ☐ | 8/12/1999 | ADDED SP-130 TO CMIS LIST |
| Nuclear Licensed Operator Training | ☐ | ☒ | | |
| Manager, Nuclear Regulatory Compliance | ☐ | ☒ | | |
| Sr. Radiation Protection Engineer | ☐ | ☒ | | |
| Nuclear Plant EOP Group | ☒ | ☐ | 8/12/99 Ken Rass | |
| Design Engineering MECHANICAL | ☒ | ☐ | 8-12-99 RONALD BORYLA | none. |
| OTHER: EQ | ☒ | ☐ | 8/12/99 | |
| | | | | |

Florida Power CORPORATION

# CALCULATION REVIEW



CALCULATION NO./REV.
I-89-0014 Rev 9 ~~8/31/99~~

**PART III - CONFIGURATION CONTROL: APPLICABLE** ☒ **Yes** ☐ **No PC #** 99-2636

The following is a list of Plant procedures/lesson plans/other documents and Nuclear Engineering calculations which require updating based on calculation results review: 9/3/99

| Document | Date Required | Responsible Organization |
|---|---|---|
| SP-132 ~~SD~~ 8.12.99 | ~~Z~~ ~~12/31/99~~ See P.C. | I&C Maint. ~~12/30~~ |
| I-84-0002 | ↓ | I&C Design Engineering |
| I-89-0010 | ↓ | ↓ |
| I-96-0002 | ↓ | ↓ |
| ~~F-97-0020~~ 98 8-11-99 F-97-0018 | ↓ | Noc. Safety Mgmt. |
| M-97-0020 | ↓ | Mech Design Engineering |
| I-88-0024 | ↓ | I&C Design Engineering |
| M-97-0076 | ↓ | Mech Design Engineering |
| M-97-0075 | ↓ | ↓ |
| I-84-0003 | ↓ | I&C Design Engineering |
| SP-130 ~~D~~ 8.12.99 | ↓ | I&C Maintenance |

**Upon completion, generate a Precursor Card in accordance with CP-111 for tracking of actions for any items identified in Part III. If calculations are listed, a copy shall be sent to the original file and the calculation log updated to reflect this impact.**

**PART IV - NUCLEAR ENGINEERING DOCUMENTATION REVIEW**

The responsible Design Engineer must thoroughly review the below listed documents to assess if the calculation requires revision to these documents. If "Yes," the change authorizations must be listed below and issued concurrently with the calculation.

| Document | Yes | No | Reference |
|---|---|---|---|
| Enhanced Design Basis Document | ☐ | ☒ | (TC#) |
| FSAR | ☐ | ☒ | (Letter#) |
| Improved Tech. Specification | ☐ | ☒ | (Letter#) |
| Improved Tech. Spec. Bases | ☐ | ☒ | (Letter#) |
| Config. Mgmt. Info. System | ☐ | ☒ | (CIDP#) |
| Design Basis Document | ☐ | ☒ | (TC#) |
| Appendix R Fire Study | ☐ | ☒ | (TC#) |
| Fire Hazardous Analysis | ☐ | ☒ | (TC#) |
| NFPA Code Conformance Document | ☐ | ☒ | (TC#) |
| Vendor Qualification Package | ☐ | ☒ | (VQP#) |
| Topical Design Basis Doc. | ☐ | ☒ | (TC#) |
| E&SQPM | ☐ | ☒ | (TC#) |

Other Documents reviewed:

| Document | Yes | No | (CHANGE DOC. REFERENCE) |
|---|---|---|---|
| | ☐ | ☐ | |
| | ☐ | ☐ | |
| | ☐ | ☐ | |
| | ☐ | ☐ | |
| | ☐ | ☐ | |

**PART V - PLANT REVIEWS/APPROVALS FOR INSTRUMENT SETPOINT CHANGE**

PRC/DNPO approval is required if a setpoint is to be physically changed in the plant through the NEP-213 process.

PRC Review Required ☐ Yes ☒ No

PRC Chairman /Date

DNPO Review Required ☐ Yes ☒ No

DNPO /Date

| DESIGN ENGINEER/DATE | DESIGN ENGINEER - PRINTED NAME |
|---|---|
| WHPowell 8/9/99 | W.H. Powell |

# CALCULATION VERIFICATION CHECKLIST

## Crystal River Unit 3

CALVERCL.FRM

| CALCULATION NUMBER | Rev. 9 |
|---|---|
| I-89-0014 | |

| | | YES | NO | N/A |
|---|---|---|---|---|
| 1. | Are inputs, including codes, standards, regulatory requirements, procedures, data, and Engineering methodology correctly selected and applied? | ☒ | ☐ | ☐ |
| 2. | Have assumptions been identified? Are they reasonable and justified? (re: NEP-101) | ☒ | ☐ | ☐ |
| 3. | Are references properly identified, correct, and complete? (re: NEP-101 ) | ☒ | ☐ | ☐ |
| 4. | Have applicable construction and operating experiences been considered? | ☐ | ☐ | ☒ |
| 5. | Was an appropriate Design Analysis/Calculation method used? | ☒ | ☐ | ☐ |
| 6. | In cases where computer software was used, has the program been verified or reverified in accordance with NEP-151 for safety related design applications and/or are inputs, formulas, and outputs associated with spreadsheets accurate? | ☐ | ☐ | ☒ |
| 7. | Is the output reasonable, compared to inputs? | ☒ | ☐ | ☐ |
| 8. | Has technical design information provided (via letter, REA, IOC, or telecon) by other disciplines or programs been verified by that discipline or program? | ☐ | ☐ | ☒ |
| 9. | Has technical design information provided via letter or telecon from an external Engineering Organization or vendor been confirmed and accepted by FPC? | ☐ | ☐ | ☒ |
| 10. | Has atypical equipment/bus alignment been considered in the calculation? | ☐ | ☐ | ☒ |
| 11. | Do the calculation results indicate a non-conforming condition exists? (If "Yes," immediately notify the responsible Supervisor.) | ☐ | ☒ | ☐ |
| 12. | Do the results require a change to other Engineering documents? (If "Yes," have these documents been identified for revision on the Calculation Review Form?) | ☒ | ☐ | ☐ |

# REVIEWER CONCURRENCE FORM

**Crystal River Unit 3**

RCF.FRM

Florida Power CORPORATION

**Document Number/Revision Level:** I-89-0014, Rev. 9

**Originator:** A. T. Barnard (Print) — A T Barnard (Sign)

Signatures delineated below signify whether the department/organization needs to review the Analysis/Calculation. This determination will be made by the individual department/organization, along with the respective discipline. All blocks must be signed by a representative from the respective department/organization.*

| Department/Organization | Review Required | Signature/Date |
|---|---|---|
| DE Electrical | ☐ Yes ☒ No | email ATB / 7/13/99 |
| DE I&C | ☒ Yes ☐ No | A T Barnard / 7/13/99 |
| DE Mechanical | ☒ Yes ☐ No | email ATB / 7/13/99 |
| DE Structural | ☐ Yes ☒ No | email ATB / 7/22/99 |
| ISI | ☐ Yes ☒ No | email ATB / 7/22/99 |
| Licensing | ☐ Yes ☒ No | email ATB / 7/14/99 |
| Maintenance | ☒ Yes ☐ No | Telecon ATB / 7/22/99 |
| Nuclear Safety Management | ☒ Yes ☐ No | email ATB / 7/15/99 |
| Operations | ☒ Yes ☐ No | email ATB / 7/13/99 |
| Operations (EOP/AP) | ☒ Yes ☐ No | email ATB / 7/13/99 |
| Programs EQ (Identify App. "R", EQ, and/or Fire Protection) | ☒ Yes ☐ No | email ATB / 7/15/99 |
| Systems Engineering | ☒ Yes ☐ No | Telecon ATB / 7/22/99 |
| Training | ☐ Yes ☒ No | email ATB / 7/14/99 |
| Other App. R / Fire Prot. | ☐ Yes ☒ No | email ATB / 7/22/99 |
| Other ______ | ☐ Yes ☐ No | ______ / ______ |

*NOTE: In lieu of signatures by respective departments, the originator may sign for them, based on verbal concurrence (telecons) , cc:Mail notes, etc.

Florida Power
CORPORATION

# INTEROFFICE CORRESPONDENCE

A-C-XMTL.FRM

| Nuclear Engineering | NT3C | 1565 |
|---|---|---|
| Office | MAC | Telephone |

SUBJECT: Crystal River Unit 3
Quality Document Transmittal - Analysis/Calculation

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-89-0014 | 8 | RC | ~~26~~ 34 mDL |

TITLE
RC PRESSURE LOOP ACCURACY FOR ES

KWDS (IDENTIFY KEYWORDS FOR LATER RETRIEVAL)
Same as Rev. 6

| DXREF (REFERENCES OR FILES - LIST PRIMARY FILE FIRST) | |
|---|---|
| I-84-0002 | |
| I-96-0002 | |
| I-97-0015 | |

| VEND (VENDOR NAME) | VENDOR DOCUMENT NUMBER (DXREF) | SUPERSEDED DOCUMENTS (DXREF) |
|---|---|---|
| FPC | N/A | N/A |

TAG

| | | |
|---|---|---|
| Same as Rev. 6 | | |

PART NO.

| | | |
|---|---|---|
| Same as Rev. 6 | | |

COMMENTS (USAGE RESTRICTIONS, PROPRIETARY, ETC.)

**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 |
|---|---|---|---|---|---|
| M.D. Lord M. D. Lord | 11/13/97 | S.Z. BARKOFSKI | 11/13/97 | W.S. Koleff | 11/20/97 |

cc: Nuclear Projects (If MAR/CGWR/PEERE Return to Service Related) ☐ Yes ☒ No
Supervisor, Config. Mgt. Info.
Mgr., Nucl. Operations Eng. (Original) w/attach
W.S. Koleff w/ attach
S. K. Bartliet w/ attach

Calculation Review form Part III actions required ☐ Yes ☒ No
(If Yes, send copy of the form to Nuclear Regulatory Assurance and a copy of the Calculation to the Responsible Organization(s) identified in Part III on the Calculation Review form.)

Rev. 3/97

Florida Power CORPORATION

# ANALYSIS/CALCULATION SUMMARY

A-C-SUM.FRM

| DOCUMENT IDENTIFICATION NUMBER | DISCIPLINE: I | CONTROL NO.: 89-0014 | REVISION LEVEL: 8 |
|---|---|---|---|

| TITLE | CLASSIFICATION (CHECK ONE) |
|---|---|
| RC PRESSURE LOOP ACCURACY FOR ES | ☒ Safety Related<br>☐ Non Safety Related |
| | MAR/SP/CGWR/PEERE NUMBER<br>SP 95-002 |
| | VENDOR DOCUMENT NUMBER<br>C-423-5510-066 |

| | APPROVAL SIGNATURES | PRINTED NAME |
|---|---|---|
| Design Engineer | M. D. Lord | M. D. Lord |
| Date | 11/13/97 | 11/11/97 |
| Verification Engineer | Stephen Barkofski | S. Z. Barkofski |
| Date | 11/13/97 | 11/13/97 |
| Supervisor | W Koleff | W. S. Koleff |
| Date | 11/20/97 | |

ITEMS REVISED

New Attachment 8 added. Revised Sheets 28, 32, 35, 36, 51, 52, 53, 57, 58, 61, 64, 66, 69, & 74.

PURPOSE SUMMARY

The purpose of this revision is to apply the CR3 I&C Design Graded Approach (as described in the I&C Design Criteria for Instrument Loop Uncertainty Calculations) to the signal sent to the T'SAT Meters, the Plant Computer, and RECALL/SPDS. The Graded Approach had not been developed when the calculation was rewritten in Revision 6 to take advantage of this less regorous method for determining uncertainties for less critical functions. The results of this calculation will be used to revise calculations I-84-0002 and I-96-0002. In addition, this revision also establishes a setpoint for the Low Temperature Overpressure Protection (LTOP) alarm based upon the LTOP initiation setpoint determined by I-97-0015.

RESULTS SUMMARY

The Calibrated Loop Error (under normal conditions) for the signal to the T'SAT Meters was reduced by +15.00 and -23.50 psig using the Category B Graded Approach versus the approach initially adopted. Under accident the error was reduced by ±39.50 psig using the Category B Graded Approach. The Calibrated Loop Error (under normal conditions) for the signal to RECALL/SPDS was reduced by ±18.50 psig. Under accident conditions, the error was reduced by ±23.25 psig.

The LTOP alarm setpoint remains 50 psig below the LTOP initation setpoint which has been reduced by I-97-0015 to 442.6 psig. Therefore, the new LTOP alarm setpoint is 392.6 psig.

Rev. 3/97

Florida Power CORPORATION

# CALCULATION REVIEW

CALC-REV.FRM



CALCULATION NO./REV.
I-89-0014, Rev. 8

**PART I - DESIGN ASSUMPTION/INPUT REVIEW: APPLICABLE ☒ Yes ☐ No**

The following organizations have reviewed and concur with the design assumptions and inputs identified for this calculation:

| | |
|---|---|
| Nuclear Plant Technical Support System Engr | R A Wiemann 11/14/97 Signature/Date |
| Nuclear Plant Operations | K R C Bell 11/15/97 Signature/Date |
| OTHER(S) Operations - EOP Group | 11/14/97 Signature/Date |
| Maintenance | John A. Campbell 11/15/97 Signature/Date |
| Licensing | Lorette V Cecilio 11/14/97 Signature/Date |

**PART II - RESULTS REVIEW: APPLICABLE ☒ Yes ☐ No**

The following organizations have reviewed and concur with the results of this calculation and understand the actions which the organizations must take to implement the results.

| | |
|---|---|
| Nuclear Plant Technical Support System Engr | R A Wiemann 11/14/97 Signature/Date |
| Nuclear Plant Operations | K R C Bell 11/15/97 Signature/Date |
| Nuclear Plant Maintenance ☒ Yes ☐ N/A | John A. Campbell 11/15/97 Signature/Date |
| Nuclear Licensed Operator Training ☐ Yes ☒ N/A | Signature/Date |
| Manager, Site Nuclear Services ☐ Yes ☒ N/A | Signature/Date |
| Sr. Radiation Protection Engineer ☐ Yes ☒ N/A | Signature/Date |
| OTHERS: EOP GROUP | 11/14/97 Signature/Date |
| | Signature/Date |

Florida Power CORPORATION

# CALCULATION REVIEW

CALC-REV.FRM



CALCULATION NO./REV.
I-89-0014, Rev. 8

**PART I - DESIGN ASSUMPTION/INPUT REVIEW: APPLICABLE ☒ Yes ☐ No**

The following organizations have reviewed and concur with the design assumptions and inputs identified for this calculation:

| | |
|---|---|
| Nuclear Plant Technical Support System Engr | RAWiemann 11/14/97<br>Signature/Date |
| Nuclear Plant Operations | Signature/Date |
| OTHER(S) | |
| Operations - EOP Group | Signature/Date |
| Maintenance | Signature/Date |
| Licensing | Lorette C Cecilia 11/14/97<br>Signature/Date |

**PART II - RESULTS REVIEW: APPLICABLE ☒ Yes ☐ No**

The following organizations have reviewed and concur with the results of this calculation and understand the actions which the organizations must take to implement the results.

| | |
|---|---|
| Nuclear Plant Technical Support System Engr | RAWiemann 11/14/97<br>Signature/Date |
| Nuclear Plant Operations | Signature/Date |
| Nuclear Plant Maintenance ☒ Yes ☐ N/A | Signature/Date |
| Nuclear Licensed Operator Training ☐ Yes ☒ N/A | Signature/Date |
| Manager, Site Nuclear Services ☐ Yes ☒ N/A | Signature/Date |
| Sr. Radiation Protection Engineer ☐ Yes ☒ N/A | Signature/Date |

OTHERS:

| | |
|---|---|
| | Signature/Date |
| | Signature/Date |

Florida Power CORPORATION

# CALCULATION REVIEW



CALCULATION NO./REV.
I-89-0014, Rev. 8

**PART III - CONFIGURATION CONTROL: APPLICABLE** ☒ **Yes** ☐ **No**

The following is a list of Plant procedures/lesson plans/other documents and Nuclear Engineering calculations which require updating based on calculation results review:

| Document | Date Required | Responsible Organization |
|---|---|---|
| I-84-0002 | 12/31/98 | NOE |
| I-96-0002 | 12/31/98 | NOE |
| SP-132 | 12/31/98 | Maintenance |
| AR-501 | ~~11/28/97~~ lok 12/31/97 | Operations |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

**Upon completion, forward a copy to the Manager, Nuclear Regulatory Assurance Group for tracking of actions if any items are identified in Part III. If calculations are listed, a copy shall be sent to the original file and the calculation log updated to reflect this impact.**

**PART IV - NUCLEAR ENGINEERING DOCUMENTATION REVIEW**

The responsible Design Engineer must thoroughly review the below listed documents to assess if the calculation requires revision to these documents. If "Yes," the change authorizations must be listed below and issued concurrently with the calculation.

| Document | Yes | No | Reference | Document | Yes | No | Reference |
|---|---|---|---|---|---|---|---|
| Enhanced Design Basis Document | ☐ | ☒ | (TC#) | Vendor Qualification Package | | | (VQP#) |
| FSAR | ☐ | ☒ | (Letter#) | Topical Design Basis Doc. | ☐ | ☒ | (TC#) |
| Improved Tech. Specification | ☐ | ☒ | (Letter#) | E/SQPM | ☐ | ☒ | (TC#) |
| Improved Tech. Spec. Bases | ☐ | ☒ | (Letter#) | Other Documents reviewed: | | | |
| Config. Mgmt. Info. System | ☒ | ☐ | (CIDP#) 97111401 | IDS RC-3A-PS4 | ☒ | ☐ | DCN 97-675 (CHANGE DOC. REFERENCE) |
| Analysis Basis Document | ☐ | ☒ | (TC#) | | ☐ | ☐ | (CHANGE DOC. REFERENCE) |
| Design Basis Document | ☐ | ☒ | (TC#) | | ☐ | ☐ | (CHANGE DOC. REFERENCE) |
| Appendix R Fire Study | ☐ | ☒ | (TC#) | | ☐ | ☐ | (CHANGE DOC. REFERENCE) |
| Fire Hazardous Analysis | ☐ | ☒ | (TC#) | | ☐ | ☐ | (CHANGE DOC. REFERENCE) |
| NFPA Code Conformance Document | ☐ | ☒ | (TC#) | | ☐ | ☐ | (CHANGE DOC. REFERENCE) |

**PART V - PLANT REVIEWS/APPROVALS FOR INSTRUMENT SETPOINT CHANGE**

PRC/DNPO approval is required if a setpoint is to be physically changed in the plant through the NEP 213 process.

PRC Review Required ☒ Yes ☐ No

PRC Chairman /Date

DNPO Review Required ☒ Yes ☐ No

DNPO /Date

| DESIGN ENGINEER/DATE | DESIGN ENGINEER - PRINTED NAME |
|---|---|
| M. D. Lord 11/13/97 | M. D. Lord |

Rev. 8/97

Florida Power CORPORATION

# CALCULATION VERIFICATION REPORT

**Crystal River Unit 3**

CALVERRP.FRM



| CALCULATION NUMBER |
|---|
| I-89-0014, Rev. 8 |
| **PROJECT/TITLE** |
| RC PRESSURE LOOP ACCURACY FOR ES |

| | YES | NO | N/A | |
|---|---|---|---|---|
| 1. | ☒ | ☐ | ☐ | Are inputs, including codes, standards, regulatory requirements, procedures, data, and Engineering methodology correctly selected and applied? |
| 2. | ☐ | ☐ | ☒ | Have assumptions been identified? Are they reasonable and justified? (See NEP 101, V.c, for discussion on references). |
| 3. | ☒ | ☐ | ☐ | Are references properly identified, correct, and complete? (See NEP 101, V.c., for discussion on assumptions and justification.) |
| 4. | ☐ | ☐ | ☐ | Have applicable construction and operating experiences been considered? |
| 5. | ☒ | ☐ | ☐ | Was an appropriate Design Analysis/Calculation method used? |
| 6. | ☐ | ☐ | ☒ | In cases where computer software was used, has the program been verified or reverified in accordance with NEP 135 for safety related design applications and/or are inputs, formulas, and outputs associated with spreadsheets accurate? |
| 7. | ☒ | ☐ | ☐ | Is the output reasonable compared to inputs? |
| 8. | ☒ | ☐ | ~~☒~~ SZB 11/13/97 | Has technical design information provided via letter, REA, IOC or telecon by other disciplines or programs been verified by that discipline or program? |
| 9. | ☐ | ☐ | ☒ | Has technical design information provided via letter or telecon from an external Engineering Organization or vendor been confirmed and accepted by FPC? |
| 10. | ☐ | ☒ | ☐ | Do the calculation results indicate a non-conforming condition exists? If "Yes," immediately notify the responsible Supervisor. |
| 11. | ☒ | ☐ | ☐ | Do the results require a change to other Engineering documents? If "Yes," have these documents been identified for revision on the Calculation Review Form? |

I have performed a verification on the subject calculation package and find the results acceptable.

| VERIFICATION ENGINEER | DATE | SUPERVISOR, NUCLEAR ENGINEERING | DATE |
|---|---|---|---|
| S. Z. Borkofski [signature] | 11/13/97 | W. S. Koleff / WSKoleff | 11/15/97 |

Florida Power CORPORATION

# INTEROFFICE CORRESPONDENCE

| Office | MAC | Telephone |
|---|---|---|
| Nuclear Engineering | NA1E | 240-3490 |

SUBJECT: Crystal River Unit 3
Quality Document Transmittal - Analysis/Calculation

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-89-0014 | 7 | RC | 7 |

TITLE
RC PRESSURE LOOP ACCURACY FOR ES

KWDS (IDENTIFY KEYWORDS FOR LATER RETRIEVAL)
Same as Rev. 6

DXREF (REFERENCES OR FILES - LIST PRIMARY FILE FIRST)
Same as Rev. 6

| VEND (VENDOR NAME) | VENDOR DOCUMENT NUMBER (DXREF) | SUPERSEDED DOCUMENTS (DXREF) |
|---|---|---|
| FPC | C-423-5510-066 | I-88-0024 |

TAG
Same as Revision 6

PART NO.

COMMENTS (USAGE RESTRICTIONS, PROPRIETARY, ETC.)

**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 |
|---|---|---|---|---|---|
| M. D. Lord | 10/24/95 | [signature] | 10/24/95 | S. K. Balliet | 12/13/95 |

cc: MAR Office (If MAR Related) ☐ Yes ☒ No
Mgr. Nucl. Config. Mgt.
Mgr., Nucl. Eng. Design
(Original) w/attach
H. WOJASINSKI /W ATTACH
S. BALLIET W/ ATTACH

Plant Document Updates Required ☒ Yes ☐ No (If Yes, send copy of the Calculation Review form to Nuclear Licensing and a copy of the Calculation to the Responsible Organization(s) identified in Part III on the Calculation Review form.)
A/E ~~GCI~~ B+W SKB ☒ Yes ☐ No
(If yes, Transmit w/attach) 10/24/95

Rev. 6/95

RET: Life of Plant RESP: Nuclear Engineering

Florida Power Corporation

# ANALYSIS/CALCULATION SUMMARY

| DOCUMENT IDENTIFICATION NUMBER | DISCIPLINE | CONTROL NO. | REVISION LEVEL |
|---|---|---|---|
| | I | 89-0014 | 7 |

| TITLE | |
|---|---|
| RC PRESSURE LOOP ACCURACY FOR ES | CLASSIFICATION (CHECK ONE)<br>[X] Safety Related<br>[ ] Non Safety Related |
| | MAR/SP/CGWR/PEERE NUMBER<br>SP 95-002 |
| | VENDOR DOCUMENT NUMBER<br>C-423-5510-066 |

| | REVISION APPROVALS | | ITEMS REVISED |
|---|---|---|---|
| Design Engineer | M. D. Ford | | Pages 60, 68, & 69 |
| Date | 10/23/95 | | |
| Verification Engineer | [illegible] | | |
| Date/Method* | 10/24/95 | R | |
| Supervisor | S. K. Balliet | | |
| Date | 12/13/95 | | |

***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 corrects minor arithmetic and typographical errors made in Revision 6.

RESULTS SUMMARY

Tolerance on Table VI of Section VI (Results/Conclusions) was corrected.

Florida Power CORPORATION

# CALCULATION REVIEW



CALCULATION NO./REV.
I-89-0014/Rev. 7

**PART I - DESIGN ASSUMPTION/INPUT REVIEW**

The following organizations have reviewed and concur with the design assumptions and inputs identified for this calculation:

Nuclear Plant Technical Support System Engr — Kurt N. Smith 11/30/95 — Signature/Date

Nuclear Plant Operations — Garrett Lab 12/4/95 — Signature/Date

OTHER(S)

Nuclear Plant Maintenance — Henry Wojtasinski 12/13/95 — Signature/Date

Signature/Date

**PART II - RESULTS REVIEW**

The following organizations have reviewed and concur with the results of this calculation and understand the actions which the organizations must take to implement the results.

Nuclear Plant Technical Support System Engr — Kurt N. Smith 11/30/95 — Signature/Date

Nuclear Plant Operations — Garrett Lab 12/4/95 — Signature/Date

Nuclear Plant Maintenance
☑ Yes ☐ N/A — Henry Wojtasinski 12/13/95 — Signature/Date

Nuclear Licensed Operator Training
☐ Yes ☒ N/A — Signature/Date

Manager, Site Nuclear Services
☐ Yes ☒ N/A — Signature/Date

Sr. Radiation Protection Engineer
☐ Yes ☒ N/A — Signature/Date

OTHERS:

Signature/Date

Signature/Date

Florida Power CORPORATION

# CALCULATION REVIEW



CALCULATION NO./REV.
I-89-0014/Rev. 7

**PART III - CONFIGURATION CONTROL**

The following is a list of Nuclear Engineering and Plant procedures/lesson plans/other documents which require updating based on calculation results review:

| Document | Date Required | Responsible Organization |
|---|---|---|
| SP-132 | 7/29/96 | Maintenance (H. WOJTASINSKI) |

**Upon completion, forward a copy to the Manager, Nuclear Licensing for tracking of actions if any items are identified in Part III.**

**PART IV - PLANT REVIEWS/APPROVALS FOR FIELD SETPOINT CHANGE**

PRC review is required if a full 10CFR50.59 Safety Evaluation is performed. DNPO approval is required if a setpoint is to be physically changed in the plant.

PRC Review Required ☐ Yes ☒ No — PRC Chairman /Date

DNPO Review Required ☐ Yes ☒ No — DNPO /Date

DESIGN ENGINEER/DATE
M. D. Ford 10/29/95

Florida Power CORPORATION

# INTEROFFICE CORRESPONDENCE

| Nuclear Engineering Design | NA1E | 231-5619 |
|---|---|---|
| Office | MAC | Telephone |

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-89-0014** | **6** | **RC** | **100** |

TITLE
**RC PRESSURE LOOP ACCURACY FOR ES**

KWDS (IDENTIFY KEYWORDS FOR LATER RETRIEVAL)
Calculation, Insulation Resistance, Setpoint, HPI, LPI, ES, Accuracy

DXREF (REFERENCES OR FILES - LIST PRIMARY FILE FIRST)
SP95-002, I-83-0001, I-89-0010, I-84-0002, SP-130,
SP-132, SP-135A, SP-135B, SP-135C, I-84-0001

| VEND (VENDOR NAME) | VENDOR DOCUMENT NUMBER (DXREF) | SUPERSEDED DOCUMENTS (DXREF) |
|---|---|---|
| FPC | C-423-5510-066 | I-89-0014, Rev. 5 |

| TAG | | |
|---|---|---|
| See Attached | | |
| | | |
| | | |

| PART NO. | | |
|---|---|---|
| | | |
| | | |

COMMENTS (USAGE RESTRICTIONS, PROPRIETARY, ETC.)

**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 |
|---|---|---|---|---|---|
| M. D. Lord | 6/1/95 | [signature] | 6/1/95 | S. K. Balliet | 6/1/95 |

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
C. C. Strzmake 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 BWNT ☒ Yes ☐ No
(If yes, Transmit w/attach)
M.D. Lord w/att.

Rev. 11/94

**RET:** Life of Plant **RESP:** Nuclear Engineering 900 628

**CALCULATION I-89-0014, REV. 6**

Tag Number

RC-3A-PT3
RC-3A-PT4
RC-3B-PT3
RC-3A-PY3
RC-3A-PY4-1
RC-3B-PY3
RC-3-BT1
RC-3-BT7
RC-3-BT2
RC-3-BT8
RC-3-BT3
RC-3-BT9
RC-3A-JX3
RC-3A-JX4
RC-3B-JX3
RC-3A-EB1
RC-3B-EB2
RC-3A-EB2
RC-3A-EB3
RC-3B-EB3
RC-3A-PS3
RC-3A-PS4
RC-3A-PS5
RC-3A-PS6
RC-3A-PS7
RC-3A-PY4
RC-3A-PI3
RC-3B-PI2
RC-163A-PY1
RC-163B-PY1
RC-154-PR/TR
RC-3-BT4
RC-3-BT5
RC-3-BT6
RC-3-BT10
RC-3-BT11
RC-3-BT12

Florida Power Corporation

# ANALYSIS/CALCULATION SUMMARY

| DOCUMENT IDENTIFICATION NUMBER | DISCIPLINE | CONTROL NO. | REVISION LEVEL |
|---|---|---|---|
| | I | 89-0014 | 6 |

TITLE

RC PRESSURE LOOP ACCURACY FOR ES

CLASSIFICATION (CHECK ONE)

[X] Safety Related
[ ] Non Safety Related

MAR/SP/CGWR/PEERE NUMBER/FILE

SP 95-002

VENDOR DOCUMENT NUMBER

C-423-5510-066

| | REVISION APPROVALS | | ITEMS REVISED |
|---|---|---|---|
| Design Engineer | M. D. Lord M. D. Lord | | Entire Calculation |
| Date | 03/24/95 | | |
| Verification Engineer | [signature] | | |
| Date/Method* | 6/1/95 | R | |
| Supervisor | S. K. Balliet | | |
| Date | 6/1/95 | | |

***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 calculation has been totally rewritten to add "AS-LEFT" and "AS-FOUND" tolerances, 1/2 minor division errors, and "CALIBRATED" errors to the calculation so as to provide a bases for the tolerances used in SP-132.

RESULTS SUMMARY

See the TABLES in Section VI "RESULTS/CONCLUSIONS" for the errors, "AS-Left" & "As-Found" tolerances, and "CALIBRATED" errors associated with the components and the loops.

Florida Power Corporation

# PLANT DOCUMENT REVIEW EVALUATION

DOCUMENT TYPE / NUMBER TO BE EVALUATED

**Calculation I-89-0014 Revision 6**

## 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
PEEREs - Insert behind PEERE page 3
CIDPs - Insert behind CIDP page 1

The above referenced document must be distributed as follows:

- ☐ Senior Radiation Protection Engineer
- ☐ Manager, Site Nuclear Services
- ☒ Manager, Nuclear Maintenance
- ☒ Supervisor, Operations Engineering & Support
- ☒ Manager, Nuclear Plant Technical Support
- ☒ Other(s):
  - D.E. McPherson for Calibration Data Sheet Revisions
  - Supervisor, Nuclear Training Controls
  - Manager, Nuclear Operations Training

| ORIGINATOR / DATE | SUPERVISOR / DATE * |
|---|---|
| M. D. Lord M. D. Lord 6/1/95 | S. K. Balliet 6/1/95 |

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.
**CIDPs** - Distribute with Attachments
**Calcs** - Distribute with Transmittal Memo, Summary - **PEERE** - Distribute with Attachments - **DCNs** - Distribute with Attachments and Drawings

## PART II

**INSTRUCTIONS:** Upon receipt of the subject document, the assigned Reviewer enters the "Reviewing Department" name below, reviews the subject document for impact on plant procedures, and completes the evaluation below.
**CAUTION: IF THE SUBJECT DOCUMENT STATES SPECIFIC PLANT PROCEDURES/DOCUMENTS MUST BE DEVELOPED OR REVISED AND IT IS DETERMINED BY THE REVIEWER NOT TO REVISE OR DEVELOP THOSE PROCEDURES/DOCUMENTS, THE ORIGINATOR MUST BE CONTACTED BY THE REVIEWER.**

REVIEWING DEPARTMENT

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

- ☐ No Action Required
- ☐ Action Required: The below listed document(s) is affected and requires revision and/or other actions as indicated (i.e., generate a new procedure, void a procedure, etc.)

DOCUMENTS / ACTIONS

| REVIEWER / DATE | SUPERVISOR / DATE * |
|---|---|
| | |

Upon completion, forward evaluation form only to Nuclear Document Control (NR2A)
* If the Supervisor or designee acts as the Originator or Reviewer, the applicable "Originator/Reviewer" block should be NA'd.

Florida Power CORPORATION

# INTEROFFICE CORRESPONDENCE

| Nuclear Engineering Design | NA1E | 240-3434 |
|---|---|---|
| Office | MAC | Telephone |

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-89-0014 | 5 | ES, RC | 22 |

TITLE
RC PRESSURE LOOP ACCURACY FOR ES

KWDS (IDENTIFY KEYWORDS FOR LATER RETRIEVAL)
ES, Actuation, Alarm, Interlock, IR, Error, Calculation

DXREF (REFERENCES OR FILES - LIST PRIMARY FILE FIRST)
SP-132

| VEND (VENDOR NAME) | VENDOR DOCUMENT NUMBER (DXREF) | SUPERSEDED DOCUMENTS (DXREF) |
|---|---|---|
| FPC/GCI | C-423-5510-066 | N/A |

TAG

| | | |
|---|---|---|
| | | |

PART NO.

| | | |
|---|---|---|
| | | |

COMMENTS (USAGE RESTRICTIONS, PROPRIETARY, ETC.)
This Revision replaces Sheets 3, 4, 5, 7, 8, 9, 10, 11, 12, 15 and 16. In addition pages 4A, 4B, 8A and Attachment 11 are being added to this calculation. No changes to Tag Numbers.

**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 [signature] | 2/3/95 | [signature] | 2/3/95 | S. K. Balliet | 2/3/95 |

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
M.D. Lord 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)

Florida Power Corporation

# ANALYSIS/CALCULATION SUMMARY

| DOCUMENT IDENTIFICATION NUMBER | DISCIPLINE | CONTROL NO. | REVISION LEVEL |
|---|---|---|---|
| | I | 89-0014 | 5 |

| TITLE | |
|---|---|
| RC PRESSURE LOOP ACCURACY FOR ES | CLASSIFICATION (CHECK ONE)<br>[X] Safety Related<br>[ ] Non Safety Related |
| | MAR/SP/CGWR/PEERE NUMBER/FILE<br>SP88-006 |
| | VENDOR DOCUMENT NUMBER<br>C-423-5510-066 |

| | REVISION APPROVALS | ITEMS REVISED |
|---|---|---|
| Design Engineer | P.E. Couvillon PEC | Revise pages 3, 4, 5, 7, 8, 9, 10, 11, 12, 15 and 16. |
| Date | 2/3/95 | Add pages 4A, 4B, 8A and Attachment 11. |
| Verification Engineer | [signature] | |
| Date/Method* | 2/3/95 R | |
| Supervisor | S. K. Balliet | |
| Date | 2/3/95 | |

***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 calculation revises the above mentioned pages to reflect the deletion of Radiation Effects from the transmitters for the actuation of the 500 and 1500 psig setpoints. In addition, the temperature range used in calculating the Temperature Effect on the pressure transmitters is being revised.

RESULTS SUMMARY

See Section VI "RESULTS/CONCLUSIONS" for the Calculated Loop Errors associated with the pressure transmitters.

Florida Power Corporation

# PLANT DOCUMENT REVIEW EVALUATION

DOCUMENT TYPE / NUMBER TO BE EVALUATED

Calculation I-89-0014 Revision 5

## 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
PEEREs - Insert behind PEERE page 3
CIDPs - Insert behind CIDP page 1

The above referenced document must be distributed as follows:

- ☐ Senior Radiation Protection Engineer
- ☐ Manager, Site Nuclear Services
- ☐ Manager, Nuclear Maintenance
- ☒ Supervisor, Operations Engineering & Support
- ☒ Manager, Nuclear Plant Technical Support

☐ Other(s):

| ORIGINATOR / DATE | SUPERVISOR / DATE * |
|---|---|
| P.E. Couvillon [signature] 2/3/95 | B.K. [signature] 2/3/95 |

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.
**CIDPs** - Distribute with Attachments
**Calcs** - Distribute with Transmittal Memo, Summary - **PEERE** - Distribute with Attachments - **DCNs** - Distribute with Attachments and Drawings

## PART II

**INSTRUCTIONS:** Upon receipt of the subject document, the assigned Reviewer enters the "Reviewing Department" name below, reviews the subject document for impact on plant procedures, and completes the evaluation below.
**CAUTION: IF THE SUBJECT DOCUMENT STATES SPECIFIC PLANT PROCEDURES/DOCUMENTS MUST BE DEVELOPED OR REVISED AND IT IS DETERMINED BY THE REVIEWER NOT TO REVISE OR DEVELOP THOSE PROCEDURES/DOCUMENTS, THE ORIGINATOR MUST BE CONTACTED BY THE REVIEWER.**

REVIEWING DEPARTMENT

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

- ☐ No Action Required
- ☐ Action Required: The below listed document(s) is affected and requires revision and/or other actions as indicated (i.e., generate a new procedure, void a procedure, etc.)

DOCUMENTS / ACTIONS

| REVIEWER / DATE | SUPERVISOR / DATE * |
|---|---|
| | |

Upon completion, forward evaluation form only to Nuclear Document Control (NR2A)
* If the Supervisor or designee acts as the Originator or Reviewer, the applicable "Originator/Reviewer" block should be NA'd.

12/94

Florida Power CORPORATION

# INTEROFFICE CORRESPONDENCE

| Nuclear Engineering | C2I | 5237 |
|---|---|---|
| OFFICE | MAC | PHONE |

**SUBJECT:** Crystal River Unit No. 3
Quality Document Transmittal - Analysis/Calculations
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 |
|---|---|---|---|
| I89-0014 | 4 | ES, RC | 4 |

**TITLE**
RC PRESSURE LOOP ACCURACY FOR ES

**KWDS** (IDENTIFY KEYWORDS FOR LATER RETRIEVAL)
ES, Actuation, Alarm, Interlock, IR, Error, 1.97, TSIP

**DXREF** (REFERENCES OR FILES - LIST PRIMARY FILE FIRST)

| VEND (VENDOR NAME) | VENDOR DOCUMENT NUMBER (DXREF) | SUPERSEDED DOCUMENTS (DXREF) |
|---|---|---|
| FPC / GCI | C-423-5510-066 | N/A |

**TAG**

**PARTNO**

**COMMENTS** (USAGE RESTRICTIONS, PROPRIETARY, ETC.)
Replace A/C Summary Sheet and calc sheet 9 with revision 4 A/C Summary sheet and calc sheet 9.
No change in Tag or DXREF.

**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 |
|---|---|---|---|---|---|
| J Owen | 1/13/93 | RHH [signature] | 1-19-94 | C. B. Doyel | 1/19/94 |

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.

Supervisor, Nuclear Document Control w/Plant Doc. Rev. Eval. and Analysis / Calc. Summary
Plant Document Review Required ~~☐ Yes~~ ☒ No
PDU RHH
A/E GCI ☒ YES
(IF YES, Transmit w/attach)
RHH 1-19-94

RHH 1-19-94

Rev. ~~4/92~~ 3/93

RET: Life of Plant RESP: Nuclear Engineering 900 628

Florida Power Corporation

# ANALYSIS/CALCULATION SUMMARY

| DOCUMENT IDENTIFICATION NUMBER | DISCIPLINE | CONTROL NO. | REVISION LEVEL |
|---|---|---|---|
| | I | 89-0014 | 4 |

| TITLE | |
|---|---|
| RC PRESSURE LOOP ACCURACY FOR ES | CLASSIFICATION (CHECK ONE)<br>[X] Safety Related<br>[ ] Non Safety Related |
| | MAR/SP NUMBER/FILE<br>SP88-006 |
| | VENDOR DOCUMENT NUMBER<br>C-423-5510-066 |

| | REVISION APPROVALS | ITEMS REVISED |
|---|---|---|
| Design Engineer | J Owen | SHEET 9 |
| Date | 1/13/93 | |
| Verification Engineer | R H Tow | |
| Date/Method* | 1-19-94 \| R | |
| Supervisor | C B Doyle | |
| Date | 1/27/94 | |

***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 corrects typographical errors on sheet 9.

RESULTS SUMMARY

No change. ES Actuation, Permit and Reset, ±40 psi

Alarm and Interlock via NNI, ±45 psi (Alarm of CFT valve not open could be at >750 psig)

Recording, ±39 psi RIP Indicator ±48 psi

See Section VI for outputs to RCITS, T-SAT, Plant Computer, Recall and RPP.

Florida Power Corporation

# PLANT DOCUMENT REVIEW EVALUATION

DOCUMENT TYPE / NUMBER TO BE EVALUATED

CALC / I89-0014 Rev 4

## 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
PEEREs - Insert behind PEERE page 2

The above referenced document must be distributed as follows:

- ☒ No Review Required
- ☐ Manager, Nuclear Plant Systems Engineering
- ☐ Nuclear Chem/Rad Protection Superintendent
- ☐ Senior Radiation Protection Engineer
- ☐ Manager, Site Nuclear Services
- ☐ Nuclear Operations Superintendent
- ☐ Nuclear Maintenance Work Controls Superintendent
- ☐ Manager, Nuclear Plant Technical Support
- ☐ Other(s):

| ORIGINATOR / DATE | SUPERVISOR / DATE * |
|---|---|
| J Owen 1/13/93 | C.B. Doyel 1/19/94 |

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

## PART II

**INSTRUCTIONS:** Upon receipt of the subject document, the assigned Reviewer enters the "Reviewing Department" name below, reviews the subject document for impact on plant procedures, and completes the evaluation below.

REVIEWING DEPARTMENT

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

- ☐ No Action Required
- ☐ Action Required: The below listed document(s) is affected and requires revision and/or other actions are required as indicated (i.e., generate a new procedure, void a procedure, etc.)

DOCUMENTS / ACTIONS

| REVIEWER / DATE | SUPERVISOR / DATE * |
|---|---|
| | |

Upon completion, forward evaluation form only to Nuclear Document Control (NR2A)
* If the Supervisor or designee acts as the Originator or Reviewer, the applicable "Originator/Reviewer" block should be NA'd.

Florida Power CORPORATION

# INTEROFFICE CORRESPONDENCE

| Nuclear Engineering | C2I | 5237 |
|---|---|---|
| OFFICE | MAC | PHONE |

**SUBJECT:** Crystal River Unit No. 3
Quality Document Transmittal - Analysis/Calculations
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 |
|---|---|---|---|
| I89-0014 | 3 | RC | 45 |

TITLE
RC Pressure Loop Accuracy for ES

KWDS (IDENTIFY KEYWORDS FOR LATER RETRIEVAL)
ES, Actuation, Alarm, Interlock, IR, Error, 1.97, TSIP

DXREF (REFERENCES OR FILES - LIST PRIMARY FILE FIRST) See Comments for add'l DXREF

| | | | | |
|---|---|---|---|---|
| I89-0004 | I84-0001 | 51-1173714 | | I88-0030 |
| I90-0014<br>I88-0014 | I88-0004<br>I84-0002 | 210-483<br>D8034033, Sh. 4 | | I89-0010<br>I88-0031 |
| I86-0011<br>I88-0015 | 210-481<br>205-047, RC11 & RC11A | SP-132 | AR-502 | 210-485<br>I88-0024 |

| VEND (VENDOR NAME) | VENDOR DOCUMENT NUMBER (DXREF) | SUPERSEDED DOCUMENTS (DXREF) |
|---|---|---|
| FPC / G/C | C-423-5510-066 | I89-0014, Rev. 2 |

**TAG**

| | | |
|---|---|---|
| RC-3A/B-PT3<br>RC-3A-PT4 | RC-3A-EB1, 2 & 3<br>RC-3B-EB2 | |
| RC-3A/B-JX3<br>RC-3A-JX4 | RC-3A-PS3, 4, 5, 6 & 7<br>RC-3A-PY4 | |
| RC-3A/B-PX3<br>RC-3A-PX4 | RC-3-BT1, 2, 3, 7, 8 & 9<br>RC-3A-PI3 | |
| RC-3A/B-PY3<br>RC-3A-PY4-1 | RC-3B-PI2<br>RC-154-PR/TR | |

**PARTNO**

| | | |
|---|---|---|
| | | |
| | | |

COMMENTS (USAGE RESTRICTIONS, PROPRIETARY, ETC.)

| | | |
|---|---|---|
| ADD'L DXREF: Tech Spec 3/4.3.2.1 & 4.5.1.d | | ICSP-132-13 |
| VQP's CABL-C595-08 | TERM-R098-05 | TERM-R098-07 |
| PEN-C515-04 | INST-R369-03 | |

**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 |
|---|---|---|
| J D Owen 4/16/92 (JDO 4/16/92) | S T Cirka 10/6/92 | C. B. Doyel 10/15/92 |

cc: MAR Office (If MAR Related) ☐ Yes ☒ No
MAR/Project File SP88-006
Mgr., Nucl. Config. Mgt.
File (CALC) — FPES - "Original" w/attach.
Mgr., Site Nucl. Eng. Serv. w/attach.

Supervisor, Nuclear Document Control w/Plant Doc. Rev.
Eval. and Analysis / Calc. Summary
Plant Document Review Required ☒ Yes ☐ No

C.B. Doyel R.L. Muzzi w/att.
J.D. Owen

Florida Power Corporation

# ANALYSIS/CALCULATION SUMMARY

| DOCUMENT IDENTIFICATION NUMBER | DISCIPLINE | CONTROL NO. | REVISION LEVEL |
|---|---|---|---|
| | I | 89-0014 | 3 |

TITLE

RC PRESSURE LOOP ACCURACY FOR ES

CLASSIFICATION (CHECK ONE)

[X] Safety Related

[ ] Non Safety Related

MAR/SP NUMBER/FILE: SP88-006

VENDOR DOCUMENT NUMBER: C-423-5510-066

| | REVISION APPROVALS | | ITEMS REVISED |
|---|---|---|---|
| Design Engineer | J D Owen | | |
| Date | 10/5/92 | | |
| Verification Engineer | S T Cirka | | |
| Date/Method* | 10/6/92 | R | |
| Supervisor | C. B. Doyel | | |
| Date | 10/15/92 | | |

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

DESCRIBE BELOW IF METHOD OF VERIFICATION WAS OTHER THAN DESIGN REVIEW

PURPOSE SUMMARY

Determine the instrument loop accuracy of the RC Pressure loops of the Engineered Safeguards (ES), control room recorders and alarms, NNI interlocks, RECALL (SPDS), $T_{SAT}$ meters, plant computer, reactimeter patch panel, and RCITS (for pressure compensation of level).

RESULTS SUMMARY

ES Actuation, Permit and Reset, ±40 psi

Alarm and Interlock via NNI, ±45 psi (Alarm of CFT valve not open could be at >750 psig)

Recording, ±39 psi    RIP Indicator ±48 psi

See Section VI for outputs to RCITS, T-SAT, Plant Computer, Recall and RPP.

# PLANT DOCUMENT REVIEW EVALUATION

DOCUMENT TYPE / NUMBER TO BE EVALUATED

Calculation / I89-0014 Rev. 3

**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
PEEREs - Insert behind PEERE page 2

The above referenced document must be distributed as follows:

- ☐ No Review Required
- ☐ Manager, Nuclear Plant Systems Engineering
- ☐ Nuclear Chem/Rad Protection Superintendent
- ☐ Senior Radiation Protection Engineer
- ☒ Nuclear Operations Superintendent
- ☐ Nuclear Maintenance Work Controls Superintendent
- ☐ Manager, Reliability Centered Maintenance
- ☐ Other(s):

| ORIGINATOR / DATE | SUPERVISOR / DATE |
|---|---|
| J D Owen 4/16/92 | C. B. Doyel 10/15/92 * |

Upon completion of **Part I**, attach to the subject document, check "Plant Document Review Required" block, as applicable, and give to Nuclear Engineering Clerk for distribution.

**Calcs** - Distribute with Transmittal Memo, Summary - **PEERE** - Distribute with Attachments - **DCNs** - Distribute with Attachments and Drawings

**PART II**

**INSTRUCTIONS:** Upon receipt of the subject document, the assigned Reviewer enters the "Reviewing Department" name below, reviews the subject document for impact on plant procedures, and completes the evaluation below.

REVIEWING DEPARTMENT

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

- ☐ No Action Required
- ☐ Action Required: The below listed document(s) is affected and requires revision and/or other actions are required as indicated (i.e., generate a new procedure, void a procedure, etc.)

DOCUMENTS / ACTIONS

| REVIEWER / DATE | SUPERVISOR / DATE |
|---|---|
| | * |

Upon completion, forward evaluation form <u>only</u> to Nuclear Document Control (NR2A)
* If the Supervisor or designee acts as the Originator or Reviewer, the applicable "Originator/Reviewer" block should be NA'd.

Florida Power
CORPORATION

# INTEROFFICE CORRESPONDENCE

| Nuclear Engineering | C2I | 4081 |
|---|---|---|
| OFFICE | MAC | PHONE |

**SUBJECT:** Crystal River Unit No. 3
Quality Document Transmittal - Analysis/Calculations
File: CALC

~~* TRANSMITTAL ONLY - SEE I89-0004 FOR DOCUMENT~~
7/13/90
PMR 7/13/90

**TO:** Records Management - NR2A

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

| DOCNO (FPC DOCUMENT IDENTIFICATION NUMBER) | REV | DATE | SYSTEM(S) | TOTAL PAGES IN PKG. |
|---|---|---|---|---|
| I-89-0014 | 2 | 10/3/89 | RC | * 25 |

**TITLE**
RC PRESSURE LOOP ACCURACY FOR ES (HPI) ACTUATION

**KWDS** (IDENTIFY KEYWORDS FOR LATER RETRIEVAL)
IR, ERROR, SETPOINT, EQ

**DXREF** (REFERENCES OR FILES - LIST PRIMARY FILE FIRST)

| | |
|---|---|
| SP 88-006 | DRS C595-3TR-001 |
| EQ 7-4-4 | DRS R098-3TR-024 |
| DRS R-369-3TR-009 | DRS C515-3TR-003A |

| VEND (VENDOR NAME) | VENDOR DOCUMENT NUMBER (DXREF) | SUPERSEDED DOCUMENTS (DXREF) |
|---|---|---|
| G/CI | C-423-5510-066 | |

| TAG | | |
|---|---|---|
| RC-003A-PT3 | | |
| RC-003A-PT4 | | |
| RC-003B-PT3 | | |
| | | |

ADD'L DXREF:

| | | |
|---|---|---|
| C-423-5510-059 | | |
| I89-0004 | | |

**COMMENTS** (USAGE RESTRICTIONS, PROPRIETARY, ETC.)

**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 |
|---|---|---|---|---|---|
| John G. Sipos | 11/16/89 | N/A | | [signature] | 11/16/89 |

J. G. SIPOS

cc: Readers
MAR/Project File
Mgr., Nucl. Config. Mgt.
File (CALC) — FPES - "Original" w/attach.
Mgr., Site Nucl. Engrg. Serv. w/attach.

Rev. 7/89

**RET:** Life of Plant **RESP:** Nuclear Ops. Engineering 900 628

Gilbert Commonwealth Companies

**POWER AND INDUSTRIAL SYSTEMS DIVISION – READING**
**CALCULATION**



PROJECT: CRYSTAL RIVER UNIT 3

IDENTIFIER: C-423-5510-066

SUBJECT: RC PRESSURE LOOP ACCURACY FOR ES (HPI) ES ACTUATION - 0.01 ft. ft. LOCA

CLASSIFICATION: SR

SECTION NAME AND NUMBER: CONTROL SYSTEMS / 0423

W.O.: 04-5510-212

| REVISION | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| ITEM(S) REVISED | | DESIGN INPUT | ALL SECTIONS | |
| ORIGINATOR | CC Strempke | CC Strempke | DT Cirka | |
| DATE | 3/7/89 | 4-5-89 | 9/1/89 | |
| REVIEWER/VERIFIER | DT Cirka | DT Cirka | M Sarmiento | |
| DATE | 3/8/89 | 4/6/89 | 9-20-89 | |
| APPROVAL | C.G. Kramer | C.G. Kramer | C.G. Kramer | |
| DATE | 3/9/89 | 4/6/89 | 10/3/89 | |
| ASSUMPTIONS/PRELIMINARY DATA | NO | NO | NO | |
| PAGES REFERENCE | | 2,3,16,17 | – | |

THIS CALCULATION REQUIRES ☐ REVIEW PER E-1 NO. 9 RESULTS ARE NOTED BELOW. ☒ VERIFICATION PER DCP 2.05

| THE REVIEW OF THE CALCULATION INCLUDED EVALUATION AGAINST THE FOLLOWING QUESTIONS: N/A See DVR | REMARKS | REMARKS | REMARKS | REMARKS |
|---|---|---|---|---|
| WERE INPUTS, INCLUDING CODES, STANDARDS, AND REGULATORY REQUIREMENTS, CORRECTLY SELECTED AND APPLIED? | | | | |
| ARE ASSUMPTIONS REASONABLE AND ADEQUATELY IDENTIFIED? | | | | |
| HAVE APPLICABLE CONSTRUCTION AND OPERATING EXPERIENCES BEEN CONSIDERED? | | | | |
| WAS AN APPROPRIATE CALCULATION METHOD USED? | | | | |
| IS THE OUTPUT REASONABLE COMPARED TO INPUTS? | | | | |

Florida Power
CORPORATION

# INTEROFFICE CORRESPONDENCE

| Nuclear Engineering | C2I | 4081 |
|---|---|---|
| OFFICE | MAC | PHONE |

**SUBJECT:** Crystal River Unit No. 3
Quality Document Transmittal - Analysis/Calculations
File: CALC

* TRANSMITTAL ONLY - SEE I89-0004 FOR DOCUMENT

**TO:** Records Management - NR2A

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

| DOCNO (FPC DOCUMENT IDENTIFICATION NUMBER) | REV | DATE | SYSTEM(S) | TOTAL PAGES IN PKG. |
|---|---|---|---|---|
| I89-0014 | 1 | 4-6-89 | RC | * |

TITLE
Calculation for RC PRESSURE LOOP ACCURACY FOR ES (HPI) ACTUATION

KWDS (IDENTIFY KEYWORDS FOR LATER RETRIEVAL)
IR, ERROR, SETPOINT, EQ

DXREF (REFERENCES OR FILES - LIST PRIMARY FILE FIRST)

| | |
|---|---|
| SP 88-006 | DRS C595-3TR-001 |
| EQ 7-4-4 | DRS R098-3TR-024 |
| DRS R-369-3TR-009 | DRS C515-3TR-003A |

| VEND (VENDOR NAME) | VENDOR DOCUMENT NUMBER (DXREF) | SUPERSEDED DOCUMENTS (DXREF) |
|---|---|---|
| G/CI | C-423-5510-066 | |

**TAG**

| | | |
|---|---|---|
| RC-003A-PT3 (S) | | |
| RC-003A-PT4 (S) | | |
| RC-003B-PT3 (S) | | |
| | | |

**~~PARTNO~~**

ADD'L DXREF:

| | | |
|---|---|---|
| C-423-5510-059 | | |
| I89-0004 | | |
| | | |
| | | |

**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). Do not include /, -, or other types of field separators, except as shown for tag numbers. When neither tag or part number applies to a calculation, leave these fields blank. If more space is required, write "See Attachment" and list on separate sheet.

| DESIGN ENGINEER | DATE | VERIFICATION ENGINEER | DATE | SUPERVISOR, NUCLEAR ENG. | DATE |
|---|---|---|---|---|---|
| John G Sipos | 6/1/89 | N/A | | P M Bulro | 6/1/89 |

J.G. SIPOS

cc: Readers
MAR File
Mgr., Nucl. Config. Mgt.
File (CALC) — FPES - "Original" w/attach.
Mgr., Site Nucl. Engrg. Serv. w/attach.

| DOCUMENT IDENTIFICATION NO. | REVISION |
|---|---|
| I-89-0014 | 10 |

## I. PURPOSE:

The purpose of this calculation is to determine the instrument loop accuracy of the RC pressure loops of the Engineered Safeguards (ES), control room recorders and alarms, NNI interlocks, RECALL (SPDS), $T_{SAT}$ meters and plant computer. The instrument loop accuracy values calculated will be used to support the ES surveillance requirements given in Improved Technical Specifications (ITS) section 3.3.5.3 (Reference 63).

The purpose of Revision 9 ICA is as follows:

- RCITS I/V uncertainty has been removed from this calculation. Reason: The RCITS I/V loop uncertainty is no longer required as input to calculation I89-0010 (Reference 60) and the RCITS loop input is not tested in SP-0132 (Reference 37). However, the loop IR effects have been revised to incorporate the MAR 97-02-12-02 (Reference 86) RC-163A-PY1 and RC-163B-PY1 I/V modification to the new Foxboro I/V module .

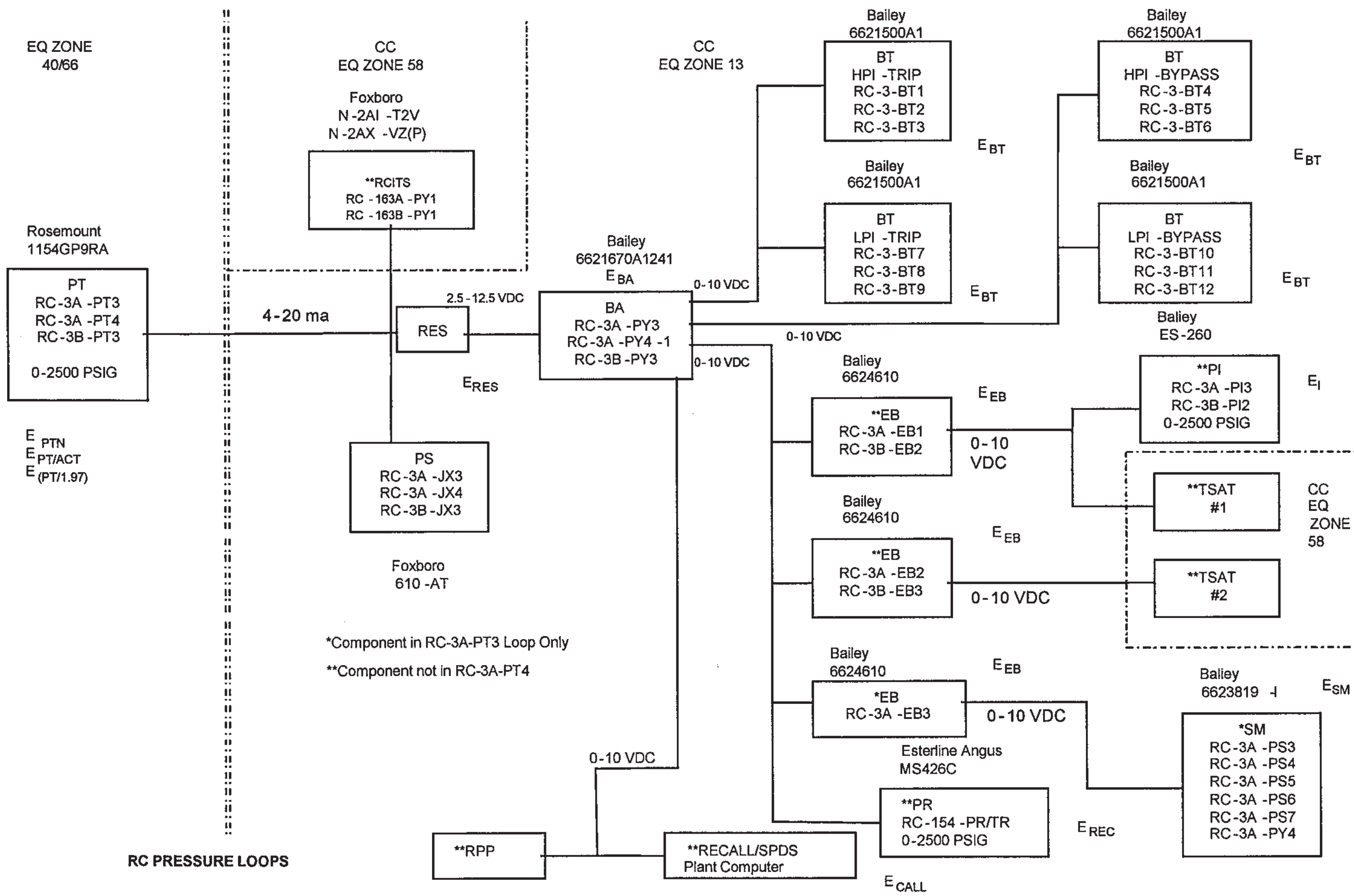
- The HPI Upgrade project altered the current high pressure injection (HPI) system to improve its reliability and capability to meet its defined functional requirements as well as reduce operator burden during accident scenarios. The change impacts the interfacing system such as the engineered safeguards actuation system (ESAS) by revising the ITS ES RCS Low Pressure setpoint, Bypass Reset and Bypass Permit values (see table below). This revision will incorporate the revised values for the ES RCS Low Pressure Trip, ES Low RC Pressure Alarm , Bypass Permit, Bypass Permit Alarm, Bypass Reset, and Bypasss Reset Alarm setpoints. The HPI MAR 97-02-12-01 and MAR 97-02-12-02 (References 85 and 86) will establish the Bypass Reset and Permit setpoints since there are no analytical limits associated with these setpoints.

| Description | Current Value | New Value |
|---|---|---|
| ES RCS Low Pressure (ITS Required Value) | ≥1500 psig | ≥1625 psig |
| ES RCS Low Pressure Bypass Reset (ITS Required Value) | ≤1700 psig | ≤1800 psig |
| ES RCS Low Pressure Bypass Permit (Plant Implemented Value) | 1670 psig | 1770 psig |
| ES RCS HPI Not Bypassed/Reset Alarm (Plant Implemented Value) | 1640 psig | 1740 psig |
| ES Low Low RC Pressure Alarm (Plant Implemented Value) | 1550 psig | 1675 psig |

- This revision also adds the Signal Monitor and Bypass Alarm setpoint values to calculation Table IV.

| DOCUMENT IDENTIFICATION NO. | REVISION |
|---|---|
| I-89-0014 | 10 |

## Instrument Loops




*Component in RC-3A-PT3 Loop Only

**Component not in RC-3A-PT4

II **RESULTS/CONCLUSIONS**:

**ERROR USAGE INFORMATION**

The error values provided in the tables below for indicators/recorders do not include indicator/recorder readability. These error values must be used along with readability when determining a proper offset for taking a required reading from one of the indicators/recorders. The required value would be offset by the appropriate error from Table VII table below, then rounded (in the conservative direction) to the 1/2 minor division for taking a reading. A more detailed discussion on this subject, with examples, is provided in the Operational Considerations section below. The list below gives the 1/2 minor division for the indication/recording devices analyzed.

| END DEVICE | 1/2 MINOR DIVISION |
|---|---|
| RC-154-PR/TR | 25 psig |
| RC-3A-PI3 | 25 psig |
| RC-3B-PI2 | 25 psig |

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-3-BT1, RC-3-BT2, & RC-3-BT3 | ≥ 1625 PSIG | FSAR TABLE 6-13* ITS TABLE 3.3.5-1 |
| RC-3-BT4, RC-3-BT5, & RC-3-BT6 | ≥ 1800 PSIG (Nominal) | ITS TABLE 3.3.5.1 |
| RC-3-BT10, RC-3-BT11, & RC-3-BT12 | ≥ 900 PSIG (Nominal) | ITS TABLE 3.3.5.1 |
| RC-3-BT7, RC-3-BT8, & RC-3-BT9 | ≥ 500 PSIG | FSAR TABLE 6-13 ITS TABLE 3.3.5.1 |
| RC-3A-PS3 (LO) | ≥ 653 PSIA | ITS Section 3.5.1 (SR 3.5.1.3) |
| RC-3A-PS3 (HI) | ≤ 750 PSIG | ITS Section 3.5.1 |

* Reference 40

**TABLE II**
**Transmitter Scaling/Calibration**

| TRANSMITTER | SCALING CORRECTION | CALIBRATION SPAN | |
|---|---|---|---|
| | | 4 mA | 20 mA |
| RC-3A-PT3 | 27.2 PSIG | 27.2 PSIG | 2527.2 PSIG |
| RC-3A-PT4 | 27.2 PSIG | 27.2 PSIG | 2527.2 PSIG |
| RC-3B-PT3 | 27.8 PSIG | 27.8 PSIG | 2527.8 PSIG |

## TABLE III
### Split Loop:IN Transmitter Setting Tolerances

| TRANSMITTER | AS-LEFT:IN (± % SPAN, mA) $AL_{LOOP\text{-}IN}$ | AS-FOUND:IN (± % SPAN, mA) $AF_{LOOP\text{-}IN}$ |
|---|---|---|
| RC-3A-PT3, RC-3A-PT4, & RC-3B-PT3 | ±0.25% SPAN, 0.04 mA | ±0.56% SPAN, 0.090 mA, |

## TABLE IV
### Split Loop:OUT (Trip) Bistable & Signal Monitor Setting Tolerances

| Bistable | ACTUATION CALIBRATED SETPOINT (Vdc, psig) | AS-LEFT (± Vdc) $AL_{BS}$ | AS-FOUND (± Vdc) $AF_{BS}$ |
|---|---|---|---|
| RC-3-BT1 (HPI TRIP) | 6.660 Vdc 1665 psig ↓ | ±0.010 Vdc | ±0.026 Vdc |
| RC-3-BT2 (HPI TRIP) | 6.660 Vdc, 1665 psig ↓ | ±0.010 Vdc | ±0.026 Vdc |
| RC-3-BT3 (HPI TRIP) | 6.660 Vdc, 1665 psig ↓ | ±0.010 Vdc | ±0.026 Vdc |
| RC-3-BT4 (HPI Bypass Permit/Reset) | Permit: 7.080 Vdc, 1770 psig ↓<br>Reset: 7.180 Vdc, 1795 psig ↑ | ±0.010 Vdc<br>±0.010 Vdc | ±0.026 Vdc<br>±0.026 Vdc |
| RC-3-BT5 (HPI Bypass Permit/Reset) | Permit: 7.080 Vdc, 1770 psig ↓<br>Reset: 7.180 Vdc, 1795 psig ↑ | ±0.010 Vdc<br>±0.010 Vdc | ±0.026 Vdc<br>±0.026 Vdc |
| RC-3-BT6 (HPI Bypass Permit/Reset) | Permit: 7.080 Vdc, 1770 psig ↓<br>Reset: 7.180 Vdc, 1795 psig ↑ | ±0.010 Vdc<br>±0.010 Vdc | ±0.026 Vdc<br>±0.026 Vdc |
| RC-3-BT7 (LPI TRIP) | 2.240 Vdc, 560 psig ↓ | ±0.010 Vdc | ±0.026 Vdc |
| RC-3-BT8 (LPI TRIP) | 2.240 Vdc, 560 psig ↓ | ±0.010 Vdc | ±0.026 Vdc |
| RC-3-BT9 (LPI TRIP) | 2.240 Vdc, 560 psig ↓ | ±0.010 Vdc | ±0.026 Vdc |
| RC-3-BT10 (LPI Bypass Permit/Reset) | Permit: 3.400 Vdc, 850 psig ↓<br>Reset: 3.500 Vdc, 875 psig ↑ | ±0.010 Vdc<br>±0.010 Vdc | ±0.026 Vdc<br>±0.026 Vdc |
| RC-3-BT11 (LPI Bypass Permit/Reset) | Permit: 3.400 Vdc, 850 psig ↓<br>Reset: 3.500 Vdc, 875 psig ↑ | ±0.010 Vdc<br>±0.010 Vdc | ±0.026 Vdc<br>±0.026 Vdc |
| RC-3-BT12 (LPI Bypass Permit/Reset) | Permit: 3.400 Vdc, 850 psig ↓<br>Reset: 3.500 Vdc, 875 psig ↑ | ±0.010 Vdc<br>±0.010 Vdc | ±0.026 Vdc<br>±0.026 Vdc |
| RC-3A-PS3 (LO) (CFT Isolation Valve Not Closed) | 2.760 Vdc, 690 psig ↓ | ±0.025 Vdc | ±0.026 Vdc |
| RC-3A-PS3 (HI) (CFT Isolation Valve Not Open) | 2.810 Vdc, 702.5 psig ↑ | ±0.025 Vdc | ±0.026 Vdc |

| Bistable | ACTUATION CALIBRATED SETPOINT (Vdc, psig) | AS-LEFT (± Vdc) $AL_{BS}$ | AS-FOUND (± Vdc) $AF_{BS}$ |
|---|---|---|---|
| RC-3A-PS4 (LTOP Alarm) | (Note 1) 1.570 Vdc, 392.6 psig ↑ | ± 0.025 Vdc | ±0.026 Vdc |
| RC-3A-PS4 (DHR ACI Valve Position Alarms) | 0.800 Vdc, 200 psig ↑ | ± 0.025 Vdc | ±0.026 Vdc |
| RC-3A-PS5 (LPI Not Bypassed Alarm) | 3.000 Vdc, 750 psig ↓ | ± 0.025 Vdc | ±0.026 Vdc |
| RC-3A-PS5 (LPI Not Reset Alarm) | 3.000 Vdc, 750 psig ↑ | ± 0.025 Vdc | ±0.026 Vdc |
| RC-3A-PS6 (HPI Not Bypassed Alarm) | 6.960 Vdc, 1740 psig ↓ | ± 0.025 Vdc | ±0.026 Vdc |
| RC-3A-PS6 (HPI Not Reset Alarm) | 6.960 Vdc, 1740 psig ↑ | ± 0.025 Vdc | ±0.026 Vdc |
| RC-3A-PS7 (DH Isolation Valve to PZR Spray Open Alarm ) | 0.800 Vdc, 200 psig ↑ | ± 0.025 Vdc | ±0.026 Vdc |
| RC-3A-PY4 (RC Low Pressure Alarm) | 6.700 Vdc, 1675 psig ↓ | ± 0.025 Vdc | ±0.026 Vdc |

Note 1: The LTOP Alarm will remain at 1.570 Vdc (392.6 psig) after implementation of the 32 EFPY LTOP Analysis setpoints. Refer to section 6.9 of this calculation for details.

### TABLE V
### Split Loop:OUT (TOTAL) Tolerances (Input at Cabinet to Output of Device)

| LOOP END DEVICE | AS-LEFT:OUT (± % SPAN, PSIG) $AL_{LOOP:OUT}$ | AS-FOUND:OUT (± % SPAN,PSIG) $AF_{LOOP:OUT}$ |
|---|---|---|
| RC-154-PR/TR | ±1.0%, ±25 psig | ±2.0%, ±50 psig |
| PC/RECALL/SPDS (R208,R210,RECL-4,RECL-5) | ±0.45%, ±11.3 psig | ±1.03%, ±25.8 psig |
| Output to T'Sat | ±0.14%, ±3.5 psig | ±0.72%, ±18.0 psig |
| RIP Indicators(RC-3A-PI3, RC-3B-PI2) | ±2.0%, ±50 psig | ±3.0%, ±75 psig |

### TABLE VI
### Split Loop:OUT(Partial) Tolerance (Input at Cabinet to Input of Bistable/Signal Monitor)

| LOOP END DEVICE | AS-LEFT:OUT (± Vdc) $AL_{PL,BS}$ | AS-FOUND:OUT (± Vdc) $AL_{PL,BS}$ |
|---|---|---|
| RC-3-BT1, RC-3-BT2, RC-3-BT3, RC-3-BT7, RC-3-BT8, & RC-3-BT9 | ±0.010 Vdc | ±0.068 Vdc |
| Signal Monitors (Alarm/Intlk) | ±0.014 Vdc | ±0.072 Vdc, |

| DOCUMENT IDENTIFICATION NO. | REVISION |
|---|---|
| I-89-0014 | 10 |

### TABLE VII
### CalibratedTotal Loop Errors ($CE_{TOTAL}$)

| END DEVICE | NORMAL (± % SPAN, PSIG) $CE_{TOTAL}$ | ACCIDENT (+,- % SPAN,+,- PSIG) $CE_{TOTAL}$ |
|---|---|---|
| RC-154-PR/TR | +3.31%, - 2.97%<br>+82.8, - 74.3 psig | +6.27%, -5.82%<br>+156.8 , -145.5 psig |
| PC/RECALL/SPDS (R208,R210,RECL-4,RECL-5) | +1.66%, -1.32%<br>+41.5, -33.0 psig | +5.55%, -5.10%<br>+138.8, -127.5 psig |
| Output to T'Sat | +1.43%, -1.09%<br>+35.8, -27.3 psig | +5.49%, -5.04%<br>+137.3, -126.0 psig |
| RIP Indicators (RC-3A-PI3, RC-3B-PI2) | +3.45%, -3.11%<br>+86.3, -77.8 psig | +6.33%, -5.88%<br>+158.3, -147.0 psig |
| Trip Units - RC-3-BT1, RC-3-BT2, RC-3-BT3, RC-3-BT7, RC-3-BT8, & RC-3-BT9 | NA | ±1.37%, ±34.3 psig |
| Signal Monitors (Alarm/Intlk) | +1.57%, - 1.23%<br>+39.3, -30.8 psig | NA |

### TABLE VIII
### HPI/LPI LOOP RESPONSE TIME

| Transmitter | Buffer Amplifier | Bistable | Total |
|---|---|---|---|
| 0.2 sec | 1 sec | 0.1 sec | 1.3 sec |

| DOCUMENT IDENTIFICATION NO. | REVISION |
|---|---|
| I-89-0014 | 10 |

## FIGURE I

## ESAS TRIP DATA

Normal Operating Pressure 2155 psig --------------

-------------- 1665 psig HPI Trip Inplant Setpoint

HPI ITS Trip Allowable Value 1625 psig --------------
& Analytical Limit

Core Flood Tank Flow Initiation 600 psig --------------

-------------- 560 psig LPI Trip Inplant Setpoint

LPI ITS Trip Allowable Value 500 psig --------------

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

| DOCUMENT IDENTIFICATION NO. | REVISION |
|---|---|
| I-89-0014 | 10 |

## FIGURE II

## ES/HPI BISTABLE DATA

------------- 1800 ITS HPI Bypass Reset Value

-------------- 1795 psig HPI BYPASS Reset Inplant Setpoint

-------------- 1770 psig HPI BYPASS Permit Inplant Setpoint

-------------- 1665 psig HPI Trip Inplant Setpoint

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

**FIGURE III**

## ES/LPI BISTABLE DATA

-------------- 900 psig ITS LPI Bypass Reset Value

-------------- 875 psig LPI BYPASS Reset Inplant Setpoint

-------------- 850 psig LPI BYPASS Permit Inplant Setpoint

-------------- 560 psig LPI Trip Inplant Setpoint

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

| DOCUMENT IDENTIFICATION NO. | REVISION |
|---|---|
| I-89-0014 | 10 |

**OPERATIONAL CONSIDERATIONS:**

**Maximum and Minimum Pressure Limits using Indicator, Recorder and Computer Points Uncertainty and ½-Minor Division Readability**

When the RC-3A or 3B indicators, recorder or computer points are used to determine the RCS 0-2500 psig pressure range, the positive and negative indicator and recorder uncertainties and ½-minor division readability (readability error is not applicable to the computer points) should be treated as follows:

For a **maximum** (increasing) pressure limit, the negative indicator, recorder or computer uncertainty value would be subtracted from the maximum allowed pressure limit value. For all indicators and recorders the resultant pressure value would then be rounded down to the nearest ½-minor scale division.

For a **minimum** (decreasing) pressure limit, the positive indicator, recorder or computer uncertainty value would be added to the minimum allowed pressure limit value. For all indicators and recorders the resultant pressure value would then be rounded up to the nearest ½-minor scale division.

EXAMPLE 1:
For example, if the **minimum** allowable RCS pressure limit for accident conditions is 1625 psig the positive indicated pressure accident uncertainty at RC-3A-PI3 and RC-3B-PI2 would be found on Table VII "Calibrated Total Loop Errors".

(1) Take the required minimum allowable RCS pressure (1625 psig) and add the positive pressure accident uncertainty value for RC-3A-PI3 and RC-3B-PI2 from Table VII ( +158.3 psig) to the required minimum limit value (1625 psig + 158.3 psig = 1783.3 psig).
(2) Round this calculated value (1783.3 psig) up to the next ½-minor division (25 psig) which gives a required minimum pressure reading (1800 psig). This is the indicated value which must not be exceeded to ensure the minimum pressure (1625 psig) is not exceeded.

Note: No rounding is required if computer points are used.

EXAMPLE 2:
If the **maximum** allowable RCS pressure limit for accident conditions is 1800 psig the negative indicated pressure accident uncertainty at RC-3A-PI3 and RC-3B-PI2 would be found on Table VII "Calibrated Total Loop Errors".

(1) Take the required minimum allowable RDS pressure (1800 psig) and subtract the negative pressure accident uncertainty value for RC-3A-PI3 and RC-3B-PI2 from Table VII ( -147.0 psig) from the required maximum limit value (1800 psig – 147.0 psig = 1653 psig).
(2) Round this calculated value (1653 psig) down to the next ½-minor division (25 psig) which gives a required maximum pressure reading (1650 psig). This is the indicated value which must not be exceeded to ensure the maximum pressure (1800 psig) is not exceeded.

Note: No rounding is required if computer points are used.

## III. DESIGN INPUT (DI):

1 Instrument loop drawing in Section I above and drawings 205-047 sheets RC-11 (Reference 1), RC-11A (Reference 2), RC-12A (Reference 73), RC-13A (Reference 56), D8034033 sheet 4 (Reference 3), 210-481 (Reference 4), 210-483 (Reference 5), 210-485 (Reference 6), 210-480 (Reference 64), 210-482 (Reference 71), and 210-484 (Reference 72) show the circuit configuration for the RC Pressure loops.

2 The transmitters RC-3A-PT3, RC-3A-PT4, and RC-3B-PT3 are part of instrument loops which provide signals to the Engineered Safeguards Actuation System (ESAS) and to R.G. 1.97 indication in the main control room. According to Section B.3.3.5 of the Improved Technical Specifications (ITS) (Reference 63), the analyzed accidents which rely upon automatic ESAS actuation include Loss of Coolant Accidents (LOCA), Main Steam Line Breaks (MSLB), Steam Generator Tube Rupture (SGTR), and feedwater line break events that result in a RCS inventory reduction or severe loss of RCS cooling. The ESAS actuation of High Pressure Injection (HPI) has been assumed for core cooling in the Small Break LOCA (SBLOCA) analysis and is also credited in the MSLB analysis for the purposes of adding boron and negative reactivity. The ITS allowable ES value of 1500 psig (ITS Table 3.3.5-1) for low RCS pressure is established to provide for the initiation of core protection systems on decreasing low RCS pressure. Such decreasing pressure would indicate either a severe overcooling event or a loss of reactor coolant. Accident analyses has previously used a conservative actual initiation setpoint of 1480 psig which bounds the ITS allowable value and accounted for uncertainties and instrument errors. The time delay between the onset of the accident and HPI initiation has been modeled in the accident analysis. At this low RCS pressure, the time delay prior to HPI initiation for some SBLOCAs can affect the PCTs achieved in the core. This will raise the ITS allowable ES value to 1625 psig and accident analysis F-98-0008 (Ref.78) will now use a setpoint approaching 1625 psig to provide a shorter time delay between onset of the accident and the initiation of HPI flow. This will result in slightly lower PCTs for the spectrum of SBLOCAs. The new ES initiation setpoint also accommodates the effects of increased steam generator tube plugging.

3 According to Section 2.4 of the TSBBD (Reference 62), the Crystal River 3 Improved Technical Specifications do not include a requirement for a low (1625 psig) RCS pressure trip setpoint for the ESAS actuation of Low Pressure Injection (LPI). According to Section B.3.3.5 of the ITS (Reference 63), the ESAS actuation of LPI has been assumed for LBLOCA's. Table 3.3.5.-1 of that same reference provides a RCS Low-Low Pressure Setpoint of ≥500 psig. Section B.3.3.5 also states that the RCS Low-Low Pressure Setpoint for LPI occurs in sufficient time to ensure LPI flow prior to the emptying of the core flood tanks during a LBLOCA. As with the RCS Low Pressure Setpoint described above, Section 2.1.4.3 of the TSBBD (Reference 41) states that the establishment of the ESAS Low-Low RCS Pressure Setpoint is determined from the accident analysis value by adjusting for errors of the instrument channel.

According to Section 2.1 of the TSBBD (Reference 62), the LBLOCA establishes the basis for the LPI safety function of ESAS. This is true from a flow perspective, but not from an operability perspective. During a SBLOCA, the HPI and RB sprays will drain the BWST. Since the HPI pumps can not take suction directly from the RB emergency sump, the LPI pumps must operate in a recirculation mode (piggyback) to maintain operability of the HPI pumps. The operability of LPI has been assumed in analyses of LBLOCA's and SBLOCA's. LPI flow is required for a range of break sizes above a certain minimum; however, the LBLOCA is the most limiting event in requiring timely actuation LPI to meet the flow requirements. For some smaller break sizes, LPI flow is required and must be manually aligned to the HPI system to support extended core cooling, but is not limiting in terms of actuation. This is due to the relatively slow decrease in RCS pressure as a function of the break size.

4 The Design Basis Document for Post-Accident Monitoring Instrumentation, Tab 5/11, (Reference 10), shows the $T_{SAT}$ meters as a Type A,B, Cat. 1 variable. This calculation will determine the error for signals sent to T'Sat for the accident environment, as well as the normal operating environment for the Post Accident Monitoring Instrumentation. Calculation I-84-0002 (Reference 59) for T'Sat will use the error values from this calculation to compute the remaining loop error for the T'Sat.

5 RC-154-PR/TR was installed as part of the Overpressure Mitigating System. CMIS classifies this recorder as a R.G. 1.97 Category 3 variable; therefore, accident environment errors will be considered for the recorder's instrument loop.

6 Pressure transmitters RC-3A-PT3, RC-3A-PT4, and RC-3B-PT3 are located in the Reactor Building.

(a) Per drawing 308-605 (Reference 12), RC-3A-PT3 is located at the North "X" Station at an elevation of 104'-1" (± 1") in the Reactor Building.

(b) Per drawing 308-606 (Reference 13), RC-3A-PT4 is located at the North "Y" Station at an elevation of 104'-½" (± 1") in the Reactor Building.

(c) Per drawing 308-603 Sheet 2 (Reference 14), RC-3B-PT3 is located at the South "X" Rack at an elevation of 102'-9" (± 4") in the Reactor Building.

(d) The connections for RC-3A-PT3, RC-3A-PT4, and RC-3B-PT3 sensing lines are shown on drawings 308-601 (Reference 15), 308-602 (Reference 16), and 308-604 (Reference 17). The connections to the RCS Hot Legs for all three transmitters are at an elevation of 167'-2½".

Per CMIS, RC-3A-PT3, RC-3A-PT4, and RC-3B-PT3 are located in EQ Zone 66. Per the Environmental and Seismic Qualification Program Manual (E/SQPM - Reference 18) EQ Zone 66 is "HARSH" and has the following specifications:

| | |
|---|---|
| Radiation - Normal: | $1.4 \times 10^7$ rads TID for 40 year dose. |
| Radiation - LOCA: | $1.3 \times 10^8$ rads TID (40 year TID + 6 months). |
| Temperature - Normal: | 70° to 109°F. |
| Temperature - LOCA: | 110° to 302°F. |
| Temperature - HELB: | NA |

Per drawing 308-601 (Reference 15) and 308-602 (Reference 16), the sensing lines are routed inside the D-Rings, which is designated as EQ Zone 40 per the E/SQPM (Reference 18) and has the following specifications:

| | |
|---|---|
| Radiation - Normal: | $3.3 \times 10^7$ rads TID for 40 year dose. |
| Radiation - LOCA: | $1.4 \times 10^8$ rads TID (40 year TID + 6 months). |
| Temperature - Normal: | 110° to 149°F. |
| Temperature - LOCA: | 110° to 302°F. |
| Temperature - HELB: | NA |

Calculation I-90-0014 (Reference 19) provides a point specific 10 year radiation dose for Zone 66.

(e) RC-3A-PT3 is located at the North "X" Station in the Reactor Building; it has a 10 year dose rate of $2.3 \times 10^3$ rads at an elevation of 104'.

(f) RC-3A-PT4 is located at the North "Y" Station in the Reactor Building; it has a 10 year dose rate of 2.3 X $10^3$ rads at an elevation of 104'.

(g) RC-3B-PT3 is located at the South "X" Rack in the Reactor Building; it has a 10 year dose rate of 8.0 X $10^3$ rads at an elevation of approximately 103'.

7 Instrument Data Sheets RC-3A-PT3 (Reference 20.a), RC-3A-PT4 (Reference 20.b), and RC-3B-PT3 (Reference 20.c) show that the pressure transmitters are Rosemount Model 1154GP9RA pressure transmitters with a calibrated span of 0 to 2,500 psig. The specifications for these transmitters are described in Instruction Manual 1260 (Reference 21). The transmitters have the following specifications:

| | |
|---|---|
| Upper Range Limit (URL): | 3,000 psig. |
| Reference Accuracy: | ±0.25% of calibrated span (includes linearity, hysteresis, & repeatability). |
| Temperature Effect: | ±(0.75% URL + 0.5% span)/100°F ambient temperature change. |
| 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:<br>420°F, 50 psig for 3 minutes<br>350°F, 110 psig for 7 minutes<br>320°F, 75 psig for 8 hours<br>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 x $10^6$ rads TID gamma radiation at the centerline per the following dose rate schedule of:<br>2 x $10^6$ rads/hr for 2 hours,<br>1.5 x $10^6$ rads/hr for 4 hours,<br>1 x $10^6$ rads/hr up to 55 x $10^6$ rads TID and an additional 55 x $10^6$ rads TID at a rate of 1 x $10^6$ rads/hr during post-accident operation. |

Normal Operating Design Temperature Limits: 40 °F to 200 °F

Mounting Position Effect: Effect is superseded by accuracy specifications.
Response Time Fixed time constant (63%) at 100°F is 0.2 seconds.

(a) Accident conditions use either the Temperature Effect or the Steam Pressure/Temperature Effect as identified in DI29.h.

(b) Per the Enhanced Design Basis Document for the Reactor Coolant System, Section 6/1 (Reference 22), the RCS pressure is limited to 2750 psig due to the Code Safety Valves and the Reactor Protection System (RPS). Because of this, the transmitters will never experience their overpressure limit, which is the same as their upper range limit (4,500 psig). Therefore, the overpressure effect for the pressure transmitters will be considered as ± 0.0%.

(c) 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%.

(d) Per Letter LFM90-0006 (Reference 23); "It is not required to apply LOCA + MHE simultaneously to system functions." In other words, a Seismic event (MHE) and a LOCA do not need to be considered to occur simultaneously. Therefore, this calculation will only consider the LOCA/HELB effects (Radiation Effect and Steam/Temperature Effect) since the Seismic Effect is less than the LOCA/HELB effects. The Seismic Effect will be considered as ± 0.0% for Normal and Accident conditions.

(e) Per Letter SNES94-0276 (Reference 24), "...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 $1 \times 10^5$ 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-3A-PT3, RC-3A-PT4, and RC-3B-PT3 is $8.0 \times 10^3$ rads for 10 years per DI6, the NORMAL total dose rate for 30 months is $2.0 \times 10^3$ rads [($8 \times 10^3$ 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 $1 \times 10^4$ rads/hour and a 30 month TID of less than $1 \times 10^5$ rads.

(f) According to Instruction Manual 1260 (Reference 21), the pressure transmitter accuracy at reference conditions shall be within ± 2.5% of the URL after exposure to the DBE for one year following the DBE. Since this value will be less than that calculated for the accident, the accident value will serve as the R.G. 1.97 post-accident accuracy.

8 All instrument string components other than the above transmitters and portions of the T'Sat Meter strings are located at the 145' elevation of the Control Complex (Reference 20 and CMIS). Per the E/SQPM (Reference 18) , the 145' elevation of the Control Complex is designated as EQ Zone 13, which is "MILD" and has the following specifications:

| | |
|---|---|
| Radiation - Normal: | $<1.00 \times 10^4$ rads TID for 40 year dose. |
| Radiation - Accident: | $<1.00 \times 10^4$ rads TID (40 year TID + 6 months). |
| Temperature - Normal: | 70°F to 80°F. |
| Temperature - LOCA: | 95°F for 1.5 hours (Based on loss of offsite power coupled with a LOCA) |

The RCITS modules are located at the 124' elevation of the Control Complex (Reference 20bb,cc). The PORV/T'Sat Meter Cabinets are located at the 108' elevation of the Control Complex(Reference 20), which according to the E/SQPM, is classified as EQ Zone 58. The zones are considered as "MILD" and have the same environmental data as Zone 13 except Temperature – LOCA = 98°F.

9 Buffer amplifier (BA) RC-3A-PY3, bistables (BT) RC-3-BT1, RC-3-BT7, RC-3-BT4, and RC-3-BT10, transmitter power supply (PS) RC-3A-JX3, and associated resistor network are located in the ES Channel Test Cabinet 1 (Reference 20).

10 Buffer amplifier (BA) RC-3A-PY4-1, bistables (BT) RC-3-BT2, RC-3-BT8, RC-3-BT5, and RC-3-BT11, transmitter power supply (PS) RC-3A-JX4, and associated resistor network are located in the ES Channel Test Cabinet 2 (Reference 20).

11 Buffer amplifier (BA) RC-3B-PY3, bistables (BT) RC-3-BT3, RC-3-BT9, RC-3-BT6, and RC-3-BT12, transmitter power supply (PS) RC-3B-JX3, and associated resistor network are located in the ES Channel Test Cabinet 3 (Reference 20).

12 Voltage buffers (EB) RC-3A-EB1, RC-3A-EB2, RC-3A-EB3, RC-3B-EB2, and RC-3B-EB3 and signal monitors (SM) RC-3A-PS3, RC-3A-PS4, RC-3A-PS5, RC-3A-PS6, RC-3A-PS7, and RC-3A-PY4 are located in the Non-Nuclear Instrumentation (NNI) cabinets (Reference 20).

13 Pressure indicators (PI) RC-3A-PI3 and RC-3B-PI2 are located on the Redundant Indicator Panel (RIP) above the ES section of the Main Control Board (Reference 20).

14 Pressure recorder (PR) RC-154-PR/TR is located on the HVR section of the Main Control Board (Reference 20).

15 Instrument Data Sheets RC-3A-PY3 (Reference 20.d), RC-3A-PY4-1 (Reference 20.e), RC-3B-PY3 (Reference 20.f) show that these buffer amplifiers are Bailey model 6621670A1241 with a 10 Vdc input span and a 0 to +10 Vdc output. Calculations I-83-0001 (Reference 45) and I-90-1020 (Reference 74) provide the following specifications:

| | |
|---|---|
| Reference Accuracy ($E_{BA(ref)}$) | = ± 0.1% span |
| Drift over 30 days ($E_{BA(dft\text{-}30)}$) | = ± 0.1% span |
| Response Time ($RT_{BA}$) | = 1 sec. |
| DRE ($E_{BA(DRE)}$) | = ± 0.399 % span |

Design Temperature Range Operating Conditions: ± 35 °F from the selected calibration temperature. Calibration temperature is to be between 75 °F and 105 °F (See Assumption xx). Therefore, operating temperature range is between 40 °F to 140 °F.

Bailey qualified the 880 series of analog devices for use in nuclear facilities and reported on those results in several reports that are referenced in I-83-0001 (Reference 45). The approach used by Bailey was to establish a Design Range Error (DRE) for the components that considered all the effects of the environment taken to the extreme range allowed by the specifications of the product. For example, the ambient temperature of the module was allowed to vary by as much as ± 35°F from the calibration (reference) temperature. Similar impacts for humidity and power supply effects were included and then combined algebraically to arrive at the DRE. This error value was used to initially calculate an "Abnormal" Condition error that was different from the "Accident" error

The meters on the front plate of the Buffer Amplifiers are not used by Operations or for surveillance. The only function they provide is a maintenance aid. For that reason, they will be excluded from this instrument error calculation.

16 Instrument Data Sheets RC-3-BT1 (Reference 20.g), RC-3-BT7 (Reference 20.h), RC-3-BT2 (Reference 20.i), RC-3-BT8 (Reference 20.j), RC-3-BT3 (Reference 20.k), RC-3-BT9 (Reference 20.l), RC-3-BT4 (Reference 20.ee), RC-3-BT5 (Reference 20.ff), RC-3-BT6 (Reference 20.gg), RC-3-BT10 (Reference 20.hh), RC-3-BT11 (Reference 20.ii), and RC-3-BT12 (Reference 20.jj) show that these bistables are Bailey model 6621500A1 with a 0 to +10 Vdc input and a contact output. Calculation I-83-0001 (Reference 45) provides the following specifications:

| | | |
|---|---|---|
| Reference Accuracy ($E_{BT(ref)}$) | = | ± 0.17% span |
| Drift over 30 days ($E_{BT(dft-30)}$) | = | ± 0.03% span |
| Potentiometer Resolution ($E_{BT(pot)}$) | = | ± 0.05% span |
| Repeatability of Setpoint ($E_{BT(sp)}$) | = | ± 0.02% span |
| Temperature Effect ($E_{BT(t)}$) | = | ± 0.07% span |
| Humidity Effect ($E_{BT(hum)}$) | = | ± 0.56% span |
| Response Time ($RT_{BT}$) | = | 100 ms |

Design Temperature Range Operating Conditions: ± 35 °F from the selected calibration temperature. Calibration temperature is to be between 75 °F and 105 °F (See Assumption xx). Therefore, operating temperature range is between 40 °F to 140 °F.

17 Calculation I-83-0001 (Reference 45) gives a 30 day drift value for the buffer amp. A 30 month drift is calculated using the SRSS method described in Section 6.2.7 of ISA-RP67.04 (Reference 38). It is assumed that the drift during each of the 30 day drift periods is random and independent.

$$
\begin{aligned}
(E_{BA(dft)}) &= \pm\, [(30)(E_{BA(dft-30)})^2]^{½} \\
&= \pm\, [(30)(0.1)^2]^{½} \\
&= \underline{\pm\, 0.548\%\ \text{span}}
\end{aligned}
$$

$$
\begin{aligned}
(E_{BT(dft)}) &= \pm\, [(30)(E_{BT(dft-30)})^2]^{½} \\
&= \pm\, [(30)(0.03)^2]^{½} \\
&= \underline{\pm\, 0.164\%\ \text{span}}
\end{aligned}
$$

18 Instrument Data Sheets RC-3A-JX3 (Reference 20.m), RC-3A-JX4 (Reference 20.n), and RC-3B-JX3 (Reference 20.o) show that these power supplies, which provide power to the above transmitters, are Foxboro model 610-AT power supplies. According to Instruction Manual 49, Volume 1C, Book 1887 (Reference 27), dc output voltage from this power supply is regulated to ± 2 volts over a range of 76 volts (10 ma) to 84 volts (50 ma). These power supplies were originally installed to support a 10-50 ma transmitter circuit; however, MAR 82-05-24-04 (Reference 51) replaced the transmitters with the 4-20 ma transmitters described in DI7. Voltage divider networks were added to allow the original power supplies to be used with the new transmitters. Although the new transmitter's minimum current (4 ma) is less than the published minimum current (10 ma) associated with the power supply output regulation value, the fact is that the resistors were sized for a total current output from the power supply that is within the 10 to 50 ma range (see MAR 82-05-24-04 Reference 51). For that reason, the ± 2 volt power supply regulation still applies with the new transmitters.

19 When MAR 82-05-24-04 (Reference 51) replaced the transmitters with Rosemount transmitters, the original 250Ω dropping resistors were replaced by voltage divider networks (consisting of 630Ω, 1300Ω, and 1600Ω resistors) to allow the continued use of the original power supplies, while providing the same input voltage range (2.5 - 12.5 Vdc) to the Buffer Amplifiers (References 4, 5, & 6) and ensuring sufficient voltage was provided to the transmitter to keep it within its design range. According to procurement documents within the MAR (including FCN-15A), the resistors are Ohmite Series 55 Acrasil Wirewound Type (Models 55-5-S-630RO-B, 55-5-S-1K300-B, and 55-2-S-1K600-B) and have a manufacturer's tolerance of ± 0.1% (Attachment 2). Since the transmitter maintains a constant current output dependent upon the pressure it sees (and not based upon inaccuracies in the load resistance), the only resistor error the Buffer Amplifiers see is that associated with the 630Ω dropping resistor across their input. The errors associated with the other resistors in the current loop will have no effect on the 2.5 - 12.5 Vdc Buffer Amplifier input voltage.

Referring to the schematic for the Buffer Amplifier given in Bailey Product Instruction E92-316 (Instruction Manual 206 - Reference 43), the input impedance for the Buffer Amplifier is 100kΩ.

The input filter resistor for a Buffer Amplifier with a gain of 1 (last digit of Buffer Amplifier part number is either a 1 or 2) has a value of 50kΩ. This resistor is in series with a 50kΩ resistor on the Buffer Amplifier's input stage amplifier up to the operational amplifier's summing point. Therefore, the input impedance is the summation of these two resistors. MAR 82-05-24-04 installed a 630Ω dropping resistor on the presumption that the input impedance of the Buffer Amplifier was 80kΩ. This value appears to be in error. Apparently it was believed that the input filter resistor was 30kΩ (instead of 50kΩ), which corresponds to an incorrect gain of 1.25. The use of the incorrectly sized dropping resistor appears to have little or no effect on plant operation since the combined dropping resistor/Buffer Amplifier resistance is so close to the correct value (626Ω rather than 625Ω). Despite this, the error created by the incorrectly sized resistor will be accounted for in this calculation.

The maximum total input current of 20 mA from the transmitter is divided between the 630Ω resistor and the two 50kΩ resistors (0.01% tolerance per Instruction Manual 206) in the Buffer Amplifier's input circuit. With a tolerance of 0.1%, the 630Ω resistor's actual value from the supplier could be 630Ω (1.001) = 630.63Ω or 630Ω (0.999) = 629.37Ω. Neglecting the tolerance of the Buffer Amplifier input resistors, the following equation can be written to describe this current divider:

$$20\ \text{mA} = (V/630.63\Omega) + (V/100\text{k}\Omega)$$

$$V = 12.534\ \text{volts}$$

and

$$20\ \text{mA} = (V/629.37\Omega) + (V/100\text{k}\Omega)$$

$$V = 12.509\ \text{volts}$$

For a resistor output of 2.5 V to 12.5 V (10 V span), the above translates into the following resistor error values:

$$E_{RES(BIAS)} = [(12.534\ \text{V} - 12.5\ \text{V})/10\ \text{V}](100\%) = +\ 0.34\%\ \text{span}$$

and

$$E_{RES(BIAS)} = [(12.509\ \text{V} - 12.5\ \text{V})/10\ \text{V}](100\%) = +\ 0.09\%\ \text{span}$$

The larger value will be used in this calculation; therefore

$$E_{RES(BIAS)} = \underline{+\ 0.34\%\ \text{span}}$$

The above resistor error is considered a bias error. It applies to the unscaled outputs of the Buffer Amplifier (i.e. 1700# HPI and 900# LPI bypass bistables, signal monitors, computer, indicators, etc.). Since this calculation assumes the Buffer Amplifier is calibrated with its resistor (Assumption 4), the above error is calibrated out for the scaled ouputs of the buffer amplifier (i.e. 1500# HPI and 500# LPI trip bistables). The scaled output has an adjustable gain which can compensate for the differences between the actual and calculated resistor values. Therefore, this resistor error will not apply to the scaled outputs of the Buffer Amplifier.

According to the Ohmite product sheet for the resistors (Attachment 2), the resistors have a temperature coefficient of ± 20 ppm/°C (or 0.002%/°C) for resistors 10Ω and above. Using the ambient temperature variation of ± 20°F normal and ± 34°F accident (Assumption 1) for the Buffer Amplifier, the following temperature effect is calculated for the 630Ω resistor:

$$E_{RESN(temp)} = \pm (0.00002/°C)(630\Omega)(20°F)(5°C/9°F) = \underline{\pm 0.14\Omega}$$

$$E_{RESA(temp)} = \pm (0.00002/°C)(630\Omega)(34°F)(5°C/9°F) = \underline{\pm 0.238\Omega}$$

This resistor error due to temperature variations produces a voltage error proportional to the transmitter current. The temperature effect will have the greatest impact at the maximum transmitter current (20 mA); therefore, this error in terms of % of span is:

$$E_{RESN(temp)} = \pm \{[(0.14\Omega)(0.020\ A)]/10\ V\}(100\%) = \underline{\pm 0.028\%\ \text{of span}}$$

$$E_{RESA(temp)} = \pm \{[(0.238\Omega)(0.020\ A)]/10\ V\}(100\%) = \underline{\pm 0.048\%\ \text{of span}}$$

The above temperature effect error term is treated as a random error in this calculation and is applied to both the scaled and unscaled Buffer Amplifier outputs.

20 Instrument Data Sheets for RC-3A-EB1 (Reference 20.p), RC-3A-EB2 (Reference 20.q), RC-3A-EB3 (Reference 20.r), RC-3B-EB2 (Reference 20.p), and RC-3B-EB3 (Reference 20.s) show that these voltage buffers are cards contained within Bailey model 6624610 buffer modules with a 0 to +10 Vdc input and a 0 to +10 Vdc output. Instruction manual 49 (Reference 46) provides the following specifications:

| | | |
|---|---|---|
| Reference Accuracy ($E_{EB(ref)}$) | = | ± 0.1% span |
| Temperature Effect ($E_{EB(temp)}$) | = | ± 0.25% span |
| Normal Temperature Range | = | 40 °F to 140°F |

21 Instrument Data Sheets RC-3A-PS3 (Reference 20.t), RC-3A-PS4 (Reference 20.u), RC-3A-PS5 (Reference 20.v), RC-3A-PS6 (Reference 20.w), RC-3A-PS7 (Reference 20.x), and RC-3A-PY4 (Reference 20.y) show that these signal monitors are Bailey model 6623819-1 with a 0 to +10 Vdc input and a span of 0 to 2,500 psig. Instruction manual 49 (Reference 47) provides the following specifications:

| | | |
|---|---|---|
| Reference Accuracy ($E_{SM(ref)}$) | = | ± 0.25% span |
| Temperature Effect ($E_{SM(temp)}$) | = | ± 0.25% span |
| Repeatability | = | ± 0.1% span |
| Hysteresis | = | ~0.05% span |
| Normal Temperature Range | = | 40 °F to 140 °F |

22 Instrument Data Sheets for RC-3A-PI3 (Reference 20.z) and RC-3B-PI2 (Reference 20.aa) show that these indicators are Bailey model ES-260 with a 0 to +10 Vdc input for a span of 0 to 25 (psi X

100 or 0-2500 psi). Instruction manual 49 (Reference 48) provide the following specifications for indicators with DC movements:

| | | |
|---|---|---|
| Reference Accuracy ($E_{ES(ref)}$) | = | ±1.0% span |
| Temperature Effect ($E_{ES(temp)}$) | = | ±0.01%/°F |
| Linearity | = | ±0.25% span |
| Hysteresis | = | 0.8% span |
| Repeatability | = | 0.25%span |
| Dead Band | = | 0.25% span |
| Humidity | = | Negligible |
| Minor Scale Division | = | 50 psig |
| Normal Temperature Range | = | 40 °F to 140 °F |

Per Assumption #9, the linearity, hysteresis, dead band, and repeatability errors are assumed to be included in the stated reference accuracy. However, the ambient temperature effects and readability must be factored in to arrive at a total error value. This is achieved using the SRSS methodology since these are considered random error terms.

23 Per FPC Calculation I-97-0015 (Reference 11), the Low Temperature Overpressure Protection (LTOP) ITS value for the PORV is 457 psig, with an inplant setpoint of 442.6 psig..

24 Instrument Data Sheet for RC-154-PR/TR (Reference 20.dd) shows that this indicator is a Esterline Angus strip chart recorder model MS426C-30(A)-90(B)-90(C)-30(D)-90(E)-90(F)-D201DR61-RD-E7 with a 0 to +10 Vdc input for a span of 0 to 2,500 psig for both the A & B pressure signals. The specifications for the pressure recorder are described in Instruction Manual 1243 (Reference 49). The recorder has the following specifications:

| | | |
|---|---|---|
| Reference Accuracy ($E_{REC(ref)}$) | = | ±0.5% span |
| Temperature Effect ($E_{REC(temp)}$) | = | ±0.03%/°C over 10°C to 45°C |
| Deadband | = | 0.2% span (maximum) |
| Minor Scale Division | = | 50 psig (indicating and recording) |
| Normal Temperature Range | = | 50 °F to 113 °F |

25 CMIS show that the Auxiliary Relays RC-3A-AR1 and RC-3A-AR2 are Bailey Model 6624913-1. These relays make no contribution to the instrument error since they are discrete (on/off) devices.

26 Bailey test modules RC-3A-PX3, RC-3A-PX4, and RC-3B-PX3 will not be considered in this calculation, because they are only used for testing ( Reference 37). The modules do not contribute to the loop error.

27 The I&C Design Criteria (Reference 25), Calculation I-89-0004 (Reference 9), and ISA-RP67.04 Part II (Reference 37) provide the bases for the development of calculations which require the incorporation of Insulation Resistance (IR) effects. According to Figure 9 of Bailey Product Instruction E92-316 (Reference 43), the transmitter loop is grounded through the Buffer Amplifier input circuit; therefore, the IR effects are due to conductor-to-ground as well as conductor-to-conductor current leakage.

28 Per Calculation I-88-0015 (Reference 26), the following is a list of the circuit data for the loop components which are located in a "HARSH" environment:

| INSTRUMENT LOOP | | | | CABLE | | WDP | | SEAL | SPL/T B | PEN NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| SENSOR | MFG | MODEL | B/M (EK) | CKT NO. | LGNT | | QT Y | MF | QTY | |
| RC-3A-PT3 | RMT | 1154 | 36A-001 | RCR86 | 130 | 188 | 1 | RMT | 2 SPL | 129 |
| RC-3A-PT4 | RMT | 1154 | 38A-001 | RCR91 | 65 | 184 | 1 | RMT | 2 SPL | 132 |
| RC-3B-PT3 | RMT | 1154 | 37A-001 | RCR95 | 150 | 185 | 1 | RMT | 2 SPL | 130 |

29 Since environmental effects can greatly affect transmitter signal accuracy, and since the accidents identified in DI2 & 3 can represent substantially different environmental conditions, this calculation must consider the following environmental scenarios under which these transmitters will operate to satisfy the requirements of DI2 & 3:

a. Normal Environmental Conditions
b. Environmental Effects Prior to ES Actuation Following LBLOCA
c. Environmental Effects Prior to ES Actuation Following SBLOCA
d. Environmental Effects Prior to ES Actuation Following MSLB
e. Environmental Effects Post-Accident (SBLOCA)
f. Environmental Effects Post-Accident (LBLOCA)
g. Environmental Effects Post-Accident (MSLB inside and outside containment)

The RB accident environment following a main feedwater line break is considered to be enveloped by the main steam line break RB environment since main feedwater temperature and pressure is lower than that of main steam. The accident analysis for the Steam Generator Tube Rupture accident takes credit for HPI; however, this accident doesn't create severe RB environmental conditions which can affect the signal accuracy. Therefore, it will not be included in this evaluation.

The above normal and accident conditions will now be discussed as to their impact on various transmitter accuracy components (i.e. temperature, insulation resistance on the circuit, steam pressure/temperature, and radiation). The normal and accident temperatures described in the ESQPM are used in all temperature calculations rather than the Technical Specification limit for RB average temperature of 130°F. The Technical Specification limit represents an average temperature over the RB elevations during normal (non-accident) plant operations. Since the subject transmitters are located on the 95' elevation, their temperatures will be lower than the average RB temperature.

a. <u>Normal Environmental Conditions</u>

The only effects considered are the transmitter temperature effects created by the differential temperature between the transmitter's calibration temperature and the normal operating temperature inside the RB. Insulation resistance (IR) degradation is not a concern since there is no steam environment and no high temperatures present to reduce insulation resistance. As explained in DI7.e, radiation effects are not a factor for the normal operating environment.

b. <u>Environmental Effects Prior to ES Actuation Following LBLOCA (>0.5 ft$^2$)</u>

**HPI**

According to DI3, HPI is not considered for LBLOCA. The depressurization to the HPI analysis actuation value (1625 psig) is so immediate that the transmitters essentially perform their HPI safety function before the changing environment has time to affect their accuracy. For that reason, the only LOCA environment that is likely to adversely affect the accuracy of the transmitters before they are able to perform their HPI safety function is the SBLOCA which will be addressed under DI29.c..

**LPI**

According to the Topical Report BAW-10103A (Reference 79), the RCS depressurizes to the LPI setpoint (500 psig) following a double-ended, 8.55 $ft^2$ break at the RCP discharge in approximately 18.5 seconds. Section 5.0 of Calculation I-88-0028 (Reference 65) states that due to the size and nature of a LBLOCA, there is very little difference in the RCS pressure responses for different break sizes and locations. The maximum RB temperature over this period rises to 299°F according to Zone 66 environmental data from the EQSPM (Reference 18).

Since the transmitter electronics housing is sealed from the environment, an accident pressure spike should have no effect on the transmitter accuracy. For this reason, the transmitter steam pressure/temperature effect error term should not apply from strictly a pressure standpoint. The real environmental parameter impacting the transmitter accuracy is the environment temperature.

Since there is a thermal lag associated with the transmitter, the transmitter housing will not reach 302°F before the LPI actuation pressure is reached. The maximum transmitter housing temperature will be far less than the temperature the transmitter was tested to for which the steam pressure/temperature effect applies. Rosemount conducted a thermal response test of the internal housing of its 1154D transmitter (using the same stainless steel housing as used on the subject transmitters) and found the thermal time constant to be approximately 4.8 minutes (Reference 8 and Attachment 3). Using a lumped parameter approach to heat transfer, a transmitter temperature at the time of LPI actuation can be derived. This method provides good results whenever the internal conductive resistance is small compared to the external convective resistance. Whenever this is true, the temperature of the object will be spatially uniform at any given time. Rosemount used this approach in Attachment 1 to determine transmitter temperature as a function of time. The approach as illustrated in Attachment 1 assumes a step change in environment temperature. In actuality, the LOCA temperature profile for the RB involves a ramp change in environment temperature. The approach will be modified to accommodate a ramp change.

According to the environmental data for Zone 66 from the ESQPM (Reference 18), the building temperature ramps from 110°F to 299°F during the first 1 second and is at 302° at the end of 150 seconds, following the LBLOCA. As mentioned earlier, a ramp up to 302°F will be assumed for the 18.5 seconds time to actuation. Attachment 1 provides the following equation:

$$(T1 - T0) = (T2 - T0)(1 - e^{(-t/TC)})$$

or

$$T1 = T0 + (T2 - T0)(1 - e^{(-t/TC)})$$

where:

T0 = Temperature of the electronics board (or other device) at time = 0

T1 = Temperature of the electronics board (or other device) at time = t
T2 = Temperature of the environment at time = t
t = Time
TC = Time Constant of the transmitter housing (or other device)

Using this equation, the transmitter temperature at the time of LPI actuation is:

$$T_{TN(18.5\ s)} = 110°F + (302°F - 110°F)(1 - e^{-(18.5\ s)/(288\ s)}) = 122°F$$

Since the transmitter temperature at the time of LPI actuation is below the 200°F design range for the Rosemount transmitter (Reference 21), the normal temperature effect error term will be used in the computation of the LPI error rather than the steam pressure/temperature effect.

Since during the time to LPI actuation the instrumentation cable, splices, conduit seals, and penetrations are exposed to an elevated environment temperature and humidity, the issue of decreased insulation resistance effects on the instrument loop must be addressed. As with the transmitter, there is a thermal lag associated with these devices. Rather than performing a rather rigorous finite element thermal analysis on each device to determine its approximate temperature at the time of LPI actuation, the above lumped parameter approach will be used for each device for this accident. Subsequent comparisons of these results with those of other accidents will be made later in the Design Inputs, using the worst case ES actuation and post-accident temperatures to determine the effect of IR.

Attachment 2 of Calculation I-89-0004 (Reference 9) states the IR lag of multiconductor cables is typically about 3 minutes for those tested in SAND89-1755C (Attachment 2 of Calculation I-89-0004 - Reference 9). Although the specific cable used in the RC pressure application was not included in the above test, since silicone rubber cable was tested, the 3 minutes thermal lag is considered applicable to this calculation. According to the report, this 3 minute period was the time it took for the cables to reach a stable value of IR. The report does not indicate how many time constants this value represents, but if it is considered that this 3 minute period represents 3 time constants, one time constant would be equal to 60 seconds. This time constant should be conservative since the cables were not tested in conduit. The RC pressure transmitter cables are routed in conduit. Conduit provides additional thermal resistance to cable temperature increases and would thus increase the actual thermal time constant of the cable (i.e. reduce the cable temperature). In addition, as will be seen later, this thermal time constant is much smaller than that calculated for heat shrink sleeving (based upon actual thermal data for the sleeving). The thermal time constant of the cable is most likely more along the order of that of the heat shrink sleeving.

Using the 60 seconds as a conservative thermal time constant, the following cable temperature at the time of LPI actuation following a LBLOCA is calculated using the above lumped parameter approach:

$$T_{C(18.5\ s)} = 110°F + (302°F - 110°F)(1 - e^{-(18.5\ s)/(60\ s)}) = 161°F$$

According to CMIS, the electrical penetration feedthroughs are Conax feedthroughs. Since the penetrations involve much more thermal mass than the transmitters, they will have a much larger thermal time constant, resulting in a lower penetration temperature at the time of LPI actuation. Since no thermal time constant information is available from the manufacturer, it is conservatively considered that the penetration temperature will be the same as the transmitter temperature (122°F) at the time of LPI actuation.

$$T_P = 122°F$$

VQP TERM-R098-04, the applicable VQP per DI33, Raychem has not published data regarding thermal lag through its WCSF-N splice sleeving. Attachment 7 containes the results of laboratory testing done on a sample of WCSF-200 material. From those test results, a thermal time constant for the HPI/LPI actuation periods (0-120 seconds) based upon the inside sleeve temperature will be determined using the same lumped parameter approach established earlier:

$$126°C = 50°C + (225°C - 50°C)(1 - e^{-(120\ s)/(TC)})$$

$$TC = 211 \text{ seconds}$$

This thermal time constant is conservative since it is based upon a splice sleeving that is not enclosed in a splice box or penetration housing. Estimated splice temperatures based on this thermal time constant will be higher than what is expected in the application for these transmitter circuits. The estimated inner sleeve temperature at LPI actuation is:

$$T_{S(18.5\ s)} = 110°F + (298°F - 110°F)(1 - e^{-(18.5\ s)/(211\ s)})$$
$$= 126°F$$

No thermal time constant information is available for the Rosemount conduit seals used at the transmitters; therefore, the seals will be considered as having the same thermal time constant as the cable. This should be conservative since the seals are an extension of the cable and are more dense than the cable. Therefore, the transmitter seal temperature at LPI actuation is considered to be the same as the cable temperature (161°F).

$$T_{CS} = 161°F$$

Attachment 4 estimates an expected integrated dose at 20 seconds following a LBLOCA of 8.55 $ft^2$ as 50 Rad. Since this exposure combined with a 30 month normal operating exposure (described in DI6) is less than the threshold for the radiation effects to apply (see DI7.e), no radiation effects will be considered for the LPI error. The transmitter performs its LPI safety function before it receives enough radiation to affect the accuracy of its signal.

c. Environmental Effects Prior to ES Actuation Following SBLOCA ($\leq$0.5 $ft^2$)

**HPI**

With the HPI/MU System upgrade (MARs 97-02-12-01 and 97-02-12-02 References 85 and 86) and associated setpoint changes, the period of operability of the ES HPI channels for a SBLOCA and the applicable RB environment at the time of actuation are determined by examining FTI documents 32-1266348-01 (Reference 87) and 32-1266137-01 (Reference 81). For small breaks from 0.5 $ft^2$ down to 0.04 $ft.^2$, the ES HPI actuates very quickly as the RC pressure drops, i.e., within the first 40 to 50 seconds into the transient. The smaller size SBLOCA's result in a much slower depressurization, which results in a greater exposure of the transmitter and other circuit devices to the post-accident reactor building environmental conditions prior to the initiation of the HPI safety function.

For a break size of 0.01 $ft.^2$, FTI document 32-1266348-01 (Reference 87) indicates that the revised HPI analysis actuation setpoint (1625 psig) is reached around 200 seconds. The corresponding RB atmosphere is at an approximate temperature of 160°F, FTI Document 32-1266137-01 (Reference 81). To be conservative and ensure that the calculation will not have to be revised each time the temperature profile changes, this instrument accuracy calculation will use a more conservative value of 180°F for the RB temperature. This value corresponds to that for a break size of 0.04 $ft.^2$ at 78 seconds. This value is taken from FTI document 32-1266137-01 (Reference 81). (Note that this is conservative because ES actuation occurs at approximately 43 seconds for the 0.04 $ft^2$ break with the revised ES actuation setpoint.)

Using the same lumped parameter approach described earlier and conservatively using a step change of the RB environment to 180°F to simplify the calculation, the transmitter housing temperature at the time of HPI actuation can be estimated 200 seconds after the SBLOCA occurs:

$$T_{TN(200\,s)} = 110°F + (180°F - 110°F)(1 - e^{-(200\,s)/(288\,s)})$$
$$= 145°F$$

Since the transmitter temperature at the time of the HPI actuation is below the 200°F design range for the transmitter, the normal temperature effect error term will be used in the computation of the HPI error. In addition, since the HPI actuation temperature for the transmitter is higher than that calculated for the LPI actuation following a LBLOCA, to simplify the error calculation, the higher HPI (SBLOCA) transmitter temperature (145°F) will be used for both.

Using the same 60 second thermal time constant used for the LBLOCA LPI evaluation and following the same approach, the following cable temperature at the time of HPI actuation following a SBLOCA is calculated:

$$T_{C(200\,s)} = 110°F + (180°F - 110°F)(1 - e^{-(200\,s)/(60\,s)})$$
$$= 178°F$$

Since this cable temperature is higher than that calculated for the LBLOCA LPI actuation, the higher temperature (178°F) will be applied to both accidents to simplify the calculation.

As was done under the LBLOCA LPI evaluation, the penetration temperature at the time of HPI actuation is conservatively considered to be same as the transmitter temperature. Since the SBLOCA HPI actuation results in a higher transmitter temperature, to simplify the calculation, the higher HPI (SBLOCA) 145°F value will be used for both actuation's.

Using the same approach and thermal time constant used for the LBLOCA LPI actuation, the following Raychem splice inner sleeve temperature is found for the HPI actuation:

$$T_{S(200\,s)} = 110°F + (180°F - 110°F)(1 - e^{-(200\,s)/(211\,s)})$$
$$= 153°F$$

Since this splice temperature is higher than that calculated for the LBLOCA LPI actuation, the higher SBLOCA HPI value (153°F) will be applied to both accidents to simplify the calculation.

As was done for the LBLOCA LPI actuation evaluation, the transmitter seal temperature is conservatively considered to be the same as the cable temperature. Since this temperature is higher than that calculated for the LBLOCA LPI actuation, the higher temperature (170°F) will be applied to both accidents to simplify the calculation.

BWNT document 51-1234893-00 (Attachment 4) estimates an expected accident integrated dose at 200 seconds following a SBLOCA of 0.01 $ft^2$ as 250 Rad. Since this exposure combined with a 30 month normal operating exposure (per DI6) is less than the threshold for the radiation effects to apply (see DI7.e), no radiation effects will be considered for the HPI error. The transmitter performs its HPI safety function before it receives enough radiation to affect the accuracy of its signal.

**LPI**
For the SBLOCA events, the combination of HPI and CFT will terminate the fuel clad heatup. Since the pump startup time is on the order of a few seconds, a slight increase in the time that LPI flow becomes available will not change the results.. Therefore, no error effects will be considered for the LPI setpoint for SBLOCA's.

d. <u>Environmental Effects Prior to ES Actuation Following MSLB</u>

**HPI**
For the overcooling events, namely the steam line break accident, the increase in the ES setpoint will result in HPI being actuated earlier which has the potential for a slightly increased cooling effect. In the analysis of record, Reference 66, HPI was initiated at 5.5 seconds (1587 psia with no ES actuation time delay). This results in approximately a 106-psi/second decrease in RCS pressure prior to actuation. Considering the worst-case instrument uncertainties, HPI could be actuated one second earlier. The makeup/HPI system modification increases the hydraulic resistance of the HPI injection lines over the current configuration. This effectively reduces the HPI flow delivery to the RCS for any given pressure.

Based upon the above, a MSLB environment will not be considered in calculating the instrument error for HPI.

**LPI**
The FSAR Chapter 14 analysis for the MSLB makes no mention of taking credit for the low-low RCS pressure ES actuation; therefore, instrument loop accuracy will not be considered for pre-ES actuation for this accident.

e. <u>Environmental Effects Post-Accident (SBLOCA)</u>
These effects are enveloped by the more severe temperature, pressure, and radioactive environment of the LBLOCA and will therefore not be calculated separately.

f. <u>Environmental Effects Post-Accident (LBLOCA)</u>
The steam pressure/temperature effect on accuracy published in the Rosemount literature applies to the transmitter (rather than the normal environmental temperature effect) since it will be exposed to the environment for the duration specified in the product specification.

To address IR effects on the cable, penetrations, seals, and splices, and to simplify the calculation, instead of calculating the maximum temperatures these devices would reach during the accident, IR values will be taken at a maximum temperature of 302°F. This is conservative since due to the thermal lag of these devices, they will never reach the maximum 302°F RB temperature (Zone 66 environmental data from the ESQPM - Reference 18).

The radiation effect specified in the product specifications for the transmitter applies since the transmitter will be exposed to a radioactive accident environment.

g. Environmental Effects Post-Accident (MSLB)

The MSLB inside the RB is encompassed by the LBLOCA profile (Reference 18) and the LBLOCA RB 302°F temperature will be used for the transmitters, cables, penetrations, seals and splice.

The steam pressure/temperature effects published in the transmitter literature apply to the transmitter since it will be exposed to the environment for the duration specified in the product specification.

The cable and penetration temperatures for a MSLB occurring inside the Intermediate Building (IB) would be greater than that of the cable and penetrations for a MSLB accident inside the RB, producing a greater insulation resistance error. However, the steam pressure/temperature error effect seen by the transmitters during a LBLOCA inside the RB, which would not apply to the transmitters for the MSLB accident inside the IB, is a much larger contributor to instrument loop error and would thus more than offset the difference in IR values. For that reason, the LBLOCA accident inside the RB represents the worst-case error.

h. The above environmental conditions are summarized by the following table:

| CONDITION | XMTR TEMP EFFECT | SPLICE TEMP. (IR) | CABL/SEAL TEMP. (IR) | PENET. TEMP. (IR) | RADIATION |
|---|---|---|---|---|---|
| Normal Operating | Normal Temperature Effect (109°F - 70°F) | No Effect | No Effect | No Effect | No Effect |
| LPI/HPI Actuation | Normal Temperature Effect (133°F - 70°F) | 153°F | 178°F | 145°F | No Effect |
| R.G.1.97 | Accident Steam Press/Temp Effect | 302°F | 302°F | 302°F | Accident Radiation Effect |

30 The Configuration Management Information System (CMIS) shows the EQ Zones and the VQP's applicable to all of the components addressed in this calculation. The component cable IR values are taken from these VQPs (References 29, 34 and 42).

31 The methodology used in Appendix D of ISA-RP67.04 (Reference 38) is used to determine the error due to degraded insulation resistance. Per Section 6.2.2 of the I&C Design Criteria For Instrument Loop Uncertainty Calculations (Reference 25): "IR uncertainties due to accident environments are considered systematic." This combined error term is therefore additive with the other terms in the total loop error calculation.

32 The cable IR ($R_C$) is derived from the cable qualification test specimen IR (R), 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:

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

According to CMIS, the VQP which applies to the cables used in this application is CABL-C595-08 (Reference 42). Contained in Tab F1 of that reference is Anaconda (same as Continental Wire & Cable Corp.) Report 79118. Appropriate IR values for the cable at the above maximum ES actuation and post-accident monitoring temperatures (DI29.h) will be taken from this report. According to Table II of Tab F1, of the specimens tested, Specimens 49.6.1, 2, and 3 were aged at the highest temperature/duration value and were aged radioactively at a gamma total integrated dose (TID) closest to that of ESQPM Zone 66 - $2.9 \times 10^7$R (DI6) versus $2.0 \times 10^7$R. Previous revisions of Calculation I-89-0014 used data from Calculation I-88-0004 (Reference 28), which determined an IR value based upon a specimen from this report which had not been aged. The 49.7 specimens were aged at a higher TID than the 49.6 specimens; however, these cables exhibited unexpected behavior with respect to IR versus temperature. As the temperature was lowered, the IR value for these specimens dropped. According to Table IV of the VQP, the 49.5 and 49.7 specimens (those aged the most radioactively) failed the high potential withstand test. Both sets of specimens exhibited the same unexpected behavior with respect to IR versus temperature. For these reasons, Specimens 49.6.1, 2, and 3 will be considered applicable for this calculation.

Table III gives conductor-to-ground IR values for the cable specimens. No conductor-to-conductor values were given; therefore, according to Assumption 10, the conductor-to-conductor value is assumed to be twice that of the conductor-to-ground value. One of the lowest IR values of the three aged specimens prior to testing was $2.44 \times 10^{11}$ ohms ($\Omega$) per Table III. According to this table, the Pre-LOCA IR reading was taken while the test chamber was at 68°F, implying the cable temperature was also 68°F. The lowest IR value of the three at the first LOCA plateau of 280°F was $1.77 \times 10^8 \Omega$ during chemical spray with an applied voltage of 500 Vdc. No test data is available in the VQP for the maximum ES actuation temperature calculated above without chemical spray and at a lower applied voltage. IR data was taken after devices were soaked at steady elevated temperatures. Using this source alone, it cannot be determined whether or not a time lag (not to be confused with the thermal lag) exists before IR begins to take effect, whether or not IR would be significant in the absence of chemical spray, and whether or not the applied voltage is a major contributor to the measured value.

Data from the SAND89-1755C report (Attachment 2 of Calculation I-89-0004 - Reference 9) and SAND90-2629 (Reference 70) does shed some light on these questions. The testing done in both was conducted without chemical spray; the cables were exposed to saturated and superheated steam. Data from both reports supports the premise that once the steam environment and cable temperatures begin to increase, the cable IR begins to decrease with little or no time lag. The IR decrease rate is rather dramatic if the environment (and cable) temperature rate of increase is also large. The SAND89-1755C report also concluded that IR is largely independent of voltage over the range of 50-250 V for the cables that were tested (which included silicon rubber).

ISA RP67.04, Part II (Reference 38) illustrates the relationship between temperature and insulation conductivity (or the inverse of insulation resistance) as an exponential function. To estimate a cable insulation resistance applicable to HPI/LPI actuation ($R_{C(ACT)}$) at a cable temperature of 170°F (maximum between calculated HPI and LPI cable temperatures in DI29.h) this relationship will be used rather than using linear interpolation (which would give a higher IR value). The relationship is as follows:

$$C = CO \bullet e^{(-B/T)}$$

where:

C = Conductivity of the insulation or the inverse of the insulation resistance (R)

| | | |
|---|---|---|
| CO & B | = | Constants |
| T | = | Temperature in °K (Absolute temperature will be expressed in °R since the constants will be derived. °R = °F + 460°F ) |

Using the above data from the pre-LOCA and first plateau, the constants are solved as follows:

$$1/(2.44 \times 10^{11}\Omega) = CO \bullet e^{[-B/(68°F + 460°F)]}$$

$$1/(1.77 \times 10^{8}\Omega) = CO \bullet e^{[-B/(280°F + 460°F)]}$$

Simplifying and taking the natural log of both sides of both equations yields the following:

$$-26.22 = \ln(CO) + (-B)(0.00189)$$

$$-18.99 = \ln(CO) + (-B)(0.00135)$$

Subtracting the second equation from the first and solving for B yields:

$$B = 13{,}389$$

Substituting this value for B into the first equation and solving for CO yields:

$$-26.22 = \ln(CO) + (-13{,}389)(0.00189)$$

$$CO = 0.4006$$

Substituting the above constants and the estimated 178°F cable temperature into the relationship yields the following cable insulation conductivity (conductor-to-ground) for the HPI/LPI actuation cable temperature:

$$C_{Cc\text{-}g(ACT)} = (0.4006) \bullet e^{[-13{,}389/(178°F + 460°F)]}$$
$$= 3.08 \times 10^{-10} \text{ mhos}$$

Since $R_{Cc\text{-}g(ACT)} = 1/C_{(ACT)}$

$$R_{Cc\text{-}g(ACT)} = 1/(3.08 \times 10^{-10} \text{ mhos})$$
$$= 3.25 \times 10^{9}\Omega \text{ (20 ft sample per page 3-2 of Tab F1)}$$

Using the cable lengths from DI28, the following cable IR values are found for the HPI/LPI actuation:

$$R_{Cc\text{-}g(ACT)} = 3.25 \times 10^{9}\Omega \text{ (20 ft)/(130 ft)}$$
$$= \underline{5.00 \times 10^{8}\Omega} \text{ for RC-3A-PT3}$$

$$R_{Cc\text{-}g(ACT)} = 3.25 \times 10^{9}\Omega \text{ (20 ft)/(65 ft)}$$
$$= \underline{1.00 \times 10^{9}\Omega} \text{ for RC-3A-PT4}$$

$$R_{Cc\text{-}g(ACT)} = 3.25 \times 10^{9}\Omega \text{ (20 ft)/(150 ft)}$$
$$= \underline{4.33 \times 10^{8}\Omega} \text{ for RC-3B-PT3}$$

The sample result agrees very closely with the IR measurements taken for the three 49.6 cable specimens at 180°F (from Table III of the cable VQP) of $1.27 \times 10^9\Omega$, $1.36 \times 10^9\Omega$, and $3.8 \times 10^8\Omega$. Therefore, the calculated value will be used for the cable IR (conductor-to-ground) at the HPI and LPI actuation points.

Per Assumption 10, the conductor-to-conductor value for the HPI/LPI actuation cable temperature is therefore:

$$R_{Cc\text{-}c(ACT)} = 2(R_{Cc\text{-}g(ACT)})$$

For the above cables, conductor-to-conductor values are then:

$$R_{Cc\text{-}c(ACT)} = 2(5.00 \times 10^8\Omega)$$
$$= \underline{\underline{1.00 \times 10^9\Omega}} \text{ for RC-3A-PT3}$$

$$R_{Cc\text{-}c(ACT)} = 2(1.00 \times 10^9\Omega)$$
$$= \underline{\underline{2.00 \times 10^9\Omega}} \text{ for RC-3A-PT4}$$

$$R_{Cc\text{-}c(ACT)} = 2(4.33 \times 10^8\Omega)$$
$$= \underline{\underline{8.66 \times 10^8\Omega}} \text{ for RC-3B-PT3}$$

For the post-accident conditions, the lowest value of the 49.6 specimens will be used:

$$R_{Cc\text{-}g(1.97)} = 8.3 \times 10^7\Omega \text{ (20 ft sample per page 3-2 of Tab F1)}$$

Using the cable lengths from DI29, the following cable IR values are found for the post-accident condition:

$$R_{Cc\text{-}g(1.97)} = 8.3 \times 10^7\Omega \text{ (20 ft)/(130 ft)}$$
$$= \underline{\underline{1.28 \times 10^7\Omega}} \text{ for RC-3A-PT3}$$

$$R_{Cc\text{-}g(1.97)} = 8.3 \times 10^7\Omega \text{ (20 ft)/(65 ft)}$$
$$= \underline{\underline{2.55 \times 10^7\Omega}} \text{ for RC-3A-PT4}$$

$$R_{Cc\text{-}g(1.97)} = 8.3 \times 10^7\Omega \text{ (20 ft)/(150 ft)}$$
$$= \underline{\underline{1.11 \times 10^7\Omega}} \text{ for RC-3B-PT3}$$

The post-accident conductor-to-conductor values are therefore (per Assumption 10):

$$R_{Cc\text{-}c(1.97)} = 2(1.28 \times 10^7\Omega)$$
$$= \underline{\underline{2.56 \times 10^7\Omega}} \text{ for RC-3A-PT3}$$

$$R_{Cc\text{-}c(1.97)} = 2(2.55 \times 10^7\Omega)$$
$$= \underline{\underline{5.10 \times 10^7\Omega}} \text{ for RC-3A-PT4}$$

$$R_{Cc\text{-}c(1.97)} = 2(1.11 \times 10^7\Omega)$$
$$= \underline{\underline{2.22 \times 10^7\Omega}} \text{ for RC-3B-PT3}$$

This estimated post-accident IR values should be conservative (i.e. applying only for a short period) since even for the worst case profile (LBLOCA), according to Zone 66 data from the ESQPM (Reference 18), the RB temperature has dropped below 302°F 4 minutes after the accident began.

33 CMIS lists three VQP's for the splices. These were reviewed for applicability with the following results:

TERM-R098-02 is for motor connection kits.
TERM-R098-04 (Reference 55) is for standard bolted and butted in-line splice assembly kits.
TERM-R098-05 is for non-standard (improperly installed) splices with Raychem WCSF-N heat shrink tubing.

Since all of the splices addressed by this calculation are in-line butt splices, VQP TERM-R098-02 does not apply. The following walk down packages were reviewed to determine whether any anomalies were present for the splice configuration so a determination of which of the remaining VQP's apply:

| TAG | CONFIGURATION | CONCLUSION/ VQP TEST RESULTS |
|---|---|---|
| RC-3A-PT3 | Per WDP 0188 (Reference 31) MAR 90-06-10-02 relocated transmitter above flood level. Work Request NU 0287448 (Reference 61) re-spiced cable. Inspection Plan accepted splices. | VQP TERM-R098-04 applies. |
| RC-3A-PT4 | Per WDP 0184 (Reference 32) MAR 90-06-10-02 relocated transmitter above flood level. Work Request NU 0287448 (Reference 61) re-spliced cable. Inspection Plan accepted splices. | VQP TERM-R098-04 applies. |
| RC-3B-PT3 | Per WDP 0185 (Reference 33) MAR 90-06-10-02 relocated splices. Per WDP, Work Request NU 0296434 installed spices. QC inspection accepted installation. | VQP TERM-R098-04 applies. |
| PEN-129 (MTBD-9A) | No anomalies per WDP 0817 (Reference 52). | VQP TERM-R098-04 applies since no anomalies found. |
| PEN-130 (MTBD-9B) | Seal on braided cable per WDP 0254 (Reference 55).<br><br>180° bend per WDP 0254 (Reference 55). | VQP TERM-R098-04 applies since no anomaly. Actual seal is on cable insulation. Raychem holds braid in place.<br><br>VQP TERM-R098-04 applies since specimen D9 (Tab B, 4.1) in-line butt splice with bend radii of less than 5 times the diameter, recorded no leakage (Tab F2, p. VIII-10). |
| PEN-132 (MTBD-9C) | No walk down on inboard per WDP 0815 (Reference 54). | Assume same as 9B and 9A. VQP TERM-R098-04 applies. |

Since either no anomalies were found or what anomalies were found had no impact on reducing the IR of the splices at the transmitters and penetrations, the IR for all of the splices will be determined by an evaluation of VQP TERM-R098-04 (Reference 55) for standard WCSF-N splice sleeves.

According to Tab F5 of the VQP, of the six specimens tested, two (Specimens 1-5 and 1-6) were not thermally aged, and two (Specimens 1-1 and 1-2) suffered splitting of the cable insulation near the splice sleeves. IR data from Table 1 of Tab F5 is incomplete for Specimen 1-3 at the lower temperatures. Therefore, data for Specimen 1-4 will be used in this calculation. IR values from Table 1 are considered to be conductor-to-ground.

Per DI29.h, the maximum splice temperature for HPI/LPI actuation is 139°F. According to Table 1 of Tab F5 of the VQP, the closest temperature to this temperature for which IR data exists is 210°F. Instead of using this value, the same approach used in DI32 will be used to estimate an IR for the lower temperature. From Table 1, Specimens 1-4 had an IR value at ambient temperature (assume 75°F) of $5 \times 10^{10}\Omega$. At the highest temperature (314°F), this specimen had an IR value of $1.8 \times 10^{7}\Omega$. The following constants are determined for the splice material:

$$1/(5.0 \times 10^{10}\Omega) = CO \bullet e^{[-B/(75°F + 460°F)]}$$

$$1/(1.8 \times 10^{7}\Omega) = CO \bullet e^{[-B/(314°F + 460°F)]}$$

Simplifying and taking the natural log of both sides of both equations yields the following:

$$-24.64 = \ln(CO) + (-B)(0.00187)$$

$$-16.71 = \ln(CO) + (-B)(0.00129)$$

Subtracting the second equation from the first and solving for B yields:

$$B = 13{,}672$$

Substituting this value for B into the first equation and solving for CO yields:

$$-24.64 = \ln(CO) + (-13{,}672)(0.00187)$$

$$CO = 2.5260$$

Substituting the above constants and the estimated 153°F splice temperature into the relationship yields the following splice conductor-to-ground insulation conductivity:

$$C_{Sc\text{-}g(ACT)} = (2.5260) \bullet e^{[-13{,}672/(153°F + 460°F)]} = 5.20 \times 10^{-10} \text{ mhos}$$

Since $R_{Sc\text{-}g(ACT)} = 1/C_{Sc\text{-}g(ACT)}$

$$R_{Sc\text{-}g(ACT)} = 1/(5.20 \times 10^{-10} \text{ mhos}) = \underline{\underline{1.92 \times 10^{9}\Omega}}$$

In comparison, the lowest IR value for Specimen 1-4 at 210°F from Table 1 of the VQP is 4.6 x $10^8\Omega$. Per Assumption 10, the conductor-to-conductor value for the HPI/LPI actuation splice temperature is therefore:

$$R_{Sc\text{-}c(ACT)} = 2(R_{Sc\text{-}g(ACT)})$$
$$= 2(1.92 \times 10^9\Omega)$$
$$= \underline{\underline{3.84 \times 10^9\Omega}}$$

Since according to Table 1 and Figure 4 of Tab F5 the IR measurement for the splices were taken 12 minutes after the initial temperature rise to 390°F, and since the splice has a thermal time constant of 211 seconds (per DI29.b), the splice specimens would have exceeded the maximum 300°F temperature estimated for the post-accident conditions (DI29.h). Therefore, the IR value at 314°F from Table 1 for Specimen 1-4 will be conservatively used.

$$R_{Sc\text{-}g(1.97)} = \underline{\underline{1.8 \times 10^7\Omega}}$$

Per Assumption 10, the conductor-to-conductor post-accident value for the splice is therefore:

$$R_{Sc\text{-}c(1.97)} = 2(R_{Sc\text{-}g(1.97)})$$
$$= 2(1.8 \times 10^7\Omega)$$
$$= \underline{\underline{3.6 \times 10^7\Omega}}$$

Additional conservatism is included in the above IR values for the splices due to the fact that per Tab F5 of the VQP, each test circuit consisted of three (3) test splices, each consisting of a single layer of WCSF-N sleeving. In addition, per Page 10 of 11 of Tab D2, a higher concentration of chemical spray was used than what is used at CR3 and for a longer duration. This calculation will use the above calculated values for the two splices in the circuit (one at the penetration, the other at the transmitter seal).

34 VQP INST-R369-03 (Reference 29) covers Rosemount Model 1154 transmitters. Tab F2, Section II, page II-5 states that the transmitters used a Conax conduit seal during the qualification testing. According to the walk down packages for RC-3A-PT3 (Reference 31), RC-3A-PT4 (Reference 32), and RC-3B-PT3 (Reference 33), Rosemount 353C conduit seals are used on the transmitters. Since VQP INST-R369-03 does not list the IR associated with the Conax conduit seal, and since a Rosemount 353C conduit seal is actually used in the plant configuration, the IR values associated with the Rosemount 353C conduit seal will be included for conservatism.

VQP PEN-R369-01 (Reference 34) documents the testing of the Rosemount Model 353C conduit seal. Calculation I-88-0003 (Reference 35) calculated an IR based upon the acceptance criteria given in the test report, which was that the voltage measured across the 500Ω in the test could not shift by more than 40 mV. According to the calculation, the test setup used in the qualification test measured total leakage (lead-to-lead and leads-to-case). It further added that since it is not possible to determine how the leakage is divided, all measured leakage current was assumed to be lead-to-lead leakage. The calculation then used the 40 volts between the seal leads to arrive at an IR value of 5 x $10^5\Omega$. Rosemount (Jane Sandstrom) indicated that the acceptance criteria values typically are very conservative.

A less conservative approach is to use actual test data from the VQP (as has been done with the other devices in the circuit) to arrive at the appropriate IR value. Two different design configurations were tested. According to Tab I4, Page 2, the conduit seals supplied to CR3 were of the Design 2 configuration (i.e. leads covered with heat shrink tubing, epoxy stycast potting, and modified strain relief). Per Tab F1, Appendix A, Page 17 & 18, the initial LOCA test was interrupted by steam escaping from the chamber. Inspection of the test units revealed that the heat shrink tubing on the lead wires of the units had been perforated during the test setup. A modification of the configuration was made, and the units were re-tested. The results of the tests were a maximum shift of unit A003 of 21 mV during the first test and 4 mV (Page 20) during the re-test. The other unit (A001) had suffered degradation; therefore, the data for unit A003 will be used in this calculation.

According to Tab F2, Sections 17.3.1 and 17.3.2 of the VQP, the acceptance criteria during the LOCA test for voltage shifts across the 500Ω resistor and for IR measurements was 40 mV and $6 \times 10^5 \Omega$. According to Sections 17.2.4 and 10.1.2.4.2, this IR measurement was to be from lead-to-case. Although the test procedure gave instructions for taking IR measurements while at elevated temperatures during the test (Section 17.3.2 and 17.2.4), this apparently was not done until after the chamber had cooled. (Tab F1, Appendix A, Table 7). Therefore, the only way to establish an IR value for the LOCA temperatures is to evaluate the voltage shift measured during the LOCA test.

Using the approach of Calculation I-88-0003 (Reference 35) and the 4 mV shift value from the test, a leakage current of $0.004\ V/500\Omega = 8 \times 10^6 A$ is found. Tab F1, Appendix A, Page 6 indicates the voltage potential between the leads was 40 V. Insulation resistance is then $40\ V/8 \times 10^6 A = 5 \times 10^6 \Omega$, which agrees closely with that determined above.

Since the data does not indicate when the maximum 4 mV shift occurred, it is reasonable to assume that it occurred at the maximum seal temperature (due to the nature of IR). Since according to Page 18 of Appendix A (Tab F1) the chamber temperature was held for 320°F for 8 hours, the seal temperature would have reached the same ambient temperature. Therefore, a less conservative estimate for conductor-to-ground IR at 320°F for the seal would be $5 \times 10^6 \Omega$.

Despite the higher IR value estimated above, this calculation (to maintain consistency between current IR calculations) will use the more conservative value of $5 \times 10^5 \Omega$ for the post-accident monitoring condition (assumed conductor-to-conductor in Calculation I-88-0003).

$$R_{SEALc\text{-}c(1.97)} = \underline{5 \times 10^5 \Omega}$$

Per Assumption 10, the post accident conductor-to-ground IR value is then:

$$\begin{aligned} R_{SEALc\text{-}g(1.97)} &= (1/2)(R_{SEALc\text{-}c(1.97)}) \\ &= (1/2)(5 \times 10^5 \Omega) \\ &= \underline{2.5 \times 10^5 \Omega} \end{aligned}$$

As stated in DI29.c, the conduit seal temperature at the time of HPI or LPI actuation is conservatively considered to be that of the cable (170°F). No IR values were recorded at that temperature during the LOCA test; however, IR values for unit A003 were taken following thermal aging during a functional aging test when the seals were cycled between 40°F and 175°F and between 50% and 95% relative humidity. According to Tab F2, Sections 10.2.2.6 and 10.1.2.4.2, the IR measurements were to be from lead-to-case. On the 20th day of such cycling, the IR value for unit A003 taken at 175°F and 50% relative humidity (value was lower than that at 95% relative humidity) was $2.8 \times 10^7 \Omega$ per Tab F1, Appendix A, Table 3. Although this test was done prior to the radiation aging, examination of data taken following the functional aging (Table 4) and following the radiation aging (Table 5) show negligible IR degradation caused by radiation. Therefore, a 2.8 x $10^7\Omega$ conductor-to-ground IR value for the HPI/LPI actuation is reasonable.

$$R_{SEALc\text{-}g(ACT)} = \underline{2.8 \times 10^7\Omega}$$

Per Assumption 10, the conductor-to-conductor IR value at the HPI/LPI seal actuation temperature is then:

$$\begin{aligned} R_{SEALc\text{-}c(ACT)} &= 2(R_{SEALc\text{-}g(ACT)}) \\ &= 2(2.8 \times 10^7\Omega) \\ &= \underline{5.6 \times 10^7\Omega} \end{aligned}$$

35 Per CMIS, Penetrations 129 (MTBD-9A), 130 (MTBD-9B), and 132 (MTBD-9C) are all covered under VQP PEN-C515-04 (Reference 36). Tab D1, note 3 of the VQP states that the test profile envelops the plant worst case LOCA/MSLB composite profile except for 60 seconds at the beginning of the test, and notes that the thermal stresses imposed by the test are considered more severe than the short 15°F temperature spike in the plant. Note 1 states that the test of Tab F1 is applicable to the CR-3 installed equipment. Note 9 states that the feedthroughs utilize #14 AWG conductors.

Per DI29.h, the penetration temperature at HPI/LPI actuation is conservatively estimated to be 133°F. According to Tab F1, Data Sheet L of the VQP, no leakage current was detected until 6 hours had elapsed in the environmental test (which reached temperatures in excess of 370°F). From this it is concluded that the 200 seconds to the HPI actuation point will present no detectable change in IR over the thermally and radiation aged reading. According to Page 10 (Section 6.12.4) of Tab F1, the lowest measurement of aged and irradiated penetration feedthroughs was 2.1 x $10^9\Omega$. It was not indicated whether this represented a conductor-to-ground or a conductor-to-conductor measurement; therefore, the conservative approach is to consider it conductor-to-conductor. Therefore:

$$R_{PENc\text{-}c(ACT)} = \underline{2.1 \times 10^9\Omega}$$

Per Assumption 10, the conductor-to-ground IR value at the HPI/LPI actuation temperature for the penetration is then:

$$\begin{aligned} R_{PENc\text{-}g(ACT)} &= (1/2)(R_{PENc\text{-}c(ACT)}) \\ &= (1/2)(2.1 \times 10^9\Omega) \\ &= \underline{1.05 \times 10^9\Omega} \end{aligned}$$

Per DI29.h, the penetration temperature to be used for post-accident monitoring is 302°F. According to Tab F1, Pages 25 and 26, IR measurements were taken during the design basis event environment test, and these results were recorded on Data Sheet P (Appendix A). Pages 1, 2, & 3 of Data Sheet P (Tab F1, Appendix A) provide the IR measurements for the #14 AWG penetration feedthroughs. The data on these data sheets implies the data was taken on 7/18/80. According to Data Sheet K (Sheet 13 of 32, Tab F1, Appendix A), the chamber temperature on that date was in excess of 314°F. This is confirmed by Data Sheet K (Sheet 3 of 32) which implies the test began on 7/14/80 and Figure 6.20.7 of Tab F1 which provides the temperature/pressure test profile. It can therefore be concluded that the data from Data Sheet P was taken when the penetration feedthroughs temperature was in excess of 302°F. The lowest IR value from those data sheets were :

$R_{PENc\text{-}g(1.97)} = 2 \times 10^{7}\Omega$
$R_{PENc\text{-}c(1.97)} = 3.0 \times 10^{7}\Omega$

Leakage current was also measured throughout the test. These measurements 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 (536 V/0.12 mA) = $4.47 \times 10^{6}\Omega$. For conservatism, this calculation will use the lower IR value and will also conservatively assume it represents a conductor-to-conductor value.

$R_{PENc\text{-}c(1.97)} = \underline{4.47 \times 10^{6}\Omega}$

Per Assumption 10:

$R_{PENc\text{-}g(1.97)} = (1/2)(4.47 \times 10^{6}\Omega)$
$= \underline{2.24 \times 10^{6}\Omega}$

36 Two types of "As-Left" tolerances will be developed in this calculation:

a) $AL_{LOOP:IN}$ will be the SRSS of the Reference Accuracies of loop components located inside a "Harsh Environment".

b) $AL_{LOOP:OUT}$ will be the SRSS of the Reference Accuracies of loop components located outside a "Harsh Environment"

Since "As-Left" tolerances are only used to determine drift between calibrations, only Normal operating condition parameters affect the determination of the tolerances.

37 In accordance with the I&C Design Criteria (Reference 25) Instrument loop errors that are associated with the HPI and LPI trip and alarm function are being calculated using the Category "A" graded approach. The "Calibrated" Loop Error will be determined from the SRSS of the random portion of the "Calculated" Loop Error and the "As-Found" tolerances for the Loop. The "Calibrated" Loop Error is the maximum error that operations could expect between calibrations of the loop.

**TERMS USED IN THE PARTIAL SPLIT LOOP "A" GRADED APPROACH**

$CE_{LOOP:\,TOTAL}$ = Calibrated Loop Error - The overall instrument channel error, which is used to determine setpoints and action values from the design limit/analytical limit.

$CE_{LOOP:\,IN}$ = Calibrated Split Loop Random Error for the instrumentation inside containment, intermediate building, or wherever a harsh environment exists during normal plant operation, precluding on-line calibration.

$CE_{LOOP:OUT}$ = Calibrated Partial Loop Random Error for the combined partial loops in an instrument channel outside of a harsh environment, which can be calibrated on line.

$E_{LOOP\ IN}$ = Calculated Split Loop In Error – Error of instrument split loop located in a harsh environment that does not take into account calibration, drift, process errors and known biases.

$= \pm [(E_{COMP1IN})^2 + (E_{COMP2IN})^2 + \ldots (E_{COMPNIN})^2]^{1/2}$

$E_{COMPPL}$ = Component Error - The SRSS of the errors associated with an individual component in a partial loop (i.e.: Reference Accuracy, Temperature Effect, etc.), with the exception of Drift.

$E_{PL\text{-}BS}$ = $\pm [(E_{COMP1PL\text{-}BS})^2 + (E_{COMP2PL\text{-}BS})^2 + \ldots (E_{COMPNPL\text{-}BS})^2]^{½}$

$E_{BS}$ = $\pm\ E_{COMPBS}$

$MTE_{LOOP:IN}$ = M&TE (Maintenance & Test Equipment) error - The errors due to the M&TE used in the calibration of equipment located in a harsh environment.

$MTE_{PL}$ = M&TE (Maintenance & Test Equipment) error - The errors due to the M&TE used in the calibration of a partial loop.

$SB_{LOOP:IN}$ = Stability/Drift - The error due to the stability/drift of the components in a harsh environment, which cannot be calibrated on-line.

$SB_{PL}$ = Stability/Drift - The error due to the stability/drift of the components in the partial loop which can be calibrated on-line.

$AL_{LOOP:IN}$ = As-Left Tolerance or Calibration Tolerance - The tolerance to which a split loop in a harsh environment is left after calibration. This term is determined from the Reference Accuracy of the components.

= $\pm [(COMP1\text{-}E_{REF})^2 + (COMP2\text{-}E_{REF})^2 + \ldots (COMPN\text{-}E_{REF})^2]^{½}$

$AL_{PL}$ = As-Left Tolerance or Calibration Tolerance - The tolerance to which a partial loop is left after calibration. This term is determined from the Reference Accuracy of the components.

$AL_{PL\text{-}BS}$ = $\pm [(COMP1\text{-}E_{REFPL\text{-}BS})^2 + (COMP2\text{-}E_{REFPL\text{-}BS})^2 + (COMPN\text{-}E_{REFPL\text{-}BS})^2]^{½}$

$AL_{BS}$ = $\pm\ COMP\text{-}E_{REFBS}$

$AF_{LOOP:IN}$ = As-Found Split Loop:In Tolerance - The tolerances in which a split loop in a harsh environment can be after a period of operation, prior to calibration. These terms includes the errors due to M&TE and Drift/Stability.

= $\pm \{AL_{LOOP:IN} + [(MTE_{LOOP:IN})^2 + (SB_{LOOP:IN})^2]^{½}\}$

$AF_{PL}$ = The tolerances in which a partial loop can be after a period of operation, prior to calibration. These terms includes the errors due to M&TE and Drift/Stability.

$AF_{PL\text{-}BS}$ = $\pm\{AL_{PL\text{-}BS} + [(MTE_{PL\text{-}BS})^2 + (SB_{PL\text{-}BS})^2]^{½}\}$

$AF_{BS}$ = $\pm\{AL_{BS} + [(MTE_{BS})^2 + (SB_{BS})^2]^{½}\}$

$E_{BIAS:IN/OUT}$ = Bias Errors - Known biases that affect the operation of an instrument loop, such as static pressure shifts, IR effects, etc.

$E_{BIAS:OUT}$ = $\pm E_{BIAS:PL\text{-}BS} \pm E_{BIAS:BS}$

$E_{PROCESSIN}$ = Process Errors - The error that results from the range of process operation limits, based on the scaling of the sensing instruments. This error includes either normal or accident conditions.

$E_{NPE}$ = Normal Process Errors - The error that results from the range of Normal process operation limits, based on the scaling of the sensing instruments.

$E_{APE}$ = Accident Process Errors - The error that results from the range of Accident process operation limits, based on the scaling of the sensing instruments. (Difference between $E_{NPE}$ extremes and accident extremes).

Nominal Value = A value determined to require no error correction.

**Category A (Split-Loop)**

1) $CE_{LOOP:IN} = \pm [(E_{LOOP:IN})^2 + (AF_{LOOP:IN})^2]^{½}$

2) $CE_{LOOP:OUT} = \pm [(E_{PL\text{-}BS})^2 + (AF_{PL\text{-}BS})^2 + (E_{BS})^2 + (AF_{BS})^2]^{1/2}$

3) $CE_{LOOP:TOTAL} = \pm [(CE_{LOOP:IN})^2 + (CE_{LOOP:OUT})^2]^{1/2} \pm E_{PROCESS:IN} \pm E_{BIAS:IN} \pm E_{BIAS:OUT}$

Instrument loop errors that are associated with the T'SAT, RECALL/SPDS, Recorders and Indicators are being calculated using the Category "B" graded approach. The formula that will be used for the calibrated loop errors is as follows:

**TERMS USED IN THE PARTIAL SPLIT LOOP "B" GRADED APPROACH**

$CE_{LOOP:\ TOTAL}$ = Calibrated Loop Error - The overall instrument channel error, which is used to determine setpoints and action values from the design limit/analytical limit.

$CE_{LOOP:\ IN}$ = Calibrated Split Loop Random Error for the instrumentation inside containment, intermediate building, or wherever a harsh environment exists during normal plant operation, precluding on-line calibration.

$CE_{LOOP:OUT}$ = Calibrated Split Loop Random Error for the instrumentation outside of a harsh environment, which can be calibrated on-line.

$E_{COMP}$ = Component Error - The SRSS of the errors associated with an individual component (i.e.: Reference Accuracy, Temperature Effect, etc.), with the exception of Drift.

$E_{LOOP\ IN/OUT}$ = Calculated Split Loop Errors - The instrument split loop errors not taking into account calibration, drift, process errors and known biases.

$= \pm [(E_{COMP1SPLIT})^2 + (E_{COMP2SPLIT})^2 + \ldots (E_{COMPNSPLIT})^2]^{½}$

$MTE_{LOOP\ IN/OUT}$= M&TE (Maintenance & Test Equipment) error - The errors due to the M&TE used in the calibration of the split loop.

$SB_{LOOP\ IN/OUT}$ = Stability/Drift - The error due to the stability/drift of the components in the split loop.

$AL_{LOOP\ IN/OUT}$ = As-Left Tolerance or Calibration Tolerance - The tolerance to which a split loop is left after calibration. This term is determined from the Reference Accuracy of the components.

$$= \pm [(COMP1\text{-}E_{REF})^2 + (COMP2\text{-}E_{REF})^2 + \ldots (COMPN\text{-}E_{REF})^2]^{½}$$

$AF_{LOOP\ IN/OUT}$ = As-Found Split Loop Tolerances - The tolerances in which a split loop can be after a period of operation, prior to calibration. These terms includes the errors due to M&TE and Drift/Stability.

$$= \pm \{AL_{SPLITLOOP} + [(MTE_{SPLITLOOP})^2 + (SB_{SPLITLOOP})^2]^{½}\}$$

$E_{BIASIN/OUT}$= Bias Errors - Known biases that affect the operation of an instrument loop, such as static pressure shifts, IR effects, etc.

$E_{PROCESSIN}$ = Process Errors - The error that results from the range of process operation limits, based on the scaling of the sensing instruments. This error includes either normal or accident conditions.

$E_{NPE}$ = Normal Process Errors - The error that results from the range of Normal process operation limits, based on the scaling of the sensing instruments.

$E_{APE}$ = Accident Process Errors - The error that results from the range of Accident process operation limits, based on the scaling of the sensing instruments. (Difference between $E_{NPE}$ extremes and accident extremes).

Nominal Value = A value determined to require no error correction.

**Category B (Split Loop)**

This is the second category in the "Graded Approach". The methodology for this category will be the same as for Category A instrument strings, except that the Normal Process Errors will be combined via the SRSS method with the other random loop errors. In addition, 2/3 of the M&TE error will be used.

This method still ensures appropriate actuator actions are taken. Nevertheless it does not compromise the ability to use the instrumentation by more accurately reflecting actual uncertainty.

**CAUTION: $CE_{LOOP:IN}$ and $CE_{LOOP:OUT}$ can have different equations (Equations 1,2, or 3) depending on which condition (Condition 1, 2, or 3) is met by each part of the split loop. For example, $CE_{LOOP:IN}$ could require Equation 1 and $CE_{LOOP:OUT}$ could require Equation 3.**

**Condition #1:**
The following criteria are to be applied separately to $CE_{LOOP:IN}$ and $CE_{LOOP:OUT}$:

If $AL_{SPLITLOOP}$ is greater than the SRSS of the Reference Accuracy of the components in the split loop and

$AF_{SPLITLOOP}$ is greater than $(AL_{SPLITLOOP} + [(2/3\ MTE_{SPLITLOOP})^2 + (SB_{SPLITLOOP})^2]^{½})$,
then the formulas to use are:

**Equation #1**

1) $CE_{LOOP:IN} = \pm [(E_{LOOP:IN})^2 + (E_{NPE:IN})^2 + (AL_{LOOP:IN} + [(2/3\ MTE_{LOOP:IN})^2 + (SB_{LOOP:IN})^2]^{½})^2]^{1/2}$

**Caution: If the $CE_{LOOP:IN}$ is less than the $AF_{LOOP:IN}$, then**

**$CE_{LOOP:IN} = \pm AF_{LOOP:IN}$**

Note: Also, see Attachment 1, General Information Number 10.

2) $CE_{LOOP:OUT} = \pm [(E_{LOOP:OUT})^2 + (AL_{LOOP:OUT} + [(2/3\ MTE_{LOOP:OUT})^2 + (SB_{LOOP:OUT})^2]^{½})^2]^{½}$

**Caution: If the $CE_{LOOP:OUT}$ is less than the $AF_{LOOP:OUT}$, then**

**$CE_{LOOP:OUT} = \pm AF_{LOOP:OUT}$**

3) $CE_{LOOP:TOTAL} = \pm [(CE_{LOOP:IN})^2 + (CE_{LOOP:OUT})^2]^{½} \pm E_{BIAS:IN} \pm E_{APE:IN} \pm E_{BIAS:OUT}$

**Condition #2**

The following criteria are to be applied separately to $CE_{LOOP:IN}$ and $CE_{LOOP:OUT}$:

If the $AL_{SPLITLOOP}$ is greater than the SRSS of the Reference Accuracy of the components in the split loop and

$AF_{SPLITLOOP}$ is less than $(AL_{SPLITLOOP} + [(2/3\ MTE_{SPLITLOOP})^2 + (SB_{SPLITLOOP})^2]^{½})$,
then the formulas to apply are:

**Equation #2**

1) $CE_{LOOP:IN} = \pm [(E_{LOOP:IN})^2 + (E_{NPE:IN})^2 + (AF_{LOOP:IN})^2]^{½}$

2) $CE_{LOOP:OUT} = \pm [(E_{LOOP:OUT})^2 + (AF_{LOOP:OUT})^2]^{½}$

3) $CE_{LOOP:TOTAL} = \pm [(CE_{LOOP:IN})^2 + (CE_{LOOP:OUT})^2]^{½} \pm E_{BIAS:IN} \pm E_{APE:IN} \pm E_{BIAS:OUT}$

**Condition #3:**
The following criteria are to be applied separately to $CE_{LOOP:IN}$ and $CE_{LOOP:OUT}$:

If the $AL_{SPLITLOOP}$ is less than or equal to the SRSS of the Reference Accuracy of the components in the split loop, then the formulas to use are:

**Equation #3**

1) $CE_{LOOP:IN} = \pm [(E_{LOOP:IN})^2 + (E_{NPE:IN})^2 + (2/3\ MTE_{LOOP:IN})^2 + (SB_{LOOP:IN})^2]^{1/2}$

**Caution: If the $CE_{LOOP:IN}$ is less than the $AF_{LOOP:IN}$, then**

**$CE_{LOOP:IN} = \pm AF_{LOOP:IN}$**

Note: Also, see Attachment 1, General Information Number 10.

2) $CE_{LOOP:OUT} = \pm [(E_{LOOP:OUT})^2 + (2/3\ MTE_{LOOP:OUT})^2 + (SB_{LOOP:OUT})^2]^{1/2}$

**Caution: If the $CE_{LOOP:OUT}$ is less than the $AF_{LOOP:OUT}$, then**

**$CE_{LOOP:OUT} = \pm AF_{LOOP:OUT}$**

Note: Also, see Attachment 1, General Information Number 10.

3) $CE_{LOOP:TOTAL} = \pm [(CE_{LOOP:IN})^2 + (CE_{LOOP:OUT})^2]^{1/2} \pm E_{BIAS:IN} \pm E_{APE:IN} \pm E_{BIAS:OUT}$

38 Surveillance Procedure SP-132 (Reference 37) describes the calibration equipment to be used during the calibration of RC-3A-PT3, RC-3A-PT4, and RC-3B-PT3 loop components. The procedure presently states that Keithley Model 2001 and Model 197A, a transmation, and Druck DPI-510 are to be used (or their equivalent). Voltage measurements on Bailey 880 modules (Buffer Amplifiers and Bistables) require a voltmeter with an input impedance of at least 100 MΩ (per Instruction Manual 206 - References 43 and 44). A Keithley 2001 satisfies this requirement.

The following MTE values combine the reference accuracy, calibration tolerance, and temperature effect terms in a SRSS fashion which is allowed by ISA-RP67.04, Part II, Section 6.2.6.1 (Reference 38).

Per Calculation I-95-0005 (Reference 68), the following M&TE values apply to the 0 - 3000 psig input range/4 - 20 mA output range Druck DPI-510 Pressure Controller/Calibrator when used on the 95' elevation of the RB:

$MTE_{DP} = \pm 0.115\%$ reading — Calculation I-95-0005 ($DPI\text{-}510_{5P2}$)
$MTE_{DI} = \pm 0.165\%$ span (4 - 20 mA output span) — Calculation I-95-0005 ($DPI\text{-}510_{5A2}$)

Note: Per calculation I-95-0005 (Reference 68), the Keithly 2001 has M&TE errors less than the ones stated for the Druck above and may be subsituted for the Druck to measure current on the 20 mAdc range.

Since the maximum calibration pressure is 2527.8 psig and the calibrated span of the transmitters is only 2,500 psig, the M&TE for the Druck will be conservatively corrected for this difference:

$$MTE_{DP} = \pm 0.115\% \text{ span } (2527.8 \text{ psig}/2500 \text{ psig}) = \underline{\pm 0.116\% \text{ span}}$$

Per Calculation I-95-0005 (Reference 68), the following M&TE value applies to the Keithley 197A Digital Multimeter when used at the 145' elevation of the Control Complex for a 4-20 mA span:

$MTE_{KI}$ = <u>± 0.190% span</u>

Note: Per Calculation I-95-0005 (Reference 68), the Keithly 197 and 2001 have M&TE errors equal to or less than the Keithley 197A above and can be subsituted for the Keithley 197A to measure current on the 20 mAdc range.

Per Calculation I-95-0005 (Reference 68), the following M&TE value applies to the Keithly 2001 when used at the 145' elevation of the Control Complex for a 0-10 V span:

$MTE_{FV}$ = <u>± 0.005% span</u>

39 Per Calculation I94-0012 (Reference 76), the error associated with RECALL/SPDS is $E_{ERECALLN}$ = ±0.220% of Full Scale Range (20 Vdc or 4096 counts) for 60 to 80 °F and $E_{EREACLLA}$ = ±0.317% of Full Scale Range (20 Vdc or 4096 counts) for accident temperatures of 70 to 104°F.

40 The NRC has accepted instrument error calculations based upon a 2 sigma confidence level via R.G. 1.105 (Reference 39). Per the I&C Design Criteria (Reference 25), published instrument errors are usually expressed at a confidence level of 3 sigma, unless otherwise indicated. That philosophy should be valid for error terms which pertain to equipment operated in a controlled environment. However, for equipment which must survive the environmental effects of an accident (LOCA, HELB), that philosophy cannot be adhered to. The reason for such is that special environmental testing to quantify the temperature, pressure, and radiation effects due to accident conditions are usually done on too small a sample to represent a 3 sigma value. Therefore, environmental error terms shall be considered as 2 sigma values unless otherwise indicated. This calculation does not convert any 3 sigma non-environmental error terms (i.e. reference accuracy, drift, etc.) into 2 sigma terms when it combines the non-environmental with the environmental terms. This approach adds conservatism to the end result.

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

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

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

For example, although the errors due to sensing line density changes and cable insulation resistance are both due to elevated temperatures created by the accident and could be assumed to be present at the same time, for conservatism, they will not be allowed to compensate for one another or for the random error terms.

42 The effect of a decreased insulation resistance (increased leakage current) on the ES RC pressure signals which are grounded loops (on the negative side of the power supply via the Buffer Amplifiers) can be to deliver either a higher or lower pressure signal to the ES and indication than is actually present. The direction depends upon the relative degradation in the insulation resistance of the two conductors within the cable. Should the negative lead (transmitter output to the Buffer

Amplifier) experience a much higher degradation (lower IR) than the positive lead from the power supply (i.e. conductor-to-ground resistance on the negative lead is much lower than conductor-to-conductor), more current will bypass the Buffer Amplifier circuit (assuming the shield-to-drain-to-ground is intact) than can be made up by conductor-to-conductor leakage. The net effect is a lower pressure value is sent to the ES and indication than is actually present. In this scenario, HPI/LPI will actuate at a higher pressure than required, which is a failure in the conservative direction for the ES which actuates on a decreasing pressure signal. This scenario will be called Case 1.

Should the leads exhibit a much lower conductor-to-conductor IR than the negative lead's conductor-to-ground value (i.e. no ground available on the negative lead), the effect will be more leakage conductor-to-conductor than can be drained to ground, resulting in a higher pressure signal sent to the ES and indication than is actually present. This failure is in the non-conservative direction, since HPI/LPI will actuate at a lower pressure than required. This scenario will be called Case 2.

Conductor-to-ground leakage on the positive lead has no effect on the transmitter signal to ES since the power supply simply makes up for the leakage. This scenario will be called Case 3. Not knowing how the conductor insulation will degrade during an accident, all three conditions will be analyzed so as to bound the error.

43 Surveillance Procedure SP-132 (Reference 37) has the following "As-Left" and "As-Found" tolerances:

| Loop Devices | AS-LEFT | AS-FOUND |
|---|---|---|
| Pressure Transmitters | ± 0.04 mAdc | ± 0.115 mAdc |
| Trip Bistable Input (1500# & 500#) | ±0.027 Vdc | ± 0.102 Vdc |
| Trip Bistable Actuation (1500# & 500#) | ± 0.010 Vdc | ± 0.027 Vdc |
| Signal Monitors Input | ± 0.063 Vdc | ± 0.138 Vdc |
| Bypass Bistable Actuation (1700# & 900# Trip) | ± 0.010 Vdc | ± 0.027 Vdc |
| Bypass Bistable Actuation (1700# & 900# Automatic Reset) | ± 0.010 Vdc | ± 0.027 Vdc |
| Plant Computer | ± 20 psig | ± 25 psig |
| Buffer Amplifier Meter | ± 75 psig | ± 75 psig |
| RECALL | ± 20 psig | ± 25 psig |
| Pressure Recorder | ± 25 psig | ± 50 psig |
| T'Sat Meter | ± 20 psig | ± 50 psig |
| RIP Indicator | ± 50 psig | ± 50 psig |
| Signal Monitor (On) | ± 0.025 Vdc | ± 0.027 Vdc |
| Signal Monitor (Off) | ± 0.025 Vdc | ± 0.027 Vdc |

44 This calculation addresses the time response of the HPI and LPI actuation instrument strings. According to Calculation I-83-0001 (Reference 45), the required time response of the components is dependent upon the relative values of the time constant, $\tau$, of the component and the time for the process to change, T (also the signal change). For step changes to the process ($\tau \approx T$), five time constants (to 99% of output) are required. For ramp inputs ($T >> \tau$), only one time constant is required. The following response times (RT) are given for the Bailey Buffer Amplifier and Bistable from DI15 and DI16:

$RT_{BA}$ = 1 sec
$RT_{BT}$ = 100 ms

According to Section 6.2 of Calculation I-83-0001 (Reference 45), the response times given for the Bailey modules are for the time required for the output of the module to change by 99% in response to a step change of the input. Since the values are based upon a step change of the input signal, they represent the worst case.

The response time given for the Rosemount transmitter in DI7 is for one time constant. According to Calculation I-83-0001 (Reference 45), the process times for the various accidents must be evaluated to justify using one time constant. For accidents which produce slow process changes ($T >> \tau$), one time constant is acceptable. For accidents which result in more rapid process changes where T and $\tau$ are nearly equal, the effect of a longer time delay must be analyzed.

Referring to DI29, the accidents under consideration regarding the issue of time response are the SBLOCA and the LBLOCA. The time to ES actuation for these accidents are 200 seconds and 18.5 seconds, both of which are much larger than the 0.2 second time constant for the transmitter. Based upon this comparison, the use of one time constant for the Rosemount transmitters is acceptable ($RT_{PT}$ = 0.2 sec).

45 The current ITS required ES Low Pressure Bypass Reset Value is ≤ 1700 psig per ITS bases B 3.3.5. This is reflected in ITS Table 3.3.5-1 "Applicable Modes and Other Specified Conditions" for the Reactor Coolant System Pressure – Low parameter. The HPI MAR (References 85 and 86) will increase the ITS required Bypass Reset Value from ≤ 1700 psig to ≤ 1800 paig. The existing ES Low Pressure Bypass Reset setpoint is 1695 psig which provides a 5 psi offset from the existing required reset value. This ensures the ES low RCS pressure trip is not bypassed during the specified conditions of ITS Table 3.3.5-1. The new ES Low Pressure Bypass Reset setpoint will also be offset from the nominal value by 5 psig therefore, the post MAR Bypass Reset setpoint will be 1795 psig. The ES Low RC Pressure Bypass bistables have an adjustable deadband which is set at 25 psig. This results in a post MAR setpoint of 1770 psig for the ES Low RC Pressure Bypass Permit function. The bistables affected by this change are RC-003-BT4, RC-003-BT5 and RC-003-BT6.

See FTI 86-5001942-02 and FPC F98-0008 for the above setpoint values (References 84 and 78)

The 1800# (revised from 1700#) and 900# setpoints for the HPI and LPI Bypass bistables are nominal values and therefore, do not need to be error corrected. According to Table 3.3.5-1 of the ITS (Reference 67), the setpoints for these bistables are considered as "Applicable Modes or Other Specified Conditions" and not as "Allowable Values". Exceeding these values (though not advised) is not considered a violation of the Technical Specifications. Administrative controls are in place to provide assurance against exceeding these values (Reference 30).

The LPI and HPI setpoints for the Bypass Bistables are as follows:

| | |
|---|---|
| 1800# HPI Bypass Permit | = 1770 psig (References 85 & 86) |
| 1800# HPI Bypass Reset | = 1795 psig (References 85 & 86) |
| 900# LPI Bypass Permit | = 850 psig (Reference 37) |
| 900# LPI Bypass Reset | = 875 psig (Reference 37) |

46 Section 3.5.1 of the ITS (Reference 63) requires that there be two core flood tanks (CFT's) operable in Mode 3 when reactor coolant (RCS) pressure > 750 psig. One of the signal monitors included in this calculation provides an alarm whenever RCS pressure is > 750 psig and the CF isolation valves are not open (i.e. CFT's not operable). This alarm is considered an operator aid during normal heatup and cooldown; therefore, the 750 psig value is treated as a nominal value. The inplant

setpoint will be established by backing off the nominal value given in ITS by the “As-Found” value for the loop to help ensure the CFT’s are operable above 750 psig RCS pressure.

No ITS requirement exists for the alarm which alerts the operator whenever RCS pressure is below 638.3 psig and the CF isolation valves are not closed (so as to prevent an inadvertent actuation). This alarm is also considered as an operator aid; therefore, the 638.3 psig value is treated as a nominal value. According to Section B 3.5.1 of the ITS (Reference 63), below 750 psig the blowdown rate is such that the LOW pressure safety injection pumps can provide adequate injection to ensure peak clad temperature remains below the required limit. The low pressure setpoint is established in the same manner as the high pressure by backing off the maximum nitrogen blanket pressure given in Section 3.5.1 of the ITS (Reference 63) of 653 psia (638.3 psig) by the “As-Found” value for the loop.

The HPI Not Bypassed and Not Reset Alarms are actuated by signal monitor RC-3A-PS6. The RC-3A-PS6 setpoint is presently 1640 psig per SP-132 (Reference 37). The HPI MAR (Reference 86) will maintain the same pressure differential as presently maintained between the Bypass/Reset functions and alarm setpoints. The HPI MAR (Reference 86) will set the ES HPI Not Bypassed/Not Reset setpoint to 1740 psig.

The ES Low Low RC Pressure Alarm setpoint is actuated by signal monitor RC-3A-PY4. The RC-3A-PY4 setpoint is presently 1550 psig per SP-132 (Reference 37). The HPI MAR (Reference 86) will maintain the same pressure differential as presently maintained between the trip and alarm setpoint. HPI MAR (Reference 86) increase the ES Low RC Pressure Alarm setpoint by 125 psi to 1675 psig.

The remainder of the signal monitor alarm setpoints will remain as specified in SP-132 (Reference 37) or Sections 8 and 9 of this calculation. Therefore, the signal monitor alarm setpoints are as follows:

| | |
|---|---|
| RC-3A-PS6 “HPI Not Bypassed” | 1740 psig (Reference 86) |
| RC-3A-PS6 “HPI Not Reset” | 1740 psig (Reference 86) |
| RC-3A-PY4 “RC Low Pressure” | 1675 psig (Reference 86) |
| RC-3A-PS5 “LPI Not Bypassed” | 750 psig (Reference 37) |
| RC-3A-PS5 “LPI Not Reset” | 750 psig (Reference 37) |
| RC-3A-PS3 “CFT Isolation Valve Not Closed” | 690 psig (Section 8) |
| RC-3A-PS3 “CFT Isolation Valve Not Open” | 702.5 psig (Section 8) |
| RC-3A-PS4 “LTOP Event in Progress” | 392.6 psig (Section 9) |
| RC-3A-PS7 “DH Isolation Valve to PZR Spray Open” | 200 psig (Reference 37) |

## IV. ASSUMPTIONS (A):

1. The modules and indicators located in Control Complex EQ Zones 13 and 58 will be calibrated at a temperature between 70° and 80°F, based on the Normal Temperature range stated in Design Inputs(DI) 8, and on the M&TE accuracy selected in DI39.

   The modules and indicators located in EQ Zones 13 and 58 will be operated over a normal temperature range of 60° to 80°F. This range is based on the maximum Normal Temperature stated in DI 8 and an assumed minimum temperature. The maximum temperature is maintained at the DI 8 stated value of 80°F since the Control Complex Heat Load Evaluation calculation M-97-0020 (reference 77) assumes this to be the maximum initial temperature for evaluation. The minimum temperature is assumed to be 60°F, since this bounds the minimum Normal Temperature stated in DI 8 and also allows for continued analyzed plant operations during HVAC equipment problems when the temperature may decrease below the minimum value stated in DI8.

   The modules and indicators located in EQ Zones 13 and 58 will be operated over an accident temperature range of 60° to 104°F. This range is based on the minimum assumed temperature discussed in the paragraph above. The maximum temperature is assumed to be 104°F, since this bounds the maximum Accident Temperature stated in DI8 and also allows for continued analyzed plant operations up to the vendor stated limit for the lowest maximum temperature rated component in the loop. The Foxboro components are limited to 104°F per Product Specification PSS 9-7A1A page 4 located in Instruction Manual 586 (reference 58), which states a 104°F ambient limit for racks fully loaded with one power supply and no fans, the configuration which exists in the RCITS Cabinets.

   Considering the above paragraphs, the module and indicator temperature effects will be calculated for the maximum change in temperature of the component from the temperature at which it was calibrated to the temperature at which it will be operated. For normal conditions, the component will be assumed to be calibrated at 80°F and operated at 60°F for a 20°F change (80-60) and for accident conditions, the component will be assumed to be calibrated at 70°F and operated at 104°F for a 34°F change (104-70).

2. The lower limit of EQ Zone 66 is 70°F and the upper limit is 109°F, the transmitters are conservatively assumed to be calibrated at 70°F. Therefore a maximum 39°F change occurs between calibration temperature and Normal operating conditions.

3. Split loop calibration is broken down into an "IN" portion of the loop and "OUT" portion of the loop. The IN part of the calibration refers to the calibration of the portion of the loop that is in containment or a harsh environment and the OUT part of the calibration refers to the calibration of the remaining portion of the loop. The OUT portion of the loop will be calibrated by inputting a signal at 4, 8, 12, 16 and 20 mA. The tolerance for these values is assumed to be ±0.004 mA which is an order of magnitude smaller than the As-Left IN tolerance of ±0.04 mA. This small tolerance of ±0.025% of span is considered to be negligible and will not be included in this calculation.

4. It is assumed that each Buffer Amplifier is calibrated with its 630Ω resistor (across its input).

5. The position taken by the I&C Design Criteria (Reference 25) typically considers input and output test equipment used during the calibration of a device as independent, thus combining the corresponding error terms by the SRSS method. This calculation assumes the input and output test equipment are independent.

6. The test equipment referenced under DI38 will be used in the future to calibrate the RC-3A-PT3, RC-3A-PT4, and RC-3B-PT3 loops.

a. Obtaining "As-Found" and "As-Left" values on each transmitter is accomplished using the Druck DPI-510. Although the Druck is essentially one piece of MTE measuring both the input and the output, it is assumed these measurements would be independent of one another. Therefore, per Assumption 5, the accuracies are combined by SRSS. The M&TE error for the pressure transmitter is:

$$\begin{aligned} MTE_{LOOPPT:IN} &= \pm [(MTE_{DP})^2 + (MTE_{DI})^2]^{1/2} \\ &= \pm [(0.116)^2 + (0.165)^2]^{1/2} \\ &= \underline{\pm 0.202\%\ span} \end{aligned}$$

b. "As-Found" and "As-Left" values for the Bistable (TRIP and BYPASS) and Signal Monitor inputs are found by using a transmation and a Keithley 197A (4-20 ma range) to supply and measure a simulated transmitter signal (4-20 ma corresponding to the "As-Found" and "As-Left" current output of the transmitter) to the input of the Buffer Amplifier's resistor network and by using a Keithley 2001 (0-10 V range) to measure the input voltage to the TRIP Bistable at its input jack and to the signal monitor at its input jack

$$\begin{aligned} MTE_{TSAT} = MTE_{BA} = MTE_{SMA} = MTE_{PL:OUT1} &= \pm [(MTE_{KI})^2 + (MTE_{FV})^2]^{1/2} \\ &= \pm [(0.190)^2 + (0.005)^2]^{1/2} \\ &= \underline{\pm 0.19\%\ span} \end{aligned}$$

c. "As-Found" and "As-Left" actuation values (and reset values as applicable) for the Bistables (TRIP and BYPASS) and Signal Monitors are found by using a transmation to supply a current signal to the input of the Buffer Amplifier's resistor network and by using a Keithley 2001(0-10 V range) to measure the voltage (at the TRIP Bistable input jack) at which each of the Bistables and Signal Monitors actuates (or resets, as applicable). Therefore, the M&TE error for the Bistables and Signal Monitors is:

$$\begin{aligned} MTE_{BT} = MTE_{PL:OUT2} &= \pm MTE_{FV} \\ &= \underline{\pm 0.005\%\ span} \end{aligned}$$

d. "As-Found" and "As-Left" values for each indicating device (Pressure Indicator, Buffer Amplifier Meter, Recorder, Plant Computer Point, RECALL Point, Reactor Patch Panel Point, and T'SAT Meter) are found by monitoring these devices while using a transmation and a Keithley 197A (4-20 mA range) to supply and measure a simulated transmitter signal (4-20 mA corresponding to the "As-Found" and "As-Left" current output of the transmitter) to the input of the Buffer Amplifier's resistor network.

$$\begin{aligned} MTE_{LOOP:OUT} &= \pm MTE_{KI} \\ &= \pm 0.190 \\ &= \underline{\pm 0.190\%\ span} \end{aligned}$$

7. 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.

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

9. Per Section 6.3.1 of I&C Design Criteria (Reference 25);

   "Accuracy as identified in a vendor specification is usually assumed to be Reference Accuracy. Reference Accuracy is a number or quantity which defines the limit that uncertainties will not exceed under reference operating conditions. Reference operating conditions are the range of operating conditions under which operating influences are negligible.

   Reference Accuracy includes the combined effects of conformity (linearity), hysteresis, and repeatability. It should be noted that linearity is a particular definition of conformity. Reference Accuracy is determined from the deviation values of a number of tests; therefore, it represents a statistical compounding of the random elements of conformity, hysteresis, and repeatability. Reference Accuracy is measured as inaccuracy but expressed as accuracy."

   In addition, the current philosophy is to endorse ANSI/ISA-S51.1-1979 (Reference 7) which includes dead band in the reference accuracy when applicable. Where conformity (linearity), hysteresis, dead band, and repeatability values are less than the specified accuracy, the above statement is to be considered true. For conservatism, where conformity (linearity), hysteresis, dead band, 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.

10. Assume conductor-to-conductor IR for cable, splices, seals, and penetration feedthroughs is twice that of conductor-to-ground IR if one of the values are not given in test data. This assumption is made since conductor-to-conductor involves twice the insulation thickness of the cable, splice, etc.

11. To allow consistent usage of Bailey 880 module accuracy and time response data, it is assumed that the analysis of Calculations I-83-0001 (Reference 45) and I-90-1020 (Reference 74) includes the Buffer Amplifier and Bistable module types used in the RC pressure loops for ES.

## V. REFERENCES:

1. Drawing 205-047, sheet RC-11, Instrument Loop Diagram Reactor Coolant to Steam Generator 3A, Revision 7

2. Drawing 205-047, sheet RC-11A, Instrument Loop Diagram Reactor Coolant to Steam Generator 3B, Revision 4

3. Drawing D8034033, sheet 4, Reactor Coolant Control Loop RC-3, RC3A, Revision 13

4. Drawing 210-481, Engineered Safeguard – Channel Test Cabinet 1, Revision 9

5. Drawing 210-483, Engineered Safeguard – Channel Test Cabinet 2, Revision 8

6. Drawing 210-485, Engineered Safeguard – Channel Test Cabinet 3, Revision 12

7. ANSI/ISA-S51.1-1979, Process Instrumentation Terminology, December 28, 1979

8. Rosemount Report 78212, Internal Thermal Response of Transmitter Housings to Steam Impingement, Revision A, SEEK 3466, Reel 0116

9. Calculation I-89-0004, Instrument Loop and Insulation Resistance (IR) Accuracy Calculations, Revision 8

10. Design Basis Document (DBD) for Post Accident Monitoring Instrumentation (Section 5/11), Revision 7 (Temporary Changes 735,929,968,986,990,997, & 1050)

11. Calculation I-97-0015, RCS Low Range Pressure Loop Accuracy, RC-147-PT & RC-148-PT, Revision 1

12. Drawing 308-605, Instruments Arrangement at North X Station, Revision 15

13. Drawing 308-606, Instruments Arrangement at North Y Station, Revision 15

14. Drawing 308-603, sheet 2, Instruments Arrangement at South X and Y Instrument Rack Station, Rev. 1

15. Drawing 308-601, Instruments Connections on Steam Generator 3A & RC 36" Line, Revision 11

16. Drawing 308-602, Instruments Connections on Steam Generator 3B & RC 36" Line, Revision 12

17. Drawing 308-604, Instruments Arrangement at South X Station Steam Generator 3B, Revision 14

18. Environmental and Seismic Qualification Program Manual (E/SQPM), Revision 11 (with Intermin Change 99-01)

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

20. Instrument Data Sheets:

    20.a RC-3A-PT3, Revision 5

    20.b RC-3A-PT4, Revision 5

20.c RC-3B-PT3, Revision 4

20.d RC-3A-PY3, Revision 1

20.e RC-3A-PY4-1, Revision 2

20.f RC-3B-PY3, Revision 2

20.g RC-3-BT1, Revision 4

20.h RC-3-BT7, Revision 3

20.i RC-3-BT2, Revision 3

20.j RC-3-BT8, Revision 3

20.k RC-3-BT3, Revision 3

20.l RC-3-BT9, Revision 3

20.m RC-3A-JX3, Revision 1

20.n RC-3A-JX4, Revision 1

20.o RC-3B-JX3, Revision 1

20.p SP-1A-EB1 (RC-3A-EB1, RC-3B-EB2), Revision 1

20.q BS-1-IB2 (RC-3A-EB2), Revision 3

20.r SP-6A-EB4 (RC-3A-EB3), Revision 2

20.s SF-1-IB1 (RC-3B-EB3), Revision 2

20.t RC-3A-PS3, Revision 4

20.u RC-3A-PS4, Revision 4

20.v RC-3A-PS5, Revision 4

20.w RC-3A-PS6, Revision 4

20.x RC-3A-PS7, Revision 2

20.y RC-3A-PY4, Revision 2

20.z RC-3A-PI3, Revision 2

20.aa RC-3B-PI2, Revision 2

20.bb RC-163A-PY1, Revision 4 and MAR 97-02-12-02 FCN #2

20.cc RC-163B-PY1, Revision 3 and MAR 97-02-12-02 FCN #2

20.dd RC-154-PR/TR, Revision 8

20.ee RC-3-BT4, Revision 3

20.ff RC-3-BT5, Revision 3

20.gg RC-3-BT6, Revision 3

20.hh RC-3-BT10, Revision 3

20.ii RC-3-BT11, Revision 3

20.JJ RC-3-BT12, Revision 3

21. Instruction Manual 1260, Revision 12
22. Enhanced Design Basis Document (EDBD) for the Reactor Coolant System (Section 6/1), Rev 8 (Temporary Changes 665, 942, 1018, and 1035)
23. Letter LFM90-0006, dated 1/29/90 – Licensing Interpretation Seismic and LOCA
24. Letter SNES94-0276, dated 9/12/94 – Response to NEA94-0694 on RPS Instruments
25. CR-3 I&C Design Criteria For Instrument Loop Uncertainty Calculations, Revision 4
26. Calculation I-88-0015, Selection of Circuit Data for IR Accuracy Calculations, Revision 6
27. Instruction Manual 49, Volume 1C (Book 1887, Revision 0), Foxboro Model 610A Power Supply, Revision 15
28. Calculation I-88-0004, Insulation Resistance of Continental Cable, Revision 2 (voided)
29. Vendor Qualification Package (VQP) INST-R369-03, Rosemount Model 1154 Transmitters, Revision 9
30. Letter SNES 94-0356, dated 12/07/94 – ESAS Bypass Permit Automatic Reset Bistable
31. Walk Down Package 0188, RC-3A-PT3, 1992
32. Walk Down Package 0184, RC-3A-PT4, 1992
33. Walk Down Package 0185, RC-3B-PT3, 1993
34. Vendor Qualification Package (VQP) PEN-R369-01, Rosemount Model 353C Conduit Seals, Revision 5
35. Calculation I-88-0003, Insulation Resistance of Rosemount Conduit Seal, Revision 3

36. Vendor Qualification Package (VQP) PEN-C515-04, Conax P/N 2325-7867/7868 Electrical Penetration Assembly, Revision 4

37. Plant procedure SP-132, Engineered Safeguards Channel Calibration, Revision 37

38. ISA-RP67.04, Part II, Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation, September 1994

39. Reg. Guide 1.105, Instrument Setpoints for Safety-related Systems, Revision 2

40. Final Safety Analysis Report, Revision 25.4

41. Technical Specification Basis Backup Document, 51-1173714-01, Volume 2, Book 1, Tab 15

42. Vendor Qualification Package (VQP) CABL-C595-08, Continental CC-2193 Instrument Cable, Revision 2

43. Instruction Manual 206, Volume 1 of 2, Revision 22, Bailey Product Instruction E92-316, 1970

44. Instruction Manual 206, Volume 1 of 2, Revision 22, Bailey Product Instruction E92-341, 1969

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

46. Instruction Manual 49, Volume 1B, Revision 19, Bailey Product Instruction E92-79, 1980

47. Instruction Manual 49, Volume 1B, Revision 19, Bailey Product Instruction E92-74, 1972

48. Instruction Manual 49, Volume 1B, Revision 19, Bailey Product Instruction E12-1-1, 1971

49. Instruction Manual 1243, Esterline Angus, Miniservo VI Strip-Chart Recorder, Revision 1

50. Instruction Manual 1278, Revision 10, Foxboro Instruction SI 1-01693, May 1979

51. MAR 82-05-24-04, 79-01B Transmitter Replacement

52. Walk Down Package 817, MTBD-9A, 1992

53. Walk Down Package 254, MTBD-9B, 1990

54. Walk Down Package 815, MTBD-9C, 1992

55. Vendor Qualification Package (VQP) TERM-R098-04, Raychem NPKC, NPKP, and NPKS Transition Splice Assemblies, Revision 5

56. Drawing 205-047, sheet RC-13A, Instrument Loop Diagram RCS Hot Leg Level/Head Level, Revision 9

57. ASME Steam Tables, Second Edition

58. Instruction Manual 586, Revision 7, Foxboro Product Specifications PSS 2E-1A1 A, 1985

59. Calculation I-84-0002, Instrument error calc. For T'Sat display, Revision 2

60. Calculation I-89-0010, RCITS Hot Leg and Reactor Vessel Level Loop Accuracy, Revision 2, ICA, Rev.00

61. WR287448 RAN 99115-1061, LOC 7169-0393

62. Technical Specification Basis Backup Document, 51-1173557-01, Volume 2, Book 1, Tab 16

63. Improved Technical Specifications, Volumes 1 and 2, Amendment 186.

64. Drawing 210-480, Engineered Safeguard – Channel Test Cab ESCC-1 Reactor Coolant Pressure, Revision 13

65. Calculation I-88-0028, Reduction in LPI Start Signal, Revision 0

66. Calculation F-97-0018, CR-3 MSLB with MFP Trip failure , Revision 0

67. WR324749 RAN 90006-2483

68. Calculation I-95-0005, Measurement and Test Equipment Accuracy Calculation, Revision 2

69. Instruction Manual 1981, Keithley 197A Multimeter, Revision 0

70. Submergence and High Temperature Steam Testing of Class 1E Electrical Cables, NUREG/CR-5655, SAND90-2629, Sandia National Laboratories

71. Drawing 210-482, Engineered Safeguard - Channel Test Cab ESCC-2 Reactor Coolant Pressure, Revision 12

72. Drawing 210-484, Engineered Safeguard - Channel Test Cab ESCC-3 Reactor Coolant Pressure, Revision 14

73 Drawing 205-047, sheet RC-12A, Instrument Loop Diagram RCS Hot Leg Level & Head Level, Revision 8

74 Calculation I-90-1020, B&WOG Cross Compatibility Analysis of Bailey Controls Company, Revision 0

75 Calculation M-97-0072 Containment Analysis for SBLOCA Rev. 2

76 Calculation I-94-0012 Computer Instrument Accuracy, Rev. 3

77 Calculation M-97-0020 Control Complex Heat Load Evaluation, Rev. 0

78 F-98-0008 IS “SBLOCA ANALYSIS FOR CRAFT2 TO RELAP5 TRANSITION” REV. 0

79 BAW-10103A, Rev. 3 Containment Analysis for SBLOCA.

80 FTI Document 32-1266137-00, CR-3 Containment Analysis for SBLOCA, December 1997

81 FTI Document 32-1266137-01, CR-3 Containment Analysis for SBLOCA, January 1998

82 FTI Document 32-1266137-02, CR-3 Containment Analysis for SBLOCA, February 1998

83 FTI Document 32-1266137-03, CR-3 Containment Analysis for SBLOCA, December 1998

84 FTI Document 86-5001942-02, CR-3 RELAP5/MOD2 SBLOCA Summary - HPI Upgrade, March1999

85 MAR 97-02-12-01, High Pressure Injection Upgrade – Mechanical and Structural Equipment.

86 MAR 97-02-12-02, High Pressure Injection Upgrade – Electrical and I&C Equipment.

87 FTI Document 32-1266348-01, "CR-3 Mk-B9 20% SGTP R5/M2 SBLOCA Spectrum (HPI Upgrade), 2/18/99.

## VI. DETAILED CALCULATION

This calculation will evaluate the instrument loop accuracies associated with the RCS pressure transmitters RC-3A-PT3, RC-3A-PT4, and RC-3B-PT3 during normal and accident conditions.

### 1. COMPONENT ERRORS

#### a. Process Error

Per DI6, the sensing lines associated with RC-3A-PT3, RC-3A-PT4, and RC-3B-PT3 are routed through EQ Zones 66 and 40. Since neither of the zones has an overwhelming portion of the sensing lines routed through it, an average of the zones Normal temperatures will be used for calculating the differential density effect. Per the E/SQPM (Reference 18) the temperature in Zone 40 is between 130°F and 149°F a majority of the time (average of 140°F), and Zone 66 is between 90° and 109°F a majority of the time (average 100°F); therefore, 120°F (average of the two averages) will be used as the average Normal sense line temperature. In addition, the normal operating pressure of the RCS is 2155 psig per the EDBD for the Reactor Coolant System (Reference 22).

According to DI6, the change in elevation between the tap connections for the transmitters on the RCS piping and the location of the transmitters is 63.13 feet (167.21' – 104.08') for RC-3A-PT3, 63.17 feet (167.21' – 104.04') for RC-3A-PT4, and 64.46 feet (167.21' – 102.75') for RC-3B-PT3.

From Table 3 of the ASME Steam Tables (Reference 57), the Specific Volume of water at 120°F and at 2169.7 psia (2155 psig) is 0.01610 $ft^3/lb$. The density is then 62.11 $lb/ft^3$ (1/0.01610 $ft^3/lb$). Therefore, the following corrections are required for the calibration of the transmitters:

<u>RC-3A-PT3</u>
$(62.11\ lb/ft^3)(1\ ft^2/144\ in^2) = 0.431\ lb/(in^2\text{-}ft)$
$(0.431\ lb/in^2\text{-}ft)(63.13\ ft) =$ <u>27.2 psig</u>

<u>TRANSMITTER SCALING = 27.2 psig (0%) to 2527.2 psig (100%)</u>

<u>RC-3A-PT4</u>
$(0.431\ lb/in^2\text{-}ft)(63.17\ ft) =$ <u>27.2 psig</u>

<u>TRANSMITTER SCALING = 27.2 psig (0%) to 2527.2 psig (100%)</u>

<u>RC-3B-PT3</u>
$(0.431\ lb/in^2\text{-}ft)(64.46\ ft) =$ <u>27.8 psig</u>

<u>TRANSMITTER SCALING = 27.8 psig (0%) to 2527.8 psig (100%)</u>

**The above mentioned correction factors are to be included in the calibration of the transmitters.**

As was found in DI29.h, the maximum temperature of cable, splices, penetrations, and transmitters following the worst accident temperature profile (MSLB) would not exceed 302°F. Transmitter sensing lines, just like these devices, have thermal mass. Since water has a very large specific heat, it is reasonable to conclude that the sensing line temperature will remain below the maximum computed in DI29. Therefore, a value of 302°F will be used to determine the maximum error due to density changes within the sensing lines. The hotter, less dense post-accident condition in the sensing lines will lower the indicated pressure. From Table 1 of the ASME Steam Tables, the saturation pressure of water at 300°F is 67.005 psia. The Specific Volume of water at this point is 0.01745 $ft^3/lb$. Therefore, the density is 57.31 $lb/ft^3$ (1/0.01745 $ft^3/lb$).

The change in pressure for the sensing lines of the pressure transmitters is related to the change in sensing line water 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 density of the sensing lines at 120°F and 300°F, respectively and L is the elevation differential in the sensing line.

The resulting effect on the transmitters' span is as follows:

RC-3A-PT3
$A_{SENSE\text{-}LINE}$ = $[(57.31\ lb/ft^3 - 62.11\ lb/ft^3)/(144\ in^2/1\ ft^2)][(63.13\ ft)/(2500\ lb/in^2)](100\%)$
= - 0.08% span

RC-3A-PT4
$A_{SENSE\text{-}LINE}$ = $[(57.31\ lb/ft^3 - 62.11\ lb/ft^3)/(144\ in^2/1\ ft^2)][(63.17\ ft)/(2500\ lb/in^2)](100\%)$
= - 0.08% span

RC-3B-PT3
$A_{SENSE\text{-}LINE}$ = $[(57.31\ lb/ft^3 - 62.11\ lb/ft^3)/(144\ in^2/1\ ft^2)][(64.46\ ft)/(2500\ lb/in^2)](100\%)$
= - 0.09% span

**Note:** This error will be neglected for the LPI/HPI actuation condition. Decreases in sensing line density create a negative error (i.e. measured value is less than actual value). Neglecting this effect in establishing the HPI/LPI setpoint is therefore conservative since the positive error term is what is used to define the setpoint for actuation's which occur on decreasing signals. The larger value will be used for the post-accident condition. Therefore:

$A_{SENSE\text{-}LINE}$ = <u>- 0.09% span</u>

b. **Device PT** **Rosemount Pressure Transmitter** DI7
Span = 2,500 psig

URL = 3,000 psig (Upper Range Limit)

**Normal Conditions ($E_{PTN}$)**

$E_{PTN(ref)}$ = Reference Accuracy = ± 0.25% span

$E_{PTN(t)}$ = Temperature Effect = ± (0.75% URL + 0.5% span)/100°F
= ± [0.75%(3000 psig/2500 psig) + 0.5%] (109°F – 70°F)/100°F — DI29.h, A2
= ± 0.55% span

$E_{PTN(op)}$ = Overpressure Effect = ± 0.0% span — DI7.b

$E_{PTN(ps)}$ = Power Supply Effect = ± 0.005% span per volt
= ± (0.005 span)(2 volts) — DI18,DI7
= ± 0.01% span

$E_{PTN(p/t)}$ = Steam Pressure/Temperature Effect = ± 0.0% span — DI7.c

$E_{PTN(s)}$ = Seismic Effect = ± 0.0% span — DI7.d

$E_{PTN(rad)}$ = Radiation Effect = ± 0.0% span — DI7.e

$$E_{PTN} = \pm[(E_{PTN(ref)})^2 + (E_{PTN(t)})^2 + (E_{PTN(ps)})^2]^{1/2}$$
$$= \pm[(0.25)^2 + (0.55)^2 + (0.01)^2]^{1/2}$$
$$= \underline{\pm 0.60\% \text{ span}}$$

**HPI/LPI Actuation ($E_{PT/ACT}$)**

$E_{PT/ACT(ref)}$ = Reference Accuracy = ± 0.25% span

$E_{PT/ACT(t)}$ = Temperature Effect = ± (0.75% URL + 0.5% span)/100°F — DI29.h, A2
= ± [0.75%(3000 psig/2500 psig) + 0.5%] (133°F – 70°F)/100°F
= ± 0.88% span

$E_{PT/ACT(op)}$ = Overpressure Effect = ± 0.0% span — DI7.b

$E_{PT/ACT(ps)}$ = Power Supply Effect = ± 0.005% span/volt
= ± 0.005% span/volt
= ± (0.005% span/volt)(2 volts) — DI18,DI7
= ± 0.01% span

$E_{PT/ACT(p/t)}$ = Steam Pressure/Temperature Effect = ± 0.0% span — DI29.h

$E_{PT/ACT(s)}$ = Seismic Effect = ± 0.0% span — DI7.d

$E_{PT/ACT(rad)}$ = Radiation Effect = ± 0.0% span — DI29.h

$$E_{PT/ACT} = \pm[(E_{PT/ACT(ref)})^2 + (E_{PT/ACT(ps)})^2 + (E_{PT/ACT(t)})^2]^{1/2}$$
$$= \pm[(0.25)^2 + (0.01)^2 + (0.88)^2]^{1/2}$$
$$= \underline{\pm 0.91\% \text{ span}}$$

**Post-Accident Conditions – ($E_{PT/1.97}$)**

$E_{PT/1.97(ref)}$ = Reference Accuracy = ± 0.25% span

$E_{PT/1.97(t)}$ = Temperature Effect = ± 0.0% span — DI29.h

$E_{PT/1.97(op)}$ = Overpressure Effect = ± 0.0% span — DI7.b

$E_{PT/1.97(ps)}$ = Power Supply Effect = ± 0.005% span/volt
= ± (0.005% span/volt)(2 volts) — DI18,DI17
= ± 0.01% span

$E_{PT/1.97(p/t)}$ = Steam Pressure/Temperature Effect = ± (2.5% URL + 0.5% span) — DI29.h, DI7
= ± [(2.5%)(3000 psig/2500 psig) + 0.5%]
= ± 3.5% span

$E_{PT/1.97(s)}$ = Seismic Effect = ± 0.0% span — DI7.d

$E_{PT/1.97(rad)}$ = Radiation Effect = ± (1.5% URL + 1.0% span) — DI29.h, DI7
= ± [(1.5%)(3000 psig/2500 psig) + 1.0%]
= ± 2.8% span

$$E_{PT/1.97} = \pm [(E_{PT/1.97(ref)})^2 + (E_{PT/1.97(ps)})^2 + (E_{PT/1.97(p/t)})^2 + (E_{PT/1.97(rad)})^2]^{1/2}$$
$$= \pm [(0.25)^2 + (0.01)^2 + (3.5)^2 + (2.8)^2]^{1/2}$$
$$= \underline{\pm 4.49\% \text{ span}}$$

**c. Insulation Resistance Errors**

Before an IR error value can be determined for the transmitter circuit, the circuit must be analyzed to determine how much leakage current exists.

NOTE: MAR 97-02-12-02 modifies the RC-163A-PY1 and RC-163B-PY1 RCS pressure loops (205-047, Sht. 11, 11A, 12, 12A) to ensure a loss of power to the modules in the RCITS does not cause an ES channel trip for low RCS pressure. The present current-to-voltage (I/V) modules in the RCITS will be replaced with a new current-to-voltage (I/V) module which consist of a I/V (Foxboro N-2AX-VZ) and a V/V (Foxboro N-2AI-T2V) combination unit. The input resistance for this device is 5Ω (Reference 86) in lieu of the 50Ω used for the previous device.

Although one of the transmitter circuits does not include the 5Ω resistor (Reference 86) for the RCITS interface, the circuit analysis will be done for the loops which include this resistor. There is negligible difference in the loops despite this additional resistor. Using a variation (grounded loop versus ungrounded loop) of the IR model given ISA-RP67.04 (Reference 38), the circuit to be analyzed is depicted in Figure 1 of Attachment 5, where:

| | | |
|---|---|---|
| VS | = | Power supply voltage |
| $I_1$ | = | Power supply current |
| $I_2, I_3$ | = | Loop Currents |
| $IE_{1,2,3}$ | = | Leakage Currents |
| IS | = | Transmitter current |
| REQ1 | = | IR for conductor-to-conductor |
| REQ2 | = | IR for conductor-to-ground (negative side of transmitter) |
| REQ3 | = | IR for conductor-to-ground (positive side of transmitter) |

The IR values for the parallel insulation resistance from each of the components (i.e. cable, splice, seal, & penetration) are combined as done in ISA-RP67.04 (Reference 38) using the following:

$$1/REQ1 = 1/R_{SEALc\text{-}c} + 1/R_{Sc\text{-}c} + 1/R_{Cc\text{-}c} + 1/R_{Sc\text{-}c} + 1/R_{PENc\text{-}c}$$

$$1/REQ2 = 1/REQ3 = 1/R_{SEALc\text{-}g} + 1/R_{Sc\text{-}g} + 1/R_{Cc\text{-}g} + 1/R_{Sc\text{-}g} + 1/R_{PENc\text{-}g}$$

Using the HPI/LPI actuation values from DI32, 33, 34, and 35, the following equivalent resistances are calculated:

<u>RC-3A-PT3 Loop</u>

$$1/REQ1_{(ACT)} = (1/5.6\times10^7\Omega) + (1/6.48\times10^9\Omega) + (1/1.30\times10^9\Omega) + (1/6.48\times10^9\Omega) + (1/2.1\times10^9\Omega)$$
$$REQ1_{(ACT)} = \underline{5.15 \times 10^7\Omega}$$

$$1/REQ2_{(ACT)} = (1/2.8\times10^7\Omega) + (1/3.24\times10^9\Omega) + (1/6.52\times10^8\Omega) + (1/3.24\times10^9\Omega) + (1/1.05\times10^9\Omega)$$
$$REQ2_{(ACT)} = \underline{2.58 \times 10^7\Omega} = REQ3_{(ACT)}$$

<u>RC-3A-PT4 Loop</u>

$$1/REQ1_{(ACT)} = (1/5.6\times10^7\Omega) + (1/6.48\times10^9\Omega) + (1/2.60\times10^9\Omega) + (1/6.48\times10^9\Omega) + (1/2.1\times10^9\Omega)$$
$$REQ1_{(ACT)} = \underline{5.26 \times 10^7\Omega}$$

$1/REQ2_{(ACT)} = (1/2.8x10^7\Omega) + (1/3.24x10^9\Omega) + (1/1.30x10^9\Omega) + (1/3.24x10^9\Omega) + (1/1.05x10^9\Omega)$
$REQ2_{(ACT)} = \underline{2.63 \times 10^7\Omega} = REQ3_{(ACT)}$

RC-3B-PT3 Loop
$1/REQ1_{(ACT)} = (1/5.6x10^7\Omega) + (1/6.48x10^9\Omega) + (1/1.13x10^9\Omega) + (1/6.48x10^9\Omega) + (1/2.1x10^9\Omega)$
$REQ1_{(ACT)} = \underline{5.12 \times 10^7\Omega}$

$1/REQ2_{(ACT)} = (1/2.8x10^7\Omega) + (1/3.24x10^9\Omega) + (1/5.65x10^8\Omega) + (1/3.24x10^9\Omega) + (1/1.05x10^9\Omega)$
$REQ2_{(ACT)} = \underline{2.56 \times 10^7\Omega} = REQ3_{(ACT)}$

Using the post-accident (1.97) values from DI33, 34, 35, and 36, the following equivalent resistances are calculated:

RC-3A-PT3 Loop
$1/REQ1_{(1.97)} = (1/5x10^5\Omega) + (1/3.6x10^7\Omega) + (1/2.56x10^7\Omega) + (1/3.6x10^7\Omega) + (1/4.47x10^6\Omega)$
$REQ1_{(1.97)} = \underline{4.31 \times 10^5\Omega}$

$1/REQ2_{(1.97)} = (1/2.5x10^5\Omega) + (1/1.8x10^7\Omega) + (1/1.28x10^7\Omega) + (1/1.8x10^7\Omega) + (1/2.24x10^6\Omega)$
$REQ2_{(1.97)} = \underline{2.16 \times 10^5\Omega} = REQ3_{(1.97)}$

RC-3A-PT4 Loop
$1/REQ1_{(1.97)} = (1/5x10^5\Omega) + (1/3.6x10^7\Omega) + (1/5.10x10^7\Omega) + (1/3.6x10^7\Omega) + (1/4.47x10^6\Omega)$
$REQ1_{(1.97)} = \underline{4.35 \times 10^5\Omega}$

$1/REQ2_{(1.97)} = (1/2.5x10^5\Omega) + (1/1.8x10^7\Omega) + (1/2.55x10^7\Omega) + (1/1.8x10^7\Omega) + (1/2.24x10^6\Omega)$
$REQ2_{(1.97)} = \underline{2.18 \times 10^5\Omega} = REQ3_{(1.97)}$

RC-3B-PT3 Loop
$1/REQ1_{(1.97)} = (1/5x10^5\Omega) + (1/3.6x10^7\Omega) + (1/2.22x10^7\Omega) + (1/3.6x10^7\Omega) + (1/4.47x10^6\Omega)$
$REQ1_{(1.97)} = \underline{4.30 \times 10^5\Omega}$

$1/REQ2_{(1.97)} = (1/2.5x10^5\Omega) + (1/1.8x10^7\Omega) + (1/1.11x10^7\Omega) + (1/1.8x10^7\Omega) + (1/2.24x10^6\Omega)$
$REQ2_{(1.97)} = \underline{2.15 \times 10^5\Omega} = REQ3_{(1.97)}$

Since the transmitter seal IR value is so much smaller than the other components, to simplify the calculation, the worst case equivalent resistances (those for RC-3B-PT3) will be used to determine insulation resistance error.

The transmitter is not a true current source since it must rely upon an external power supply. It acts as a variable resistor which maintains a constant current (IS) for a constant pressure input.

From References 86 the input impedance for the new I/V module is 5Ω. Referring to DI19, the input impedance for the buffer amplifier is 100kΩ.

The cases defined in DI42 will now be analyzed.

CASE 1 – Negative Conductor-to-Ground Leakage Predominates
The first case to be analyzed assumes REQ2 << REQ1 and REQ2 << REQ3. All of the leakage current passes from the negative conductor (i.e. transmitter to buffer amplifier) to ground. This case assumes

the ground for the circuit is intact. The net effect is to produce a signal to the buffer amplifier that is smaller than that sent by the transmitter; therefore, the error will be negative. These assumptions essentially remove REQ1 and REQ3 and place REQ2 in parallel with the 630Ω input resistor across the buffer amplifier input and with the buffer amplifier's input impedance (100kΩ). Combining the 630Ω with the 100kΩ results in the following buffer amplifier equivalent resistance ($R_{BA}$):

$$R_{BA} = \frac{(630\Omega)(100k\Omega)}{630\Omega + 100k\Omega} = 626\Omega$$

This case simplifies to that shown in Figure 2 of Attachment 5. The leakage current (IE) for this scenario is simply the current through the current divider between the negative conductor-to-ground and the buffer amplifier's resistance. Therefore:

$$IE_2 = IS(626\Omega)/(REQ2 + 626\Omega)$$

Per ISA-RP67.04 (Reference 38) the percentage error ($IE_2\%$) due to degraded insulation resistance is:

$$IE_2\% = [IE_2/(IS_{MAX} - IS_{MIN})](100\%)$$

Substituting the above expression for $IE_2$ yields:

$$IE_2\% = \frac{[IS(626\Omega)/(REQ2 + 626\Omega)](100\%)}{IS_{MAX} - IS_{MIN}}$$

The following insulation resistance error (IE%) values are calculated for the HPI/LPI actuation and post-accident conditions using the worst case (lowest) equivalent resistance values for REQ2 calculated above. The error is negative for the reason given above.

<u>HPI/LPI</u>

$$IE_2\%_{(ACT)} = -\frac{[(0.020\text{ A})(626\Omega)/(2.56 \times 10^7\Omega + 626\Omega)](100\%)}{0.020\text{ A} - 0.004\text{ A}}$$

$= -0.003\%$ for a 0.020 A transmitter current

$$IE_2\%_{(ACT)} = -\frac{[(0.004\text{ A})(626\Omega)/(2.56 \times 10^7\Omega + 626\Omega)](100\%)}{0.020\text{ A} - 0.004\text{ A}}$$

$= -0.0006\%$ for a 0.004 A transmitter current

The above error values are considered negligible when compared to the other error terms in the instrument loop. This calculation thus neglects insulation resistance error for the HPI/LPI actuation condition for Case 1. Therefore:

$IE_2\%_{(ACT)}$ = <u>0.0% span</u>

<u>Post-Accident (1.97)</u>

$$IE_2\%_{(1.97)} = -\frac{[(0.020\text{ A})(626\Omega)/(2.15 \times 10^5\Omega + 626\Omega)](100\%)}{0.020\text{ A} - 0.004\text{ A}}$$

= - 0.36% for a 0.020 A transmitter current

$$IE_2\%_{(1.97)} = -\frac{[(0.004\ A)(626\Omega)/(2.15 \times 10^5\Omega + 626\Omega)](100\%)}{0.020\ A - 0.004\ A}$$

= - 0.073% for a 0.004 A transmitter current

The error due to insulation resistance is largest at the highest transmitter current, therefore:

$IE_2\%_{(1.97)}$ = <u>-0.36% span</u>

CASE 2 – Conductor-to-Conductor Leakage Predominates

The second case to be analyzed assumes REQ1 << REQ2 and REQ1 << REQ3. All of the leakage current passes from the positive conductor to the negative conductor. This case assumes the ground for the circuit is not intact. These assumptions essentially remove REQ2 and REQ3 from the circuit. The net effect is to produce a signal to the buffer amplifier and to RCITS that is larger than that sent by the transmitter; therefore, the error will be positive. The circuit simplifies to that shown in Figure 3 of Attachment 5.

Using Kirchoff's Law, summing the voltage drops around Loop ABCDA results in the following equation:

$$VS = I_2(5\Omega) + IE_1(REQ1) + I_2(626\Omega) + I_1(1300\Omega)$$
$$= I_2(631\Omega) + IE_1(REQ1) + I_1(1300\Omega) \qquad \text{EQN. 1}$$

Summing voltage drops around Loop ADA results in the following equation:

$$VS = I_3(1600\Omega) + I_1(1300\Omega) \qquad \text{EQN. 2}$$

From Instruction Manual 49 (Reference 27), the output voltage of each of the transmitter power supplies is 84 Vdc @ 10 mA and 76 Vdc @ 50 mA. From this the following relationship between the power supply output voltage and output current can be derived:

$$VS = 86\ V - (200\Omega)IL_1 \qquad \text{EQN. 3}$$

Summing the currents at Node B yields the following:

$$I_2 = IS + IE_1 \qquad \text{EQN. 4}$$

Summing the currents at Node A yields the following:

$$I_1 = I_2 + I_3 \qquad \text{EQN. 5}$$

Setting EQN. 1 equal to EQN. 2 yields:

$$I_2(631\Omega) + IE_1(REQ1) + I_1(1300\Omega) = I_3(1600\Omega) + I_1(1300\Omega)$$

Simplifying and solving for $I_3$ yields:

$$I_3 = \underline{I_2(631\Omega) + IE_1(REQ1)} \qquad \text{EQN. 6}$$

1600Ω

Setting EQN. 2 equal to EQN. 3 yields:

$I_3(1600\Omega) + I_1(1300\Omega) = 86\text{ V} - (200\Omega)IL_1$

Simplifying yields:

$86\text{ V} = I_3(1600\Omega) + I_1(1500\Omega)$ EQN. 7

Substituting EQN. 5 into EQN. 7 yields:

$86\text{ V} = I_3(1600\Omega) + I_2(1500\Omega) + I_3(1500\Omega)$

Simplifying yields:

$86\text{ V} = I_3(3100\Omega) + I_2(1500\Omega)$ EQN. 8

Substituting EQN. 6 into EQN. 8 yields:

$$86\text{ V} = \frac{(3100\Omega)[I_2(631\Omega) + IE_1(REQ1)]}{1600\Omega} + I_2(1500\Omega)$$

Simplifying yields:

$86\text{ V} = 2722.56\Omega(I_2) + 1.9375(IE_1)(REQ1)$ EQN. 9

Substituting EQN. 4 into EQN. 9 yields:

$86\text{ V} = 2722.56\Omega(IS + IE_1) + 1.9375(IE_1)(REQ1)$

Solving for $IE_1$ (the leakage current) yields:

$$IE_1 = \frac{86\text{ V} - (2722.56\Omega)IS}{2722.56\Omega + 1.9375(REQ3)} \quad \text{EQN. 10}$$

Per ISA-RP67.04 (Reference 38) the percentage error ($IE_1\%$) due to degraded insulation resistance is:

$$IE_1\% = [IE_1/(IS_{MAX} - IS_{MIN})](100\%)$$

Substituting the above expression for $IE_1$ yields:

$$IE_1\% = \frac{[86\text{ V} - (2722.56\Omega)IS](100\%)}{[2722.56\Omega + 1.9375(REQ1)](IS_{MAX} - IS_{MIN})}$$

The following insulation resistance error (IE%) values are calculated for the HPI/LPI actuation and post-accident conditions using the worst case (lowest) equivalent resistance values for REQ1 calculated above. The error is positive for the reason given above.

HPI/LPI

$$IE_1\%_{(ACT)} = \frac{[86\ V - (2722.56\Omega)(0.020\ A)](100\%)}{[2722.56\Omega + 1.9375(5.12 \times 10^7\Omega)](0.020\ A - 0.004\ A)}$$

$= +\ 0.0020\%$ span for a 0.020 A transmitter current

$$IE_1\%_{(ACT)} = \frac{[86\ V - (2722.56\Omega)(0.004\ A)](100\%)}{[2722.56\Omega + 1.9375(5.12 \times 10^7\Omega)](0.020\ A - 0.004\ A)}$$

$= +\ 0.0047\%$ span for a 0.004 A transmitter current

The above error values are considered negligible when compared to the other error terms in the instrument loop. This calculation thus neglects insulation resistance error for the HPI/LPI actuation condition for Case 2. Therefore:

$IE_1\%_{(ACT)}$ = $\underline{0.0\%\ \text{span}}$

Post-Accident (1.97)

$$IE_1\%_{(1.97)} = \frac{[86\ V - (2722.56\Omega)(0.020\ A)](100\%)}{[2722.56\Omega + 1.9375(4.30 \times 10^5\Omega)](0.020\ A - 0.004\ A)}$$

$= +\ 0.24\%$ span for a 0.020 A transmitter current

$$IE_1\%_{(1.97)} = \frac{[86\ V - (2722.56\Omega)(0.004\ A)](100\%)}{[2722.56\Omega + 1.9375(4.30 \times 10^5\Omega)](0.020\ A - 0.004\ A)}$$

$= +\ 0.56\%$ span for a 0.004 A transmitter current

The error due to insulation resistance is largest at the lowest transmitter current, therefore:

$IE_1\%_{(1.97)}$ = $\underline{+\ 0.56\%\ \text{span}}$

**d. Device BA Bailey Buffer Amplifier ($E_{BA}$)** DI15

| | | | |
|---|---|---|---|
| $E_{BA(ref)}$ | = Reference Accuracy | $= \pm\ 0.1\%$ span | |
| $E_{RESN(temp)}$ | = Resistor Temperature Effect | $= \pm\ 0.028\%$ span | DI19 |
| $E_{RESA(temp)}$ | = Resistor Temperature Effect | $= \pm\ 0.048\%$ span | DI19 |
| $E_{BA(DRE)}$ | = Design Range Error | $= \pm\ 0.399\%$ span | DI15 |

**NORMAL**

$$E_{BAN} = \pm\ [(E_{BA(ref)})^2 + (E_{RESN(temp)})^2 + (E_{BA(DRE)})^2]^{1/2}$$
$$= \pm\ [(0.1)^2 + (0.028)^2 + (0.399)^2]^{1/2}$$
$$= \underline{\pm\ 0.41\%\ \text{span}}$$

**ACCIDENT**

$$E_{BAA} = \pm\ [(E_{BA(ref)})^2 + (E_{RESA(temp)})^2 + (E_{BA(DRE)})^2]^{1/2}$$
$$= \pm\ [(0.1)^2 + (0.048)^2 + (0.399)^2]^{1/2}$$
$$= \underline{\pm\ 0.41\%\ \text{span}}$$

**e. Device BT TRIP & BYPASS Bistable Actuation ($E_{BT}$)** DI16

$E_{BT(ref)}$ = Reference Accuracy =± 0.17% span

$E_{BT(pot)}$ = Potentiometer Resolution = ± 0.05% span

$E_{BT(sp)}$ = Setpoint Repeatability = ± 0.02% span

$E_{BT(t)}$ = Temperature Effect = ± 0.07% span

$E_{BT(hum)}$ = Humidity Effect = ± 0.0 span A8

$$E_{BT} = \pm [(E_{BT(ref)})^2 + (E_{BT(pot)})^2 + (E_{BT(sp)})^2 + (E_{BT(t)})^2]^{1/2}$$
$$= \pm [(0.17)^2 + (0.05)^2 + (0.02)^2 + (0.07)^2]^{1/2}$$
$$= \underline{\pm 0.19\% \text{ span}}$$

**f. Device EB Bailey Voltage Buffer ($E_{EB}$)** DI20

$E_{EB(ref)}$= Reference Accuracy = ± 0.1% span

**NORMAL**

$E_{EBN(temp)}$ = Temperature Effect = ± 0.25(20°F)/100°F A1
= ± 0.05% span

**ACCIDENT**

$E_{EBA(temp)}$ = Temperature effect = ± 0.25(34°F)/100°F A1
= ± 0.085% span

**NORMAL**

$$E_{EBN} = \pm [(E_{EB(ref)})^2 + (E_{EBN(temp)})^2]^{1/2}$$
$$= \pm [(0.1)^2 + (0.05)^2]$$
$$= \underline{\pm 0.11\% \text{ span}}$$

**ACCIDENT**

$$E_{EBA} = \pm [(E_{EB(ref)})^2 + (E_{EBA(temp)})^2]^{1/2}$$
$$= \pm [(0.1)^2 + (0.085)^2]$$
$$= \underline{\pm 0.13\% \text{ span}}$$

**g. Device SM Bailey Signal Monitor ($E_{SM}$)** DI21

$E_{SM(ref)}$ = Reference Accuracy = ± 0.25% span

**NORMAL**

$E_{SMN(temp)}$ = Temperature Effect = ± 0.25(20°F)/100°F A1
= ± 0.05% span

**ACCIDENT**

$E_{SMA(temp)}$ = Temperature Effect = ± 0.25(34°F)/100°F A1
= ± 0.09% span

Repeatability and hysteresis assumed included in $E_{SM(ref)}$ A9

**NORMAL**

$$E_{SMN} = \pm [(E_{SM(ref)})^2 + (E_{SMN(temp)})^2]^{1/2}$$
$$= \pm [(0.25)^2 + (0.05)^2]^{1/2}$$
$$= \underline{\pm 0.25\% \text{ span}}$$

**ACCIDENT**

$$E_{SMA} = \pm [(E_{SM(ref)})^2 + (E_{SMAtemp)})^2]^{1/2}$$
$$= \pm [(0.25)^2 + (0.085)^2]^{1/2}$$
$$= \underline{\pm 0.26\% \text{ span}}$$

**h. Device ES Bailey Indicator ($E_{ES}$)** DI22

$E_{ES(ref)}$ = Reference Accuracy = ± 1.0% span

**NORMAL**

$E_{ESN(temp)}$ = Temperature Effect = ± (0.01/°F)(20°F) A1

= ± 0.20% span

**ACCIDENT**

$E_{ESA(temp)}$ = Temperature Effect = ± (0.01/°F)(34°F) A1

= ± 0.34% span

Linearity, repeatability, and hysteresis assumed included in $E_{ES(ref)}$ A9

$E_{ES(sc)}$ = Scale Error = ± ½ minor scale division

= ± [(0.5)(50 psig)/2500 psig](100%)

= ± 1.0% span

**NORMAL**

$$E_{ESN} = \pm [(E_{ES(ref)})^2 + (E_{ESN(temp)})^2 + (E_{ES(sc)})^2]^{1/2}$$
$$= \pm [(1.0)^2 + (0.2)^2 + (1.0)^2]^{½}$$
$$= \underline{\pm 1.43\% \text{ span}}$$

**ACCIDENT**

$$E_{ESA} = \pm [(E_{ES(ref)})^2 + (E_{ESA(temp)})^2 + (E_{ES(sc)})^2]^{1/2}$$
$$= \pm [(1.0)^2 + (0.34)^2 + (1.0)^2]^{½}$$
$$= \underline{\pm 1.45\% \text{ span}}$$

**i. Device REC Esterline Angus Recorder ($E_{REC}$)** DI24

$E_{REC(ref)}$ = Reference Accuracy = ± 0.5% span

**NORMAL**

$E_{REC(temp)}$ = Temperature Effect = ± [(0.03/°C)(20°F)(5°C/9°F)

= ± 0.33% span

**ACCIDENT**

$E_{REC(temp)}$ = Temperature Effect = ± [(0.03/°C)(34°F)(5°C/9°F)

= ± 0.57% span

$E_{ES(sc)}$ = Scale Error = ± ½ minor scale division

= ± [(0.5)(50 psig)/2500 psig](100%)

= ± 1.0% span

**NORMAL**

$$E_{RECN} = \pm [(E_{REC(ref)})^2 + (E_{REC(temp)})^2 + (E_{ES(sc)})^2]^{1/2}$$
$$= \pm [(0.5)^2 + (0.33)^2 + (1.0)^2]^{½}$$
$$= \underline{\pm 1.17\% \text{ span}}$$

**ACCIDENT**

$$E_{RECA} = \pm [(0.5)^2 + (0.57)^2 + (1.0)^2]^{½}$$
$$= \underline{\pm 1.25\% \text{ span}}$$

**j. Device RCALL RECALL/SPDS/Plant Computer ($E_{RCALL}$)**

**NORMAL**

$E_{RECALLN}$ = ± 0.220% FSR **DI39**
= ± (0.220%)(20 Vdc/10 Vdc)
= ± 0.44% span

**ACCIDENT**

$E_{RECALLA}$ = ± 0.317% FSR **DI39**
= ± (0.317%)(20 Vdc/10 Vdc)
= ± 0.63% span

## 2. CALCULATED LOOP ERRORS

### a. Transmitter

**NORMAL ($E_{LOOPPTN:IN}$)**

$E_{LOOPPTN:IN}$ $= \pm[(E_{PTN})$
$= \pm (0.60\%)$
$= \underline{\pm 0.60\% \text{ span}}$

**ACCIDENT 1.97 ($E_{LOOPPT/197:IN}$)**

$E_{LOOPPT/197:IN}$ $= \pm E_{PT/1.97}$
$= \underline{\pm 4.49\% \text{ span}}$

**HPI/LPI Actuation ($E_{LOOPPT/ACT:IN}$)**

$E_{LOOPPT/ACT:IN} = \pm (E_{PT/ACT})$
$= \underline{\pm 0.91\% \text{ span}}$

### b. TRIP Bistable (1625# & 500#) - HPI/LPI Actuation

**NORMAL ($E_{PL\text{-}BSBTL/ACTN:OUT}$)**

$E_{PL\text{-}BSACTN:OUT}$ $= \pm E_{BAN}$
$= \pm 0.41$
$= \underline{\pm 0.41\% \text{ span}}$

$E_{BSACTN:OUT}$ $= \pm E_{BT}$
$\underline{= \pm 0.19\% \text{ span}}$

**ACCIDENT** ($E_{PL\text{-}BSBTL/ACTA:OUT}$)

$E_{PL\text{-}BSACTA:OUT}$ $= \pm E_{BAA}$
$= \underline{\pm 0.41\% \text{ span}}$

$E_{BSACTA:OUT}$ $= \pm E_{BT}$
$\underline{= \pm 0.19\% \text{ span}}$

Note: Only the positive error value is used to establish the HPI/LPI setpoints due to the actuation's occurring on a decreasing RCS pressure signal.

### c. Pressure Recorder

**Normal ($E_{LOOPPR(N):OUT}$)**

$E_{LOOPPR(N):OUT}$ $= \pm [(E_{BAN})^2 + (E_{RECN})^2]^{1/2}$
$= \pm [(0.41)^2 + (1.17)^2]^{1/2}$
$= \underline{\pm 1.24\% \text{ span}}$

**Accident ($E_{LOOPPR(1.97):OUT}$)**

$$E_{LOOPPR(1.97):OUT} = \pm [(E_{BAA})^2 + (E_{RECA})^2]^{1/2}$$
$$= \pm [(0.41)^2 + (1.25)^2]^{1/2}$$
$$= \underline{\pm\ 1.32\%\ \text{span}}$$

**d. Plant Computer, RECALL, & SPDS**

**Normal ($E_{LOOPRECALLN:OUT}$)**

$$E_{LOOPRECALLN:OUT} = \pm [(E_{BAN})^2 + (E_{RECALLN})^2]^{1/2}$$
$$= \pm [(0.41)^2 + (0.44)^2]^{1/2}$$
$$= \underline{\pm\ 0.60\%\ \text{span}}$$

**Accident ($E_{LOOPRECALLA:OUT}$)**

$$E_{LOOPRECALLA:OUT} = \pm [(E_{BAA})^2 + (E_{RECALLA})^2]^{1/2}$$
$$= \pm [(0.41)^2 + (0.63)^2]^{1/2}$$
$$= \underline{\pm\ 0.75\%\ \text{span}}$$

**e. Output to T'Sat.**

**Normal ($E_{LOOPTSATN:OUT}$)**

$$E_{LOOPTSATN:OUT} = \pm [(E_{BAN})^2 + (E_{EBN})^2]^{1/2}$$
$$= \pm [(0.41)^2 + (0.11)^2]^{1/2}$$
$$= \underline{\pm\ 0.42\%\ \text{span}}$$

**Accident ($E_{LOOPTSATA:OUT}$)**

$$E_{LOOPTSATA:OUT} = \pm [(E_{BAA})^2 + (E_{EBA})^2]^{1/2}$$
$$= \pm [(0.41)^2 + (0.13)^2]^{1/2}$$
$$= \underline{\pm\ 0.43\%\ \text{span}}$$

**f. RIP Indicators**

**Normal ($E_{LOOPPI(N):OUT}$)**

$$E_{LOOPPI(N):OUT} = \pm [(E_{BAN})^2 + (E_{EBN})^2 + (E_{ESN})^2]^{1/2}$$
$$= \pm [(0.41)^2 + (0.11)^2 + (1.43)^2]^{1/2}$$
$$= \underline{\pm\ 1.49\%\ \text{span}}$$

**Accident ($E_{LOOPPI(1.97):OUT}$)**

$$E_{LOOPPI(1.97):OUT} = \pm [(E_{BAA})^2 + (E_{EBA})^2 + (E_{ESA})^2]^{1/2}$$
$$= \pm [(0.41)^2 + (0.13)^2 + (1.45)^2]^{1/2}$$
$$= \underline{\pm\ 1.51\%\ \text{span}}$$

### g. NNI Alarm and Interlock Contacts

**Normal ($E_{PL\text{-}BSALN:OUT}$)**

$$E_{PL\text{-}BSALN:OUT} = \pm [(E_{BAN})^2 + (E_{EBN})^2$$
$$= \pm [(0.41)^2 + (0.11)^2]^{1/2}$$
$$= \underline{\pm\ 0.42\%\ \text{span}}$$

$$E_{BSALN:OUT} = \pm E_{SMN}$$
$$\underline{= \pm\ 0.25\%\ \text{span}}$$

3. **"AS-LEFT" TOLERANCES** DI37

a. **Pressure Transmitter**

$AL_{LOOPPTN:IN} = \pm (E_{PTN(ref)})$
$= \pm 0.25\%$ span
$= \pm (0.25\%/100\%)(16\ mA)$
$= \pm 0.040\ mA$

Per the SP-132 for RC-3A-PT3, RC-3A-PT4, and RC-3B-PT3, the currently used "As-Left" tolerance for calibrating these transmitters is ± 0.04 mA. Since the calculated tolerance is the same as currently used, the "As-Left" tolerance for all three pressure transmitters will remain at ± 0.04 mA. Therefore:

$AL_{LOOPPTN:IN} = \underline{\pm 0.25\%\ span = \pm 0.04\ mA}$

b. **TRIP & BYPASS Bistable Actuation** ($AL_{BSBTA}$)

$AL_{BSBTA:OUT} = \pm (E_{BT(ref)})$
$= \pm 0.17\%$ span
$= \pm (0.17\%/100\%)(10\ Vdc]$
$= \pm 0.017\ Vdc$

Per DI43, the "As-Left" tolerance currently used for the TRIP and BYPASS bistable actuation is ± 0.01 Vdc. Based on past experience of being able to calibrate the bistables to the tighter tolerance currently in SP-132, the procedure will continue to use this tolerance. Consequently, this calculation will use the same value for all three pressure transmitter loops. Therefore:

$AL_{BSBTA:OUT} = \underline{\pm 0.10\ \%\ span = \pm 0.010\ Vdc}$

c. **NNI Alarm and Interlock Contacts** ($AL_{BSAL}$)

$AL_{BSAL:OUT} = \pm (E_{SM(ref)})$
$= \pm 0.25\%$ span
$= \pm (0.25\%/100\%)(10\ Vdc)$
$= \pm 0.025\ Vdc$

Per DI43, the "As-Left" tolerance currently used for the NNI Alarm bistable actuation is ± 0.025 Vdc. Based on past experience of being able to calibrate to the tolerance currently in SP-132, this calculation will use the same value as calculated. Therefore:

$AL_{BSAL:OUT} = \underline{\pm 0.25\%\ span = \pm 0.025\ Vdc}$

d. **TRIP Bistable Input** ($AL_{PL\text{-}BSBTI}$) **- Partial Loop**

$AL_{PL\text{-}BSBTI:OUT} = \pm E_{BA(ref)}$
$= \pm 0.10\%$ span
$= \pm (0.10\%/100\%)(10\ Vdc)$
$= \pm 0.010\ Vdc$ for all three transmitter loops

$AL_{PL\text{-}BSBTI:OUT} = \underline{\pm 0.10\%\ span = \pm 0.010\ Vdc}$

e. **NNI Alarm and Interlock Input** ($AL_{PL\text{-}BSALI}$) **- Partial Loop**

$AL_{PL\text{-}BSALI:OUT} = \pm [(E_{BA(ref)})^2 + (E_{EB(ref)})^2]^{1/2}$
$= \pm [(0.1)^2 + (0.1)^2]^{1/2}$

$= \pm 0.14\%$ span
$= \pm (0.14\%/100\%)(10\ \text{Vdc})$
$= \pm 0.014$ Vdc for RC-3A-PT3 loop:

$AL_{PL\text{-}BSALI:OUT} = \underline{\pm 0.14\%\ \text{span} = \pm 3.5\ \text{psig} = 0.014\ \text{Vdc}}$

**f. Plant Computer, RECALL & SPDS**

$$AL_{LOOPRECALL:OUT} = \pm [(E_{BA(ref)})^2 + (E_{RECALLN})^2]^{1/2}$$
$$= \pm [(0.1)^2 + (0.44)^2]^{1/2}$$
$$= \pm 0.45\%\ \text{span}$$
$$= \pm (0.45\%)(2500\ \text{psig})$$
$$= \pm 11.3\ \text{psig}$$

Since this is a new split loop calculation and prior calibrations have included the transmitter input the calculated AL will be used. Therefore:

$AL_{LOOPRECALL:OUT} = \pm 0.45\%$ span = 11.3 psig

**g. Pressure Recorder**

$$AL_{LOOPPR:OUT} = + [(E_{BA(ref)})^2 + (E_{REC(ref)})^2]^{1/2}$$
$$= + [(0.1)^2 + (0.5)^2]^{1/2}$$
$$= + 0.51\%\ \text{span}$$
$$= + (0.51\%)(2500\ \text{psig})$$
$$= + 12.8\ \text{psig for RC-3A-PT3 and RC-3B-PT3 loops}$$

Since the Recorder can only be read to 25 psig (½ minor scale division), the "As-Left" tolerance for the Recorder will be rounded to ± 25 psig (± 1.0% span). Per DI43, the current "As-Left" tolerance is ± 50 psig. Since this is a new split loop calculation and prior calibrations have included the transmitter input the rounded up AL will be used. Therefore:

$AL_{LOOPPR:OUT} = \underline{\pm 1.0\%\ \text{span} = \pm 25\ \text{psig}}$

**h. Output to T'Sat.**

$$AL_{LOOPTSAT:OUT} = \pm [(E_{BA(ref)})^2 + (E_{EB(ref)})^2]^{1/2}$$
$$= \pm [(0.1)^2 + (0.1)^2]^{1/2}$$
$$= \pm 0.14\%\ \text{span}$$
$$= \pm (0.14\%)(2500\ \text{psig})$$
$$= \pm 3.5\ \text{psig}$$

Since this is a new split loop calculation and prior calibrations have included the transmitter input the calculated AL will be used. Therefore:

$AL_{LOOPTSAT:OUT} = \pm 0.14\% = 3.5$ psig

**i. RIP Indicators**

$AL_{LOOPPI:OUT}$ $= \pm [(E_{BA(ref)})^2 + (E_{EB(ref)})^2 + (E_{ES(ref)})^2]^{1/2}$

$= \pm [(0.1)^2 + (0.1)^2 + (1.0)^2]^{1/2}$

$= \pm$ 1.01% span

$= \pm$ (1.01%)(2500 psig)

$= \pm$ 25.3 psig for RC-3A-PT3 and RC-3B-PT3 loops

Since the Indicator can only be read to 25 psig (½ minor scale division) and the current SP-132 value is 50 psig the error will be rounded up to 50 psig. Therefore:

$AL_{LOOPPI:OUT}$ = <u>± 2% span = ± 50 psig</u>

### 4. "AS-FOUND" TOLERANCES

$SB_{LOOPPTN:IN}$ $= \pm E_{PTN(dft)}$ = (Drift (Stability):±0.2% of upper range limit for 30 months.) DI7
= (0.2%)(3000/2500)
= ± 0.24% span

**a. Pressure Transmitter** A6

Category A Method

$AF_{LOOPPT:INA} = \pm \{AL_{LOOPPTN:IN} + [(SB_{LOOPPTN:IN})^2 + (MTE_{LOOP:IN})^2]^{1/2}\}$
$= \pm \{0.25 + [(0.24)^2 + (0.202)^2]^{1/2}\}$
= ± 0.56% span
= ± (0.56%/100%)(16 mA)
= ± 0.090 mA for all three transmitter loops

Since the calculated tolerance is based on applying a new category A method, the calculated value will be used in the calculation and the procedure in lieu of the current SP-132 value.

$AF_{LOOPPT:IN}$ = ± 0.56% span = ± 0.090 mA

**b. TRIP & BYPASS Bistable Actuation** DI17

$SB_{BSBT:OUT} = \pm E_{BT(dft)}$
= ± 0.164% span

$AF_{BSBTA:OUT} = \pm \{AL_{BSBTA:OUT} + [(SB_{BSBT:OUT})^2 + (MTE_{PL:OUT2})^2]^{1/2}\}$ A6
$= \pm \{0.10 + [(0.164)^2 + (0.005)^2]^{1/2}\}$
= ± 0.26% span
= ± (0.26%/100%)(10 Vdc)
= ± 0.026 Vdc for all three transmitter loops

Per DI43, the "As-Found" tolerance currently used for the TRIP and BYPASS bistable actuation is ± 0.027 Vdc. Based on applying a new Split-Loop method and Design Guide methodology the tigher tolerance calculated above will be used. Therefore:.

$AF_{BSBTA:OUT}$ = ± 0.26% span = ± 0.026 Vdc

**c. NNI Alarm and Interlock Contacts**

$AF_{BSAL:OUT} = \pm (AL_{BSAL:OUT} + MTE_{PL:OUT2})$
= ± (0.25 + 0.005)
= ± 0.26% span
= ± (0.26%/100%)(10 Vdc)
= ± 0.026 Vdc for RC-3A-PT3 loop

Per DI43, the "As-Found" tolerance currently used for the NNI Alarm bistable actuation is ± 0.027 Vdc. Based on applying a new Split-Loop method and Design Guide methodology the tigher tolerance calculated above will be used. Therefore:

$AF_{BSAL:OUT}$ = ± 0.26% span = ± 0.026 Vdc

**d. TRIP Bistable – Partial Loop** DI17

$SB_{PL\text{-}BSBA:OUT} = \pm E_{BA(dft)}$

$= \pm 0.548\%$ span

$AF_{PL\text{-}BSBTI:OUT} = \pm \{AL_{PL\text{-}BSBTI:OUT} + [(SB_{PL\text{-}BSBA:OUT})^2 + (MTE_{PL:OUT1})^2]^{½}\}$ A6

$= \pm \{0.10 + [(0.548)^2 + (0.19)^2]^{½}\}$

$= \pm 0.68\%$ span

$= \pm (0.68\%/100\%)(10\ Vdc)$

$= \pm 0.068$ Vdc for all three transmitter loops

Since this calibration is a partial loop (not including the input tolerance) the $AF_{LOOPBTL:OUT}$ value will be revised to the following tighter tolerance:

$AF_{PL\text{-}BSBTI:OUT}$ = <u>± 0.68 % span = ±0.068 Vdc</u>

**e. NNI Alarm and Interlock – Partial Loop**

$AF_{PL\text{-}BSALI:OUT} = \pm [(AL_{PL\text{-}BSALI:OUT}) + [(SB_{PL\text{-}BSBA:OUT})^2 + (MTE_{PL:OUT1})^2]^{1/2}$ A7

$= \pm \{0.14 + [(0.548)^2 + (0.19)^2]^{½}\}$

$= \pm 0.72\%$ span

$= \pm (0.72\%/100\%)(10\ Vdc)$

= <u>± 0.072 Vdc for RC-3A-PT3 loop</u>

Since this calibration is a partial loop (not including the transmitter values) the $AF_{LOOPBTL:OUT}$ value will be revised to the following tighter value:

$AF_{PL\text{-}BSALI:OUT}$ = <u>± 0.72 % span = ±0.072 Vdc</u>

**f. Plant Computer, RECALL & SPDS**

$AF_{LOOPRECALL:OUT} = \pm \{AL_{LOOPRECALL:OUT} + [(SB_{PL\text{-}BSBA:OUT})^2 + (MTE_{LOOP:OUT})^2]^{1/2}$

$= \pm \{0.45\% + [(0.548)^2 + (0.190)^2]^{1/2}$

$= \pm 1.03\%$ span

$= \pm 1.03\%(2500\ psig)$

$= \pm 25.8$ psig

Since this is a new split loop calculation and prior calibrations have included the transmitter input the calculated AF will be used. Therefore:

$AF_{LOOPRECALL:OUT}$ = <u>± 1.03% span = ± 25.8 psig</u>

**g. Pressure Recorder**

$$AF_{LOOPPR:OUT} = \pm \{AL_{LOOPPR:OUT} + [(SB_{PL-BSBA:OUT})^2 + (MTE_{LOOP:OUT})^2]^{1/2}\}$$
$$= \pm \{1.0 + [(0.548)^2 + (0.190)^2]^{1/2}\}$$
$$= \pm\ 1.58\%\ \text{span}$$
$$= \pm\ (1.58\%)(2500\ \text{psig})$$
$$= \pm\ 39.5\ \text{psig for RC-3A-PT3 and RC-3B-PT3 loops}$$

Since the recorder can only be read to 25 psig (½ minor scale division), the "As-Found" tolerance for the recorder will be rounded up to ± 50 psig or 2.0% span. Since this is a new split loop calculation and prior calibrations have included the transmitter input the calculated AF will be used. Therefore;

$$AF_{LOOPPR:OUT} = \underline{\pm\ 2.0\%\ \text{span} = \pm\ 50\ \text{psig}}$$

**h. Output to T'Sat.**

$$AF_{LOOPTSAT:OUT} = \pm \{AL_{LOOPTSAT:OUT} + [(SB_{PL-BSBA:OUT})^2 + (MTE_{LOOP:OUT})^2]^{1/2}$$
$$= \pm \{0.14 + [(0.548)^2 + (0.19)^2]^{1/2}\}$$
$$= \pm\ 0.72\%\ \text{span}$$
$$= \pm\ 0.72\%(2500\ \text{psig})$$
$$= \pm\ 18.0\ \text{psig}$$

Since this is a new split loop calculation and prior calibrations have included the transmitter input the calculated AF will be used. Therefore:

$$AF_{LOOPTSAT:OUT} = \underline{\pm\ 0.72\%\ \text{span} = \pm\ 18.0\ \text{psig}}$$

**i. RIP Indicators**

$$AF_{LOOPPI:OUT} = \pm\{AL_{LOOPPI:OUT} + [(SB_{PL-BSBA:OUT})^2 + (MTE_{LOOP:OUT})^2]^{1/2}\}$$
$$= \pm \{2.00 + [(0.548)^2 + (0.19)^2]^{1/2}\}$$
$$= \pm\ 2.58\%\ \text{span}$$
$$= \pm\ (2.58\%)(2500\ \text{psig})$$
$$= \pm\ 64.5\ \text{psig for RC-3A-PT3 and RC-3B-PT3 loops}$$

Since the Indicator can only be read to 25 psig (½ minor scale division), the "As-Found" tolerance for the Indicator will be rounded up to ± 75 psig or ± 3.0% span. Therefore:

$$AF_{LOOPPI:OUT} = \underline{\pm\ 3.0\%\ \text{span} = \pm\ 75\ \text{psig}}$$

## 5. CALIBRATED LOOP ERRORS

### a. TRIP Bistable Actuation HPI/LPI ACTUATION

**NOTE:** The resistor bias is not include in the scaled trip unit (See DI19) and the accident $E_{LOOPBTL/ACTA}$ values will be used.

Instrument loop errors that are associated with the HPI and LPI trip and alarm function are being calculated using the Category "A" (Partial Loop) graded approach. The formula that will be used for the calibrated loop errors is as follows:

**ACCIDENT**

$CE_{LOOP:IN} = \pm [(E_{LOOP:IN})^2 + (AF_{LOOP:IN})^2]^{½}$

$CE_{LOOP:OUT} = \pm [(E_{PL\text{-}BS})^2 + (AF_{PL\text{-}BS})^2 + (E_{BS})^2 + (AF_{BS})^2]^{1/2}$

$CE_{LOOP:TOTAL} = \pm [(CE_{LOOP:IN})^2 + (CE_{LOOP:OUT})^2]^{1/2} \pm E_{PROCESS:IN} \pm E_{BIAS:IN} \pm E_{BIAS:OUT}$

$CE_{LOOPBT:IN} = \pm [(E_{LOOPPT/ACT:IN})^2 + (AF_{LOOPPT:IN})^2]^{1/2}$
$= \pm [(0.91)^2 + (0.56)^2]^{1/2}$
$= \underline{\pm 1.07\%\ span}$
$= \pm (1.07\%)(2500\ psig)$
$= \mathbf{\underline{\pm 26.8\ psig}}$

$CE_{LOOPBT:OUT} = \pm [(E_{PL\text{-}BSACTA:OUT})^2 + (AF_{PL\text{-}BSBTI:OUT})^2 + (E_{BSACTA:OUT})^2 + (AF_{BSBTA:OUT})^2]^{1/2}$
$= \pm [(0.41)^2 + (0.68)^2 + (0.19)^2 + (0.26)^2]^{1/2}$
$\underline{= \pm 0.86\%\ span}$
$= \pm (0.86\%\ span)(2500\ psig)$
$= \mathbf{\underline{\pm 21.5\ psig}}$

$CE_{LOOPBT:TOTAL} = \pm [(CE_{LOOPBT:IN})^2 + (CE_{LOOPBT:OUT})^2]^{1/2}$
$= \pm ((1.07)^2 + (0.86)^2)^{1/2}$
$= \underline{\pm 1.37\%\ span}$
$= \pm (1.37\%)(2500\ psig)$
= **<u>± 34.3 psig for all three transmitter loops</u>**

### b. Pressure Recorder

**Normal ($CE_{LOOPPRN:TOTAL}$)**

**$CE_{LOOP:IN}$**

NOTE: The transmitter is a Category A, Therefore the Category A equation will be used.

$CE_{LOOP:IN} = \pm[(E_{LOOP:IN})^2 + (AF_{LOOP:IN})^2]^{½}$

$CE_{LOOPPRN:IN} = \pm[(E_{LOOPPTN:IN})^2 + (AF_{LOOPPT:IN})^2]^{1/2}$
$= \pm[(0.60)^2 + (0.56)^2]^{1/2}$

$= \underline{\pm\ 0.82\%\ \text{span}}$

$CE_{LOOPPRN:IN}$ $= \underline{\pm\ \mathbf{0.82\%\ span}}$

**$CE_{LOOP:OUT}$** - NOTE: The OUT function is Category B:

$AL_{LOOPPR:OUT}$ (1.0% span) is greater than SRSS of the Reference Accuracy of the components in the split loop (0.51% span) and the $AF_{LOOPPR:OUT}$ (2.0% span) is greater than ($AL_{SPLITLOOP}$ + $[(2/3\ MTE_{SPLITLOOP})^2 + (SB_{SPLITLOOP})^2]^{½}$ = 1.58% span), Therefore Equation #1 of Category B will be used;

$CE_{LOOP:OUT}$ $= \pm[(E_{LOOP:OUT})^2 + (AF_{LOOP:OUT} + [(2/3\ MTE_{LOOP:OUT})^2 + (SB_{LOOP:OUT})^2]^{1/2})^2]^{½}$

$CE_{LOOPPRN:OUT}$ $= +[(E_{LOOPPR(N):OUT})^2 + (AF_{LOOPPROUT} + [(2/3\ MTE_{LOOP:OUT})^2 + (SB_{PL\text{-}BSBA:OUT})^2]^{1/2})^2]^{1/2}$
$= +[(1.24)^2 + (2.0 + [(0.13)^2 + (0.548)^2]^{1/2})^2]^{1/2}$
$= +\ 2.85$
$= \underline{+\ 2.85\%\ \text{span}}$

$CE_{LOOPPRN:OUT}$ (2.85%) is greater than $AF_{LOOPPR:OUT}$ (2.0%). Therefore;
$CE_{LOOPPRN:OUT}$ $= \underline{\pm \mathbf{2.85\%\ span}}$

$CE_{LOOPPRN:TOTAL}$ $= +[(CE_{LOOPPRN:IN})^2 + (CE_{LOOPPRN:OUT})^2]^{1/2} + E_{RES(BIAS)}$ DI19
$= +[(0.82)^2 + (2.85)^2]^{1/2} + 0.34$
$= +\ 2.97 + 0.34$
= **<u>+ 3.31% span for RC-3A-PT3 and RC-3B-PT3 loops</u>**
= +3.31%(2500 psig)
= + 82.8 psig

$CE_{LOOPPRN:TOTAL}$ $= -\ [(CE_{LOOPPRN:IN})^2 + (CE_{LOOPPRN:OUT})^2]^{1/2}$
$= -\ [(0.82)^2 + (2.85)^2]^{1/2}$
= **<u>- 2.97% span for RC-3A-PT3 and RC-3B-PT3 loops</u>**
= - 2.97%(2500 psig)
= - 74.3 psig

**Accident ($CE_{LOOPPR1.97:TOTAL}$)**

**$CE_{LOOP:IN}$**

NOTE: The transmitter is a Category A, Therefore the Category A equation will be used.

$CE_{LOOP:IN}$ $= \pm[(E_{LOOP:IN})^2 + (AF_{LOOP:IN})^2]^{½}$

$CE_{LOOPPR197:IN}$ $= \pm[(E_{LOOPPT/197})^2 + (AF_{LOOPPT:IN})^2]^{1/2}$
$= \pm\ [(4.49)^2 + (0.56)^2]^{1/2}$

$CE_{LOOPPR197:IN}$ $= \underline{\pm\ \mathbf{4.53\%\ span}}$

**$CE_{LOOP:OUT}$** - NOTE: The OUT function is Category B:

$AL_{LOOPPR:OUT}$ (1.0% span) is greater than SRSS of the Reference Accuracy of the components in the split loop (0.51% span) and the $AF_{LOOPPR:OUT}$ (2.0% span) is greater than ($AL_{SPLITLOOP}$ + [(2/3 $MTE_{SPLITLOOP})^2$ + $(SB_{SPLITLOOP})^2]^{½}$ = 1.58% span), Therefore Equation #1 of Category B will be used;

$$CE_{LOOP:OUT} = \pm[(E_{LOOP:OUT})^2 + (AF_{LOOP:OUT} + [(2/3\ MTE_{LOOP:OUT})^2 + (SB_{LOOP:OUT})^2]^{1/2})^2]^{½}$$

$$CE_{LOOPPR197:OUT} = +[(E_{LOOPPR(197):OUT})^2 + (AF_{LOOPPROUT} + [(2/3\ MTE_{LOOP:OUT})^2 + (SB_{PL-BSBA:OUT})^2]^{1/2})^2]^{1/2}$$
$$= +[(1.32)^2 + (2.0 + [(0.13)^2 + (0.548)^2]^{1/2})^2]^{1/2}$$
$$= \underline{+\ 2.88\%\ \text{span}}$$

$CE_{LOOPPR197:OUT}$ (2.88%) is greater than $AF_{LOOPPR:OUT}$ (2.0%). Therefore;
$CE_{LOOPPR197:OUT}$ = **$\underline{\pm 2.88\%\ \text{span}}$**

$$CE_{LOOPPR197:TOTAL} = +[(CE_{LOOPPR197:IN})^2 + (CE_{LOOPPR197:OUT})^2]^{1/2} + E_{RES(BIAS)} + IE_1\%_{(1.97)}$$
$$= +[(4.53)^2 + (2.88)^2]^{1/2} + 0.34 + 0.56$$
$$= +\ 5.37 + 0.34 + 0.56$$
$$= \underline{+\ 6.27\%\ \text{span for RC-3A-PT3 and RC-3B-PT3 loops}}$$
$$= +6.27\%(2500\ \text{psig})$$
$$= \mathbf{\underline{+\ 156.8\ psig}}$$

$$CE_{LOOPPR197:TOTAL} = -[(CE_{LOOPPR197:IN})^2 + (CE_{LOOPPR197:OUT})^2]^{1/2\ 2} - A_{SENSE-LINE} - IE_2\%_{(1.97)}$$
$$= -[(4.53)^2 + (2.88)^2]^{1/2} - 0.09 - 0.36$$
$$= -\ 5.37 - 0.09 - 0.36$$
$$= \underline{-\ 5.82\%\ \text{span for RC-3A-PT3 and RC-3B-PT3 loops}}$$
$$= -5.82\%(2500\ \text{psig})$$
$$= \mathbf{\underline{-\ 145.5\ psig}}$$

### c. Plant Computer, RECALL, & SPDS

**NORMAL ($CE_{LOOPRECALLN:TOTAL}$)**

**$CE_{LOOP:IN}$**

NOTE: The transmitter is a Category A, Therefore the Category A equation will be used.

$$CE_{LOOP:IN} = \pm[(E_{LOOP:IN})^2 + (AF_{LOOP:IN})^2]^{½}$$

$$CE_{LOOPRECALLN:IN} = \pm[(E_{LOOPPTN})^2 + (AF_{LOOPPT:IN})^2]^{1/2}$$
$$= \pm[(0.60)^2 + (0.56)^2]^{1/2}$$
$$CE_{LOOPRECALLN:IN} = \underline{\pm\ 0.82\%\ \text{span}}$$

**$CE_{LOOP:OUT}$** - NOTE: The OUT function is Category B:

The $AL_{LOOPRECALL:OUT}$ (0.45%) is equal to the SRSS of the Reference Accuracy of the components in the split loop (0.45%), Therefore, Category B Equation #3 will be used.

$$CE_{LOOP:OUT} = \pm[(E_{LOOP:OUT})^2 + (2/3\ MTE_{LOOP:OUT})^2 + (SB_{LOOP:OUT})^2]^{½} \pm E_{BIAS:OUT}$$

$$CE_{LOOPRECALLN:OUT} = \pm[(E_{LOOPRECALLN:OUT})^2 + (2/3MTE_{LOOP:OUT})^2 + (SB_{PL-BSBA:OUT})^2]^{1/2}$$

$= \pm [(0.60)^2 + (2/3(.190))^2 + (0.548)^2]^{1/2}$
$= \underline{\pm 0.82\% \text{ span}}$

$CE_{LOOPRECALLN:OUT}$ (0.82%) is less than $AF_{LOOPRECALL:OUT}$ (1.03%). Therefore;

$CE_{LOOPRECALLN:OUT} = \pm AF_{LOOPRECALL:OUT}$
$= \underline{\pm \mathbf{1.03\% \text{ span}}}$

$CE_{LOOPRECALLN:TOTAL} = +[(CE_{LOOPRECALLN:IN})^2 + (CE_{LOOPRECALLN:OUT})^2]^{1/2} + E_{RES(BIAS)}$
$= +[(0.82)^2 + (1.03)^2]^{1/2} + 0.34$
$= + 1.32 + 0.34$
$= \underline{+ 1.66\% \text{ span for RC-3A-PT3 and RC-3B-PT3 loops}}$
$= +1.66\%(2500 \text{ psig})$
$= \underline{\mathbf{+ 41.5 \text{ psig}}}$

$CE_{LOOPRECALLN:TOTAL} = -[(CE_{LOOPRECALLN:IN})^2 + (CE_{LOOPRECALLN:OUT})^2]^{1/2}$
$= -[(0.82)^2 + (1.03)^2]^{1/2}$
$= - 1.32$
$= \underline{- 1.32\% \text{ span for RC-3A-PT3 and RC-3B-PT3 loops}}$
$= -1.32\%(2500 \text{ psig})$
$= \underline{\mathbf{- 33.0 \text{ psig}}}$

**ACCIDENT ($CE_{LOOPRECALLA:TOTAL}$)**

**$CE_{LOOP:IN}$**

NOTE: The transmitter is a Category A, Therefore the Category A equation will be used.

$CE_{LOOP:IN} = \pm[(E_{LOOP:IN})^2 + (AF_{LOOP:IN})^2]^{½}$

$CE_{LOOPRECALLA:IN} = \pm[(E_{LOOPPT197})^2 + (AF_{LOOPPT:IN})^2]^{1/2}$
$= \pm [(4.49)^2 + (0.56)^2]^{1/2}$
$CE_{LOOPRECALLA:IN} = \underline{\pm 4.53\% \text{ span}}$

**$CE_{LOOP:OUT}$**. NOTE: The OUT function is Category B:

The $AL_{LOOPRECALL:OUT}$ (0.45%) is equal to the SRSS of the Reference Accuracy of the components in the split loop (0.45%), Therefore, Category B Equation #3 will be used.
$CE_{LOOP:OUT} = \pm[(E_{LOOP:OUT})^2 + (2/3\ MTE_{LOOP:OUT})^2 + (SB_{LOOP:OUT})^2]^{½}$

$CE_{LOOPRECALLA:OUT} = +[(E_{LOOPRECALLA:OUT})^2 + (2/3MTE_{LOOP:OUT})^2 + (SB_{PL-BSBA:OUT})^2]^{1/2}$
$= +[(0.75)^2 + (2/3(.190))^2 + (0.548)^2]^{1/2}$
$= + 0.94$
$CE_{LOOPRECALLA:OUT} = \underline{+ 0.94\% \text{ span}}$

$CE_{LOOPRECALLA:OUT}$ (0.94%) is less than $AF_{LOOPRECALL:OUT}$ (1.03%). Therefore;

$CE_{LOOPRECALLA:OUT} = + AF_{LOOPRECALL:OUT}$
$= \underline{\mathbf{+ 1.03\% \text{ span}}}$

$CE_{LOOPRECALLA:TOTAL}$ $= +[(CE_{LOOPRECALLA:IN})^2 + (CE_{LOOPRECALLA:OUT})^2]^{1/2} + IE_1\%_{(1.97)} + E_{RES(BIAS)}$
$= +[(4.53)^2 + (1.03)^2]^{1/2} + 0.56 + 0.34$
$= + 4.65 + 0.56 + 0.34$
= $\underline{+\ 5.55\%}$ span for RC-3A-PT3 and RC-3B-PT3 loops
$= +5.55\%(2500$ psig)
= **+ 138.8 psig**

$CE_{LOOPRECALLA:TOTAL}$ $= -[(CE_{LOOPRECALLA:IN})^2 + (CE_{LOOPRECALLA:OUT})^2]^{1/2} - A_{SENSE\text{-}LINE} - IE_2\%_{(1.97)}$
$= -[(4.53)^2 + (1.03)^2]^{1/2} - 0.09 - 0.36$
$= - 4.65 - 0.09 - 0.36$
= $\underline{-\ 5.10\%}$ span for RC-3A-PT3 and RC-3B-PT3 loops
$= -5.10\%(2500$ psig)
= **- 127.5 psig**

**d. Output to T'Sat.**

**NORMAL ($CE_{LOOPTSATN:TOTAL}$)**

**$CE_{LOOP:IN}$**

NOTE: The transmitter is a Category A, Therefore the Category A equation will be used.

$CE_{LOOP:IN}$ $= \pm[(E_{LOOP:IN})^2 + (AF_{LOOP:IN})^2]^{½}$

$CE_{LOOPTSATN:IN}$ $= \pm[(E_{LOOPPTN})^2 + (AF_{LOOPPT:IN})^2]^{1/2}$
$= \pm[(0.60)^2 + (0.56)^2]^{1/2}$
$= \underline{\pm\ 0.82\%\ \text{span}}$

$CE_{LOOPTSATN:IN}$ $= \underline{\pm\ 0.82\%\ \text{span}}$

**$CE_{LOOP:OUT}$.** NOTE: The OUT function is Category B:

The $AL_{LOOPTSAT:OUT}$ (0.14%) is equal to the SRSS of the Reference Accuracy of the components in the split loop (0.14%), Therefore, Category B Equation #3 will be used.

$CE_{LOOP:OUT}$ $=\pm[(E_{LOOP:OUT})^2 + (2/3\ MTE_{LOOP:OUT})^2 + (SB_{LOOP:OUT})^2]^{½}$

$CE_{LOOPTSATN:OUT}$ $= \pm[(E_{LOOPTSATN:OUT})^2 + (2/3MTE_{LOOP:OUT})^2 + (SB_{PL\text{-}BSBA:OUT})^2]^{1/2}$
$= \pm\ [(0.42)^2 + (2/3(.190))^2 + (0.548)^2]^{1/2}$

$CE_{LOOPTSATN:OUT}$ $= \underline{\pm\ 0.70\%\ \text{span}}$

$CE_{LOOPTSATN:OUT}$ (0.70%) is less than $AF_{LOOPTSAT:OUT}$ (0.72%). Therefore;

$CE_{LOOPTSATN:OUT}$ $= \pm\ AF_{LOOPTSAT:OUT}$
$= \pm\ 0.72$
= **$\underline{\pm\ 0.72\%\ \text{span}}$**

$CE_{LOOPTSATN:TOTAL}$ $= +[(CE_{LOOPTSATN:IN})^2 + (CE_{LOOPTSATN:OUT})^2]^{1/2} + E_{RES(BIAS)}$
$= +[(0.82)^2 + (0.72)^2]^{1/2} + 0.34$

$= + 1.09 + 0.34$
$= \underline{+ 1.43\% \text{ span for RC-3A-PT3 and RC-3B-PT3 loops}}$
$= +1.43\%(2500 \text{ psig})$
$= \underline{\mathbf{+ 35.8 \text{ psig}}}$

$CE_{LOOPTSATN:TOTAL} = -[(CE_{LOOPTSATN:IN})^2 + (CE_{LOOPTSATN:OUT})^2]^{1/2}$
$= -[(0.82)^2 + (0.72)^2]^{1/2}$
$= \underline{- 1.09\% \text{ span for RC-3A-PT3 and RC-3B-PT3 loops}}$
$= -1.09\%(2500 \text{ psig})$
$= \underline{\mathbf{- 27.3 \text{ psig}}}$

**ACCIDENT ($CE_{LOOPTSATA:TOTAL}$)**

**$CE_{LOOP:IN}$**

NOTE: The transmitter is a Category A, Therefore the Category A equation will be used.

$CE_{LOOP:IN} = \pm[(E_{LOOP:IN})^2 + (AF_{LOOP:IN})^2]^{½}$

$CE_{LOOPTSATA:IN} = \pm [(E_{LOOPPT197})^2 + (AF_{LOOPPT:IN})^2]^{1/2}$
$= \pm [(4.49)^2 + (0.56)^2]^{1/2}$
$CE_{LOOPTSATA:IN} = \underline{\pm 4.53\% \text{ span}}$

**$CE_{LOOP:OUT}$.** NOTE: The OUT function is Category B:

The $AL_{LOOPTSAT:OUT}$ (0.14%) is equal to the SRSS of the Reference Accuracy of the components in the split loop (0.14%), Therefore, Category B Equation #3 will be used.
$CE_{LOOP:OUT} = \pm[(E_{LOOP:OUT})^2 + (2/3\ MTE_{LOOP:OUT})^2 + (SB_{LOOP:OUT})^2]^{½}$

$CE_{LOOPTSATA:OUT} = \pm [(E_{LOOPTSATA:OUT})^2 + (2/3MTE_{LOOP:OUT})^2 + (SB_{PL-BSBA:OUT})^2]^{1/2}$
$= \pm [(0.43)^2 + (2/3(.190))^2 + (0.548)^2]^{1/2}$
$= \underline{\pm 0.71\% \text{ span}}$

$CE_{LOOPTSATA:OUT}$ (0.71%) is less than $AF_{LOOPTSAT:OUT}$ (0.72%). Therefore;

$CE_{LOOPTSATA:OUT} = \pm AF_{LOOPTSAT:OUT}$
$= \underline{\pm 0.72\% \text{ span}}$

$CE_{LOOPTSATA:TOTAL} = +[(CE_{LOOPTSATA:IN})^2 + (CE_{LOOPTSATA:OUT})^2]^{1/2} + IE_1\%_{(1.97)} + E_{RES(BIAS)}$
$= +[(4.53)^2 + (0.72)^2]^{1/2} + 0.56 + 0.34$
$= + 4.59 + 0.56 + 0.34$
$= \underline{+ 5.49\% \text{ span for RC-3A-PT3 and RC-3B-PT3 loops}}$
$= +5.49\%(2500 \text{ psig})$
$= \underline{\mathbf{+ 137.3 \text{ psig}}}$

$CE_{LOOPTSATA:TOTAL} = -[(CE_{LOOPTSATA:IN})^2 + (CE_{LOOPTSATA:OUT})^2]^{1/2} - A_{SENSE-LINE} - IE_2\%_{(1.97)}$
$= -[(4.53)^2 + (0.72)^2]^{1/2} - 0.09 - 0.36$
$= - 4.59 - 0.09 - 0.36$

= <u>- 5.04% span for RC-3A-PT3 and RC-3B-PT3 loops</u>
= -5.04%(2500 psig)
= **<u>- 126.0 psig</u>**

**e. RIP Indicators**

**NORMAL ($CE_{LOOPPIN:TOTAL}$)**

**$CE_{LOOP:IN}$**

NOTE: The transmitter is a Category A, Therefore the Category A equation will be used.

$CE_{LOOP:IN} = \pm[(E_{LOOP:IN})^2 + (AF_{LOOP:IN})^2]^{½}$

$CE_{LOOPPIN:IN} = \pm[(E_{LOOPPTN})^2 + (AF_{LOOPPT:IN})^2]^{1/2}$
$= \pm[(0.60)^2 + (0.56)^2]^{1/2}$
$= \underline{\pm 0.82\%\ span}$

$CE_{LOOPPIN:IN} = \underline{\pm 0.82\%\ span}$

**$CE_{LOOP:OUT}$** - NOTE: The OUT function is Category B:

The $AL_{LOOPPI:OUT}$ (2.00%) is greater than the SRSS of the Reference Accuracy of the components in the split loop (1.01%), and $AF_{LOOPPI:OUT}$ (3.00%) is greater than ($AL_{LOOPPI:OUT}$ + $[(2/3\ MTE_{LOOP:OUT})^2 + (SB_{LOOPBA:OUT})^2]^{½}$ (2.58%), Therefore Category B Equation #1 will be used.

$CE_{LOOP:OUT} = \pm[(E_{LOOP:OUT})^2 + (AL_{LOOP:OUT} + [(2/3\ MTE_{LOOP:OUT})^2 + (SB_{LOOP:OUT})^2]^{½})^2]^{½}$

$CE_{LOOPPIN:OUT} = \pm[(E_{LOOPPI(N):OUT})^2 + (AL_{LOOPPI:OUT} + [(2/3\ MTE_{LOOP:OUT})^2 + (SB_{PL-BSBA:OUT})^2]^{½})^2]^{½}$
$= \pm [(1.49)^2 + (2.0 + (2/3(.190))^2 + (0.548)^2]^{1/2}$
$= \underline{\pm 2.96\%\ span}$

$CE_{LOOPPIN:OUT}$ (2.97%) is less than $AF_{LOOPPI:OUT}$ (3.00%). Therefore;

$CE_{LOOPPIN:OUT} = + AF_{LOOPPI:OUT}$
$= \underline{\pm 3.00\%\ span}$

$CE_{LOOPPIN:TOTAL} = +[(CE_{LOOPPIN:IN})^2 + (CE_{LOOPPIN:OUT})^2]^{1/2} + E_{RES(BIAS)}$
$= +[(0.82)^2 + (3.00)^2]^{1/2} + 0.34$
$= + 3.11 + 0.34$
= <u>+ 3.45% span for RC-3A-PT3 and RC-3B-PT3 loops</u>
= +3.45%(2500 psig)
= **<u>+ 86.3 psig</u>**

$CE_{LOOPPIN:TOTAL} = -[(CE_{LOOPPIN:IN})^2 + (CE_{LOOPPIN:OUT})^2]^{1/2}$
$= -[(0.83)^2 + (3.00)^2]^{1/2}$
= <u>- 3.11% span for RC-3A-PT3 and RC-3B-PT3 loops</u>
= -3.11%(2500 psig)
= **<u>- 77.8 psig</u>**

**ACCIDENT ($CE_{LOOPPIA:TOTAL}$)**

**$CE_{LOOP:IN}$**

NOTE: The transmitter is a Category A, Therefore the Category A equation will be used.

$CE_{LOOP:IN}$ $= \pm[(E_{LOOP:IN})^2 + (AF_{LOOP:IN})^2]^{½}$

$CE_{LOOPPIA:IN}$ $= \pm [(E_{LOOPPT197})^2 + (AF_{LOOPPT:IN})^2]^{1/2}$
$= \pm [(4.49)^2 + (0.56)^2]^{1/2}$
$CE_{LOOPPIA:IN}$ = $\underline{\pm 4.53\%\text{ span}}$

**$CE_{LOOP:OUT}$** - NOTE: The OUT function is Category B:

The $AL_{LOOPPI:OUT}$ (2.00%) is greater than the SRSS of the Reference Accuracy of the components in the split loop (1.01%), and $AF_{LOOPPI:OUT}$ (3.00%) is greater than ($AL_{LOOPPI:OUT}$ + [(2/3 $MTE_{LOOP:OUT})^2$ + $(SB_{LOOPBA:OUT})^2]^{½}$ (2.56%), Therefore Category B Equation #1 will be used.

$CE_{LOOP:OUT}$ $= \pm[(E_{LOOP:OUT})^2 + (AL_{LOOP:OUT} + [(2/3\ MTE_{LOOP:OUT})^2 + (SB_{LOOP:OUT})^2]^{½})^2]^{½}$

$CE_{LOOPTPIA:OUT}$ $= \pm[(E_{LOOPPI(197):OUT})^2 + (AL_{LOOPPI:OUT} + [(2/3\ MTE_{LOOP:OUT})^2 + (SB_{PL-BSBA:OUT})^2]^{½})^2]^{½}$
$= \pm [(1.51)^2 + (2.0 + (2/3(.190))^2 + (0.548)^2]^{1/2}$
= $\underline{\pm 2.97\%\text{ span}}$

$CE_{LOOPPIA:OUT}$ (2.98%) is less than $AF_{LOOPPI:OUT}$ (3.00%). Therefore;

$CE_{LOOPPIA:OUT}$ $= + AF_{LOOPPI:OUT}$
= $\underline{+ 3.00\%\text{ span}}$

$CE_{LOOPPIA:TOTAL}$ $= +[(CE_{LOOPPIA:IN})^2 + (CE_{LOOPPIA:OUT})^2]^{1/2} + IE_1\%_{(1.97)} + E_{RES(BIAS)}$
$= +[(4.53)^2 + (3.00)^2]^{1/2} + 0.56 + 0.34$
= + 5.43 + 0.90
= <u>+ 6.33% span for RC-3A-PT3 and RC-3B-PT3 loops</u>
= +6.33%(2500 psig)
**= <u>+ 158.3 psig</u>**

$CE_{LOOPPIA:TOTAL}$ $= -[(CE_{LOOPPIA:IN})^2 + (CE_{LOOPPIA:OUT})^2]^{1/2} - A_{SENSE-LINE} - IE_2\%_{(1.97)}$
$= -[(4.53)^2 + (3.00)^2]^{1/2} - 0.09 - 0.36$
= - 5.43 - 0.45
= <u>- 5.88% span for RC-3A-PT3 and RC-3B-PT3 loops</u>
= -5.88%(2500 psig)
**= <u>- 147.0 psig</u>**

**f. NNI Alarm and Interlock Contacts**

| DOCUMENT IDENTIFICATION NO. | REVISION |
|---|---|
| I-89-0014 | 10 |

Instrument loop errors that are associated with the HPI and LPI trip and alarm function are being calculated using the Category "A" (Partial Loop) graded approach. The formula that will be used for the calibrated loop errors is as follows:

$$CE_{LOOP:IN} = \pm [(E_{LOOP:IN})^2 + (AF_{LOOP:IN})^2]^{½}$$

$$CE_{LOOP:OUT} = \pm [(E_{PL-BS})^2 + (AF_{PL-BS})^2 + (E_{BS})^2 + (AF_{BS})^2]^{1/2}$$

$$CE_{LOOP:TOTAL} = \pm [(CE_{LOOP:IN})^2 + (CE_{LOOP:OUT})^2]^{1/2} \pm E_{PROCESS:IN} \pm E_{BIAS:IN} \pm E_{BIAS:OUT}$$

$$\begin{aligned} CE_{LOOPAL:IN} &= \pm [(E_{LOOPPTN:IN})^2 + (AF_{LOOPPT:IN})^2]^{1/2} \\ &= \pm [(0.60)^2 + (0.56)^2]^{1/2} \\ &= \underline{\pm 0.82\% \text{ span}} \\ &= \pm (0.82\%)(2500 \text{ psig}) \\ &= \underline{\mathbf{\pm 20.5 \text{ psig}}} \end{aligned}$$

$$\begin{aligned} CE_{LOOPAL:OUT} &= \pm [(E_{PL-BSALN:OUT})^2 + (AF_{PL-BSALI:OUT})^2 + (E_{BSALN:OUT})^2 + (AF_{BSAL:OUT})^2]^{1/2} \\ &= \pm [(0.42)^2 + (0.72)^2 + (0.25)^2 + (0.26)^2]^{1/2} \\ &= \underline{\pm 0.91\% \text{ span}} \\ &= \pm (0.91\% \text{ span})(2500 \text{ psig}) \\ &= \underline{\mathbf{\pm 22.8 \text{ psig}}} \end{aligned}$$

$$\begin{aligned} CE_{LOOPAL:TOTAL} &= + [(CE_{LOOPAL:IN})^2 + (CE_{LOOPAL:OUT})^2]^{1/2} + E_{RES(BIAS)} \\ &= + ((0.82)^2 + (0.91)^2)^{1/2} + 0.34 \\ &= \underline{+ 1.57\% \text{ span}} \\ &= + (1.57\%)(2500 \text{ psig}) \\ &= \underline{\mathbf{+ 39.3 \text{ psig for RC-3A-PT3 Loop}}} \end{aligned}$$

$$\begin{aligned} CE_{LOOPAL:TOTAL} &= - [(CE_{LOOPAL:IN})^2 + (CE_{LOOPAL:OUT})^2]^{1/2} \\ &= - ((0.82)^2 + (0.91)^2)^{1/2} \\ &= \underline{- 1.23\% \text{ span}} \\ &= - (1.23\%)(2500 \text{ psig}) \\ &= \underline{\mathbf{- 30.8 \text{ psig for RC-3A-PT3 Loop}}} \end{aligned}$$

## 6. LOOP RESPONSE TIME

The time response for both the HPI and LPI actuations are the same since the same modules are involved in each actuation. Using values from DI7 and DI44, the following loop response time ($RT_L$) applies to all three channels of ESAS and for both HPI and LPI:

$$\begin{aligned} RT_L &= RT_{PT} + RT_{BA} + RT_{BT} \\ &= 0.2 \text{ sec} + 1 \text{ sec} + 0.1 \text{ sec} \\ &= \underline{1.3 \text{sec}} \end{aligned}$$

## 7. <u>HPI/LPI Trip/Bypass Instrument Setpoints</u>:

**HPI/LPI Trip**

The setpoints for TRIP Bistable Actuation HPI/LPI ACTUATION using $CE_{LOOPBT:TOTAL}$ (Section 5.a.) are calculated as follows:

The current philosophy on establishing inplant setpoints (SP) is to back off from the analytical limit (ANL) by the amount of the calibrated loop error (CE) which includes the "As-Found" tolerance ($SP_{LPI} = ANL_{LPI} + CE_{LOOPBT:TOTAL}$). Ideally, the Improved Technical Specification setpoint (ITS) is offset from the inplant setpoint by the amount of the "As-Found" tolerance (AF). This approach assures plant maintenance personnel that as long as the "As-Found" value can be achieved, the Improved Technical Specification value will not be exceeded ($SP_{LPI} = ITS_{LPI} + AF_{BTL}$).

Since no analytical limit currently exists for LPI, the Improved Technical Specification value of 500 psig will be used.

Since LPI actuates on a decreasing RCS pressure signal, the actual inplant LPI setpoint is to be set above the Analytical Limit by the amount of the calibrated loop error ($CE_{LOOPBT:TOTAL}$). The value of this error is added to the Analytical Limit to arrive at an inplant LPI setpoint. Therefore, the inplant LPI setpoint is:

$$\begin{aligned} SP_{LPI} &= ANL_{LPI} + CE_{LOOPBT:TOTAL} \\ &= 500 \text{ psig} + 34.3 \text{ psig} \\ &= 534.3 \text{ psig} \\ &= [(534.3 \text{ psig})/(2500 \text{ psig})](10 \text{ Vdc}) \\ &= 2.137 \text{ Vdc} \end{aligned}$$

To maintain the existing setpoint of 560 psig,a margin of 25.7 psig will be added to the calculated setpoint for ease of setting. Therefore:

$$\begin{aligned} SP'_{LPI} &= SP_{LPI} + \text{Margin} \\ &= 534.3 \text{ psig} + 25.7 \text{ psig} \\ &= \underline{\underline{560 \text{ psig}}} \\ &= [(560 \text{ psig})/(2500 \text{ psig})](10 \text{ Vdc}) \\ &= \underline{\underline{2.240 \text{ Vdc}}} \end{aligned}$$

Since HPI actuates on a decreasing RCS pressure signal at an Analytical Limit ($ANL_{HPI}$) of 1625 psig, the actual inplant HPI setpoint ($SP_{HPI}$) is to be set above 1625 psig by the amount of calibrated loop error ($CE_{LOOP:TOTAL}$). The value of this error is added to the Analytical Limit as follows:

$$\begin{aligned} SP_{HPI} &= ANL_{HPI} + CE_{LOOPBT:TOTAL} \\ &= 1625 \text{ psig} + 34.25 \text{ psig} \\ &= 1659.25\text{psig} \\ &= [(1659.25 \text{ psig})/(2500 \text{ psig})](10 \text{ VDC}) \\ &= 6.637 \text{ VDC} \end{aligned}$$

To establish a new HPI setpoint of 1665 psig, a margin of 5.75 psig will be added to the calculated setpoint. Therefore:

$$\begin{aligned} SP'_{HPI} &= SP_{HPI} + \text{Margin} \\ &= 1659.25 \text{ psig} + 5.75 \text{ psig} \\ &= \underline{\underline{1665 \text{ psig}}} \\ &= [(1665 \text{ psig})/(2500 \text{ psig})](10 \text{ Vdc}) \end{aligned}$$

= 6.660 Vdc

**HPI/LPI Bypass & Reset**

| | | | |
|---|---|---|---|
| RC-3-BT4, BT5, & BT6 | "HPI Bypass Permit" | =[(1770 psig)/(2500 psig)](10 Vdc)<br>= 7.080 Vdc | DI45 |
| | "HPI Bypass Reset" | =[(1795 psig)/(2500 psig)](10 Vdc)<br>= 7.180 Vdc | DI45 |
| RC-3-BT10, BT11, & BT12 | "LPI Bypass Permit" | =[(850 psig)/(2500 psig)](10 Vdc)<br>= 3.400 Vdc | DI45 |
| | "LPI Bypass Reset" | =[(875 psig)/(2500 psig)](10 Vdc)<br>= 3.500Vdc Vdc | DI45 |

**8. NNI Alarm and Interlock Setpoints**

The calculated setpoint for the NNI Alarm and Interlock Contacts using $CE_{LOOPAL:TOTAL}$ (Section 5.f.) applies only to those alarms described in DI46 dealing with the CF isolation valves. The setpoint for the alarm to close the CFT valves will be established using the maximum CFT nitrogen pressure of 638.3 psig (DI46). To assure the alarm is activated before 638.3 psig is reached on a decreasing pressure signal, the positive $CE_{LOOPAL:TOTAL}$ value could be added to the ITS value (using the approach used for the other setpoints); however, this approach would result in a higher setpoint for the low alarm than for the high alarm and confuse the operator. To avoid this, high and low setpoints will be established by backing off the values given in the ITS by the "As-Found" value for the loop.

$$
\begin{aligned}
AF_{LOOPAL:TOTAL} &= [(AF_{LOOPPTNA:IN})^2 + (AF_{LOOPALL:OUT})^2]^{1/2} \\
&= [(0.57)^2 + (0.77)^2]^{1/2} \\
&= \underline{0.96\%\ span} \\
&= (0.96\%)(2500) \\
&= \underline{24.0\ psig}
\end{aligned}
$$

The ITS value of 750 psig (DI46) will be used to establish a setpoint for the alarm to open the valves.

$$
\begin{aligned}
SP_{CF(HI)} &= ITS - AF_{LOOPAL:TOTAL} \\
&= 750\ psig - 24.00\ psig \\
&= 726\ psig
\end{aligned}
$$

An additional setback of 23.5 psig will be included to allow the continued use of the existing inplant setpoint of 702.5 psig.

$$
\begin{aligned}
SP'_{CF(HI)} &= SP_{CF(HI)} - \text{Additional Setback} \\
&= 726\ psig - 23.5\ psig \\
&= \underline{702.5\ psig} \\
&= [(702.5\ psig)/(2500\ psig)](10\ Vdc) \\
&= \underline{\mathbf{2.810\ Vdc}}
\end{aligned}
$$

As mentioned above, the 638.3 psig value will be used to establish the low setpoint.

$$
\begin{aligned}
SP_{CF(LO)} &= ITS + AF_{LOOPAL:TOTAL} \\
&= 638.3\ psig + 24\ psig \\
&= 662.3\ psig
\end{aligned}
$$

An additional setback of 27.7 psig will be included to allow the continued use of the existing setpoint of 690 psig.

$SP'_{CF(LO)}$ $= SP_{CF(LO)}$ + Additional Setback
= 662.3 psig + 27.7 psig
= 690 psig
=[(690 psig)/(2500 psig)](10 Vdc)
= **2.760 Vdc**

RC-3A-PS6 = [(1740 psig)/(2500 psig)](10 Vdc) DI46
= **6.960 Vdc**

RC-3A-PY4 = [(1675 psig)/(2500 psig)](10 Vdc) DI46
= **6.700 Vdc**

RC-3A-PS5 = [(750 psig)/(2500 psig)](10 Vdc) DI46
= **3.000 Vdc**

RC-3A-PS7 = [(200 psig)/(2500 psig)](10 Vdc) DI46
= **0.800 Vdc**

## 9. LTOP Setpoint

According to Reference 11, the ITS value for LTOP initiation is 457 psig with an inplant setpoint of 442.6 psig. There is no ITS value for the LTOP alarm. As stated in DI46, the LTOP alarm setpoint will be considered as a nominal value. This is consistent with the Graded Approach established by Revision 2 of Reference 25. The LTOP alarm setpoint is being classified as a Category D under the Graded Approach since it is part of a defense-in-depth strategy complimenting other alarms/indications to allow the operator to terminate a Low Temperature Over Pressurization (LTOP) event. The LTOP actuation of the PORV provides the redundant protective function. The alarm serves to provide an early indication of an impending LTO event and to transfer a recorder to high speed to record the event. Prior to the issuance of I-97-0005 (being superseded by I-97-0015), the previous LTOP alarm setpoint (500 psig) was set 50 psig below the previous LTOP initiation setpoint (550 psig). With the LTOP setpoint initiation change made by I-97-0015, this 50 psig differential was retained. Therefore, the LTOP alarm setpoint was chosen as **392.6 psig**.

LTOP Alarm =[(392.6 psig)/(2500 psig)](10 Vdc)
= 1.570 Vdc

The LTOP ITS value will change from 457 psig to 454 psig and the inplant setpoint will change to from 442.6 psig to 441 psig (Reference 11) after implementation of the 32 EFPY LTOP analysis. Because the alarm setpoint is considered a nominal value per Category D under the Graded Approach methodology of Reference 25, it will remain at 392.6 psig after implementing the new inplant setpoint of 441 psig. The 1.6 psig reduction in margin between the PORV actuation setpoint and the alarm is insignificant when considering operator actions are based on indicators with readability resolution no better than ± 25 psig.

## VII. ATTACHMENTS:

1. Analysis of the Model 1153 Series D Transmitters to 420°F for Three Minutes, Rosemount Report 108220A, Revision A (6 Pages)

2. Excerpt from Ohmite Catalog #101, 1980 (1 page)

3. Rosemount Inc letter to FPC (Dave Owen), dated 10/23/91 (1 page)

4. B&W Nuclear Technologies Letter FPC-95-027, Doc. No. 51-1234893-00, Revision 0 (6 pages)

5. IR Analysis for RC Pressure Loops (3 pages)

6. Deleted

7. Vendor Qualification Package (VQP) TERM-R098-04, TAB14, Thermal Lag Through Raychem WCSF (1 page)

Rosemount

ROSEMOUNT INC., POST OFFICE BOX 35129 / MINNEAPOLIS, MINNESOTA 55435 / TEL. (612) 941-556

TWX: 910-576-3103, TELEX: 29-018

# NUCLEAR OPERATIONS GROUP

ANALYSIS OF THE MODEL 1153 SERIES D TRANSMITTERS

TO 420°F FOR THREE MINUTES

RMT REPORT 108220A

REVISION A

Approved by Eng. Sharon Wildgen Date 10/21/82

SHARON WILDGEN - Nuclear Project Engineer

Approved by Eng. Charles J. Odegaard Date 11/5/82

CHUCK ODEGAARD - Nuclear Operations Manager

Approved by Q.A. Gerald D. Anderson Date 11/5/82

JERRY ANDERSON - Quality Assurance Supervisor

Approved by Q.A. Michael N. Pollack Date 10-25-82

MIKE POLLACK - Quality Project Engineer

ANALYSIS OF THE MODEL 1153 SERIES D TRANSMITTER

TO 420 F FOR THREE MINUTES

RMT REPORT 108220A

REVISION A

1.0 SCOPE

The 1153 Series D transmitter was tested during qualification to the following steam temperature/pressure profile: 350 F, 85 psig for 10 minutes; 320 F, 60 psig for 3 hours; 240 F, 27 psig for 21 hours; 175.4 F, 3 psig for 30 days. There are numerous applications where a LOCA condition will cause high temperature transients in excess of 350 F. For these applications it is necessary to have a transmitter that is qualified to operate above 350 F for short time periods. The intent of this report is to justify raising the temperature limit during a LOCA condition to 420 F for 3 minutes, followed by 350 F for 7 minutes in place of the 1153 Series D steam profile of 350 F for 10 minutes.

2.0 REFERENCES

2.1 420 F Temperature Test Results, Model 1153 Series B, RMT Report 48223C, Rev. None.

2.2 1153 Series D Qualification Test Report (pending).

2.3 Internal Thermal Response of Transmitter Housings to Steam Impingement, Rosemount models 1153 Series B and D, RMT Report 78212, Rev. A.

## 3.0 ANALYSIS

The 1153 Series D transmitter is virtually identical to the 1153 Series B transmitter. The only differences are: 1) the use of an elev. /supp. switch vs. jumper wires, and 2) different electronics housings. The 1153 Series B is intended for BWR applications (and out-of-containment PWR applications) and has an aluminum housing. The 1153 Series D is intended for PWR applications and has a stainless steel housing. Functionally, they are identical, therefore, the 420 F temperature test performed on the 1153 Series B will provide the basis for justifying a 420 F temperature spike for the 1153 Series D.

A test was setup to expose seven 1153 Series B transmitters to superheated steam at 420 F for 3 minutes. The transmitters had previously been exposed to 24.4 megarads gamma radiation and two steam temperature/pressure tests typical of a BWR. Radiation shielding for stainless steel is about twice the value for aluminum, therefore 24.4 megarads on an aluminum housing is approximately equivalent to 50 megarads on a stainless steel housing.

During the test, thermocouple readings inside the steam chamber indicated the transmitters were exposed to temperatures in excess of 435 F for more than four minutes. The temperature transient from room temperature to 420 F took approximately 1 minute to achieve. During the test, chamber pressure was in excess of 115 psig for more than two minutes. Throughout the test all seven units continued functioning and the maximum errors were within the present LOCA specification of $\pm$ 8.0% of upper range limit.

Since the electronics housings are different, the temperature effect on the electronics must be determined separately. During the 1153 Series B test, the maximum average electronics board temperature was 326 F. (Ref. 2.1). Since the electronics in the two models are identical, test results will be identical if the 1153 Series D electronics board does not exceed 326 F.

The time constant for the stainless steel housing used on the 1153 Series D is approximately 4.8 minutes. (Ref. 2.3). Using this value, the electronics board temperature can be determined as follows:

$$(T1 - T0) = (T2 - T0)\ (1 - \exp(-t/TC))$$

Where:

T0 = Temperature of the electronics board at time = 0 (= 70 F)
T1 = Temperature of the electronics board at time = t
T2 = Temperature of the chamber at time = t (= 420 F)
t = time (= 3 minutes)
TC = time constant (= 4.8 minutes)

$$T1 - 70\ F = (420F - 70\ F)\ (1 - \exp(-3/4.8))$$

$$T1 = 233\ F$$

The temperature of the electronics board will be approximately 233 F after the transmitter has been exposed to superheated steam at 420 F for 3 minutes. After the chamber temperature is lowered to 350 F, the electronics board temperature will continue to heat as follows:

$$T1 - T0 = (T2 - T0)\ (1 - \exp(-t/TC))$$

Where:

T0 = Temperature of the electronics board at time = 0 (= 233 F)

T1 = Temperature of the electronics board at time = t

T2 = Temperature of the chamber at time = t (= 350 F)

t = time (= 7 minutes)

TC = time constant (= 4.8 minutes)

$$T1 - 233\ F = (350\ F - 233\ F)\ (1 - \exp(-7/4.8))$$

$$T1 = 323\ F$$

The temperature of the electronics board will be about 323 F after the temperature profile of 420 F for 3 minutes, followed by 350 F for 7 minutes. This is approximately the temperature achieved during the 1153 Series B test.

## 4.0 CONCLUSION

There are situations where an 1153 Series D transmitter could see a 420 F temperature for 3 minutes during a LOCA condition. Although the 1153 Series D has never been tested to 420 F, the 1153 Series B transmitter was exposed to temperatures in excess of 420 F for at least 3 minutes During the 1153 Series B test, the maximum errors were withi the existing ± 8.0% of upper range limit LOCA specificatio and the maximum temperature of the electronics was 326 F The calculated maximum temperature is 323 F for the 115: Series D electronics exposed to 420 F for 3 minutes, followe by 350 F for 7 minutes. The electronics and function of the two models are identical, therefore by similarity, the 1153 Series D would continue to function within specification if exposure to 420 F for 3 minutes was included in the accident profile.

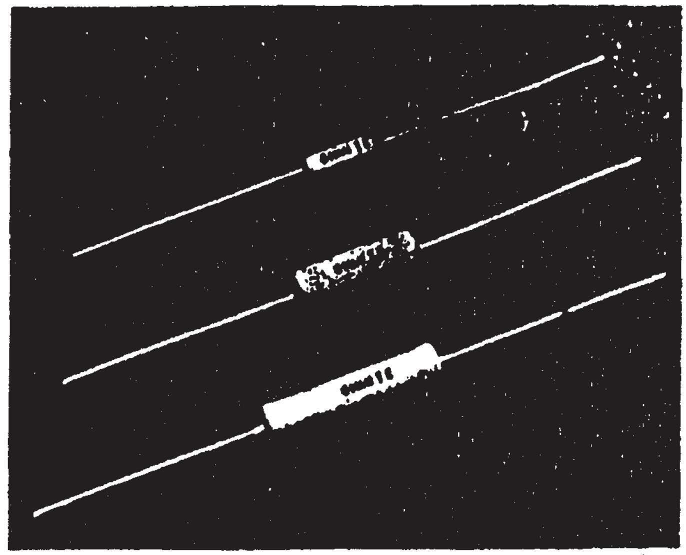
# Series 55 ACRASIL®

## Conformal Silicone Axial Lead Wirewound Resistors

### Features

- Low Temperature Coefficient
- High Dielectric Strength
- MIL-R-26 Approved Units Available
- All Welded Construction
- Ideal for Machine Insertion
- High Reliability

I-89-0014, Rev. 9, ICA, Rev. 00
Attachment 2
Page 1 of 1



### Specifications

Tolerance ±1% std. ±.05% to ±10% available.

Temperature Coefficient
±20ppm/°C 10 ohms and above.
±50ppm/°C 1 to 9.99 ohms.
±90ppm/°C less than 1 ohm.

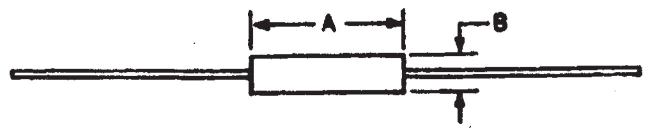
Dielectric Withstanding Voltage 1000 VAC. (500 VAC for 1 watt size.)

Overload 10X rated wattage for 5 seconds for 5 watt size and larger. 5X rated wattage for under 5 watt size.

Inductance Standard units have single layer inductive winding. Non-inductive (Aryton Perry or limited inductance) windings available.

Core Steatite ceramic

Coating Conformal silicone

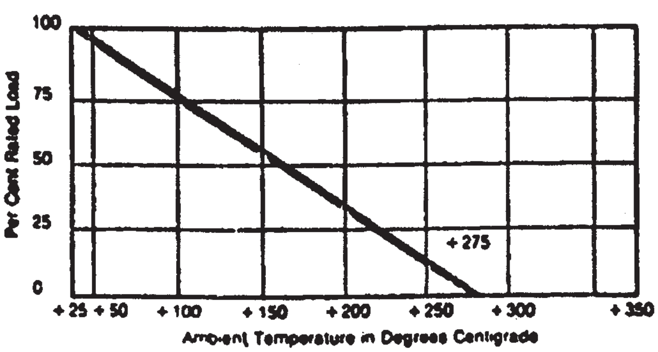



| Watts | Type | Resistance Range Ω Min.-Max. | Body Dimensions Max. Lgth. "A" In. | MM | Max. Dia. "B" In. | MM | Leads 1.5 in. (38.1mm) Ga. |
|---|---|---|---|---|---|---|---|
| 1.25 | 551P | .5—6.7K | .437 | 8.4 | .125 | 3.2 | 24 |
| 2 | 552 | .1—6.7K | .406 | 10.3 | .219 | 5.6 | 20 |
| 3 | 553 | .1—22.1K | .563 | 14.3 | .250 | 6.4 | 20 |
| 5 | 555 | 1.0—75K | .937 | 23.8 | .343 | 8.7 | 18 |
| 7 | 557 | 1.0—119K | 1.280 | 32.5 | .343 | 8.7 | 18 |
| 10 | 550 | 1.0—223K | 1.843 | 46.8 | .406 | 10.3 | 18 |

*ACRASIL is a registered trade mark of Ohmite Mfg. Co.

### Deratings

Wattage ratings are based on 25°C Free Air Rating. For higher ambient temperatures, use derating chart.




### Ordering Data

To specify resistors see below. Available only as "made to order" items.

Typical No. 55-1-S-R5000-J

**OHMITE SERIES NO.** Identifies basic resistor construction.

**WATTAGE**
1P = 1.25W
2 = 2W
3 = 3W
5 = 5W
7 = 7W
0 = 10W

**MISCELLANEOUS SPECIFICATIONS**
S = Standard winding.
N = Non-inductive winding.

**RESISTANCE VALUE**
R = Decimal Pt.
K = Decimal Pt. and X1000
Examples:
R5000 = .5 ohm
1R000 = 1 ohm
250R0 = 250 ohms
1K000 = 1000 ohms
25K00 = 25,000 ohms
25K50 = 25,500 ohms

**TOLERANCE**
A = ±.05%
B = ±.1%
W = ±.125%
C = ±.25%
D = ±.5%
F = ±1%
G = ±2%
H = ±3%
J = ±5% std.
Not available for non-inductive type.

FROM OHMITE CATALOG 101
DATED 1980

**ROSEMOUNT** Measurement
Control
Analytical
Valves

Rosemount Inc.
12001 Technology Drive
Eden Prairie, MN 55344 U.S.A
Tel (612) 941-5560
Telex 4310012
Fax (612) 828-3088

October 23, 1991

Florida Power Corporation
P.O. Box 14042
St. Petersburg, FL 33733

Att: David Owen, M/C C2I

Dear Mr. Owen:

Enclosed please find a copy of Report 78212 as requested. This report will apply to the Model 1154 and 1154 Series H transmitters as well.

If you have any further questions please feel free to call me at (612) 828-3100.

Sincerely,

Neil P. Lien
Marketing Engineer
Rosemount Nuclear Products

enc: Report 78212

**B&W NUCLEAR TECHNOLOGIES**

3315 Old Forest Road
P.O. Box 10935
Lynchburg, VA 24506-0935
Telephone: 804-832-3000
Telecopy: 804-832-3663

February 10, 1995
FPC-95-027

Mr. W.W. Nisula, C2I
Manager, Nuclear Engineer
Projects
Florida Power Corporation
3201 34th Street South
Post Office Box 14042
St. Petersburg, FL 33733

Attention: Mr. S.K. Balliet

Subject: Crystal River Unit 3
FPC Contract NPM010AD, WA #1, Small Account Request #24
Task 616 - Reactor Coolant Pressure ESAS Actuation Setpoints

Gentlemen:

Attached is BWNT Document 51-1234893-00 which is the deliverable for the subject contract.

Should you have any questions or comments, please call me.

Very truly yours,

for RLB

R.L. Black
Customer Service Manager
Plant Engineering Projects

RLB/skg
Attachment

c: P.E. Couvillon
R.J. Finnin
G.W. Christman
B.J. Shepherd

BW B&W NUCLEAR TECHNOLOGIES

# ENGINEERING INFORMATION RECORD

Document Identifier 51-1234893-00

Title Low & Low-Low Pressure ESAS Setpoints

| PREPARED BY: | REVIEWED BY: |
|---|---|
| Name J.C. Seals | Name R.H. Ellison |
| Signature [signature] Date 2/3/95 | Signature [signature] Date 2/3/95 |

Technical Manager Statement: Initials [initials]
Reviewer is Independent.

Remarks:

The NRC is asking the Florida Power Corporation (FPC) questions relating to the low and low-low reactor coolant system (RCS) pressure setpoints of the engineered safeguards actuation system (ESAS). In particular, the current technical specification setpoint may be violated when the setting tolerance is added to the calculated instrument uncertainty and drift. FPC has asked BWNT to clarify the bases that should be applied to the uncertainty calculation. In response, the following discussion is presented herein.

**Background**

The NRC is asking the Florida Power Corporation (FPC) questions relating to the low and low-low reactor coolant system (RCS) pressure setpoints of the engineered safeguards actuation system (ESAS). In particular, the current technical specification setpoint may be violated when the setting tolerance is added to the calculated instrument uncertainty and drift. FPC has asked BWNT to clarify the bases that should be applied to the uncertainty calculation. In response, the following discussion is presented:

The ESAS monitors the reactor coolant (RC) and reactor building (RB) pressures and will initiate emergency core coolant system (ECCS) injection on indications of an accident. The design basis accident that determines the low and low-low pressure setpoints is the small break loss-of-coolant accident (LOCA). For the Crystal River-3 plant, the in-plant low pressure setpoint is 1540 psig and the in-plant low-low pressure setpoint is 540 psig. The allowed plant technical specifications values are 1500 and 500 psig, respectively for the low and low-low pressure setpoints (Ref.1). The primary function of the ESAS low pressure setpoint is to initiate the high pressure injection (HPI) pumps, isolate the RB, and isolate normal makeup and letdown flows. The primary function of the low-low pressure setpoint is to initiate the low pressure injection (LPI) or decay heat pumps. Once actuated, these setpoints perform no other safety functions. Therefore, any environmental conditions used in determining the setpoint uncertainty should only be based on the period of operability, or the time from the beginning of the transient to the time of actuation.

In previous calculations, FPC has determined that the instrument uncertainty for the low pressure ESAS setpoint is $\pm$39.25 psi. The setting tolerance is $\pm$12.5 psi. In the worst case, then, the total instrument error could be $\pm$51.75 psi and could result in an action value (1488.25 psig) that is less than the allowed plant technical specification setpoint (1500 psig). It should be stated that although the plant technical setpoint may be violated following these assumptions, plant safety is not compromised.

In order to justify the current in-plant setpoint, the NRC-approved B&W approach for determining technical specification and in-plant setpoints should be understood. The values modeled in the plant design bases accident analyses were chosen to protect a safety limit (e.g. 110 percent of the design pressure or limits on peak clad temperature). The plant technical specification limit is determined based on the specific instrument string errors corresponding to the limiting environmental conditions for the period of operability for a given setpoint function. The actual in-plant setpoint should be set conservatively to the technical specification value by accounting for instrument drift, repeatability error, and setting tolerance.

In 1982, a preliminary safety concern was written (PSC 25-82). The PSC related to possible delayed ESAS actuation. B&W issued a site instruction (Ref. 2) for determining the plant low pressure ESAS setpoint for the B&W-design plants operating with a rated core power level of 2568 MWt or less. The guidance was based on the small break LOCA design basis accident analysis and determined that the plant setpoint should be 1600 psig or 1480 psig plus the plant specific total instrument uncertainty, whichever is greater. The concern was transmitted to the individual utilities for their evaluation.

The affected utilities generally chose to set the plant setpoints based on 1480 psig plus plant specific instrument uncertainty rather than following the B&W guidance to use 1600 psig. B&W agreed with this position (Ref. 3). This is acceptable so long as actuation of the low pressure ESAS setpoint can be guaranteed to occur at an RCS pressure greater than 1480 psig as measured at the hot leg pressure taps. For the Crystal River-3 plant, the minimum allowed plant setpoint, or action value, should be 1531.75 psig based on the existing calculated instrument error and setting tolerance to ensure that the safety limits is preserved. Since the actual plant setpoint of 1540 psig is greater than the minimum allowed plant setpoint from the design bases accident analyses, plant safety was not compromised.

**Low RCS Pressure ESAS Setpoint**

For the low pressure ESAS setpoint, the limiting design basis accident is a small break LOCA on the order of 0.01 $ft^2$. For the break size, the RCS will depressurize to the analysis actuation setpoint within approximately 115 seconds (Ref. 4). The expected integrated dose at 115 seconds is 250 Rad (Ref. 5). BWNT does not have a specific calculation for RB building pressure and temperature corresponding to a 0.01 $ft^2$ break, but a calculation for a 0.04 $ft^2$ is available. The results for the 0.04 $ft^2$ case would be conservative because of the higher mass and energy release. At 115 seconds for the 0.04 $ft^2$ break, the expected building temperature is 180°F (Ref. 6). The instrument string error for the low RCS pressure ESAS setpoint should be based on these environmental conditions.

**Low-Low RCS Pressure ESAS Setpoint**

The low-low RCS pressure setpoint was based on a review of both small and large break LOCAs. No specific calculations have been performed to support the low-low RCS pressure setpoint. The justification of the setpoint was based on engineering evaluations of the existing design basis accident analyses (Ref. 7). For small break LOCA, the key factors are (1) does the event evolve to RCS conditions that would challenge the low-low setpoint, and (2) if the setpoint is reached, how long will it take the RCS pressure to decrease to below the shut-off head of the LPI (or decay heat) pumps? For large break LOCAs, the key factor is to verify that the initiation of LPI flow to the RCS must occur no later than what was considered in the accident analysis.

For the limiting size small break LOCA of approximately 0.07 ft$^2$, relative to peak clad temperature concerns, immediate actuation of the low-low setpoint is not required. The RCS pressure will decrease to near 600 psia. HPI and the core flood tanks are adequate to maintain a two-phase mixture level above the top of the active fuel region. Larger small break LOCAs will result in a depressurization of the RCS to below the low-low pressure setpoint, but these sizes are not limiting. Due to the steep depressurization rate, flashing of the saturated coolant will cause the mixture to swell and the core will remain covered. For the largest small break LOCA, 0.5 ft$^2$, the 500 psia setpoint will be reached at approximately 125 seconds. The RCS depressurizes to the shut-off head of the pumps by about 200 seconds (Ref. 8). Since the LPI pump start time is on the order of a few seconds (Ref. 8), the small break LOCAs will not be the limiting breaks to be considered when determining the low-low RCS pressure ESAS setpoint.

For large break LOCAs, it must be shown that the LPI injection time credited in the existing calculations is preserved with the low-low RCS pressure ESAS setpoint. The RCS pressure will decrease to 500 psia by approximately 18 seconds and to about 200 psia by 21 seconds into the large break LOCA transient. The RB pressure will be less than 60 psia during this time. This is conservative in that it bounds the maximum calculated RB pressure. The environment will be saturated resulting in a temperature of less than 293°F. From a dose perspective, Reference 5 can still be applied. The title states that the integrated dose is for small break LOCAs, but the method applied to the calculation is independent of the system thermal-hydraulic response. The integrated dose was based on an instantaneous release of 100 percent of the fuel gap and coolant activities. Therefore, the same curve can be applied to determine the integrated dose for the large break LOCA response. At approximately 20 seconds into the event, the integrated dose is 50 rads (Ref. 5). The instrument string error for the low-low RCS pressure ESAS setpoint should be based on these environmental conditions.

**Conclusion**

A review of existing documentation has been performed to determine the dose and environmental conditions that should be applied to the string error calculations for the ESAS low and low-low RCS pressure setpoints. The period of operability for these setpoints was considered in establishing the conditions. For the low pressure setpoint, an integrated dose of 250 Rad and a temperature of 180°F should be considered for a period of operability of 115 seconds. For the low-low pressure setpoint, an integrated dose of 50 Rad and a temperature of 293°F should be considered for a period of operability of 20 seconds. As long as the instrument strings associated with these setpoints can be qualified to these conditions, then no additional dose contribution needs to be considered in the string error calculation.

**References**

1. Crystal River-Unit 3 Plant Technical Specifications, Table 3.3.5-1, Amendment 149.

2. B&W Document 51-1146255-04, Site Instruction for Oconee 1, 2, 3, ANO-1, CR-3.

3. B&W Document 51-1176207-00, HPI Setpoint Description.

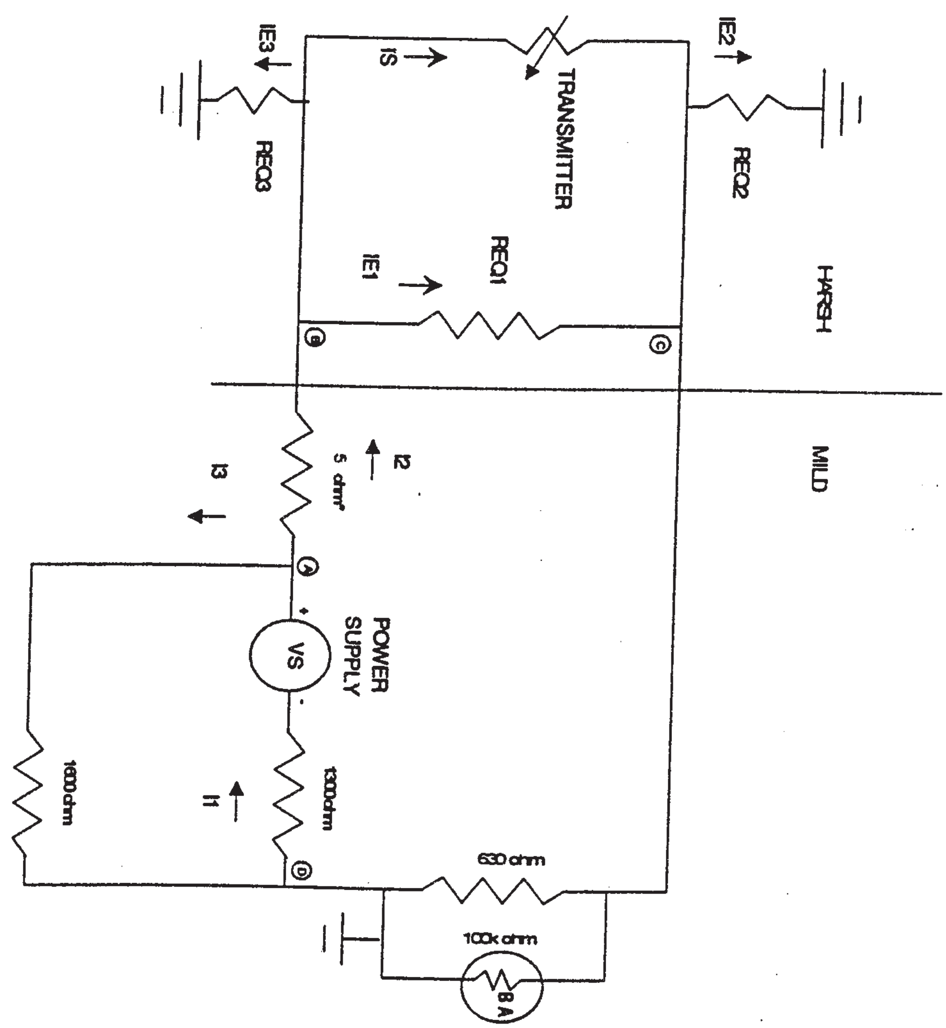
4. Small Break Loss-of-Coolant Accident Analysis for B&W 177FA Lowered Loop Plants in Response to NUREG-0737, Item II.K.3.31, <u>BAW-1976A</u>, Babcock and Wilcox, Lynchburg, Virginia, May 1989.

5. B&W Document 32-1125564-00, Small LOCA Containment Integrated Doses for 177 Plants.

6. B&W Document 86-1103119-01, Containment Response to a Small Break LOCA.

7. B&W Document 51-1172948-00, Reduction in LPI Start Signal.

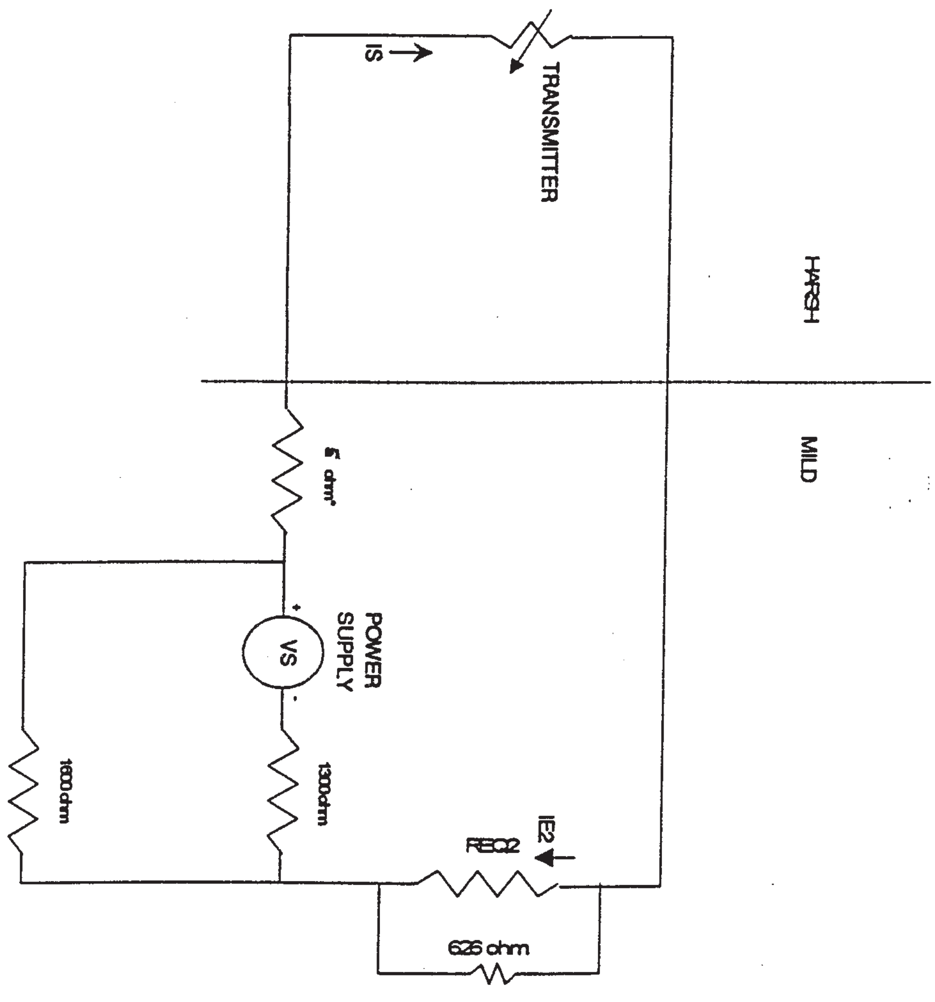
8. ECCS Analysis of B&W's 177-FA Lowered-Loop NSS, <u>BAW-10103A, Rev. 3</u>, Babcock and Wilcox, Lynchburg, Virginia, July 1977.




* 5 ohm resistor not part of RC-3A-PT4 circuit

**IR ANALYSIS FOR RC PRESSURE LOOPS**

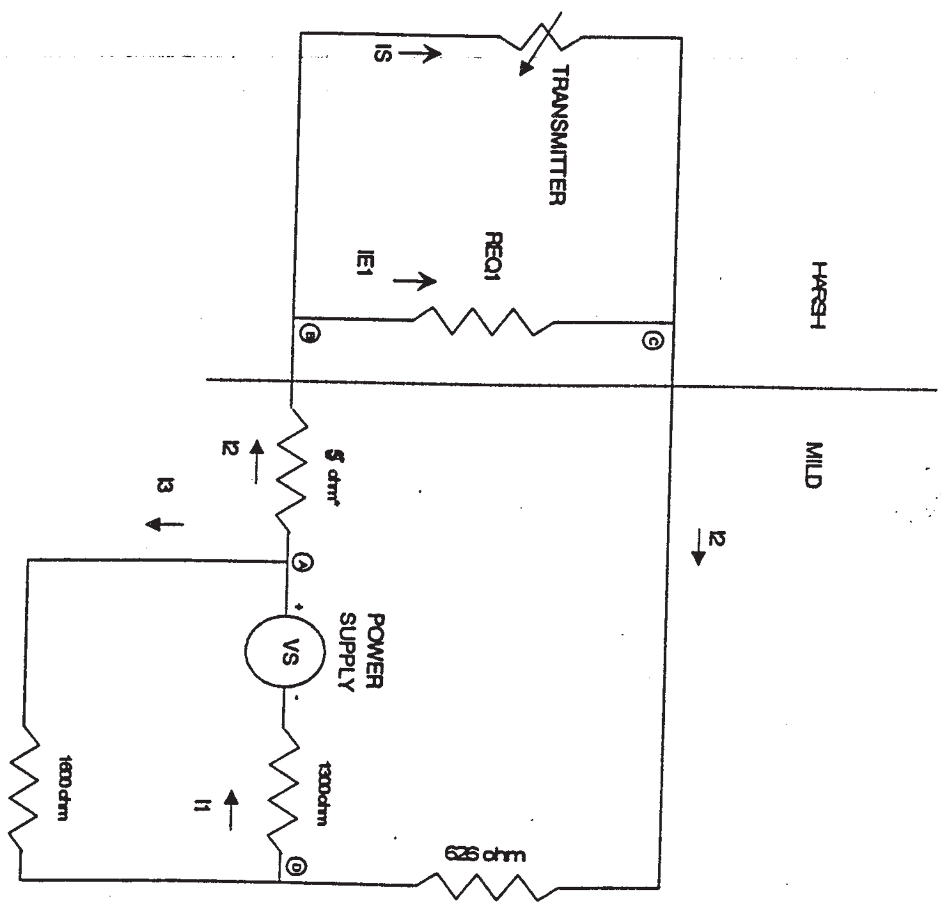
**FIGURE 1**




* 5 ohm resistor not part of RC-3A-PT4 circuit

IR ANALYSIS FOR RC PRESSURE LOOPS

Figure 2




* 5 ohm resistor not part of RC-3A-PT4 circuit

IR ANALYSIS FOR RC PRESSURE LOOPS

FIGURE 3

# RECORD OF MEETING/TELECON

| | | |
|---|---|---|
| Signature [signature] | X Telecon | Doc. No.: 330802-2.4-096 |
| Date: 3/2/90<br>6/8/90 | Meeting(Loc) | Distr.: MDThomas |
| Page 1 of 1 | | |

PROJECT: CR-3 SLB Study | PROJECT NO.: 3308-01

SUBJECT: Thermal Lag Through Raychem WCSF

PARTICIPANTS(NAME/ORGANIZATION): Gary Will/Raychem
Steve Pauly/TENERA

**SUMMARY:**

Raychem has not published data regarding thermal lag through WCSF-N but has performed laboratory tests on a sample consisting of a splice constructed of WCSF-200. It took approximately 12 minutes for the sample to come to equilibrium with a constant 225C environment. The following heat-up points were measured on the inside surface and outside surface of the splice:

| Time(min) | Inside(C) | Outside (C) |
|---|---|---|
| 0 | 50 | 50 |
| 1 | 90 | |
| 2 | 126 | 147 |
| 3 | 156 | 168 |
| 4 | 177 | 184 |
| 5 | 189 | 190 |
| 6 | 199 | 201 |
| 7 | 206 | 209 |
| 8 | 210 | 213 |
| 9 | 215 | 216 |
| 10 | 217 | 217 |
| 11 | 220 | 220 |
| 12 | 223 | 223 |
| 13 | 224 | 224 |

Gary also noted that Raychem products have proven sound during exposure to high temperature (442F) steam in the Wyle 58722 report series.

**ACTION ITEMS:**

Raychem to signify concurrence with above data by signing below:

Concurrence Gary Will Date 6/13/90

TENERA, L.P.