ENFORCEMENT CONFERENCE AGENDA
DUKE POWER COMPANY
9:30 A.M., JULY 1, 1988
NRC/REGION II HEADQUARTERS BUILDING
ATLANTA, GEORGIA
ENVIRONMENTAL QUALIFICATION OF EQUIPMENT

OPENING REMARKS	Hal Tucker
OCONEE	
STATION EQ PROGRAM	Mike Tuckman
DESCRIPTION and ANALYSIS of INSPECTION FINDINGS	Jim Thomas Bob Smith
OVERALL ASSESSMENT OF OCONEE INSPECTION RESULTS	Jim Thomas
CATAWBA	
DESCRIPTION and ANALYSIS of INSPECTION FINDINGS	Jim Thomas Bob Smith
STATION EQ PROGRAM	Tony Owen Ralph Neigenfind
OVERALL ASSESSMENT OF CATAWBA INSPECTION RESULTS	Jim Thomas
CLOSING REMARKS	Hal Tucker

ENFORCEMENT CONFERENCE AGENDA
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OCONEE NUCLEAR STATION
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Inadequate Maintenance Procedures

Operability Evaluation of Problem Investigation Report (PIR) (Unresolved Item)

Reactor Building Level Transmitter's Oil Level Not at Top of Instrument Termination Junction Box

Installed Cable Similarity to Tested Vendor Specimens

High Range Radiation Monitors

OVERALL ASSESSMENT OF OCONEE INSPECTION RESULTS	**Jim Thomas**

88-03-01 : Inadequate Maintenance Procedures

- **Duke concurs with the inspection report that the overall EQ maintenance program is acceptable and that the program is changing and improving.**

- **The inspection noted areas of concern requiring further clarification/ enhancement of maintenance procedures.**

- **None of the identified inadequacies resulted in unqualifiable equipment.**

- **All procedures concerning the inspection findings have been supplemented to provide the required clarifications.**

88-03-01 :

- *It is Duke Power Company's position that this violation falls under Paragraph III of the enclosure to Generic letter 88-07(i.e., not sufficiently significant to be considered for escalation, and should be considered a severity level IV or V).*

88-03-02 : Operability Evaluation Concerning Problem Investigation Report (PIR) 87-0231 (Unresolved Item)

- This item relates to an installation deviation discovered by Duke, evaluated as operable and documented under PIR 87-0231.

- During a review of PIR 87-0231 the inspector noted that the Operability Evaluation did not consider terminal block leakage currents caused by surface moisture film.

- It should be noted the original evaluation did include an analysis considering condensation and its effects.

- Additional information was provided following the inspection demonstrating that leakage currents caused by surface moisture films are not a failure mechanism for the Oconee application.

- The installation was qualified and the file will be updated to clarify that leakage currents are insignificant.

Table 5-2

Typical Leakage Current Data From Salomon
for One Manufacturer I, Model A Terminal Block
Powered at 45 Vdc in an Clean Steam Environment

Measurement No.	Time (min)	Temperature (°C)	Leakage Current (mA)
1	0	22	0
2	1	70	0
3	2	75	0.1×10^{-3}
4	3	77	0.4×10^{-3}
5	4	77.5	1.2×10^{-3}
6	8	80	3.7×10^{-3}
7	10	81	5.6×10^{-3}
8	15	83	8.0×10^{-3}
9	22	85	11.0×10^{-3}
10	25	86	12.4×10^{-3}
11	30	86	15.0×10^{-3}
12	55	86	21.4×10^{-3}
13	60	86	29.0×10^{-3}

Salomon's data, not all of which are presented herein, show several things. First, the data show a great deal of variability in the magnitude of the leakage currents. Variations between 10^{-7} A to 10^{-3} A were noted, with the latter value being rare. Although, the example in Figure 5-10 does not clearly show the effect, when containment spray was present the currents were frequently enhanced and often reached the milliampere region. One was as high as 6 mA. The greatest variety of tests were run on the Manufacturer I, Model A terminal block. Table 5-3 tabulates the leakage currents observed at the end of the test for these blocks. The environment temperature for these observations was between 80°C (176°F) and 90°C (194°F).

Except for the block dipped in saturated NaCl solution and dried, the final leakage currents are the highest values observed during the test. For similar block conditions, these endpoint leakage current values compare reasonably well with data reported for the Phase I quiescent tests by Salomon. The "as-received" condition in the Phase I test had values varying from 0.024 mA at 100 Vac to 0.095 mA at 400 Vac, while the Phase II value was 0.029 mA at 45 Vdc. During the Phase I tests, the terminal block which had been dipped in saturated NaCl solution and dried experienced leakage currents of 9 mA at 10 Vac to 200 mA and breakdown at 400 Vac. For this same block condition, a maximum of only 0.33 mA was observed in the Phase II test. This difference may possibly be attributed to the polarization of the electrolytic solution [61] that occurs in conductive solutions when a dc potential is applied.

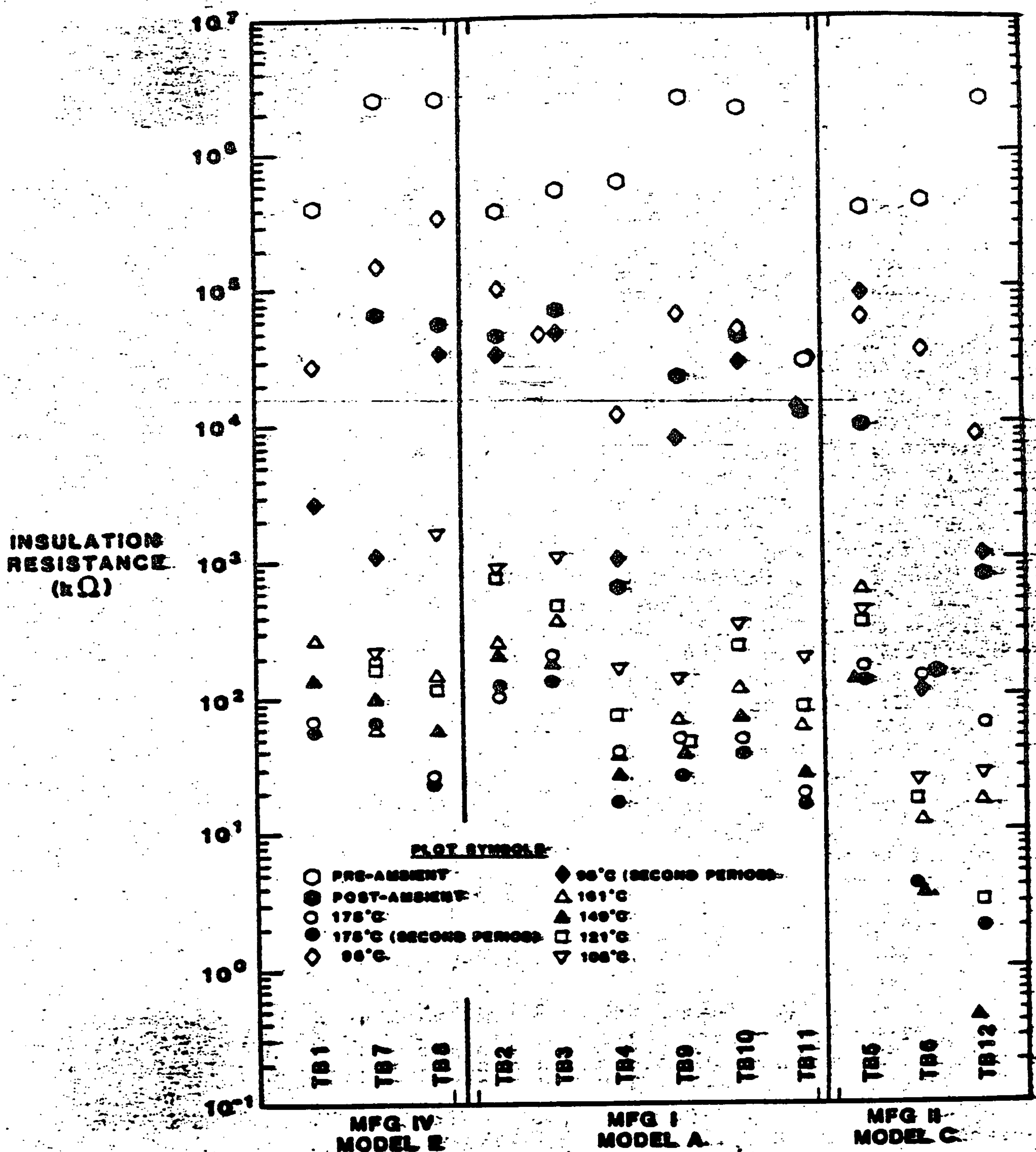


Figure 4-5: Insulation Resistance A for Sandia Phase II Terminal Blocks

Insulation resistance A is the IR calculated for the A path (see Figure 4-2). Terminal Blocks 1-6 powered at 125 Vdc, 1 A and Terminal Blocks 7-12 powered at 45 Vdc, 20 mA.

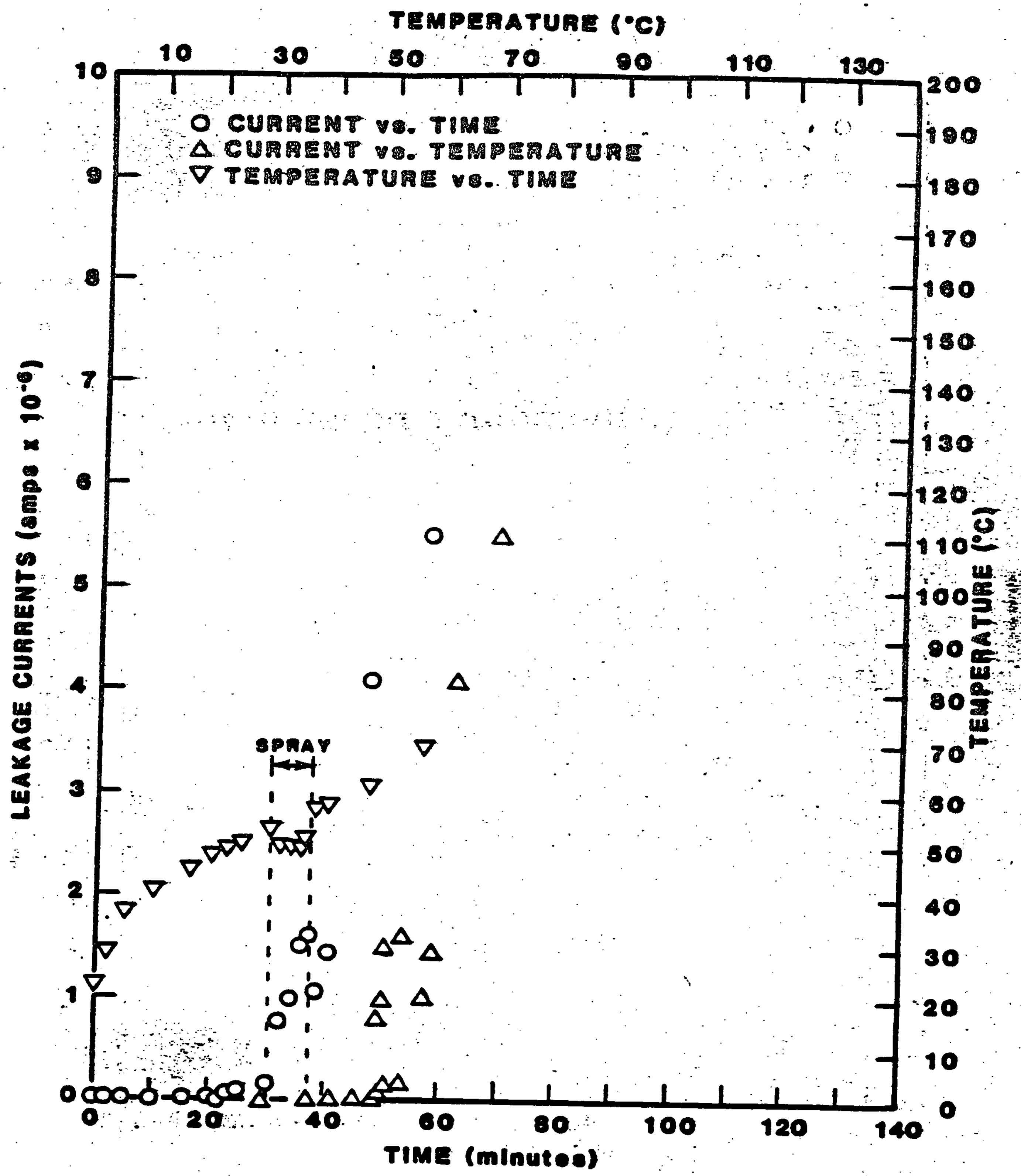


Figure 5-10: Leakage Currents at 45 Vdc as a Function of Time and and Temperature for a Manufacturer I, Model A Terminal Block in the "As-Received" Condition and Subjected to 7 Minutes of Finely Atomized Chemical Spray

Environmental temperature as a function of time is also shown.

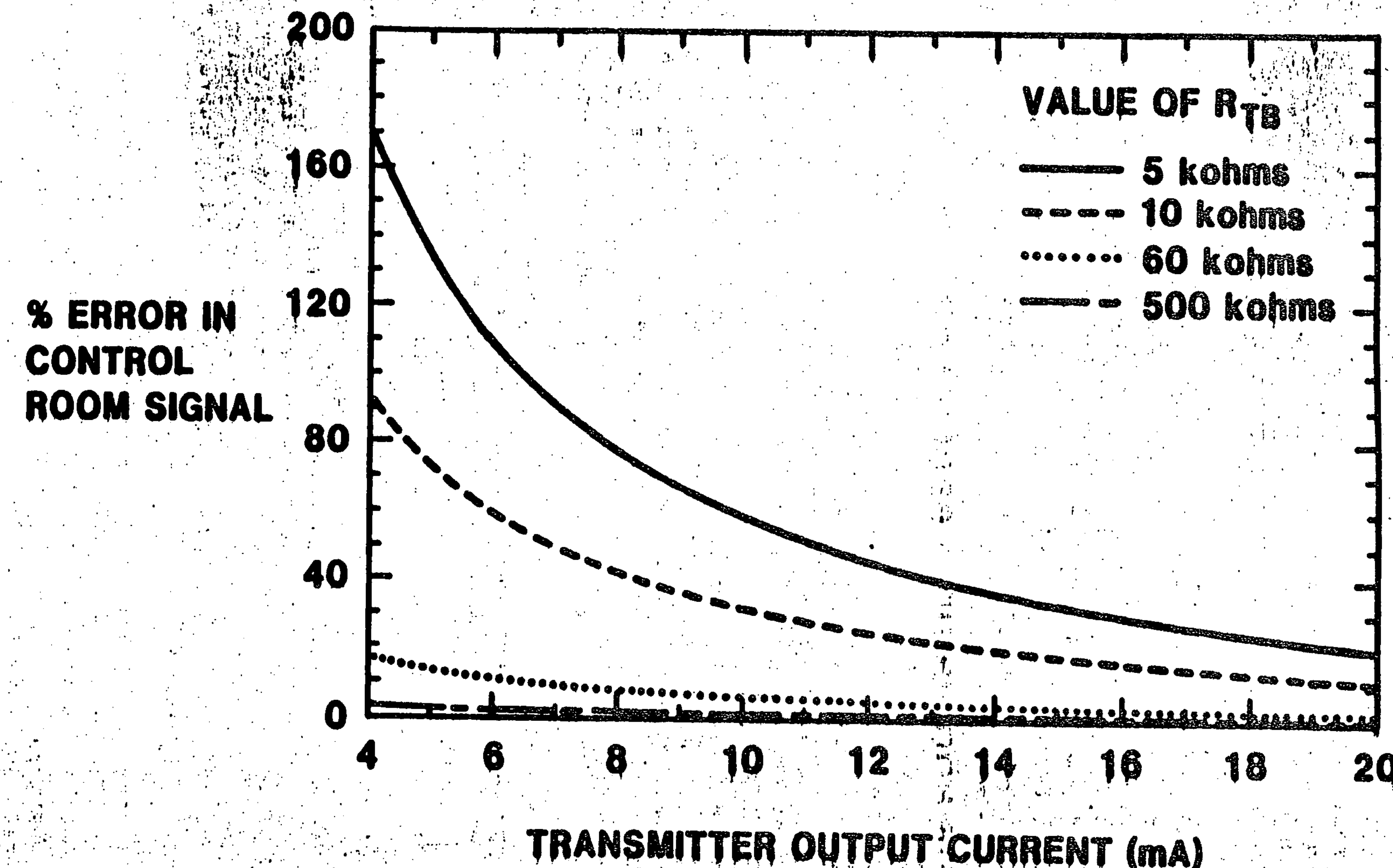


Figure 8-2: Percent Error in a Transmitter Circuit for Selected Values of Terminal Block Insulation Resistance (R_o = 1000 Ω and V_s = 45 Vdc)

88-03-03 : (Also used as example in Violation 88-03-01)

Reactor Building Level Transmitter Oil Level Not to Top of Junction Box

- During the walkdown the inspector noted that the oil level in the Reactor Building level transmitter junction box was not to the top and not in the "as-tested" configuration.

- The oil level had been lowered during a maintenance activity after initial installation and was not fully refilled.

- The junction box is gasketed and the cable entrance is sealed.

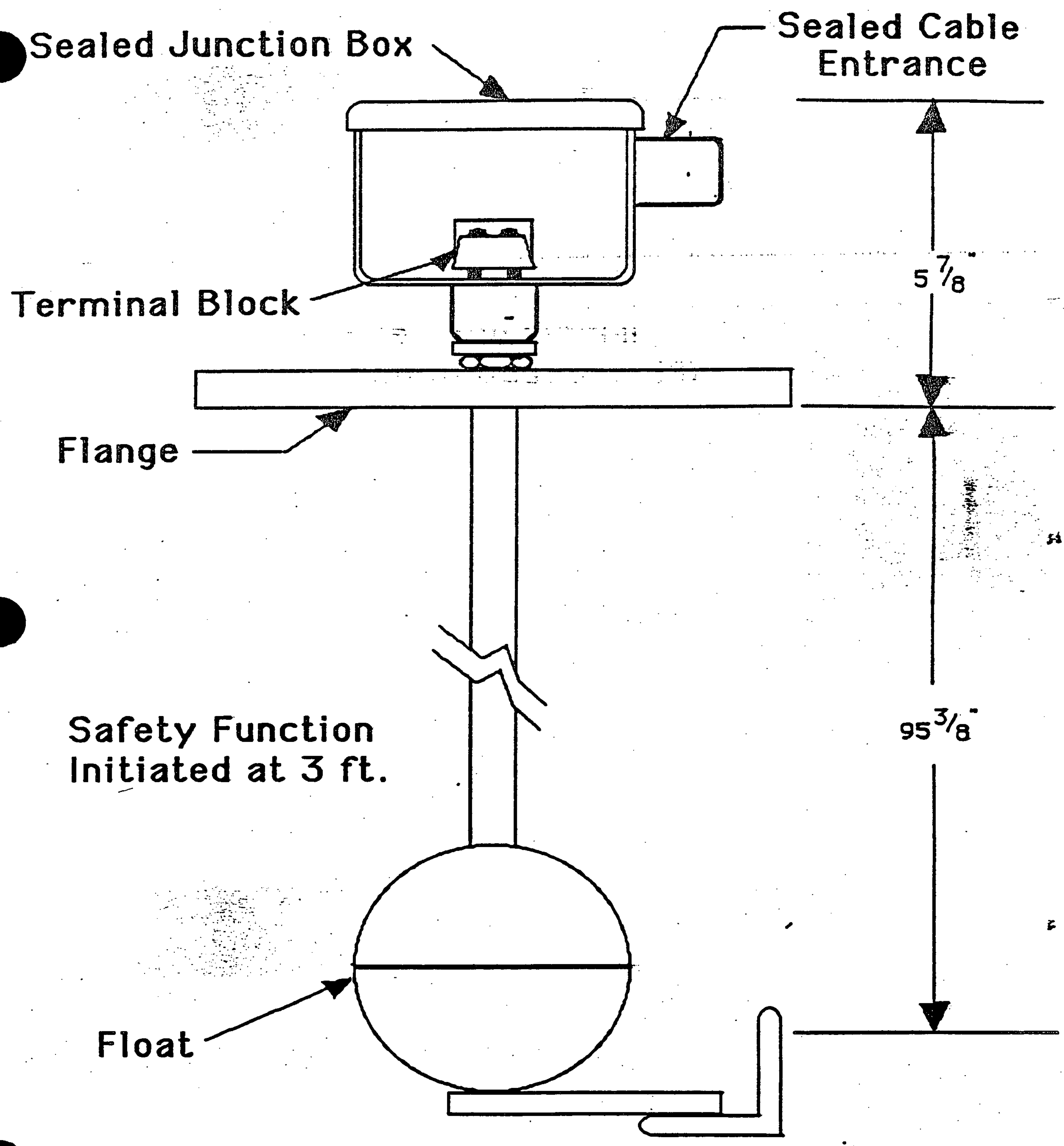
- Duke demonstrated during the inspection the condition was qualifiable for this application.

- Duke evaluation was found acceptable.

- Procedure revised to require verification of proper oil level each refueling outage.

88-03-03 :

- ***It is Duke Power Company's position that this violation falls under Paragraph III of the enclosure to Generic letter 88-07(i.e., not sufficiently significant to be considered for escalation, and should be considered a severity level IV or V).***



REACTOR BUILDING LEVEL TRANSMITTER

88-03-04 : Similarity Analysis for Installed Cable to Tested Vendor Specimens

- Section 13.c(9) of the inspection report states, "None of the cable files reviewed included similarity analysis addressing installed equipment and tested vendor specimens. Additionally, most of the files did not specifically identify or describe plant installed equipment".
- As noted in the inspection report, Duke does take exception to the violation as stated.
- The installed cable insulation and jacket materials are specifically identified on the title page of all cable equipment qualification documentation packages(EQDP).
- All cable EQDP's identify the installed cable configurations via the Duke Power cable mark number.
- This number delineated the cable configuration by identifying the number of conductors or pairs, conductor AWG size, voltage rating, and other construction information.

- Through the cable mark number, along with purchase requisitions provided during the inspection, the cable thickness(voltage rating) can be determined.

- Although the purchase requisitions are not part of the EQDP, the cable mark numbers are referenced in the EQDP and on the appropriate purchase requisition.

- Vendors certify that cable procured on an applicable purchase order is environmentally qualified per the applicable test report. This certification also confirms the installed cable is identical to the tested cable.

- The vendor certification is included in the EQDP for each cable type.

- It should also be noted, as stated in the inspection report, traceability and qualification was demonstrated during the inspection.

88-03-04

- *It is Duke Power Company's position that the cable EQDP's were adequate .*
- *Duke considers the EQDP's to be auditable.*
- *Clarifications have been added to the EQDP's to simplify auditability.*

88-03-05 : **Inadequate Documentation of Installed Configuration for the Victoreen High Range Radiation Monitors**

- Victoreen Configuration
  - Detector with integral male connector
  - Pigtail with female connector (pigtail coax soldered to back of female and potted, covered by braided hose with swagelok)
  - Junction box
  - Field cable with penetration connector
- Duke experienced operational problems with Victoreen connectors and junction box

88-03-05 :

- Duke made decision(August 8, 1983) to replace all connectors and junction box with Duke qualified cable, Duke qualified splices, and Duke qualified potting

- Victoreen reviewed and provided on site assistance during initial installation(August 9, 1983)

- Qualification reports on file during audit for all segments of Duke modification

- Victoreen EQ report had not been addended to reference Duke reports

- Duke drawings reflected the installed Duke design

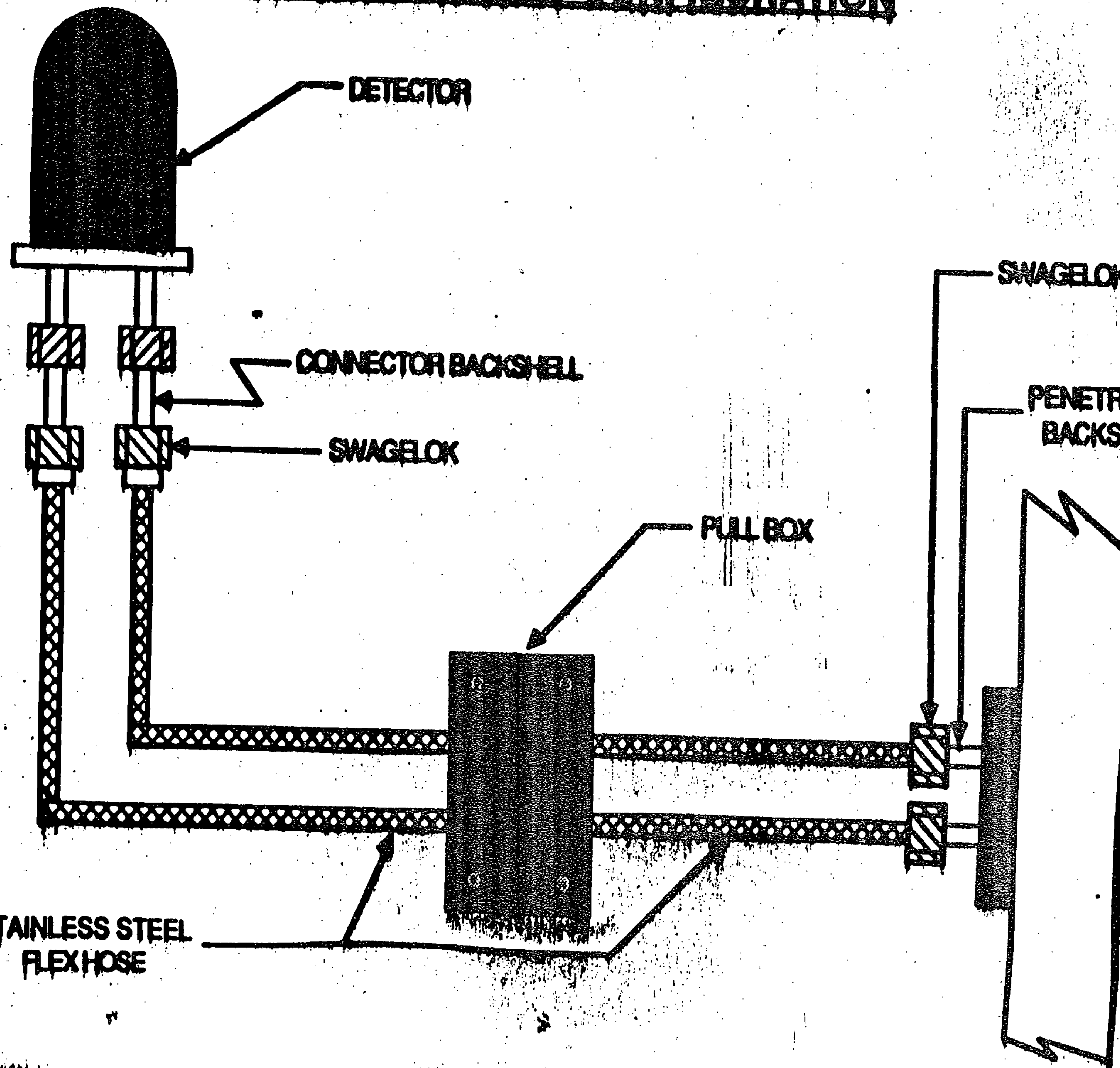
- Duke configuration is fully qualified

- Victoreen EQ files have been supplemented for clarification

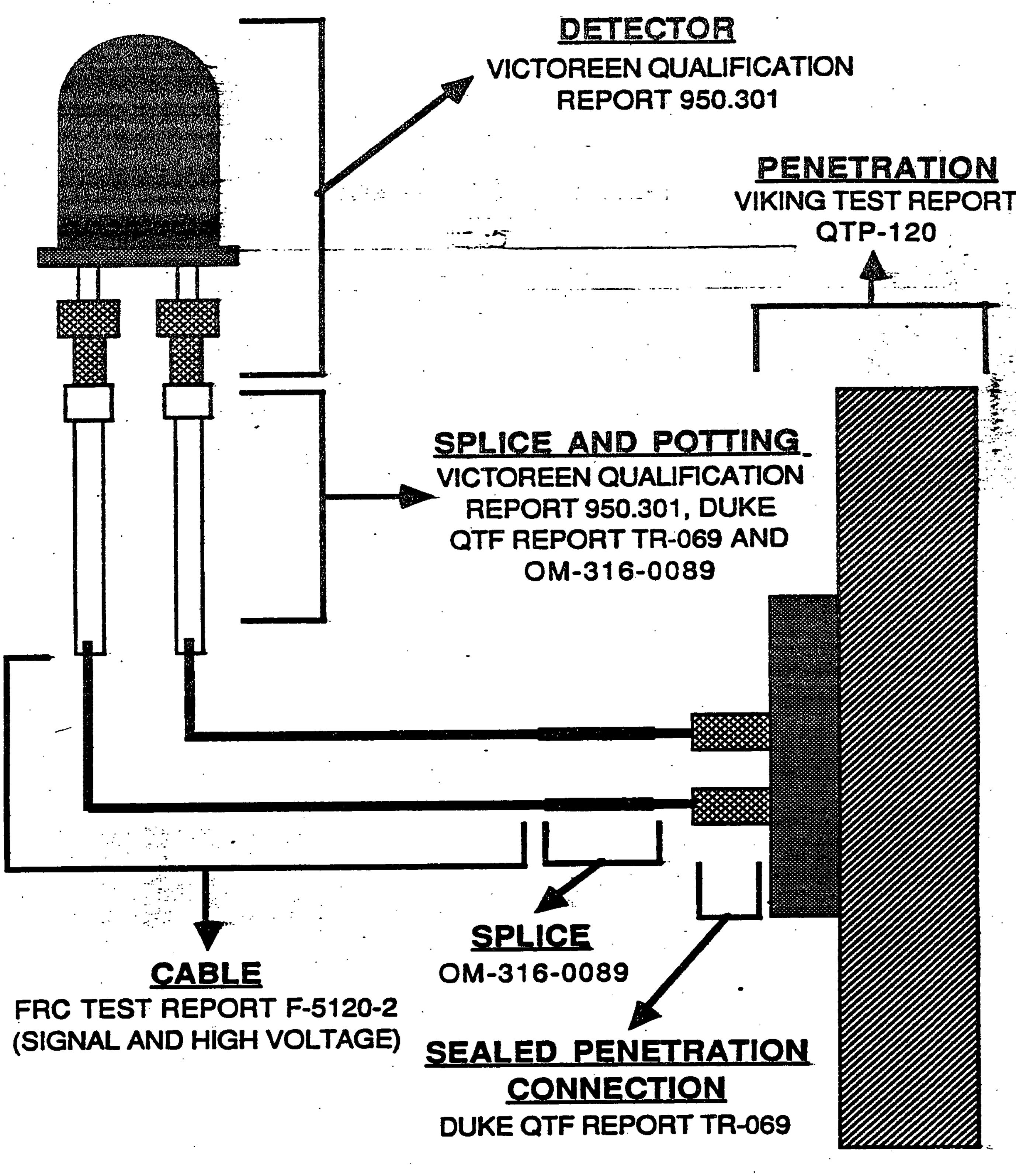
88-03-05

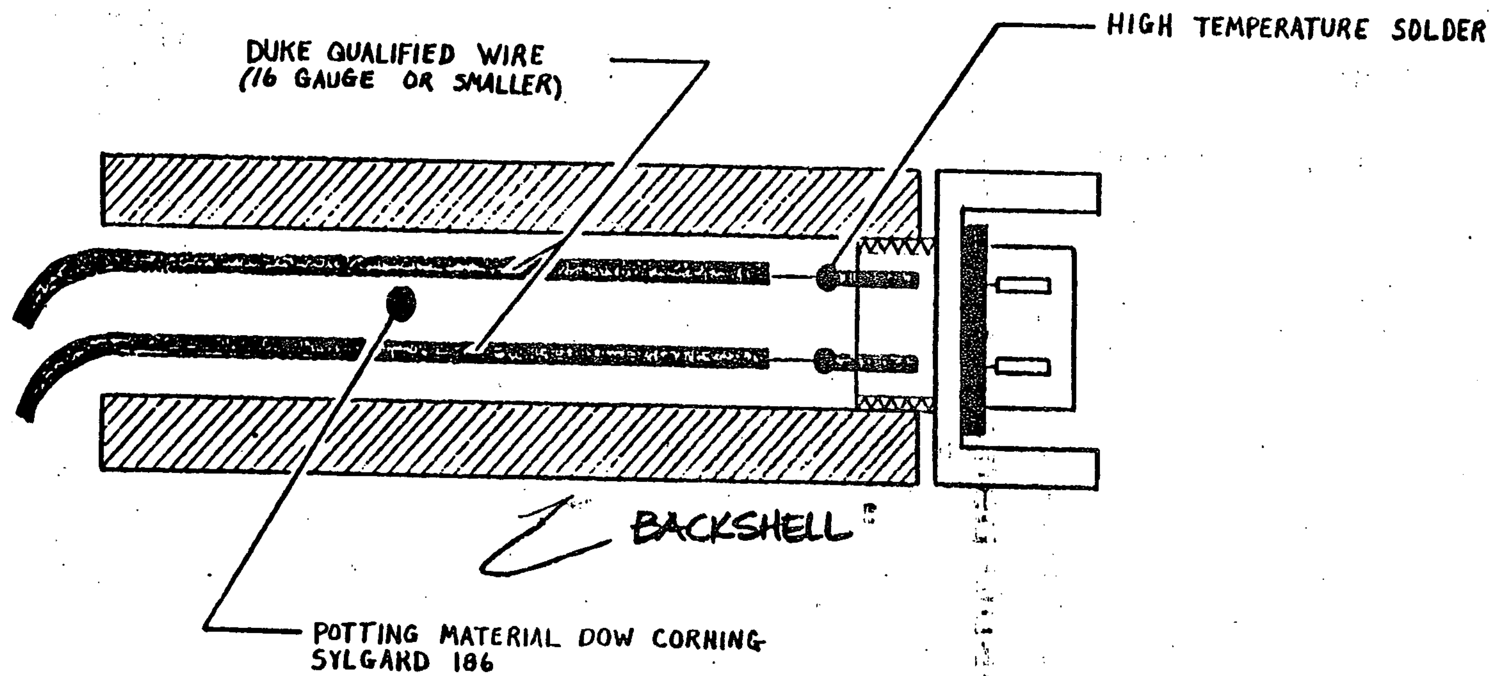
- ***It is Duke Power Company's position that this item is a documentation/auditability violation and falls under Paragraph III of the enclosure to Generic Letter 88-07(i.e., not sufficiently significant to be considered for escalation, and should be considered a severity level IV or V).***

VICTOREEN TEST CONFIGURATION



DUKE INSTALLED CONFIGURATION QUALIFICATION REFERENCES





VICTOREEN CONNECTOR TERMINATION

Figure 6

ENCLOSURE 9.7

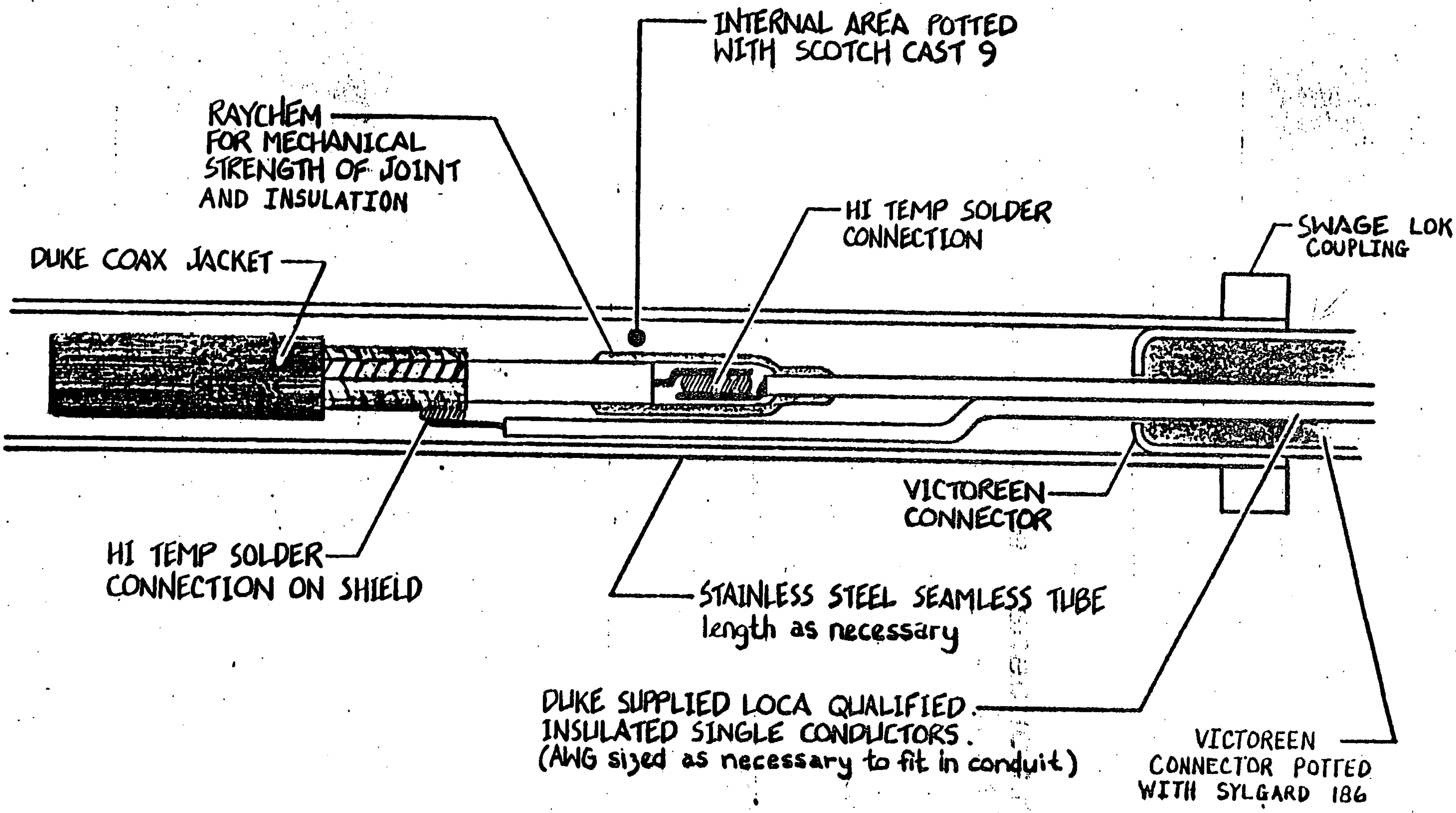


Figure 5

ENCLOSURE 9.6

NSM-1397 Sht 6 of 7

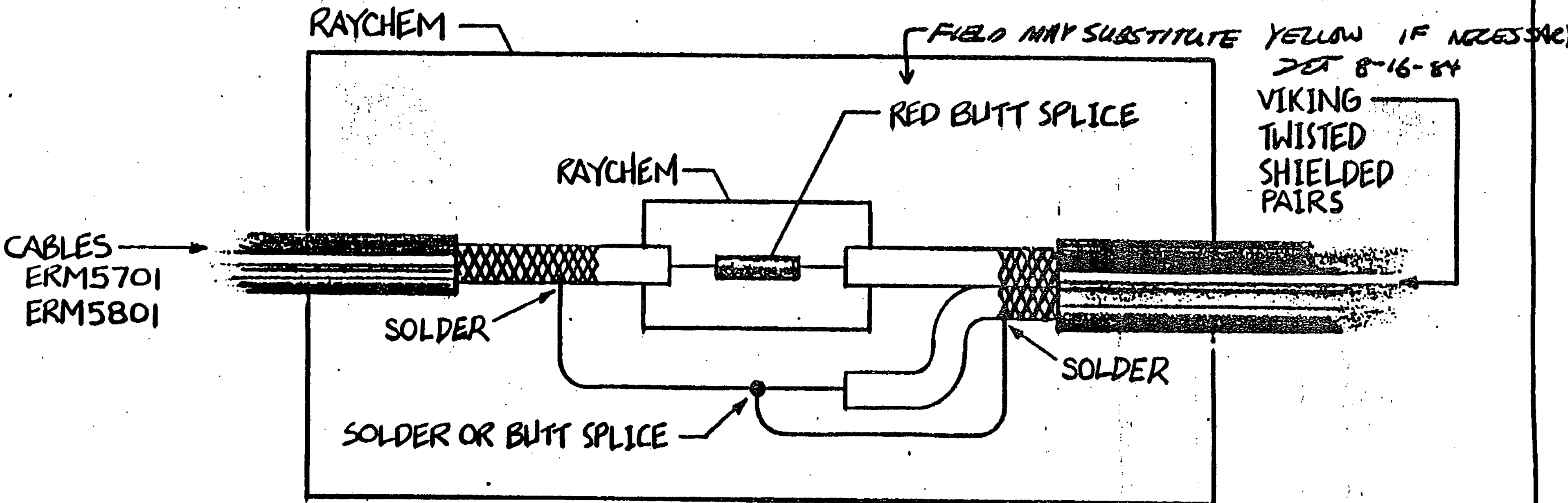


Figure 2

ENCLOSURE 9.3

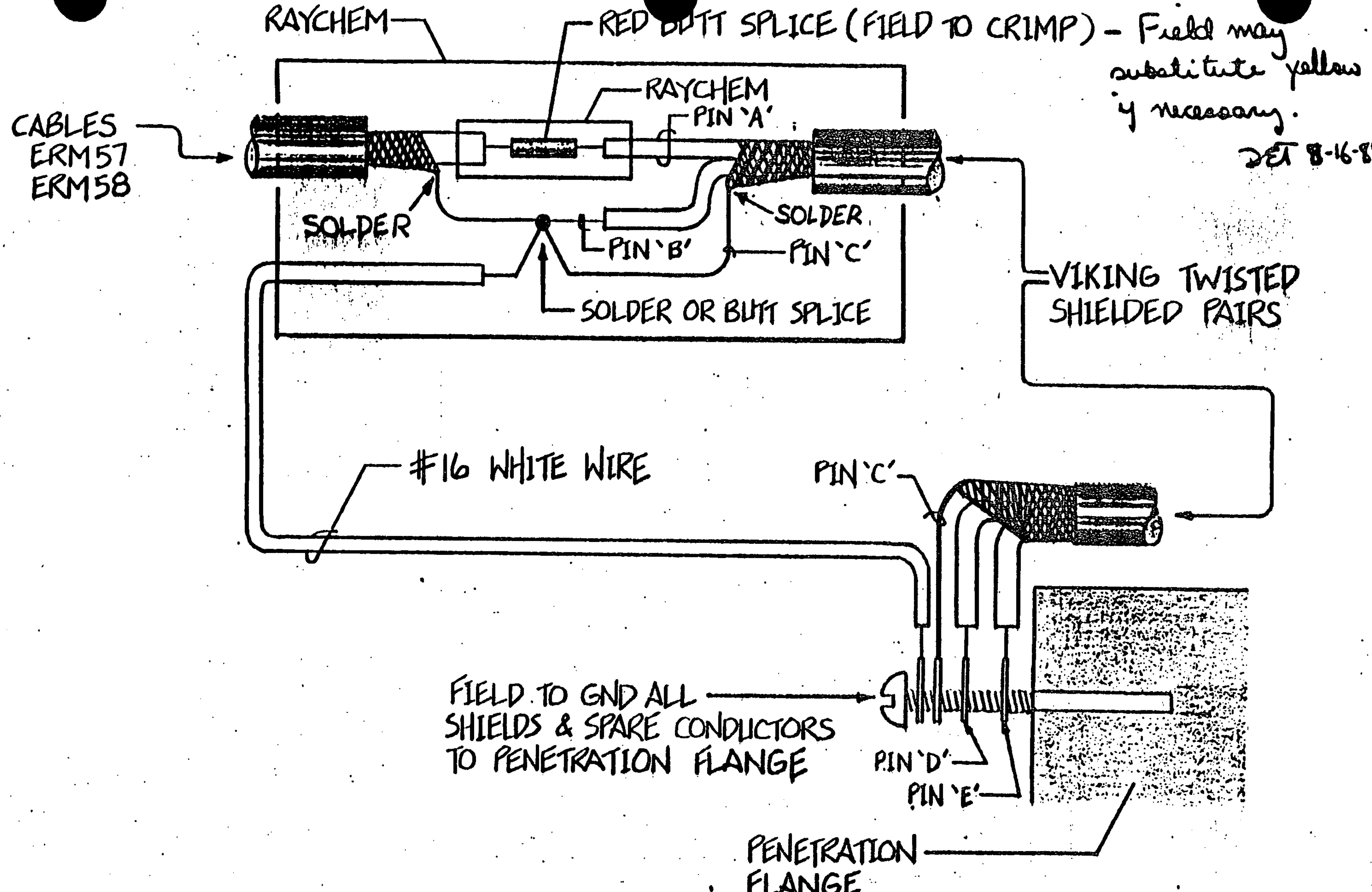


Figure 1

HRCM SIGNAL CABLE SPLICE OUTSIDE CONTAINMENT END

OCONEE INSPECTION OVERVIEW

88-03-01 : Inadequate Maintenance Procedures

- Overall Program Adequate
- Clarifications/Enhancements of Procedures Incorporated

88-03-02 : Operability Evaluation of PIR

- Duke Identified Discrepancy
- Operability Considered Acceptable by Duke
- Supplemental Information Demonstrates Inspection Concerns (leakage currents) Insignificant for Oconee Application

88-03-03 : Reactor Building Level Transmitters Oil Level

- Qualification Demonstrated During Inspection
- Maintenance Procedure Clarified

OVERVIEW (CONTINUED)

88-03-04 : Cable Similarity

- Duke Position that Files are Complete
- Clarifications Provided During Inspection Confirmed Qualification and Auditability

88-03-05 : High Range Radiation Monitors

- Installed Configuration Qualified
- File Supplemented to Clarify Vendor Scope of Qualification

DUKE ASSESSMENT OF INSPECTION FINDINGS

- Duke concurs with the inspection report that Duke has implemented a program to meet the requirements of 10CFR50.49 for the Oconee Nuclear Station.

- Duke concurs with the inspection report that Oconee Nuclear Station has an acceptable EQ maintenance program.

- The maintenance discrepancies identified in the inspection have been reviewed and procedures enhancements incorporated.

- Based on the extent and depth of the inspection, the Duke assessment is that there are no programmatic problems with the EQ program.

  * Limited Number of Findings

  * Lack of Safety Significance of violations identified during the inspection (no equipment modifications required)

ASSESSMENT(CONTINUED)

- *Duke does not consider any of the deficiencies discovered during the inspection sufficiently significant to be considered for escalated enforcement, individually or collectively.*

  * *No Programmatic Problems*

  * *Limited Findings Affecting Limited Systems*

  * *No Equipment Modifications Required (All equipment qualified or qualifiable)*

88-07-02 : RCS Wide Range RTDs not Installed in accordance with Tested Configuration.

- Licensee identified violation, reported by LER, and corrected prior to inspection.
- During an inspection of Raychem splices by Design Engineering, the NEMA 4 junction box for the RTD/cable splice was questioned in regard to meeting the vendor requirement for a "sealed" box.
- The condition was evaluated by Design Engineering to be operable, but a modification was made to pot the entire junction box to minimize moisture induced leakage current effects on instrument accuracy.
- In the process of finalizing the modification, an installation error was detected.

- An unqualified condition had resulted from misinterpretation of notes on drawings during initial installation.

- Duke standard practice is to add flex conduit for additional mechanical protection if vendor supplied cable is not armored.

- RTDs are provided with braid, not armor.

- Craft had inadvertently removed underlying bellows in attempt to replace braid with flex conduit.

- As noted in the inspection report, the fix is fully qualified and no finding was identified for the EQ package.

- It is Duke Power Company's position that the original installation was unqualified.

- The condition was identified, reported, and corrected by Duke prior to the inspection.

- Duke does not consider this item to meet the criteria (Generic Letter 88-07, Section II) for "clearly knew or clearly should have known"

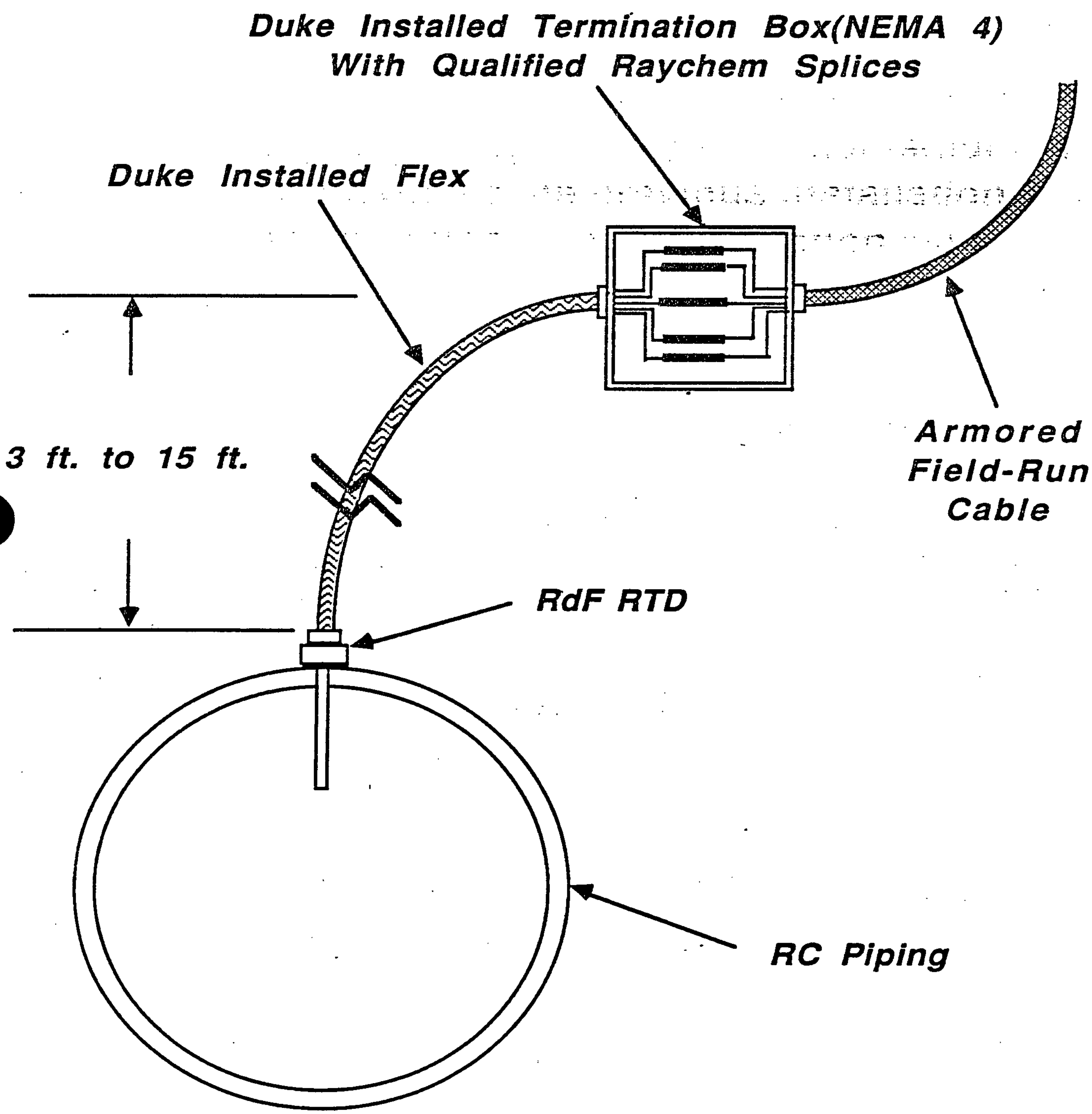
- In that regard, this specific equipment was evaluated during the March 6-8, 1984 NRC EQ audit of Catawba (prior to receipt of Unit 1 fuel load license):

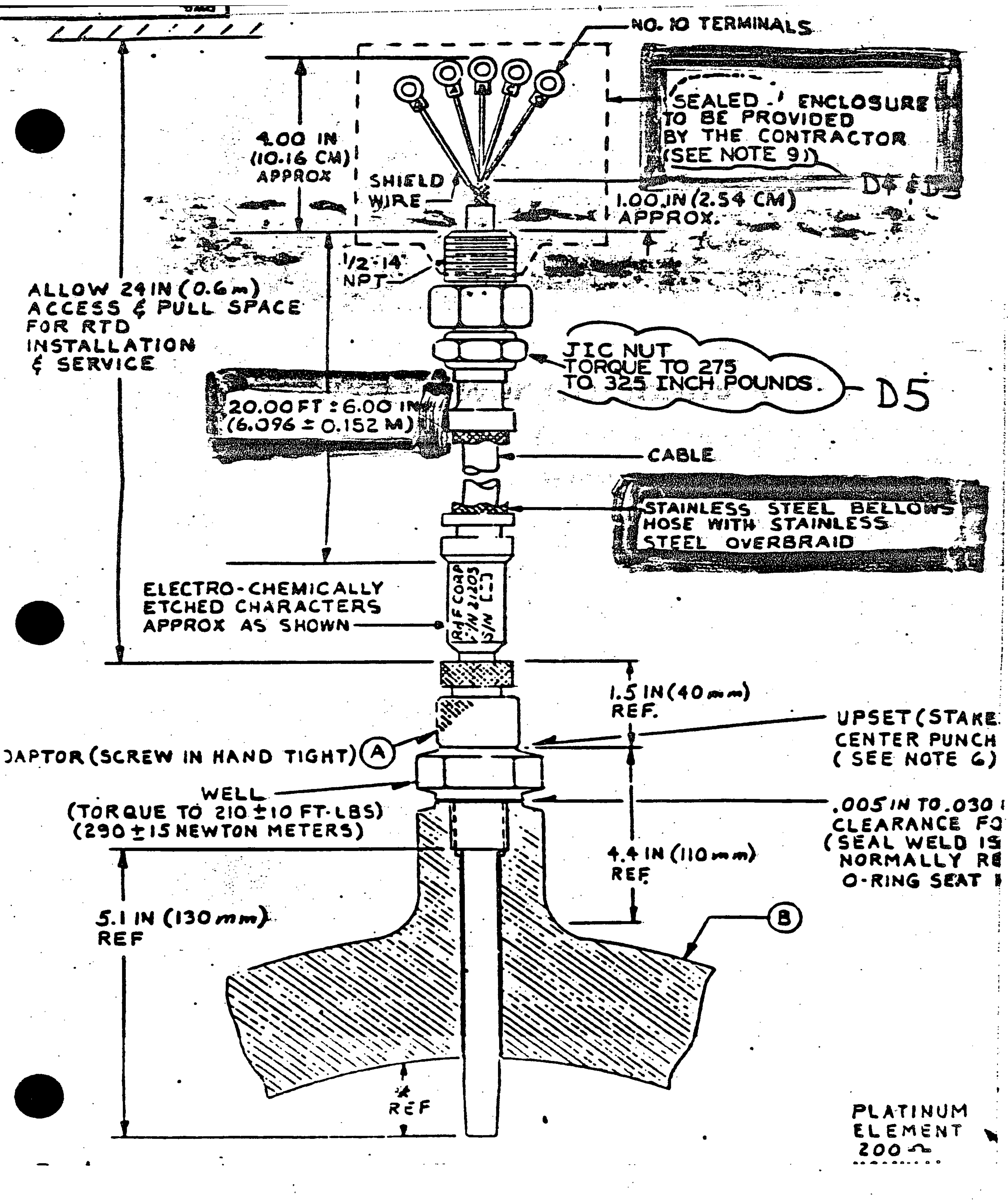
  * The installation deficiency was very difficult to detect, even by experienced walkdown personnel!

  * As documented in the Catawba SER, this equipment was specifically inspected to verify the installation was consistent with the qualification documentation.

  * The installation deficiency was not detected, even though it was a specific objective of the walkdown.

Duke RdF RTD Installed Configuration




NO. 10 TERMINALS
SEALED ENCLOSURE TO BE PROVIDED BY THE CONTRACTOR (SEE NOTE 9)
D4 & D5
4.00 IN (10.16 CM) APPROX
SHIELD WIRE
1.00 IN (2.54 CM) APPROX.
1/2-14 NPT
ALLOW 24 IN (0.6 m) ACCESS & PULL SPACE FOR RTD INSTALLATION & SERVICE
JIC NUT TORQUE TO 275 TO 325 INCH POUNDS.
D5
20.00 FT ± 6.00 IN (6.096 ± 0.152 M)
CABLE
STAINLESS STEEL BELLOWS HOSE WITH STAINLESS STEEL OVERBRAID
ELECTRO-CHEMICALLY ETCHED CHARACTERS APPROX AS SHOWN
1.5 IN (40 mm) REF.
UPSET (STAKE
CENTER PUNCH
(SEE NOTE 6)
DAPTOR (SCREW IN HAND TIGHT) A
WELL (TORQUE TO 210 ± 10 FT-LBS) (290 ± 15 NEWTON METERS)
.005 IN TO .030
CLEARANCE FO
(SEAL WELD IS
NORMALLY RE
O-RING SEAT
4.4 IN (110 mm) REF
5.1 IN (130 mm) REF
B
REF
PLATINUM ELEMENT 200 Ω

1. IN ORDER TO " NTAIN THE SEISMIC QUALIFICATION OF THIS INSTRUMENT, THE A/E IS RESPONSIBLE FOR PROVIDING SEISMIC SUPPORT (NO RESONANCE BELOW 35 HZ) FOR THE RTD CABLE.

D5 — MAX. RELATIVE DISPLACEMENT (SEISMIC) OF FIRST SUPPORT AND RTD REAR HOUSING IS 1 IN. (25 MM) AND SHALL NOT RESULT IN A DIRECT LINEAR PULL ALONG THE AXIS OF THE RTD.

2. THIS INSTRUMENT IS SENSITIVE TO RESISTANCE CHANGES IN THE SIGNAL CIRCUIT, (e.g. SHORTS, SHUNTING RESISTANCES, TERMINAL DEGRADATION). INTERMEDIATE TERMINAL POINTS IN FIELD WIRING BETWEEN RTD AND INSTRUMENT RACKS TO BE KEPT TO ABSOLUTE MINIMUM. TO AVOID CONTAMINATION BY CONDENSATION OR DRIPPAGE, CABLES SHOULD ENTER JUNCTION BOXES FROM SIDES.

3. THE A/E IS RESPONSIBLE FOR PROVIDING WIRING AND ELECTRICAL CONNECTIONS WHICH MEET THE REQUIREMENTS OF IEEE 383 FOR THE SPECIFIC PLANT CONTAINMENT ENVIRONMENT.

4. FIELD WIRING TO BE SHIELDED TWISTED QUAD TO INSTRUMENT RACKS WITH SHIELD CARRIED AS 5TH WIRE (UNGROUNDED) AT ALL TERMINAL POINTS.

5. AT INSTALLATION, RECORD LOCATION TAG NO. , MFR. , P/N, S/N, CONTINUITY, AND INSULATION RESISTANCE. CONTINUITY AND INSULATION SHALL BE CHECKED WITH AN OHM METER ONLY (3.0 VOLTS MAX.).

6. ADAPTOR MUST BE INSTALLED AND STAKED BEFORE RTD IS PUT IN PLACE. IF RE-STAKING IS REQUIRED FOR ANY REASON, RTD MUST BE REMOVED FIRST.

7. CONVERSION TO S.I. UNITS ARE IN ACCORDANCE WITH ASTM E380, INCLUDING RULES FOR ROUNDING. NOTES CONT'D.

D4

8. RTD DWG NO.-21205-SPIN NO. QAELRT-01

DUKE POWER COMPANY
PLANT: CATAWBA NUCLEAR STATION
UNITS: 1 & 2 ITEM-10
STATUS: CERTIFIED FOR CONSTRUCTION
CERTIFICATION LTR. NO. CATAWBA-2862
AUTHORITY: F. J. TWOGOOD
ENGR. LTR. NO. EP/SA-37666

COMPONENT INFORMATION:

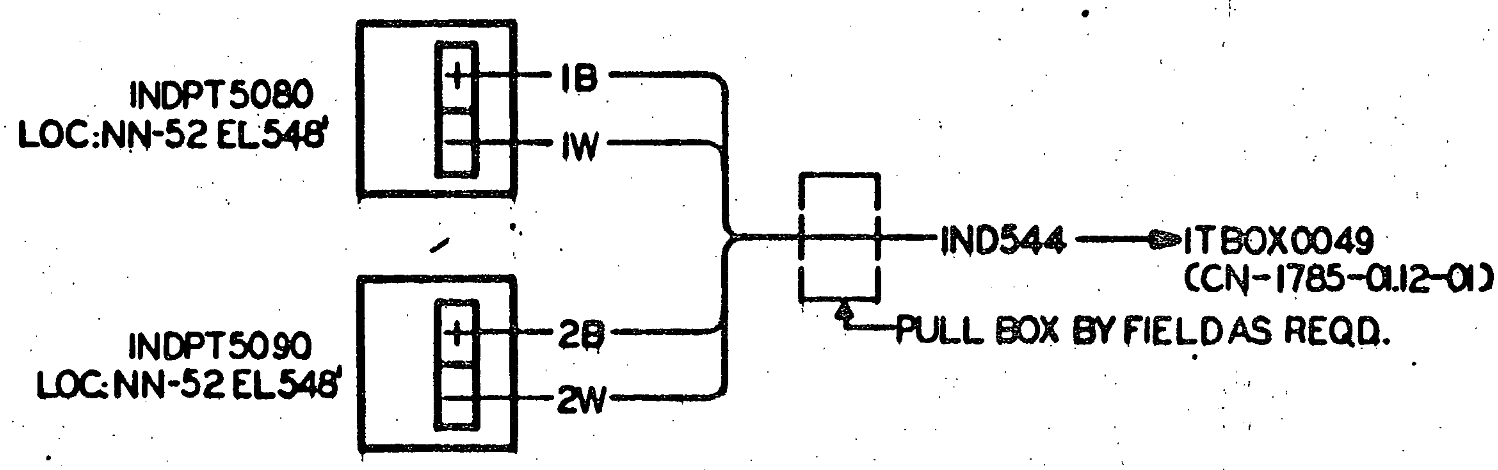
(A) ADAPTORS FROM VARIOUS RTD MANUFACTURERS ARE MECHANICALLY INTERCHANGEABLE IN THE WELL. RTD'S MAY (OR MAY NOT) BE INTERCHANGEABLE IN THE ADAPTORS FROM OTHER MANUFACTURERS, OR OTHER DESIGNS FROM THE SAME MANUFACTURER. (TO CHECK, VERIFY SAME THREAD SIZE ON ADAPTOR AND FINGER NUT OF RTD.)

(B) BOSS AND WELL SUPPLIED AS COMPONENT PARTS OF REACTOR COOLANT PIPING SYSTEM. REF. W DWG. 271C315 AND 206C470.

NOTES

1. FOR WIRING OF DEVICES ON MULTI-PAIR CABLES (2, 4 OR 8SPX16G.3) FIELD IS TO ADD (SIZE AND INSTALL) PULL BOX AS REQUIRED.
2. FOR TERMINATION OF THE MULTI-PAIR CABLES (LISTED IN NOTE 1) TO THE CORRECT DEVICE. THE COLOR CODE FOR A DEVICE IS SHOWN TO THE RIGHT OF THE DEVICE IN COLUMN MARKED COLOR CODE. WITH THE COLOR B ALWAYS BEING (+) POSITIVE AND CONNECTED TO THE (+) POSITIVE TERMINAL ON THE DEVICE AND COLOR CODE W ALWAYS BEING (−) NEGATIVE AND CONNECTED TO THE (−) NEGATIVE TERMINAL OF THE DEVICE, UNLESS OTHERWISE NOTED.

EXAMPLE: CABLE 1ND544 IS A 2SPX16G.3 CABLE ROUTED TO DEVICES 1NDPT5080 (1B & 1W) AND 1NDPT5090 (2B & 2W) FROM 1TBOX0049, TO BE TERMINATED AS FOLLOWS:



3. FIELD TO FURNISH SIZE AND MOUNT EDC CONDULET BOX AS REQUIRED.
4. CABLE (INVFT5450) FURNISHED BY VENDOR.
5. CABLES 1#SM555 AND 1#SM556 HAVE 1 SPARE PAIR PER CABLE.
6. IF LEADS (SUPPLIED BY VENDOR) ARE COVERED WITH BRAIDED ARMOR FIELD IS TO ADD FLEXIBLE CONDUIT TO LEADS FOR ADEQUATE PROTECTION AFTER INSTALLATION.
7. FIELD TO INSERT POWER SUPPLY CALIBRATION RESISTOR, IF NECESSARY, TO MAKE SURE THE MIN. LOAD RESISTANCE IS 500 OHMS.
8. FIELD TO LOCATE POWER SUPPLY INSIDE OF TRANSMITTER CASE.
9. COLORS SHOWN REPRESENT IDENTIFICATION OF WIRING AND NOT ACTUAL COLOR.
10. CONNECT TERMINAL SEVEN (7) OF POWER SUPPLY TO CASE.
11. POWER SUPPLY—ACOPION 32U40.
12. FIELD TO CUT LEADS IF TO LONG FOR PROPER [redacted] BE. [redacted]

CONT'D.

88-07-03 : Incorrect Valves Supplied by Vendor(VX System)

- This condition was discovered by Duke in 1984 during the construction phase.

- Operators supplied by the vendor were not in compliance with the Duke specification although all related vendor supplied paperwork indicated compliance. Vendor committed to provide replacement valves.

- Duke evaluated the valves for upper containment application and concluded the valves to be acceptable.

- During a January, 1986, inspection concerning lubrication, the completeness of the Duke evaluation was questioned in regard to lubrication. Justification for the lubrication adequacy was provided to supplement the EQ file to demonstrate qualification.

- Replacement valves received from vendor were installed in Unit 1 in February, 1986 (1st refueling outage). The Unit 2 valves were replaced before initial criticality.

88-07-03

- Duke did not interpret the April 17, 1986 NRC Report No.50-413/86-05(lubrication audit) to indicate that the supplemental EQ information for the previous installation was insufficient. No further action was taken concerning the EQ file for the previous installation.

- Follow-up review of the superseded EQ file during February, 1988 EQ audit resulted in additional questions concerning the need for subcomponents to be specifically addressed in the file.

- Supplemental information addressing the additional questions demonstrates the operators were qualified for the required environmental conditions.

88-07-03

- *It is Duke Power Company's position that this violation is strictly a documentation concern. This violation falls under Paragraph III of Generic letter 88-07(i.e., not sufficiently significant to be considered for escalation, and would be considered a severity level IV or V).*

6-7

DUKE POWER COMPANY

P. O. BOX 33189

GENERAL OFFICES
422 SOUTH CHURCH STREET
CHARLOTTE, N. C. 28242

TELEPHONE: AREA 704
373-4011

May 22, 1984

Mr. George Chang
Robert E. Mason Company
1726 North Graham Street
P. O. Box 33424
Charlotte, NC 28233

Re: Catawba Nuclear Station Units 1 and 2
VX System Containment Isolation Valves 1,2/VX/1A,2B
12 in. Type 9220 w/Limitorque SMB-000 2HOBC
Specification CNS-1205.02-00-0005 Through Add. 6
MPSCo Order No.: A-98506
Duke File: CN-1205.02

Dear Mr. Chang:

A recent review has indicated that the referenced valves have been supplied with actuator motors having Class B insulation. Per Limitorque Qualification Report B0003, Class B insulated motors are qualified for use outside containment only. Class RH insulated motors (qualified by Limitorque Qualification Report 600456) are required for use inside containment.

It is our opinion that Fisher has supplied under qualified motors which do not comply with the referenced specification. In order to support our Unit 1 criticality schedule, Fisher should provide two qualified motors ASAP. Two additional motors for the Unit 2 valves are also needed, but may be furnished at a later date.

Questions may be directed to David Causey (373-8020).

Very truly yours,

S. K. Blackley, Jr., Chief Engineer
Mechanical and Nuclear Division

E D Lindsay / BBt
E. D. Lindsay, Design Engineer II

FDC/tkh

cc: R. H. Armstrong
P. R. Herran
R. R. Kovacs

Robert E. Mason Company
1726 North Graham Street
P.O. Box 33424
Charlotte, North Carolina 28233
Phone 704/375-4464

→ FDC
RRK

Robert E. Mason

June 21, 1984

Duke Power Company
P. O. Box 33189
Charlotte, NC 28242

Attn: Mr. E. D. Lindsay
Design Engineer II

RE: Catawba Nuclear Station, Units 1 and 2
Containment Isolation Valves 1&2/VX/1A and 2B
Duke Specification CNS-1205.02-00-0005 thru Addendum #6
Mill-Power Order No. A-98506
Duke File No. CN-1205.02
Limitorque Actuators

Dear Mr. Lindsay:

Per your letter of May 22, 1984 and my discussions with Mr. David Causey, please be advised that our preliminary finding is that the Limitorque actuators furnished for the above referenced valves indeed have non-qualified motor insulation.

Fisher Controls International, Inc. acknowledges the mistake and will furnish replacement actuators as requested. In order to ensure that the replacement units comply with your requirements, we ask you to please send us the complete specification for these actuators. We will provide you with the ship schedule as soon as it is available.

We regret that the original order was filled incorrectly. Should you have any questions, please feel free to contact this office.

Very truly yours,

FISHER CONTROLS INTERNATIONAL, INC.

George Chang

George Chang
ROBERT E. MASON COMPANY
DIST. REPR.

GC/gs

Distribution: See Page 2

Representative of Fisher Controls

xc - P. M...

DUKE POWER COMPANY
DESIGN ENGINEERING-MECHANICAL SYSTEMS AND EQUIPMENT SECTION
ENGINEERING JUSTIFICATION REPORT

Date: June 15, 1984	Report No.: SES-JR-45		
To: Mfr. Drawing File	Originated By: [signature]	Date: 6-22-84	
Station: Catawba	Checked By: [signature]	Date: 6-22-84	
System: VX	Approved By: [signature]	Date: 6-27-84	
File No.: CN-1205.02	QA Approval: [signature]	Date: 6/29/84	

Re: Valve Numbers 1,2VX1A and 1,2VX2B
Valve List CBF-3
Specification CNS-1205.02-00-0005
Order No. A-98528
Limitorque Qualification Report B0058 (CNM-1205.19-0001)
Catawba Environmental Qualification Criteria Manual (Rev. 4)

Description of Variation:

Subject valves and attached electric motor actuators were procured from Fisher Controls Company. As required by the Specification, Limitorque Corporation motor actuators were provided by Fisher.

These valve assemblies isolate the Hydrogen Skimmer Fans located inside Containment. A recent survey has indicated the actuator motors are fitted with the "class B" motor insulation system. However, only the "class RH" insulation system is intended by Limitorque for use inside Containment.

Engineering Analysis Required:

Class RH insulation is qualified for inside Containment Design Basis Event environmental conditions. Class B insulation is qualified for the less harsh DBE environments outside Containment. There are no other functional differences in these insulation systems. The purpose of this report is to justify the class B insulation system for use inside Containment for this application only.

Engineering Conclusion:

The qualified environment for the class B insulated motor is as follows:

250°F for 24 hours followed by 200°F for 16 Days

2×10^7 Rad Total Radiation Dose

The actual DBE environments for 1,2VX1A and 1,2VX2B are as follows:

180°F peak (per FSAR Figure 6.2.1-6)

1.2×10^7 Rad Total Radiation Dose (per CNC-1229.00-00-0019)

Per FSAR Table 3.9.3-14, the response time is 60 seconds and response is to an SP signal. Per system description CNSD-1211.00-13, these valves open 10 minutes following on SP signal and would remain open for the duration of a LOCA. The time delay of 10 minutes plus the 60 second response time amount to a required operability time of 660 seconds. Using Figure 5.0-1 of the Catawba Environmental Qualification Criteria Manual, the dose received in 660 seconds is less than $(.05)(1.2 \times 10^7) = 6 \times 10^5$ Rad.

To summarize the actual DBE environment for the required response time:

180°F peak

6×10^5 Rad Total Radiation Dose

Since the actual DBE environments are less severe than the qualified environments, the Limitorque class B insulation system is acceptable for use in the 1,2VX1A and 1,2VX2B applications.

cc: C. A. Little
D. G. Gardner
P. R. Herran
F. D. Causey
T. Moleff
R. E. Miller

1-31

January 17, 1986

J. W. Hampton, Manager
Catawba Nuclear Station

Re: Catawba Nuclear Station
IVX1A and IVX2B
Limitorque Valve Operators
Duke File: CN-1205.19

Attached is a copy of our environmental review of Sun EP50 grease, demonstrating that it is enviromentally qualified in the subject application.

Engineering Justification Report SES-JR-45 (CNM-1205.02-0614) addresses the significant environmental parameters experienced by the operators. Containment spray does not degrade the performance of the operator due to its weatherproof motor enclosure.

The above information is sufficient to demonstrate that IVX1A and IVX2B are environmentally qualified in accordance with 10CFR50.49.

We understand that replacement, "containment chamber" type actuators are now available. These should be used to replace the operators now installed during the next refueling outage. Further, it is recommended that the 2VX1A and 2VX2B operators be replaced with "containment chamber" type actuators prior to fuel load.

T. F. Wyke, Chief Engineer
Mechanical and Nuclear Division

H. E. Edwards

H. E. Edwards, Supervising Design Engineer

RRK/tkh

Attachment

cc: W. A. Houston
W. B. Smith
C. L. Hartzell (Cat-NPD)
F. P. Schiffley (Cat-NPD)
R. W. Eaker
CENTRAL RECORDS

Agent Order No. 33-A02C82628

26151 (R6-84)

Form 930.1A Rev. 5

DEC 12 1985

DUKE POWER COMPANY
QUALITY ASSURANCE DEPARTMENT
SUPPLIER QUALITY ASSURANCE CERTIFICATION

MAILED JAN 10 1986

Name of Supplier Fisher Controls Int'l Inc. Date 12/12/85

Address of Supplier Plant 205 S. Center St. Mill Power Order No. A98506-13-008 CO#1

Marshalltown, IA 50158 Duke Item or Req. No.

Spec. No. CNS 1205.02-00-0005 Rev. Addendum 3

Supplier ID Nos. Replacement Parts

Description of Component(s) or Material(s) Dwg. No. 17A8676X012, Actuator

☑ Attached Documentation covers all Components/Materials on Mill Power Order.

☐ Attached Documentation covers partial shipment of Components/Materials on Mill Power Order.

The following listed tests, inspections and reports have been completed as required by the specification:

☐ Physical & Chemical Analysis
☐ Hydro (Test Pressure — PSIG ______)
☐ Major Repair Records & Charts
☐ Personnel Qualifications on Record

☑ Design Report
☐ Radiographic Test
☐ Penetrant Test
☐ Operating Test
☐ Dimensional Check
☐ Stress Report
☐ Ultrasonic Test
☐ Repair NDE
☐ Performance Curve
☐ Deviation Record #
☐ Heat Treatment
☐ Magnetic Particle
☐ Cleanliness
☐ ASME Data Report

1)

2)

3)

This certifies that the listed Component(s) or Material(s) conform to the requirements of the above referenced Duke Power documents including all codes, standards, test requirements and Quality Assurance requirements invoked therein.

Diane Ohrt
Supplier Representative Authorized Signature

Title Q.A. Analyst Date 12/12/85

(See Instructions)

88-07-04 : Fan Motor Breather-Drains

- The breather-drains on the originally supplied fan assemblies were installed by Joy prior to shipping.
- Two (2) spare motors were ordered by Duke from Joy in 1981.
- The Hydrogen Skimmer Fan assemblies were returned to Joy for repair in 1985.
- Duke returned the 1981 procured motors to Joy as the replacement motors to be assembled on the repaired fans.
- The repaired fan assemblies were shipped back to Duke without installed breather-drains.

88-07-04 :

- During the walkdown, the inspector noted breather-drains missing.
- Evaluation demonstrating qualification without breather-drains was presented during the inspection.
- A formal calculation demonstrating qualification was provided to the NRC.
- Installation drawings have been revised to include specific reference to install breather-drains for conservatism.

88-07-04

- It is Duke Power Company's position that this violation falls under Paragraph III of Generic Letter 88-07(i.e., not sufficiently significant to merit escalated enforcement, and would be considered a severity level IV or V).

V#
OT
RB

PURCHASE ORDER

Mill-Power Supply Co.

12-07-81

IMPORTANT
No. G60466-78
THIS ORDER NUMBER MUST APPEAR ON ... OF THE INVOICE AND ON ALL PACKAG...

JOY MFG CO
%STIPP & POWELL INC
P O BOX 240276
CHARLOTTE NC 28224

HEREIN DESIGNATED SHIPPER

SHIP TO
DUKE POWER CO.
C/O J.W.HAMPTON,MGR. G60...
CATAWBA NUCLEAR STATION
HWY 274, NEWPORT
P.O. BOX 256
CLOVER, SC 29710

VIA ROADWAY EXPRESS

MAKE INVOICE TO:
[X] DUKE POWER CO.
[ ] MILL-POWER SUPPLY CO.
MAIL INVOICE AS DIRECTED BELOW UNDER NOTICE TO SELLER*

BUYER WHOSE ADDRESS AND SIGNATURE APPEAR BELOW AGREES TO PU... FROM SELLER THE GOODS AND/OR SERVICES DESCRIBED BELOW UPON TH... AND CONDITIONS SET FORTH ON BOTH THE FRONT AND REVERSE SIDES... PURCHASE ORDER SELLER SHALL TRANSFER AND DELIVER TO BUYER OR TO... HEREIN DESIGNATED, AT THE LOCATION AT THE TIME OR TIMES AND BY THE... HEREIN SPECIFIED, THE FOLLOWING GOODS AND/OR SERVICES

ITEM NO	QUANTITY	UNIT	DESCRIPTION	ID NUMBER	PRICE
			THE FOLLOWING SPARE PARTS ARE FOR THE HYDROGEN SKIMMER FAN		
			MATERIALS SHALL MEET ALL REQUIREMENTS OF SPEC. #CNS 1211.00-6 REVISION #9 VX-2		
1	2	EA	MOTOR, 600287-74	20670057N	30,434.0
			DO NOT DELIVER PRIOR TO 1-1-82.		
			THE SPARE PARTS LISTED ABOVE ARE TO BE STORED IN PROTECTION LEVEL B.		
			THIS MATERIAL SHALL BE FURNISHED UNDER THE QUALITY ASSURANCE PROGRAM OF THE JOY MFG. FACILITY AT 338 S. BROADWAY, NEW PHILA. OHIO 44663.		
			PRICE AND DELIVERY PER JOY MFG. CO. QUOTATION DATED 7-23-81 IN RESPONSE TO OUR MPSC INQUIRY NO. 1212-P-72.		
			DELIVERY COMMITMENT 35 WEEKS A.R.O.		
			FORMS ATTACHED AS PART OF THIS ORDER:		
			(CONT. ON PAGE 2)		

SHIPPING TERMS FOB NEW PHILADELPHIA, OHIO

CASH TERMS NET 30 DAYS

*NOTICE TO SELLER

1. ACKNOWLEDGE ORDER BY PROMPT ACCEPTANCE AND GIVE DATE ORDER WILL BE SHIPPED.
2. Acceptance is expressly limited to terms and conditions set forth herein and on reverse side.
3. If freight is prepaid and added to invoice attach expense bill.
4. Show lot numbers on boxes and invoices if shown on this order.
5. THREE COPIES OF INVOICE, WITH SHIPPING PAPERS ATTACHED, ARE TO BE MAILED TO:

MILL-POWER SUPPLY CO.
CHARLOTTE, N.C. 28232
P.O. BOX 32307 TELEX 57-2346

MILL-POWER SUPPLY COMPANY ("BUYE...
W. T. ROBERTSON, JR., PRES.

ADDRESS REPLY TO: C M BALLARD
(704) 373-7663

MASTER COPY

ENFORCEMENT CONFERENCE AGENDA
DUKE POWER COMPANY
CATAWBA NUCLEAR STATION
JULY 1, 1988
NRC/REGION II HEADQUARTERS BUILDING
ATLANTA, GEORGIA
ENVIRONMENTAL QUALIFICATION OF EQUIPMENT

DESCRIPTION and ANALYSIS of INSPECTION FINDINGS — **Jim Thomas, Bob Smith**

~~EQ Files Support of Four-to-One Electrical Tape Splice Used on Hydrogen Recombiners~~

RCS (NC) wide Range RTD's not Installed in Accordance with the Tested Configuration

Limitorque Motor Operated Valves in the Containment Air Return and Hydrogen Skimmer (VX) System

Joy Reliance Fan Motors Without Breather-Drains

EQ Files Support of Minco RTDs

Namco Limit Switch Improper Installation

Limitorque Operators Without T-Drains Installed

T-Drains Not Installed at Low Point(Unresolved Item)

AGENDA(CONTINUED)

STATION EQ PROGRAM	**Tony Owen/Ralph Neigenfind**

- Administrative Controls
- Implementation and Training
- Program Enhancements

OVERALL ASSESSMENT OF CATAWBA INSPECTION RESULTS	**Jim Thomas**
CLOSING REMARKS	**Hal Tucker**

88-07-01 : Inadequate Documentation of Qualification of Splices for Hydrogen Recombiners

- As discussed in the inspection report, qualification was demonstrated during the inspection.

- Splice is consistent with manufacturers recommendation and Duke design documentation.

- The documentation which demonstrates qualification of the tape splices was on file but was not specifically referenced in the Hydrogen Recombiner EQ Package.

- As demonstrated during the inspection, the tape splices are qualified for this application and Duke has placed on file an EQ package which specifically addresses the recombiner splices. This document ties together the test reports which were presented to the inspectors during the inspection.

88-07-01

- *It is Duke Power Company's position that this finding falls under Section III of the enclosure to Generic Letter 88-07 (i.e., not sufficiently significant to merit escalated enforcement)*

- *In that qualification was demonstrated during the inspection, the item should be considered severity level IV or severity level V.*

ATTACHMENT 3

MC-1362.00

CU-1362.00

ATTACHMENT

3-3. Recombiner Electrical Connections - The recombiner has an electrical junction box which is located on the right-hand side of the unit (figure 3-1). This box contains the electrical leads from the heaters. The box is built into the recombiner. To allow maximum flexibility in establishing incoming power lead runs, the cable entry cover plate is not predrilled. To drill the cover plate for the power circuit entrance, remove the cover plate and drill to suit.

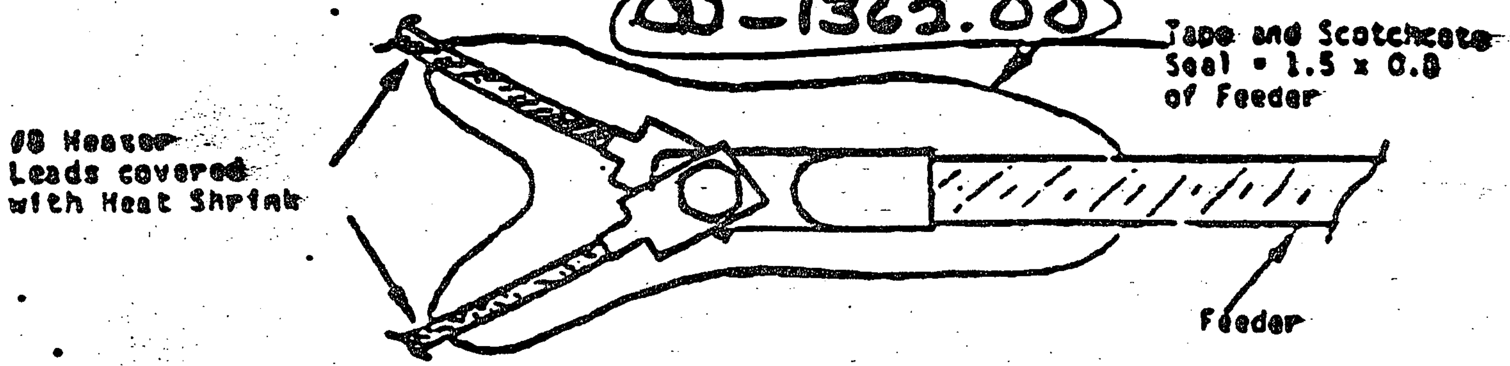
All heater leads (phase 1, 2, 3, and neutral) are fastened together by bolting through the Burndy indent-type lug terminals. To connect the incoming feeder, use Burndy indent-type lugs (or equivalent) on the feeder leads and bolt to the appropriate heater lead phase of neutral bundle lugs. Figure 3-2 shows the wiring diagrams. All lead connections should be taped and/or potted per installing agency procedures to prevent arcing.

A ground hole is provided on the base of the recombiner. As a standard safety measure, a ground strap (not provided by Westinghouse) should be connected to the ground hole and to an adequate ground.

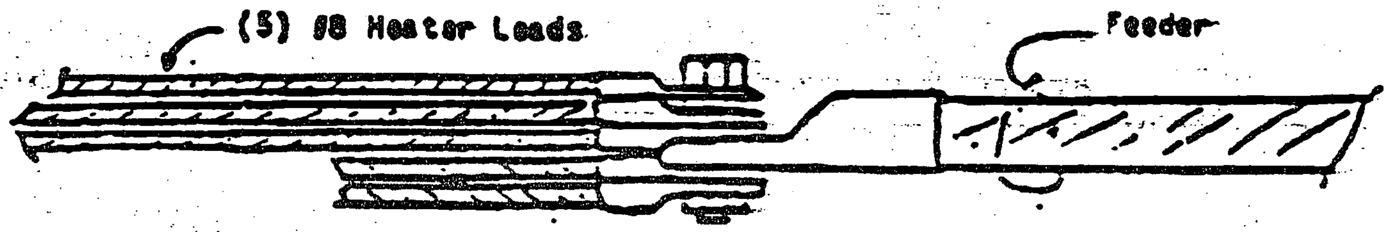
MC-1362.00

DU-1362.00

ATTACHMENT



PLAN VIEW



SECTION VIEW

GUIDELINES FOR TERMINATION

1. Cover each individual heater conductor with (1) one layer of WCSF-N heat shrink (approximately three inches long). Reference Specification MCS-1390.01-00-0063.

2. Lug the (5) five #8 heater leads/conductors with the appropriate feeder lead. Torque the bolted connection in accordance with Specification MCS-1390.01-00-0063.

3. Tape entire connection with Bishop No. W-962 or 3M No. 130C tape. Continue taping connection until sufficient layers have been applied to equal 1.5 times the outside diameter (OD) of the feeder conductor.

4. Apply appropriate amounts of Scotchcote in conjunction with (2) two half-lap layers of Bishop No. 20 or Scotch No. 70 silicone tape.

5. Application of tape and Scotchcote shall be in a manner that covers entire connection promoting an effective seal.

ATTACHMENT 1

0004690745

83371211.00-00-0027-00 PMW RRW RLD V#90190303 OT00 EU20 DSC/SHG/

CC1090 PCC1090

IMPORTANT

No. M25519-15

THIS ORDER NUMBER MUST APPEAR ON ALL COPIES OF THE INVOICE AND ON ALL PACKAGES

PURCHASE ORDER

MILL-POWER SUPPLY CO.

6-13-85

JOY MFG
338 S BROADWAY
NEW PHILADELPHIA OH 44663

HEREIN DESIGNATED SELLER

SHIP TO
DUKE POWER CO.
C/O E M COUCH M25519-15
PROJECT MANAGER
CATAWBA NUCLEAR STATION
SC HWY 274
NEWPORT, SC 29710

VIA CAROLINA FREIGHT CARRIERS

MAKE INVOICE TO:
DUKE POWER COMPANY
TAX CERTIFICATE NUMBER
NC 26 SC 1002-19

MAIL INVOICE AS DIRECTED UNDER NOTICE TO SELLER*
BUYER WHOSE ADDRESS AND SIGNATURE APPEAR BELOW AGREES TO PURCHASE FROM SELLER THE GOODS AND/OR SERVICES DESCRIBED BELOW UPON THE TERMS AND CONDITIONS SET FORTH ON BOTH THE FRONT AND REVERSE SIDES OF THIS PURCHASE ORDER. SELLER SHALL TRANSFER AND DELIVER TO BUYER OR TO PERSON HEREIN DESIGNATED AT THE LOCATION AT THE TIME OR TIMES AND BY THE MEANS HEREIN SPECIFIED THE FOLLOWING GOODS AND/OR SERVICES.

ITEM NO.	QUANTITY	UNIT	DESCRIPTION	ID NUMBER	PRICE
			CATAWBA NUCLEAR STATION		
			FURNISH REPAIR PARTS FOR HYDROGEN SKIMMER FAN HSF-2A, S/N GF-22043, IN ACCORDANCE WITH DUKE POWER SPECIFICATION NO. CNS-1211.00-00-0006 THROUGH REVISION NO. 12 DATED SEPTEMBER 17, 1984.		
			REPAIR PARTS LISTED BELOW AS TAKEN FROM JOY DRAWING NO. FF 16372:		
1	1	EA	15U24584 INLET SIDE PLATE ASSEMBLY (ITEM 2)		
2	1	EA	15U24452 WHEEL ASSEMBLY (ITEM 3)		
3	1	EA	1F203270 RETAINER PLATE (ITEM 4)		
4	2	EA	1F203248 SIDE PLATE GASKET (ITEM 11)		
5	1	EA	GASKET ADHESIVE (ITEM 12)		
6	2	EA	1F203271 HUB SEAL (ITEM 13)		

(CONT. ON PAGE 2)

SHIPPING TERMS FOB S/P

CASH TERMS NET 30 DAYS

*NOTICE TO SELLER

1. ACKNOWLEDGE ORDER BY PROMPT ACCEPTANCE AND GIVE DATE ORDER WILL BE SHIPPED.
2. Acceptance is expressly limited to terms and conditions set forth herein and on reverse side.
3. If freight is prepaid and added to invoice, attach freight bill or other appropriate shipping documents.
4. Show numbers on boxes and invoices if shown on this order.
5. TWO COPIES OF INVOICE, WITH FREIGHT BILL OR OTHER SHIPPING DOCUMENTS ATTACHED, ARE TO BE MAILED TO:

MILL-POWER SUPPLY CO.
P.O. BOX 32307
CHARLOTTE, N.C. 28232-2307

MILL-POWER SUPPLY COMPANY ("BUYER")
W. T. ROBERTSON, JR. PRES.

ADDRESS REPLY TO: D.S. CARTER

(704) 5818

TELEX 57-2346

REV: 9-84

MASTER COPY

88-07-05 : MINCO RTDs - Termination Submergence

- Inspector unable to physically examine the termination of the RTDs due to time restraint.

- Duke provided documentation demonstrating sufficient length of mineral insulated cable had been ordered with RTD to accommodate termination above flood level.

- Inspector expressed concern that he had observed installations at other utilities with cable coiled at termination box.

- During the inspection, the inspector indicated that information had been provided by another utility and, based on the inspector's knowledge of this application, the configuration should be qualifiable even if submerged.

- Duke walked down RTDs subsequent to inspection in response to inspectors concern.

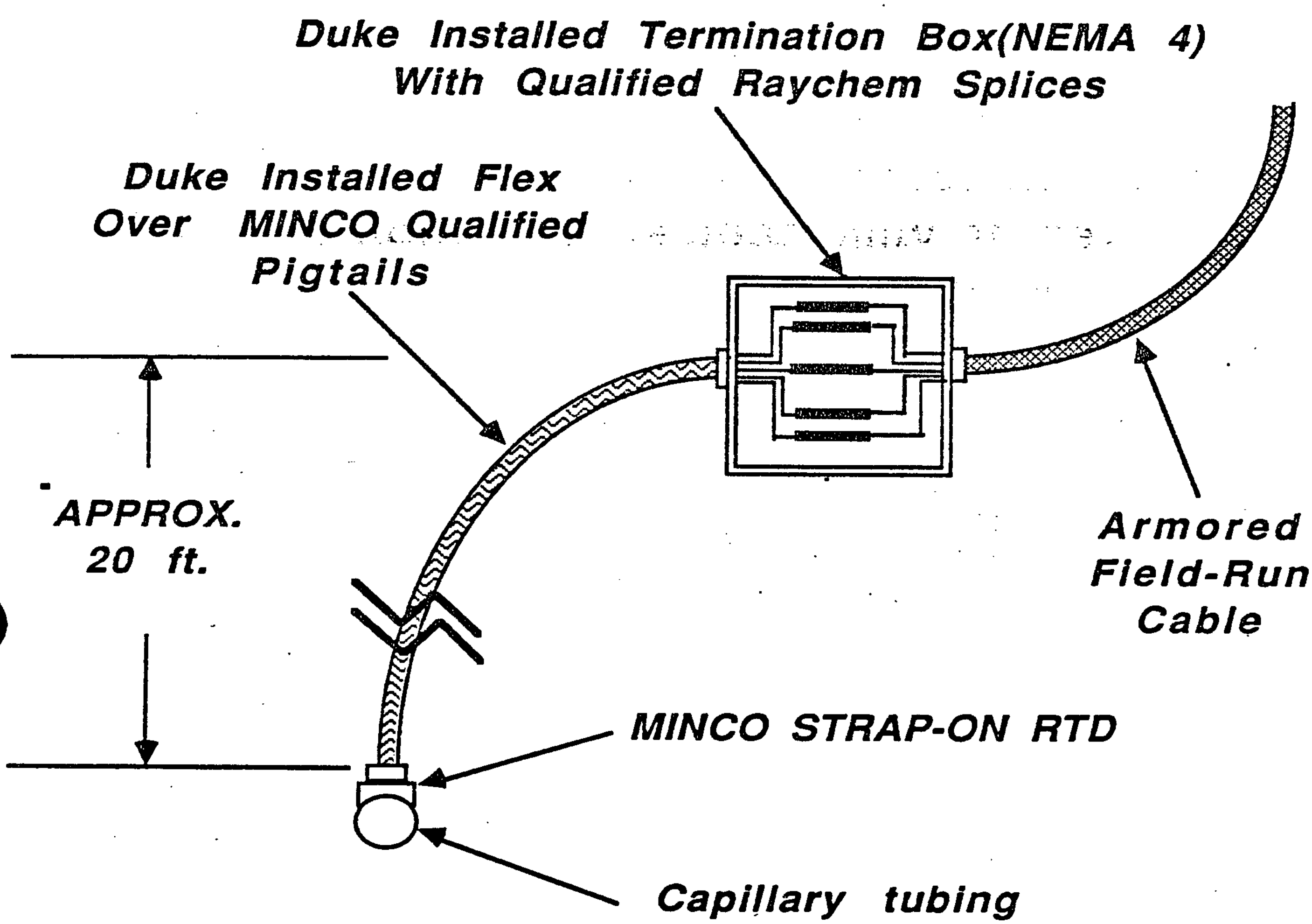
88-07-05 :

- Duke notified NRC of walkdown results that some terminations were below flood level.
- Duke also provided the NRC with documentation and test performance data demonstrating the RTD terminations were qualifiable for submergence.
- Inspector found the method of qualification acceptable.

88-07-05

- ***It is Duke Power Company's position that this documentation deficiency falls under Paragraph III of the enclosure to Generic Letter 88-07(i.e.- EQ violation not sufficiently significant to merit escalated enforcement, and would be considered a severity level IV or V).***

MINCO RTD Installed Configuration



Three (3) RTDs per train, per unit, had been terminated in junction boxes below flood level.

88-07-06 : NAMCO Limit Switch Cover Gasket

- During the Unit 2 walkdown, a cover gasket was noted to be improperly installed(no other limit switches were found with installation deviations during the inspection).

- Evaluation of the function of the limit switch indicated the switch was not required to be on the Master List.

- The switches are included for maintenance consistency and conservatism.

- An inspection of accessible Unit 1 and 2 inside containment NAMCO limit switches and all Unit 2 switches required for control functions has been completed. None of these other switches were found with installation deviations.

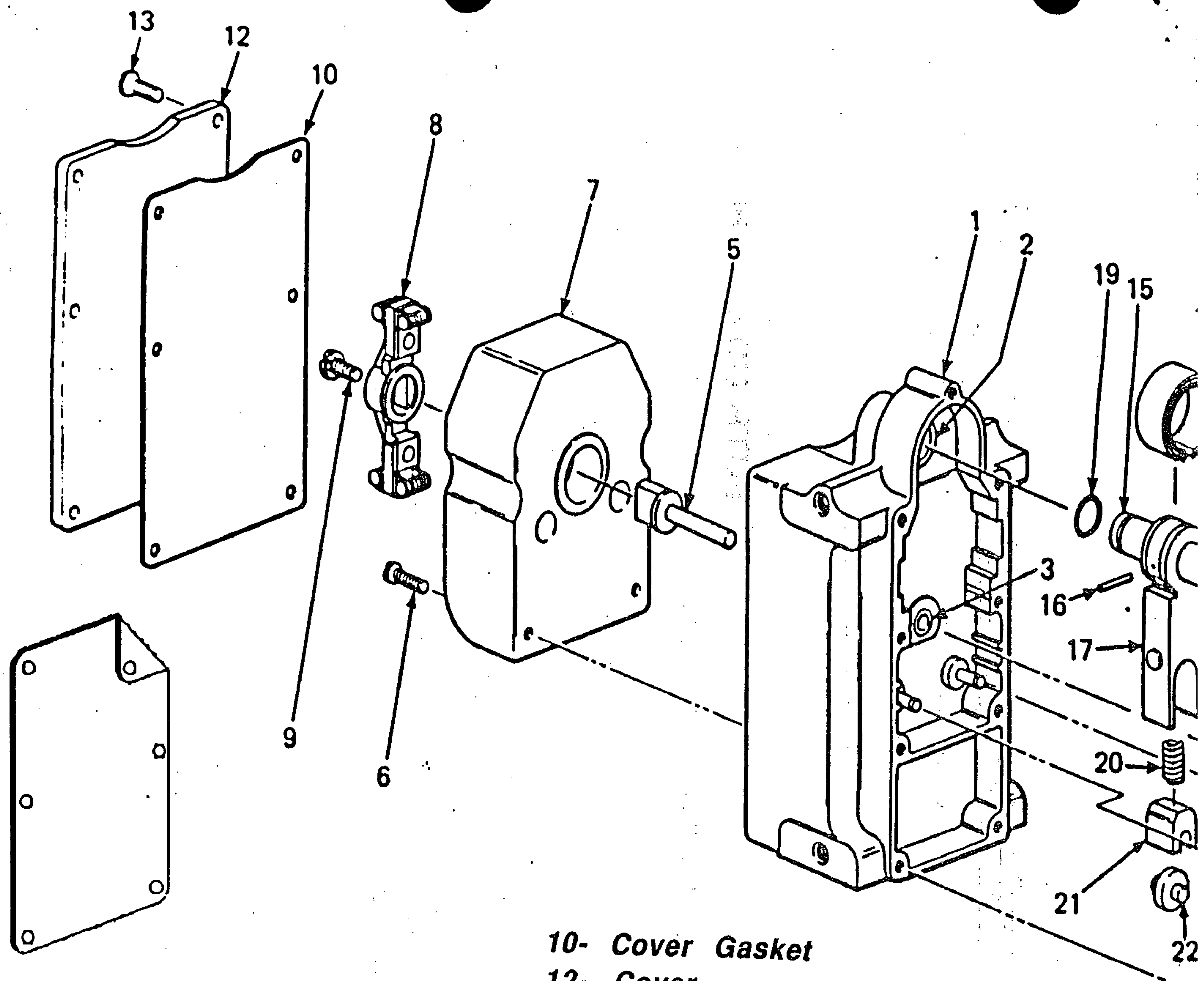
88-07-06 :

- All remaining inside containment NAMCO limit switches will be inspected at next outage of sufficient duration.
- An inspection of the outside containment NAMCO limit switches has also been completed and although some problems were found and corrected, these switches were not required to be on the Master List. The NRC was notified by courtesy call.
- Installation procedures have been refined/revised to preclude a recurrence of this situation.
- This item was specifically addressed during subsequent station technician EQ training.

88-07-06

- ***It is Duke Power Company's position that this violation falls under Paragraph IV.B of Generic Letter 88-07(i.e., Duke demonstrated at the time of the inspection that this switch was not required to be on the EQ list and therefore should not be considered for enforcement action).***

NAMCO LIMIT SWITCH



10- Cover Gasket
12- Cover
1 - Switch Body

Duke as-found configuration

88-07-07 : Limitorque T-drains

- As documented in the inspection report, there was an extensive review of the Limitorque EQ files with no deficiencies found.

- The only item of concern that was determined during the inspection of the actuators was the possibility of the T-drains being plugged with paint.

- The principal purposes for use of T-drains are, 1) to provide drainage of internal actuator condensation; and 2) to serve as the primary vehicle for internal-to-external pressure equalization.

- Duke provided an analysis as to the functional operability of those actuators found without T-drains or with T-drains painted over.

- It was demonstrated by the analysis that clogged or missing T-drains on the affected actuators did not compromise safety for the period this situation existed.

88-07-07

- The corrective actions outlined in the analysis have been completed:

  * The Construction & Maintenance Department has retrained painters

  * Station Instrumentation and Electrical procedures have been revised to clarify T-drain installation requirements

  * Formal T-drain specific training for appropriate personnel has been completed

subject to enforcement action.

88-07-07

- It is Duke Power Company's position that this violation falls under Paragraph III of the enclosure to Generic Letter 88-07(i.e., EQ violation not sufficiently significant to merit escalated enforcement, and would be considered a severity level IV or V).

OVERVIEW

88-07-01: Hydrogen Recombiner Tape Splice

- Installed Configuration Qualified
- Issue more related to auditability

88-07-02 : RCS Wide Range RTDs

- Installation Error
- Misinterpretation of Drawings
- Discovered and Reported by Duke
- Immediate Corrective Action (Unit shutdown)

88-07-03 : VX Motor Operated Valves

- Previous Installation Configuration was Qualified
- Completeness of File Issue
- Equipment Replaced for Conservatism
- Replacement Operators are Fully Qualified

OVERVIEW(CONTINUED)

88-07-04 : Fan Motor Breather-Drains

- Equipment Qualifiable without Drains
- Vendor Maintenance Error
- Drains to be Installed for Conservatism

88-07-05 : MINCO RTDs

- Installed Configuration Qualified
- Design Oversight

88-07-06 : NAMCO Limit Switch

- Specific Equipment not Required
- Failure to Follow Construction Installation Procedure
- Subsequent Walkdowns Revealed No EQ Deficiencies

88-07-07 : Limitorque T-drains

- Qualification Not Compromised
- Lack of EQ Precautions in Painting Procedures

88-07-08 : 2NI-122B T-drains (Unresolved Item)

- Qualified Configuration

DUKE ASSESSMENT OF INSPECTION FINDINGS

- ***Duke concurs with the inspection report that Duke has implemented a program to meet the requirements of 10CFR50.49 for the Catawba Nuclear Station.***

- ***Duke concurs with the inspection report that an acceptable EQ maintenance program is in effect and maintaining equipment in a qualified state.***

- ***The maintenance discrepancies identified in the inspection have been reviewed and training enhancements incorporated.***

- ***As discussed in the inspection report, Duke had previously identified the need for training enhancements. Enhancements being implemented during the inspection have been completed.***

ASSESSMENT(CONTINUED)

- *Based on the extent and depth of the inspection, the Duke assessment is that there are no programmatic problems with the EQ program.*

  * *Limited Number of Findings*

  * *Lack of Safety Significance of violations identified during the inspection (no equipment modifications required)*

ASSESSMENT(CONTINUED)

- *Duke does not consider any of the deficiencies discovered during the inspection sufficiently significant to be considered for escalated enforcement, individually or collectively.*

  * *No Programmatic Problems*

  * *Limited Findings Affecting Limited Systems*

  * *No Equipment Modifications Required*

ASSESSMENT(CONTINUED)

- *It is Duke's position that the EQ violation(RdF RTDs) identified by Duke prior to the inspection does not meet the "clearly knew" or "clearly should have known" criteria and therefore is not subject to enforcement action.*

- *In addition, the following mitigating factors apply to the Rdf RTDs:*

  (1) The violation was limited and affected only one (1) system

  (2) The violation was identified by Duke prior to the inspection

  (3) The violation was promptly reported by LER to the NRC

  (4) The violation was corrected and full compliance was achieved within a reasonable time(Unit shutdown for fix)

  (5) Duke had demonstrated best efforts to complete EQ within deadline

Form 01077 (R10-86)

FORM 101.1	REVISION 10

CERTIFICATION OF ENGINEERING CALCULATION

STATION AND UNIT NUMBER Oconee Nuclear Station Units 1-3

TITLE OF CALCULATION Containment High Range Radiation Monitors RIA-57, 58 Instrument Loop Accuracy Calculation

CALCULATION NUMBER OSC-29Φ4

ORIGINALLY CONSISTING OF:

PAGES 1 THROUGH 6

TOTAL ATTACHMENTS 6 TOTAL MICROFICHE ATTACHMENTS Φ

TOTAL VOLUMES 1

THESE ENGINEERING CALCULATIONS COVER QA CONDITION 1 ITEMS. IN ACCORDANCE WITH ESTABLISHED PROCEDURES, THE QUALITY HAS BEEN ASSURED AND I CERTIFY THAT THE ABOVE CALCULATION HAS BEEN ORIGINATED, CHECKED OR APPROVED AS NOTED BELOW:

ORIGINATED BY E M Welch DATE 3/2/88

CHECKED BY [signature] Moss DATE 03/03/88

APPROVED BY E S [signature] DATE 3/4/88

ISSUED TO GENERAL SERVICES DIVISION ______ DATE ______

RECEIVED BY GENERAL SERVICES DIVISION ______ DATE ______

MICROFICHE ATTACHMENT LIST:

M1 ID# ______ # OF SHEETS ______ M4 ID# ______ # OF SHEETS ______

M2 ID# ______ # OF SHEETS ______ M5 ID# ______ # OF SHEETS ______

M3 ID# ______ # OF SHEETS ______ M6 ID# ______ # OF SHEETS ______

REV. NO.	CALCULATION PAGES (VOL)			ATTACHMENTS (VOL)			VOLUMES		ORIG	CHKD	APPR	ISSUE DATE
	REVISED	DELETED	ADDED	REVISED	DELETED	ADDED	DELETED	ADDED	DATE	DATE	DATE	REC'D DATE

Oconee Nuclear Station Units 1-3
Containment High Range Radiation
Monitors RIA-57, 58 Instrument
Loop Accuracy Calculation

STATEMENT OF PROBLEM

The purpose of this calculation is to determine the accuracy of the Containment High Range Radiation Monitors RIA-57, 58. Each Radiation monitor system consists of a Victoreen model 877-1 Detector located inside containment and a Victoreen model 876A-1M readout module located in the control room. Train A for all three (3) units also contains a PAM strip chart recorder located in the control room.

RELATION TO APPLICABLE QA CONDITION

The instrument loops provide the operator with indication and record of radiation levels inside containment during and after a loss of coolant accident (LOCA). This is a post accident monitoring function and is QA Condition 1.

DESIGN METHOD USED

The methodology used to estimate the accuracy of an instrument loop is the statistical combination of error components that are not interactive. The error components that are interactive are grouped together and summed. These sums are then statistically combined with other error components with which they are not interactive. The relationship between the error components and the total statistical error allowance for a channel (instrument loop) is given in the equations listed on attachment #1; definitions for the error components are also included.

DUKE POWER COMPANY

Form 00184 (6-81)

Dev./Station ______ Unit ____ File No. ______

Subject ______

______ By ______ Date ______

Sheet No. ___ of ___ Problem No. ______ Checked By ______ Date ______

Oconee Nuclear Station Units 1-3
Containment High Range Radiation
Monitors RIA-57, 58 Instrument
Loop Accuracy Calculation

File: OSC-2904
Date: 3/2/88
By: Em Welch

APPLICABLE CODES AND STANDARDS

NRC Regulatory Guide 1.97, Page 1.97-14

OTHER DESIGN CRITERIA

Safety Related Instrumentation Qualification Review and Documentation Procedure, MDIC-PR2, Revision 2

PSAR/FSAR APPLICABILITY

Section 3.11, Environmental Design of Mechanical and Electrical Equipment

REFERENCES

1) Oconee Nuclear Station Environmental Qualification Criteria Manual, Revision 8

2) Oconee Equipment Qualification Reference Index, Revision 9

3) Victoreen Operation/Maintenance Manual and Test Report - Radiation Monitoring System (OM-333A-108)

4) Electrical Elementary Drawings OEE-123-1 Rev. 1, OEE-223-1 Rev. 1, OEE-323-1 Rev. 1.

DUKE POWER COMPANY

Form 00184 (6-81)

Dev./Station ______ Unit ____ File No. ______

Subject ______

______ By ______ Date ______

Sheet No. ___ of ___ Problem No. ______ Checked By ______ Date ______

Oconee Nuclear Station Units 1-3
Containment High Range Radiation
Monitors RIA-57, 58 Instrument
Loop Accuracy Calculation

File: OSC-2904
Date: 3/2/88
By: E m Welch

5) Memo to file OS-120 concerning loop accuracy calculation methodology dated October 2, 1987. (Attachment #1)

6) Memo to file OS-90A concerning Qualification Analysis of Viking Penetrations dated January 29, 1988. (Attachment #2)

7) Letter from Ken Stafford of Victoreen, Inc. to R.G. Mallaney of Duke Power dated February 26, 1988. (Attachment #3)

8) Letter from Ken Stafford of Victoreen, Inc. to E.G. Frampton of Duke Power dated March 1, 1988. (Attachment #4)

9) Qualification Test Report for Brand Rex Coaxial cable, Duke Power cable type SP151. (CNM-1354.00-0021)

10) Memo to file OS-90 concerning cable splicing dated January 21, 1988. (Attachment #6)

ASSUMPTIONS

1. EA — Per the Victoreen test report on these monitors (reference 3) the worst case system accuracy at the analog outputs is ±28% of input radiation. The worst case system accuracy at the meter or readout module is ±36% of input radiation including inaccuracies associated with readibility. Any errors associated with SCA, SD, or STE are assumed to be included in this value.

2. PMA — This error allowance is not applicable based on this application.

3. PEA — This error allowance is not applicable since this application does not contain a primary element.

DUKE POWER COMPANY

Form 00184 (6-81)

Dev./Station ______ Unit ____ File No. ______

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Oconee Nuclear Station Units 1-3
Containment High Range Radiation
Monitors RIA-57, 58 Instrument Loop
Accuracy Calculation

File: OSC-2964
Date: 3/2/88
By: Em Welch

4. SPE — This error allowance is not applicable. Changes in the static pressure of the process do not apply to this application.

5. RCA — There are two rack components in this system, the readout module and the PAM strip chart recorder. The RCA term for the readout module is assumed to be included in the worst case accuracy of the system (±36%). The PAM strip chart recorder provides indication and record of radiation levels in addition to that provided by the readout module. Since both devices provide the same indication, inaccuracies of both devices are not additive. The error specifically associated with the readout module is assumed to be greater than that of the PAM recorder based on the ±8% differential between the system accuracy at the analog outputs versus the readout module. Therefore, RCA is equal to 0% for the recorder. This same analogy also applies to the RD term.

6. RCSA — This error allowance is not applicable since there is no comparator device in the monitor system.

7. RTE — This error allowance is not applicable since both the readout module and the recorder are located in the control room.

8. RRA — This error allowance is included in the worst case system accuracy at the readout module.

Oconee Nuclear Station Units 1-3
Containment High Range Radiation
Monitors RIA-57, 58 Instrument Loop
Accuracy Calculation

CALCULATION

Normal Condition:

The Containment High Range Radiation Monitors are designed to provide radiation level indication inside containment during and post LOCA only. Therefore, a loop accuracy calculation for normal operation is not applicable.

Accident Condition:

$$\text{Total Error} = CL \pm \sqrt{EA^2 + PMA^2 + PEA^2 + (SCA+SD)^2 + STE^2 + SPE^2 + (RCA+RCSA+RD)^2 + RTE^2 + RRA^2}$$

where
- EA = ±36% (See Assumption #1 and Reference #3)
- CL = Φ% (See Attachment #5)
- PMA = Φ% (See Assumption #2)
- PEA = Φ% (See Assumption #3)
- SCA = Φ% (See Assumption #1)
- SD = Φ% (See Assumption #1)
- STE = Φ% (See Assumption #1)
- SPE = Φ% (See Assumption #4)
- RCA = Φ% (See Assumption #5)
- RCSA = Φ% (See Assumption #6)
- RD = Φ% (See Assumption #5)
- RTE = Φ% (See Assumption #7)
- RRA = Φ% (See Assumption #8)

DUKE POWER COMPANY

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Dev./Station ______ Unit ____ File No. ______

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Oconee Nuclear Station Units 1-3
Containment High Range Radiation
Monitors RIA-57,58 Instrument Loop
Accuracy Calculation

File: OSC-2904
Date: 3/2/88
By: Em Welch

Therefore, Total Error (%) = ± 36%

CONCLUSION

The total error or calculated loop accuracy for the Containment High Range Radiation monitors is ± 36%. Per Regulatory Guide 1.97, the required accuracy for the monitors is to be within a factor of 2 over the entire range. (+100%, -50%) Therefore, the calculated loop accuracy is within the required loop accuracy.

October 2, 1987

Memorandum to File CN-1210.04
MG-1210.04
OS-120

Subject: Meeting of 09-29-87

On September 29, 1987, a meeting was held to discuss preparation of loop accuracy calculations for Catawba, McGuire, and Oconee. The following people attended:

R. S. Black, ESES
J. E. Burchfield, Jr., MNSA
L. B. Castles, ESES
E. G. Frampton, EOPE
P. K. Moore, EOPE
T. E. Sanders, EOPE
E. M. Welch, Jr., EOPE

The results of the meeting follow:

1. For calculations in the future, both a normal and accident accuracy rating will be given for each loop. For normal conditions, the equation for total loop accuracy will be

$$TLA = \pm\sqrt{PMA^2 + PEA^2 + (SCA + SD)^2 + SPE^2 + STE^2 + (RCA + RCSA + RD)^2 + RTE^2 + RRA^2}$$

For accident conditions, the equation for total loop accuracy will be

$$TLA = CL \pm\sqrt{EA^2 + PMA^2 + PEA^2 + (SCA + SD)^2 + SPE^2 + STE^2 + (RCA + RCSA + RD)^2 + RTE^2 + RRA^2}$$

The terms are defined as follows:

CL Current Leakage - Allowance for the effects of penetration and parallel leakage resistance to ground on instrument loop accuracy.

EA Environmental Allowance - The effect of a potentially harsh environment on component acccuracy, typically associated only

PMA Process Measurement Allowance - Allowance for variations and non-ideal conditions in the process, e.g., the temperature stratification of fluids

PEA Primary Element Allowance - Allowance for the inaccuracies of the loop's primary element, such as flow orifice or Pitot tube

SCA Sensor Calibration Accuracy - combined effects of hysteresis, linearity, and repeatability for the sensor only

SD Sensor Drift - Allowance for sensor drift over time, assumed eighteen months

SPE Static Pressure Effects - Allowance for the effects of changes in the static pressure of the process

STE Sensor Temperature Effects - Allowance for the effects of changes in the ambient temperature on transmitters, etc. The effects of temperature changes in the process are not included in this term, but should be included in the PMA term.

RCA Rack Calibration Accuracy - combined effects of hysteresis, linearity, and repeatability for rack components

RCSA Rack Calibration Setting Accuracy - combined effects of hysteresis, linearity, and repeatability for bistable or comparator settings

RD Rack Drift - Allowance for drift of rack components over time, assumed eighteen months

RTE Rack Temperature Effects - Allowance for the effects of changes in the ambient temperature on rack components.

RRA Rack Readability Allowance - Allowance for the inability to read indicators because of parallax distortion. This term shall be equal to the percentage of full scale represented by one half of the smallest increment on the indicator scale or 1%, whichever is smaller.

When more than one device contribute to the RCA, RCSA, RD, RTE, and RRA terms, the square-root-of-the-sum-of-the-squares method should be used for combining the effects of multiple devices on each term.

2. The EA term should be what is stated in the manufacturer's product bulletins.

If plant conditions differ significantly from those on which the manufacturer's allowance is based, data in applicable test reports may be used to calculate the EA term. In such cases the EA term shall be chosen to envelope the 95% confidence limits of the sample data and the randomness of the instrument errors demon-

strated. If the test data indicate other than random error, the manufacturer's stated accuracy shall be used. When anything other than the manufacturer's stated allowance is chosen for the EA term, the term shall be taken out of the square root function and directly added to the CL and radical terms.

3. The calculations should include reference to the revision number and date of all documents referenced, including manufacturers' data sheets.

4. An assumption needs to be made for Rack Drift, when no published data are available. Assumptions must be documented in the calculations, and the assumed calibration intervals should be stated. R. S. Black will ask NPD what interval would envelope actual plant calibration intervals.

5. A formal procedure for performing accuracy calculations needs to be made at the Department or Division level. R. S. Black and P. K. Moore will work together to revise the current ESES PR-2 workplace procedure and pursue having it made a Department or Division procedure.

This memorandum is meant to accurately document the results of the subject meeting and further discussions on September 30 and October 1, 1987. It will be used as a design criteria, with ESES PR-2, until a Division or Department Procedure is developed. If there are any comments or questions, please call R. S. Black at 382-0346 or P. K. Moore at 373-2558.

R S Black — P. K. Moore

By: R. S. Black — P. K. Moore

xc: Attendees
R. E. Hardin
G. B. Swindlehurst

January 29, 1988

MEMO TO FILE: OS-90A

SUBJECT: Oconee Nuclear Station
Electrical Penetration Assemblies - Viking Types B, D and J Qualification Analysis Qualification of Functional Characteristics (Insulation Resistance)

REFERENCES: (1) OM337-0080, "Environmental Qualification Documentation Package for Electrical Penetration Assemblies - Viking Industries, Inc. Types A, B, C1, C2, D, E, E1, F1, F2, G, H1, H2, & H3, J and K"

(2) CG-3007.02-08, "Commercial Grade Item Documentation Package for Buchanan Terminal Blocks and Accessories"

The referenced Environmental Qualification Documentation packages, as they apply to the Viking Electrical Penetration Assemblies, represent a complex developmental/qualification/verification process. Many years of documentation has been accumulated and included in these documentation packages. The purpose of this qualification analysis is to establish a worst case functional characteristic (insulation resistance) for the Viking Electrical Penetration Assemblies, Types B, D and J which are required for IE operation during worst case environmental conditions.

The Viking Electrical Penetration Assemblies were specified and purchased consistent with the industry practices of the late 1960's to early 1970's. The operability of the electrical penetration assemblies during post DBE environmental conditions (inside containment) was primarily demonstrated by applying a continuous current at normal operating voltage on the conductors (series circuit) and observing no discontinuity or breakdowns in the test circuit during testing. The insulation resistance of the conductors was typically measured prior to and following the environmental testing.

In recent years, however, specific functional characteristic (insulation resistance) of the Viking Electrical Penetration Assemblies have been evaluated from time-to-time. These specific functional characteristics were evaluated based on the limited number of insulation resistance measurements taken, on assumptions made from existing data and on Duke Power Company's experience with electrical penetration assemblies and electrical connectors.

The Viking Industries, Inc., Electrical Penetration Assemblies, Types B, C1, D, F2 and J were subjected to DBE Environmental Testing and the results of this testing provides the basis for this analysis. Due to the time period in which these tests were performed, the test methods used and the type of data recorded, it was determined that the most reasonable and conservative way to interpret the test results was to establish a worst case functional characteristic (insulation resistance) based on a thorough overall review of the Environmental Documentation packages. Based on this review it was determined that the worst case Functional Characteristic (insulation resistance) for Viking Industries, Inc., Electrical Penetration Assemblies, Types B, C1, C2, D, F2 and J (with exception of the RG11 triaxial circuits) is 250KΩ at 500 VDC. The qualification including the functional characteristic (insulation resistance) for the Type J (RG11 triaxial circuits) is limited by the RG11 triaxial cable connected to the triaxial connectors.

SUMMARY OF THE QUALIFICATION OF THE VIKING INDUSTRIES, INC., ELECTRICAL PENETRATION ASSEMBLIES TYPES, B, C1, C2, D, F2 AND J CONCERNING FUNCTIONAL CHARACTERISTICS (INSULATION RESISTANCE):

1.0 The following provides information as to the inside containment Environmental Qualification:

1.1 The environmental qualification of the Type B electrical penetrations was performed by Viking Industries, Inc. as documented in the following file number.

1.1.1 OM337-0080-001, pages 4-111 through 4-134

1.1.1.1 Normal operating voltage and circuit continuity was maintained (OM337-0080-01, page 4-125).

1.1.1.2 The minimum insulation resistance measurement taken prior to and following the environmental testing was 9,000 MEG OHMS (OM337-0080-001, page 4-130).

1.2 The environmental qualification of the Types C1, C2 and D electrical penetrations was performed by Viking Industries, Inc. as documented in the following file number:

1.2.1 OM337-0080-001, pages 4-136 through 4-185

1.2.1.1 Normal operating voltage and circuit continuity was maintained (OM337-0080-001, pages 4-156 and 4-179).

1.2.2.2 The minimum insulation resistance measurement taken prior to and following the environmental testing was 400 MEG OHMS (OM337-0080-001, pages 4-151, 4-152, 4-153, 4-169, 4-170, 4-171, 4-172, 4-173, 4-174, 4-175 and 4-176).

1.2.2.3 The Type C2 electrical penetrations are similar in design and materials to the Types C1 and D electrical penetrations. The environmental qualification and functional characteristics (insulation resistance) of the Types C1 and D electrical penetrations are representative of the Type C2 electrical penetrations.

1.3 The environmental qualification of the Types F2 and J electrical penetrations was performed by Viking Industries Inc. as documented in the following file number:

1.3.1 OM337-0080-001, pages 4-187 through 4-229

1.3.1.1 Normal operating voltage and circuit continuity was maintained (OM337-0080-001, pages 4-210, 4-213EE, 213PP, 4-227 and 4-2290).

1.3.1.2 The minimum insulation resistance measurement taken prior to and following the environmental testing was 250 MEG OHMS (OM337-0080-001, pages 4-205, 4-206, 4-207, 4-213G, 4-213H, 4-213I, 4-213X, 4-213Z, 4-213AA, 4-213BB, 4-213HH,

4-213II, 4-213JJ, 4-213ZZ, 4-213AAA, 4-213BBB, 4-220, 4-221, 4-222, 4-223, 4-224, 4-229B, 4-229C, 4-229D, 4-229E, 4-229F and 4-229O).

1.3.1.3 The minimum insulation resistance measurement taken during the environmental testing was recorded as being less than 500 KΩ at 500 VDC (OM337-0080-001, pages 4-213CC, 4-213DD, 4-213EE, 4-213KK, 4-213LL, 4-213PP, 4-229B, 4-229C, 4-229D, 4-229E and 4-229F).

1.3.1.4 The qualification of the RG11 triaxial circuits in the type J electrical penetrations are limited by the RG11 triaxial cable connected to the triaxial connectors (OM337-0080-001, pages 4-213CCC, 4-213DDD and 4-213EEE).

2.0 The following provides information as to the outside containment Environmental Qualification:

2.1 The Environmental Qualification of the types B, C1, C2, D, F2 and J electrical penetration assemblies was performed by Viking Industries, Inc. As documented per Section 1.0 of this analysis. The inside containment Environmental Qualification envelopes the outside containment environmental conditions.

2.2 The Environmental Qualification of the Buchanan Terminal Blocks used with the Viking Electrical Penetration Assemblies was verified by Duke Power Company as documented in the following file number.

2.2.1 CG-3007.02-08, "Commercial Grade Item Documentation Package for Buchanan Terminal Blocks and Accessories"

2.2.1.1 The minimum insulation resistance was recorded as greater than 1 meg ohm at 500 vdc (Duke Power Company Steam Production Department Qualification and Testing Facility Report No. TR-028, Page 17).

The Environmental Condition for inside and outside containment are due to unrelated events and will not occur simultaneously. By recognizing that the environmental conditions inside containment are much more severe than the environmental conditions outside containment it can be assumed that the worst case functional characteristic (insulation resistance) will occur as a result of the environmental conditions inside containment.

Although the majority of the circuits tested exhibited much higher insulation resistance values it was determined that the higher values were not completely representative of the actual capabilities of the equipment. Since the minimum insulation resistance measured was recorded as being less than 500 KΩ at 500 VDC, a worst case functional characteristic (insulation resistance) of 250 KΩ at 500 VDC was assumed. In summary, the functional characteristic (insulation resistance of 250 KΩ at 500 VDC) provides both a technically conservative and technically justified representation of the Viking Industries, Inc., Electrical Penetration Assemblies, Types B, C1, D, F2 and J (with the exception of the RG11 triaxial circuits) during all environmental conditions (inside or outside containment).

The effect of a 250 KΩ at 500 VDC insulation resistance has been analyzed (see Attachment 1) for all Oconee safety circuits which must remain functional in the long term post accident utilizing Viking Electrical Penetration Assemblies Types B, D and J (with the exception of the RG11 triaxial circuits). The results indicate that the required long term circuit accuracies can be maintained at a penetration assembly insulation resistance of 250 KΩ at 500 VDC.

CONCLUSION:

Based on the extremely conservative interpretation of the qualification documentation available and the Oconee circuit analyses, it is concluded that the test verifies the adequacy of the Viking Electrical Penetration Assemblies, Types B, D and J for their Oconee applications.

PREPARED BY: R. P. Dover
Technical Associate

INSPECTED BY: B. G. Burton
Senior Technical Specialist

REVIEWED BY: J. P. Voglewede
Supervising Design Engineer

APPROVED BY: J. L. Crenshaw
Senior Engineer

ATTACHMENT 1 (3 PAGES)

Victoreen, Inc.

VICTOREEN

February 26, 1988

DUKE POWER COMPANY
ATTN R G MALLANEY
ELECTRICAL DIVISION
DESIGN ENGINEERING
526 SOUTH CHURCH ST
CHARLOTTE NC 28298

Reference: Enclosure 9.1
Victoreen Radiation Monitor in Containment
Termination Procedure

Dear Mr. R. G. Mallaney:

I have reviewed the referenced document received this date. It appears that Duke Power Company has attempted to address the concerns raised in Victoreen Qualification Report 950.301. This presupposes that the materials not covered by report 950.301 have been separately qualified for the LOCA environment.

One area of concern resulted from this review. The mismatch in temperature coefficient between the copper conductors and the plastic insulation may be such the excessive stress may result at the connection of the 16 gage wire to the connector. This could lead to breakage of the connection.

In response to the verbal question concerning the voltage applied between signal to ground, for an electrical analysis of circuit, the ion chamber is electrically equivalent to a guarded air capacitor. Therefore, the voltage impressed across the signal to ground would be the voltage drop caused by 7E-11 amps flowing through air at the 1R/hr end of the scale and that caused by 7E-4 amps at the 10E7 R/hr end of the scale.

If there are any further questions, please feel free to contact the undersigned.

Yours truly,

VICTOREEN, INC.

K. E. Stafford
Manager, Reliability Engineering

KES/slk

6000 Cochran Road
Cleveland, Ohio 44130-3395
(216) 248-9300
FAX (216) 248-9301
TWX 810-421-8287

SK 2: DUKE

Attachment #4
Page 1 of 1

Victoreen, Inc.

VICTOREEN

March 1, 1988

DUKE POWER COMPANY
ATTN E G FRAMPTON
DESIGN ENGINEERING
526 SOUTH CHURCH STREET
CHARLOTTE NC 28242

Dear Mr. Frampton:

Victoreen has reviewed the sketch of the Oconee Field Installation transmitted by Fax on February 29, 1988. This design addresses the area of concern raised in the letter from K. E. Stafford to R. G. Mallaney of February 26, 1988.

If there are any further questions, please feel free to contact the undersigned.

Yours truly,

VICTOREEN, INC.

K. E. Stafford

K. E. Stafford
Manager
Reliability Engineering

KES/slk

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DUKE POWER COMPANY

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Subject ______

______ By ______ Date ______

Sheet No. ___ of ___ Problem No. ______ Checked By ______ Date ______

Oconee Nuclear Station Units 1-3
Containment High Range Radiation
Monitors RIA-57, 58 Instrument
Loop Current Leakage Calculation

Attachment #5
Page: 1 of 16
File: OSC-2964

STATEMENT OF PROBLEM

Degradation of the insulation resistance of the incontainment cabling and of the containment penetrations used in the subject instrument loops could introduce an error in the measurement.

DESIGN METHOD USED

Based on the configuration and operation of the High Range Radiation Monitor System the following methodology was used:

1) Determine the effect of penetration and conductor parallel leakage resistances to ground on the transmitted current signal from the model 877-1 Detector.

2) Determine the effect of penetration and conductor parallel leakage resistances to ground on the high voltage (500 Vdc nominal) supply to the model 877-1 Detector.

CALCULATION

1) The following analysis to determine the effect of leakage resistance on the transmitted current signal is based on conversations with Ken Stafford of Victoreen, Inc. along with information supplied in reference #7. This analysis is similar to evaluations performed for the High Range Radiation monitoring system at McGuire Nuclear station. The High range radiation monitors at McGuire have the same principle of operation as the Victoreen monitors

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Oconee Nuclear Station Units 1-3
Containment High Range Radiation
Monitors RIA-57,58 Instrument
Loop Current Leakage Calculation

Attachment # 5
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File: OSC-2964

installed at Oconee. Based on the installation arrangement of the high range monitors at Oconee, as specified in installation procedure TN/2/A/1397/Ø1/C, two (2) possible leakage paths are assumed:

A. Leakage resistance from the Duke type SP-151 coax cable to ground (R_c).

B. Leakage resistance from the electrical penetration to ground (R_p)

It should be noted that the SP-151 coax cable is spliced to qualified #16AWG cable at the detector as specified in the referenced installation procedure. This splice is environmentally sealed within a swagelock connector. This calculation assumes the splice does not create any additional leakage paths. ie) The splice is considered to be as good as the cable. (See reference # 1Ø).

Below is a circuit model representing the current signal portion of the high range radiation monitors.

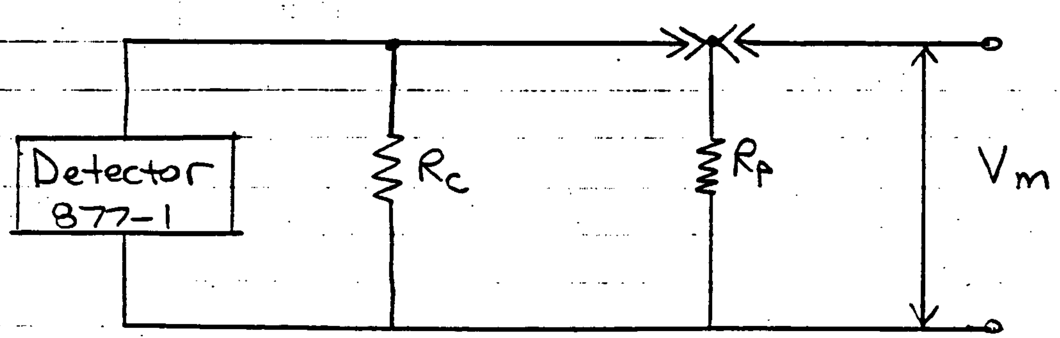

Figure 1

DUKE POWER COMPANY

Form 00184 (6-81)

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Oconee Nuclear Station Units 1-3
Containment High Range Radiation
Monitors RIA-57,58 Instrument
Loop Current Leakage Calculation

Attachment #5
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Values for Rp, Rc, and Vm are obtained as follows:

Rp

Rp is the worst case insulation resistance (IR) value for the electrical penetration during or post LOCA. Rp is equal to 250KΩ at 500Vdc for Viking type J penetrations per reference #6. The SP-151 cable on RIA-57,58 for all three (3) units goes through Viking type J penetrations, therefore, Rp = 250KΩ.

Rc

The value for Rc can be different for each loop on each unit due to differences in the IR/ft rating of the cable during or post LOCA and the length of the cable. The worst case value of Rc is obtained from the loop with the smallest IR/ft cable rating and the longest cable length. The worst case Rc value for RIA-57,58 is on the unit 3 RIA-57 loop and its value is determined as follows:

$$Rc(w.c.) = \frac{(1/1.1\times10^{7}\Omega)}{15ft} \times 116 ft = 7.03\times10^{-7}\mho = 1.422M\Omega$$

The IR/ft rating used is the worst case value for the cable during the first 42 hours of LOCA testing. (See reference #9). For monitor 3RIA-57 the cable # is 3ERM57A, the cable type is SP-151, and the vendor is Brand Rex. The cable length was determined by reviewing cable sheets.

Oconee Nuclear Station Units 1-3
Contaiment High Range Radiation
Monitors RIA-57, 58 Instrument
Loop Current Leakage Calculation

Vm

Vm is the maximum voltage seen at the input of the preamplifier (connection J302). This voltage is a maximum since the transmitted current signal is a D.C. signal as opposed to a pulse signal. The value of Vm is in the range of a few microvolts on the low end of the detector range (7×10^{-11}A) and in the range of a few millivolts on the high end of the detector range (7×10^{-9}A).

Since R_c and R_p are connected in parallel in figure 1, the total leakage resistance (R_L) can be found as follows:

$$R_L = R_c \parallel R_p = \frac{(1.422 \times 10^6 \Omega)(250 \times 10^3 \Omega)}{(1.422 \times 10^6 \Omega + 250 \times 10^3 \Omega} = 212{,}629 \Omega$$

By using the above values for Vm and R_L the error or leakage current produced on the low end and high end of the detector range can be calculated. For conservatism, assume Vm on the low end is 10 microvolts and Vm on the high end is 10 millivolts.

$$\text{Error (leakage) current on low end} = \frac{10 \times 10^{-6} V}{212{,}629 \Omega} = 4.7 \times 10^{-11} A$$

$$\text{Error (leakage) current on high end} = \frac{10 \times 10^{-3} V}{212{,}629 \Omega} = 4.7 \times 10^{-8} A$$

This error or leakage current usually flows in the wrong direction forcing the output down scale. ie) The transmitted current signal from the detector must overcome this loss of current before the monitor will give an output. Therefore, the leakage current causes an offset in the measured radiation levels. This offset can be calculated in terms of the R/Hr scale of the readout module as follows:

DUKE POWER COMPANY

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Oconee Nuclear Station Units 1-3
Containment High Range Radiation
Monitors RIA-57,58 Instrument
Loop Current Leakage Calculation

Attachment #5
Page: 5 of 10
File: OSC-2904

Detector Current Signal (Amps)	Monitor Readout (R/Hr)
7×10^{-11}	1
7×10^{-10}	10^{1}
7×10^{-9}	10^{2}
7×10^{-8}	10^{3}
7×10^{-7}	10^{4}
7×10^{-6}	10^{5}
7×10^{-5}	10^{6}
7×10^{-4}	10^{7}

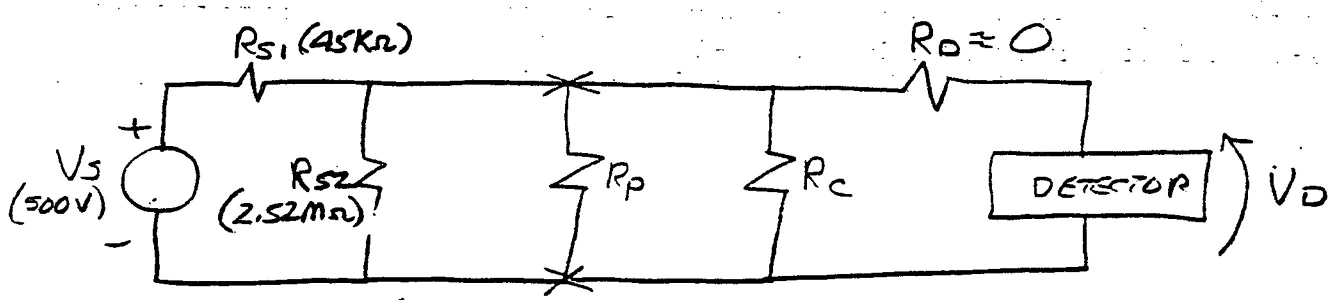
From the table above, a leakage current of 4.7×10^{-11}A on the low end will cause an R/hr offset of less than 1. A leakage current of 4.7×10^{-8}A on the high end will cause an R/hr offset of less than 1000. the less than 1000 R/hr offset at the high end is considered negligible when compared to the R/hr range of 10^{7}. The less than 1 R/hr offset at the low end is considered negligible since the purpose of the monitors is to detect high radiation levels inside containment. Assuming a linear relationship between Vm and the detector current signal over the entire range of the monitors, any R/hr offsets will be negligible when compared to the corresponding monitor readout range.

2) The following analysis is to determine the effect of leakage resistances on the high voltage (500 Vdc nominal) supply to the model 877-1 Detector.

Oconee Nuclear Station Units 1-3
Containment High Range Radiation
Monitors RIA-57, 58 Instrument
Loop Current Leakage Calculation

Attachment #5
Page: 6 of 10
File: OSC-2904

Below is a model of the Victoreen High Range Containment Radiation Monitor (RIA-57 & RIA-58) used at Oconee 1, 2 & 3. This circuit is based on information given in Reference #3.



V_S = Detector Power Supply (500 VDC nominal)
R_{S1} = Series resistance of detector power supply (45 KΩ)
R_{S2} = Parallel resistance of detector power supply (2.52 MΩ)
R_P = Penetration leakage resistance
R_C = Cable Insulation Resistance (IR)
R_D = Series resistance of power supply cable to detector (negligible)
V_D = Vottage at detector

The purpose of this calculation is to determine the voltage present at the detector (V_D) at various radiation levels using the worst case values of penetration and cable leakage resistance.

Values for Rp and Rc are obtained as follows:

Rp

Rp is the worst case insulation resistance (IR) value for the electrical penetration during or post LOCA. Rp is equal to 250KΩ at 500 VDC for Viking type J penetrations per memo to file OS-90A dated 01/29/88. Since the cabling between the detector and readout modules for RIA-57 and RIA-58 on all three (3) units goes through Viking type J penetrations, the 250KΩ value is used for Rp in this power supply current leakage calculation.

Rc

The value for Rc is obtained from the detector with the longest cable (116 ft).

$$R_c = \frac{(1/1.1 \times 10^7 \Omega)}{15\,ft} \times 116\,ft = 7.0303 \times 10^{-7} ℧$$

$$= 1.422\,M\Omega$$

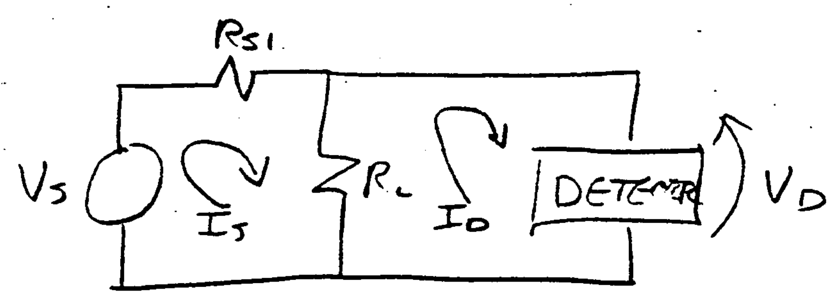
The IR/ft rating for the cable was obtained from the test report given in Reference #9. The cable length

was determined by reviewing cable sheets,

For simplification, let R_L = the parallel combination of R_{S2}, R_P and R_C.

$$R_L = 2.52M \| 250K \| 1.422M = 0.909M \| 250K = 196K\Omega$$

With this simplification, the model now becomes as shown below:



Writing loop equations for this circuit yields the following:

$$V_S = (R_{S1} + R_L) I_S - R_L I_D$$
$$I_S (R_{S1} + R_L) = V_S + R_L I_D$$

$$I_S = \frac{V_S + R_L I_D}{R_{S1} + R_L}$$

$$V_D = (I_S - I_D) R_L$$

$$V_D = \left[\frac{V_S + R_L I_D}{R_{S1} + R_L} - I_D\right]\left[R_L\right]$$

$$= \left[\frac{V_S + R_L I_D - I_D(R_{S1} + R_L)}{R_{S1} + R_L}\right]\left[R_L\right]$$

$$V_D = \left[\frac{V_S - R_{S1} I_D}{R_{S1} + R_L}\right] R_L$$

Solving the above equation for values of detector current (I_D) the following values for V_D are obtained:

$$V_D\Big|_{I_D=7\cdot10^{-11}A} = \left[\frac{500-(0.045\cdot10^{6})(7\cdot10^{-11})}{45K+196K}\right]\left[196K\right]$$

$$= 406.6\ V$$

In a similar manner, values for V_D are obtained for each decade of radiation. These results are shown in the table below.

MONITOR RANGE (R/HR)	I_D (A)	$V_{DETECTOR}$
1	$7\cdot10^{-11}$	406.6
10	$7\cdot10^{-10}$	406.6
10^2	$7\cdot10^{-9}$	406.5
10^3	$7\cdot10^{-8}$	406.5
10^4	$7\cdot10^{-7}$	406.5
10^5	$7\cdot10^{-6}$	406.3
10^6	$7\cdot10^{-5}$	404.0
10^7	$7\cdot10^{-4}$	380.9

DUKE POWER COMPANY

Form 00184 (6-81)

Dev./Station	Unit	File No.	
Subject			
	By	Date	
Sheet No. ___ of ___ Problem No.	Checked By	Date	

Oconee Nuclear ~~Station~~ Units 1-3
Containment High Range Radiation
Monitors RIA-57,58 Instrument
Loop Current Leakage Calculation

Attachment #5

File: OSC-2904

CONCLUSION

The error in the transmitted current signal of the high range radiation monitor system due to the effect of current leakage is considered negligible.

The minimum voltage at the detector for any range of radiation is 380.9 volts. This lowest voltage reading occurs only at the highest radiation level (10^7 R/hr). At all other levels ($1-10^6$ R/hr) the voltage remains above 400 volts. While a failure alarm may occur at the readout module for RIA-57 or RIA-58, the monitor will continue to provide ~~accurate readings~~. adequate readings for operator information.

Attachment #6
Page: 1 of 5

January 21, 1988

Memo to Files: CN-1367.01/MC-1367.01/OS-90

Subject: All Nuclear Stations
Raychem Nuclear Splices
Leakage Currents

References:
1) CNM1354.00-0073-001, Wyle Report No. 58722-2
2) CNM1354.00-0043-001, Wyle Report No. 58442-1
3) CNM1354.00-0078-001, 002, 003;
   CCL Report No. 86-1995
   Wyle Report No. 17859-02P
   Wyle Report No. 17859-02B
   Patel Report No. PEI-TR-860300-01
4) Raychem letter of 01/19/88 to R G Sokal (attached)
5) CNM1354.00-0069-001, Rockbestos Report No. QR-5804
6) CNM1354.00-0072-001, Rockbestos Report No. QR-5805

The purpose of this memo is to demonstrate that the affect of Raychem nuclear grade splices to circuit loop accuracies is negligible. By completely sealing and reinsulating the metallic splice connection, the electrial performance of the splice insulation is similar to corresponding lengths of cable.

In Wyle Report No. 58422-1 the worst case insulation resistance reading during the LOCA simulation of all the test samples was 1.2×10^{7} ohms (reference 2, page 17). The test samples were Raychem in-line splices over Rockbestos Firewall III insulated wire. Although the lengths of the test samples were not identified in the report, analysis of circuit diagrams, photographs, and test mandrel size indicate that the sample lengths inside the chamber were approximately 8 feet. An insulation reading of 1.2×10^{7} ohms per 8 feet equates to 96K ohms per 1000 feet. (Note that this is a conservative value for the test samples since the insulation readings during LOCA included the affects of extension leads outside the chamber which if taken into consideration when equating to ohms/1000 feet would result in a higher insulation resistance value).

In Rockbestos qualification report QR-5805 on Firewall III irradiation XLPE wire, the worst case insulation resistance reading during the LOCA simulation was 90K ohms/1000 feet (reference 6, page 3-84). In Rockbestos qualification report QR-5804 on Firewall III chemically XLPE wire, the worst case insulation resistance reading during the LOCA was 8K ohms/1000 (reference 5, page 3-96). Note that the insulation reading for cable and splices were equal to or better than for cable alone.

In Wyle Report No. 58722-2 the worst case insulation reading during the LOCA simulation of all the test samples was 2.4×10^{6} ohms (reference 1, page 3-22). The test samples were Raychem in-line splices over Rockbestos Firewall III chemically XLPE insulated wire. A 3-1/2 foot test sample with an insulation resistance reading of 2.4×10^{6} ohms equates to 8.4K ohms per 1000 feet (Again, from analysis of test report photographs and circuit diagrams, the sample lengths inside the chamber are approximately 3-1/2 feet).

As stated above, the worst case insulation resistance reading during the Rockbestos QR-5804 test was 8K ohms per 1000 feet. Again, the insulation resistance readings of splice and cable samples are equivalent to or better than cable samples alone.

As extra conservatism in concluding that the affects of splices to circuit loop accuracies is negligible, the following lists "incorrectly" installed tested splice configurations and their respective measured leakage currents during accident simulations. These configurations were tested by various sponsor utilities to answer operability concerns of poorly installed Raychem splices raised by NRC IE Notice 86-53. This following information is documented in reference 3, Volumes 1, 2, and 3.

1) In Corporate Consulting Report No. 86-1995 sponsored by TVA, severely bent splices with shorter than required overlaps recorded less than 1 milli-Amp leakage during the accident simulation (reference 3, pages 7-39 through 7-52).

2) In Wyle Report No. 17859-02P sponsored by Commonwealth Edison, severely bent splices (samples Z8, Z9, and Z10) and splices with short overlaps (samples Z2, and Z3) all had peak recorded leakage current readings of 0 milli-Amps (reference 3, page 8-96).

3) In Wyle Report No. 17859-02B sponsored by Commonwealth Edison, sample D2 (improper tubing hold-out), sample D9 (badly bent splice) and samples D13, D14, and D15 (short overlaps, connected in series) all had peak recorded leakage current readings of 0 milli-Amps (reference 3, pages 9-171, 9-173)

4) In Patel Engineers Report No. PEI-TR-860300-01 sponsored by N.Y. Power Authority, samples 11 and 13 (short overlaps) had maximum current leakage readings of less than 1/2 milli-Amp (reference 3, page 17-15).

The conclusion that the contribution of Raychem splices to circuit loop accuracies is negligible is also supported by Ken Baker, Nuclear Products Manager of Raychem (see reference 4, attached).

Based on all the above information and test data, the contribution to circuit leakage currents by a properly installed Raychem nuclear grade splice is negligible.

Checked: R J Smith
Design Engineer I

By: R G Sokal
Technical Assistant III

Approved: J P Voglewede
Supervising Design Engineer

Attachment*

cc: J L Crenshaw*
J E Thomas*
G B Swindlehurst*
T P Harrall*
J P Voglewede*
R J Smith*
Central Records

Raychem

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January 19, 1988

Duke Power Company
526 South Church Street
Charlotte, NC 28242

Attention: Mr. Richard Sokal
Design Engineering

Subject: Leakage Currents

Dear Mr. Sokal:

The following is in response to your question concerning the contribution or affect of the Raychem nuclear grade splice to circuit loop accuracies (e.g., leakage currents):

- By completely sealing and reinsulating each connection, electrical performance of splices is similar to corresponding length of cable.

- Periodic IR reading during the LOCA exposure (Wyle 58422-1):
  - ~ 10^{10} initial (ambient in water)
  - ~ 10^{7} at 300°F (after peak)
  - ~ 10^{8} at 230°F
  - ~ 10^{10} final (ambient in water)

- Polymeric materials (including cable insulation) lower their electrical resistance values as temperature goes up, returning as temperature returns.

- Leakage current of the cable/splice assembly in ANSI C119-1 (see EDR-5008) of only 70 microamps at 600 Vac. (note: cable lengths were two feet long.)

- Leakage current measurement of the cable/splice assembly during LOCA test (EDR-5011) was 2.3ma at 340°F with insulation resistance of $1x10^{9}$ at the same temperature. (note: cable lengths were approximately ten feet long.)

XE ELECOPIER 295 ; 1-20-88:11:46 AM: ENERGY CUST SERVICE → 7043738107 : # 3
JAN-20-'88 09:45 ID:ENERGY CUST SERVICE TEL NO:#415-361-2375 #245 P03

Considering all of the aforementioned information and test data. the contribution to the circuit leakage currents by a properly installed Raychem nuclear grade splice is negligible.

If you have any questions. do not hesitate to contact me at (415) 361-2276.

Sincerely.

Kenneth Baker
Nuclear Products Manager
Nuclear Product Marketing
Energy Division

xc: John Hoffman (Raychem, Menlo Park, CA)
Frank Fitzgerald (Raychem, Atlanta, GA)