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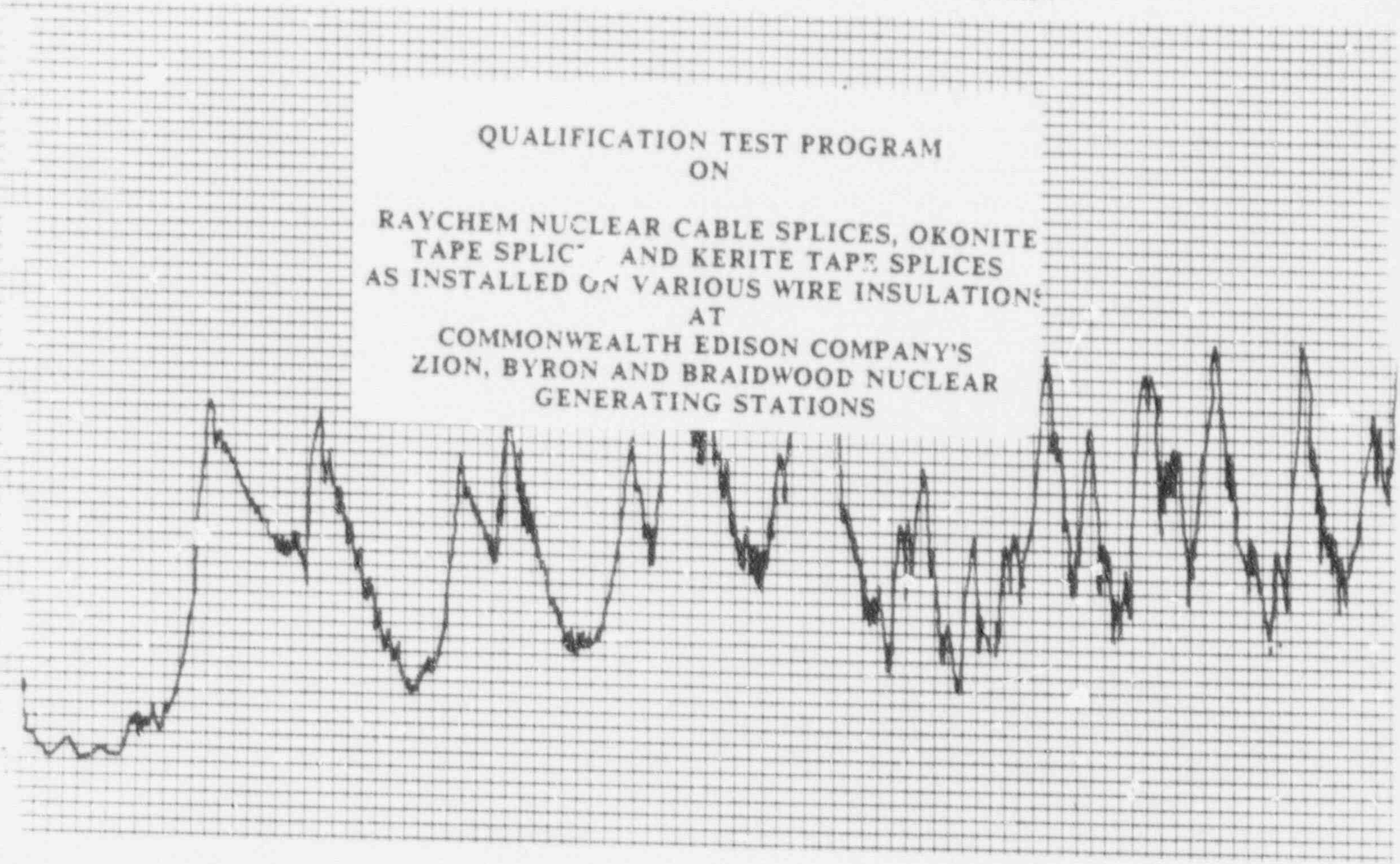

QUALIFICATION TEST PROGRAM
ON
RAYCHEM NUCLEAR CABLE SPLICES, OKONITE TAPE SPLICES AND KERITE TAPE SPLICES AS INSTALLED ON VARIOUS WIRE INSULATIONS
AT
COMMONWEALTH EDISON COMPANY'S ZION, BYRON AND BRAIDWOOD NUCLEAR GENERATING STATIONS

NEQ
NUCLEAR ENVIRONMENTAL QUALIFICATION

9204070287 920219
PDR ADOCK 05000348
G PDR

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test REPORT

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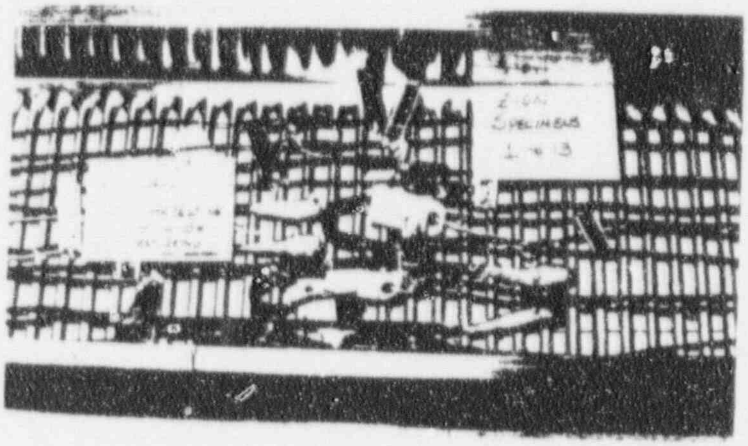
NEQ

Nuclear Environmental Qualification

Test Report



REPORT NO. 17859-02P

WYLE JOB NO. 17859

CUSTOMER P. O. NO. 806121 Release NU-2

PAGE i OF 345 PAGE REPORT

DATE March 11, 1987

SPECIFICATION (S) See References in Paragraph 8.0 of this Summary Section

1.0 CUSTOMER Commonwealth Edison Company

ADDRESS P. O. Box 767, Chicago, IL 60960

2.0 TEST SPECIMEN Raychem Nuclear Cable Splices, Okonite Splices and Kerite Splices

3.0 MANUFACTURER Raychem, Okonite and Kerite

4.0 SUMMARY

Various cable and cable splice assemblies, as described in Paragraph 6.0, were subjected to the environmental qualification program described herein. These specimens are as installed in Commonwealth Edison Company's Zion, Byron and Braidwood Nuclear Generating Stations.

This Qualification Test Program was performed to satisfy the intent of IEEE Standard 323-1974, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations".

STATE OF ALABAMA }
COUNTY OF MADISON } ss. Alabama Professional Eng. Reg. No. 7948

Frederick M. Sittason, being duly sworn, deposes and says: The information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.

SEAL

SUBSCRIBED and sworn to before me this 11th day of March, 19 87

Notary Public in and for the State of Alabama at large

My Commission expires June 13, 19 87

Wyle shall have no liability for damages of any kind to person or property, including special or consequential damages, resulting from Wyle's providing the services covered by this report

PREPARED BY 3/11/87
J. T. Hazelrigg

APPROVED BY 3/11/87
F. R. Johnson

WYLE Q. A. 3-11-8
for G. W. Hight

WYLE
LABORATORIES SCIENTIFIC SERVICES & SYSTEMS
HUNTSVILLE, ALABAMA

①

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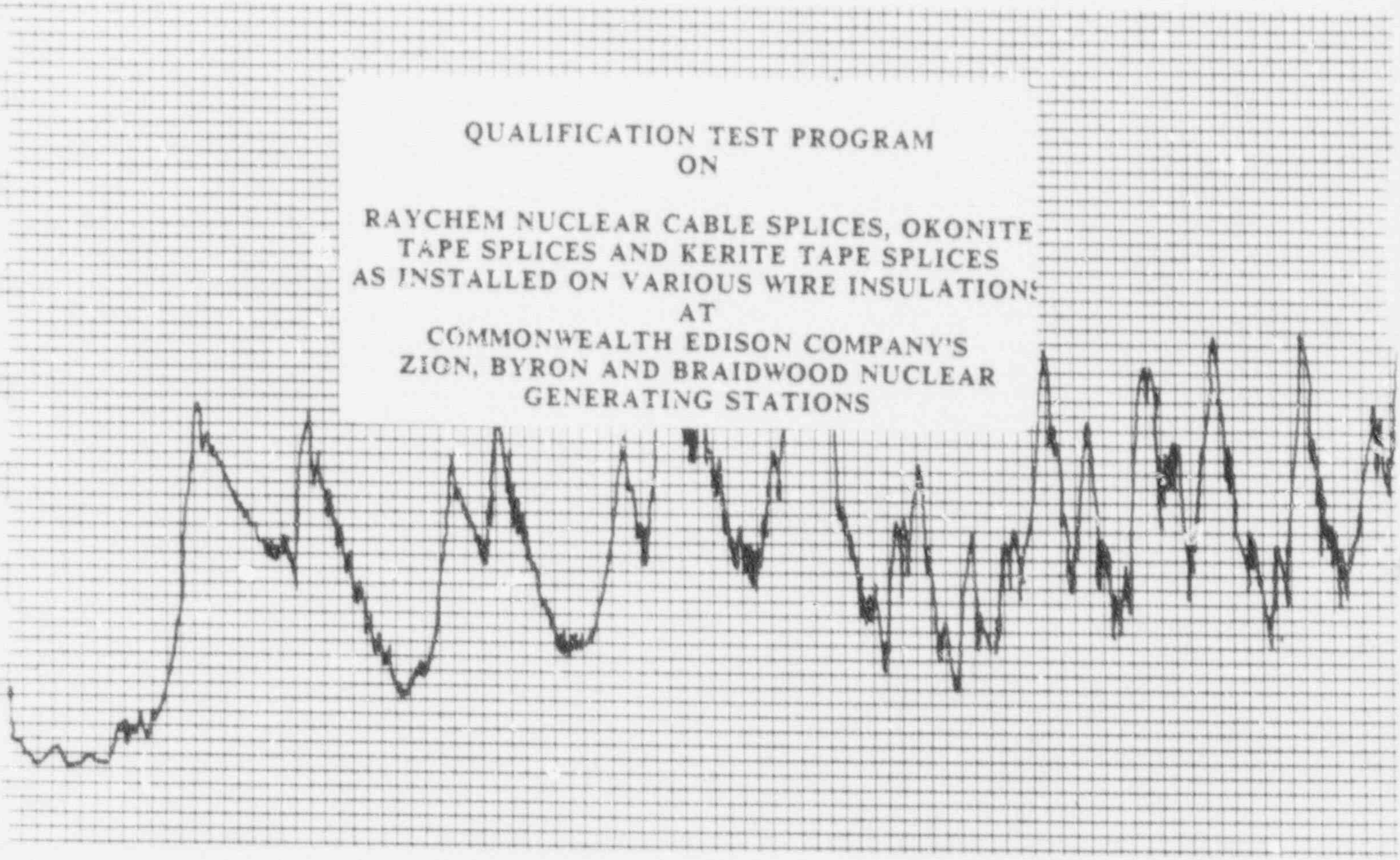

QUALIFICATION TEST PROGRAM ON RAYCHEM NUCLEAR CABLE SPLICES, OKONITE TAPE SPLICES AND KERITE TAPE SPLICES AS INSTALLED ON VARIOUS WIRE INSULATIONS AT COMMONWEALTH EDISON COMPANY'S ZION, BYRON AND BRAIDWOOD NUCLEAR GENERATING STATIONS

NEQ

NUCLEAR ENVIRONMENTAL QUALIFICATION

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test REPORT

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7597-03-E91-25-1

NUCLEAR REGULATORY COMMISSION

Docket No. 50-348/364-CivP Official Exh. No. 27

In the matter of Alabama Power Company

Staff ________ IDENTIFIED 3:44 p.m.

Applicant ✓ RECEIVED 3:44 p.m. 2/19/92

Intervenor ________ REJECTED ________

Cont'g Off'r ________

Contractor ________ DATE 2/19/92

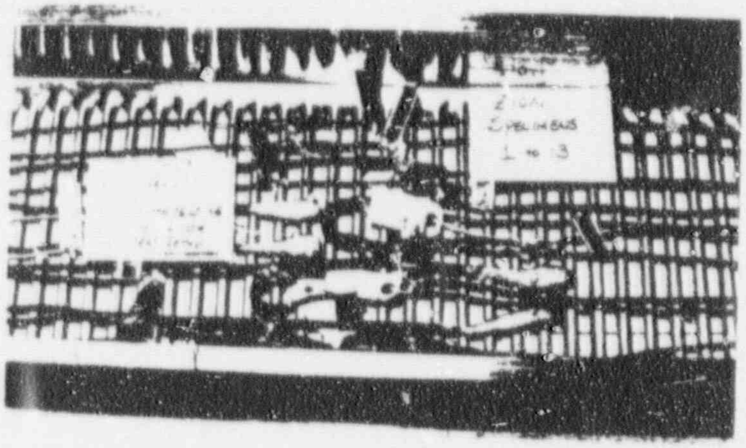
Other ________ Witness ________

Reporter Estep

NEQ

Nuclear Environmental Qualification

Test Report



REPORT NO. 17859-02P

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PAGE 1 OF 345 PAGE REPORT

DATE March 11, 1987

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1.0 **CUSTOMER** Commonwealth Edison Company

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STATE OF ALABAMA
COUNTY OF MADISON } ss. Alabama Professional Eng. Reg. No. 7948

Frederick M. Sittason, being duly sworn, deposes and says: The information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.

SEAL Frederick M. Sittason

SUBSCRIBED and sworn to before me this [illegible] day of March, 1987

Notary Public in and for the State of Alabama at large.

My Commission expires June 13, 1987

Wyle shall have no liability for damages of any kind to person or property, including special or consequential damages, resulting from Wyle's providing the services covered by this report.

PREPARED BY 3/11/87
J. T. Hazelethe

APPROVED BY 3/11/87
F. R. Johnson

WYLE Q. A. 3-11-87
for G. W. Hight

WYLE
LABORATORIES SCIENTIFIC SERVICES & SYSTEMS
HUNTSVILLE, ALABAMA

5.0 REPORT FORMAT

The test program was performed as specified in Reference 8.1 and as detailed in this report. The individual test results and the test procedure are presented in the following sections:

o	Section I	-	Baseline Functional Tests
o	Section II	-	Normal Radiation Exposure
o	Section III	-	Post-Normal Radiation Exposure Functional Tests
o	Section IV	-	Thermal Aging
o	Section V	-	Post-Thermal Aging Functional Tests
o	Section VI	-	Accident Radiation Exposure
o	Section VII	-	Post-Accident Radiation Exposure Functional Tests
o	Section VIII	-	Accident (LOCA) Test
o	Section IX	-	Post-Accident (LOCA) Functional Tests
o	Section X	-	Wyle Laboratories' Qualification Plan Number 17859-01, Revision C

6.0 TEST SPECIMEN DESCRIPTION

The test specimens consisted of seven Byron/Braidwood samples (specimens B1-B-7) and 13 Zion samples (specimens Z1-Z13) as detailed in the following table. All specimens, except B-5 which was constructed at Wyle Laboratories, were constructed by Commonwealth Edison Company (CECO) technicians from the applicable generating station.

Specimen Number	Splice Material	Configuration	Overlap*	See App. I Figure**
B-1	Raychem WCSF-N	Single conductor #14 Rockbestos to 2-1 conductor #14 Rockbestos - WCSF-N splice	1/2"	1
B-2	Raychem	Single conductor #14 Rockbestos to 2-1 WCSF-N conductor #14 Okonite - WCSF-N splice	1/2"	2
B-3	Raychem	2 conductor #16 Rockbestos to 3-1 conductor WCSF-N #16 Rockbestos - WCSF-N splice	1/2"	3
B-4	Okonite	#14 Okonite to #14 Okonite (lugged back to back) V-type splice with Okonite tape and no insulation tape in crotch	-	4

*Overlap refers to the amount of distance that the splice insulating material extended past the end of the metal used in the physical connection of the joined wires.

**Refers to the applicable sketch in Appendix I of this section.

6.0 TEST SPECIMEN DESCRIPTION (Continued)

Specimen Number	Splice Material	Configuration	Overlap	See App. I Figure
B-5	Okonite	#14 Okonite to #14 Nomax (pigtail from Limitorque) (lugged back to back) V-type splice with Okonite tape and no insulation in crotch	-	5
B-6	Okonite	#10 Okonite to #10 Okonite (lugged back to back) V-type splice with Okonite tape and no insulation in crotch	-	6
B-7	Okonite	500 - Okonite to 500 - Okonite V-type splice with Okonite tape.	-	N/A
Z-1	Raychem NPKV	#14 BIW (Boston Insulated Wire) single conductor to ASCO solenoid valve lead wire w/non-impregnated braid-Raychem stub type connector NPKV-2-10A	-	7
Z-2	Raychem NPKS	#14 BIW to #15 Kapton insulated wire-Raychem NPKS-1-11A	1/2"	8
Z-3	Raychem NPKS	#14 BIW to #16 Kapton Insulated wire-Raychem NPKS-1-11A	3/4"	9
Z-4	Raychem NPKS	#14 BIW single conductor to Static-O-Ring switch lead wire w/impregnated braid-Raychem NPKS-1-11A	1/2"	10
Z-5	Raychem NPKS	#14 BIW single conductor to Static-O-Ring switch lead wire w/impregnated braid-Raychem NPKS-1-11A	3/4"	11
Z-6	Raychem NPKV	#14 field conductor BIW to silicone hi-temp braid motor lead-Raychem NPKV-2-10A	-	12
Z-7	Kerite	#14 BIW to #14 BIW - V-type splice with Kerite tape	-	16
Z-8	Raychem NPKS	#14 BIW to #14 BIW-Raychem NPKS-1-11A with 180 degree bend	1/2"	13
Z-9	Raychem NPKS	#14 BIW to #14 BIW-Raychem NPKS 1-11A with 180 degree bend	1"	14
Z-10	Raychem NPKS	#14 BIW to #14 BIW-Raychem NPKS 1-11A with 180 degree bend	2"	15

6.0 TEST SPECIMEN DESCRIPTION (Continued)

Specimen Number	Splice Material	Configuration	Overlap	See App. I Figure
Z-11	Kerite	#14 BIW to silicone hi-temp braid motor lead-Kerite tape over bolted V connector with putty in crotch	-	16
Z-12	Kerite	#14 BIW to silicone hi-temp brand motor lead-Kerite tape over bolted V connector with putty in crotch	-	16
Z-13	Kerite	#14 BIW to #14 BIW - V type splice with Kerite tape	-	16

7.0 TEST PROGRAM RESULTS

It was demonstrated by testing that all of the test specimens, except for Z11, Z12 and B4, are qualified to the below listed environmental conditions in accordance with IEEE Standard 323-1974, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations".

Radiation Dose:	16 Megarads Gamma normal 40-year TID
	184 Megarads Gamma accident dose (includes 10% margin)
Service Temperature:	122°F
Qualified Life:	40 years
Design Basis Event:	See Test Profiles in Figure VIII-5 of Section VIII.

Two anomalies occurred during this test program. These anomalies are discussed briefly and in more detail in Section VIII.

Notice of Anomaly No.	Date	Description
1	9/25/86	Documents the inability of specimens Z11, Z12 and B4 to hold their specified voltages without blowing fuses during the LOCA test. These specimens did not demonstrate qualification to IEEE Standards 323-1974 or 383-1974 during this test program.
2	9/25/86	Documents a circuitry change to specimen Z2 which occurred due to an operator error while adjusting the circuit voltage. The operator error damaged a Wyle supplied OMEGA PX114 transmitter which was the circuit load. This transmitter was replaced by a fixed precision rheostat. Qualification status of specimen Z2 was not affected.

8.0 REFERENCES

8.1 Wyle Laboratories Final Qualification Plan 17859-01, Revision C, "Environmental Qualification of Raychem WCSF-N Nuclear Splices, Okonite Tapes, Scotch Tapes, Kerite Tapes, and Amp Splices as installed on Various Wire Insulations at Commonwealth Edison Company's LaSalle County, Zion, Dresden, Quad Cities, Byron, and Braidwood (See Section X).

8.2 IEEE Standard 323-1974, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations".

8.3 IEEE Standard 383-1974, "IEEE Standard for Type Testing of Class 1E Cables, Field Splices, and Connections for Nuclear Power Generating Stations".

8.4 NUREG-0588 "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment," Revision 1, dated July 1981.

8.5 Regulatory Guide 1.89.

8.6 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants."

8.7 Code of Federal Regulations 10 CFR 21.

8.8 Code of Federal Regulations 10 CFR 50, Appendix B.

9.0 QUALITY ASSURANCE

All work performed on the test program was done in accordance with Wyle Laboratories' Quality Assurance Program, which complies with the applicable requirements of 10 CFR 50, Appendix B, ANSI N45.2, and the "daughter" standards. Defects are reported in accordance with the requirements of 10 CFR Part 21.

10.0 TEST EQUIPMENT AND INSTRUMENTATION

All instrumentation, measuring and test equipment used in the performance of this test program were calibrated in accordance with Wyle Laboratories' Quality Assurance Program, which complies with the requirements of Military Specification MIL-STD-45662. Standards used in performing all calibrations are traceable to the National Bureau of Standards by report number and date. When no national standards exist, the standards are traceable to international standards or the basis for calibration is otherwise documented.

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APPENDIX I

SPLICE CONSTRUCTION DETAILED SKETCHES

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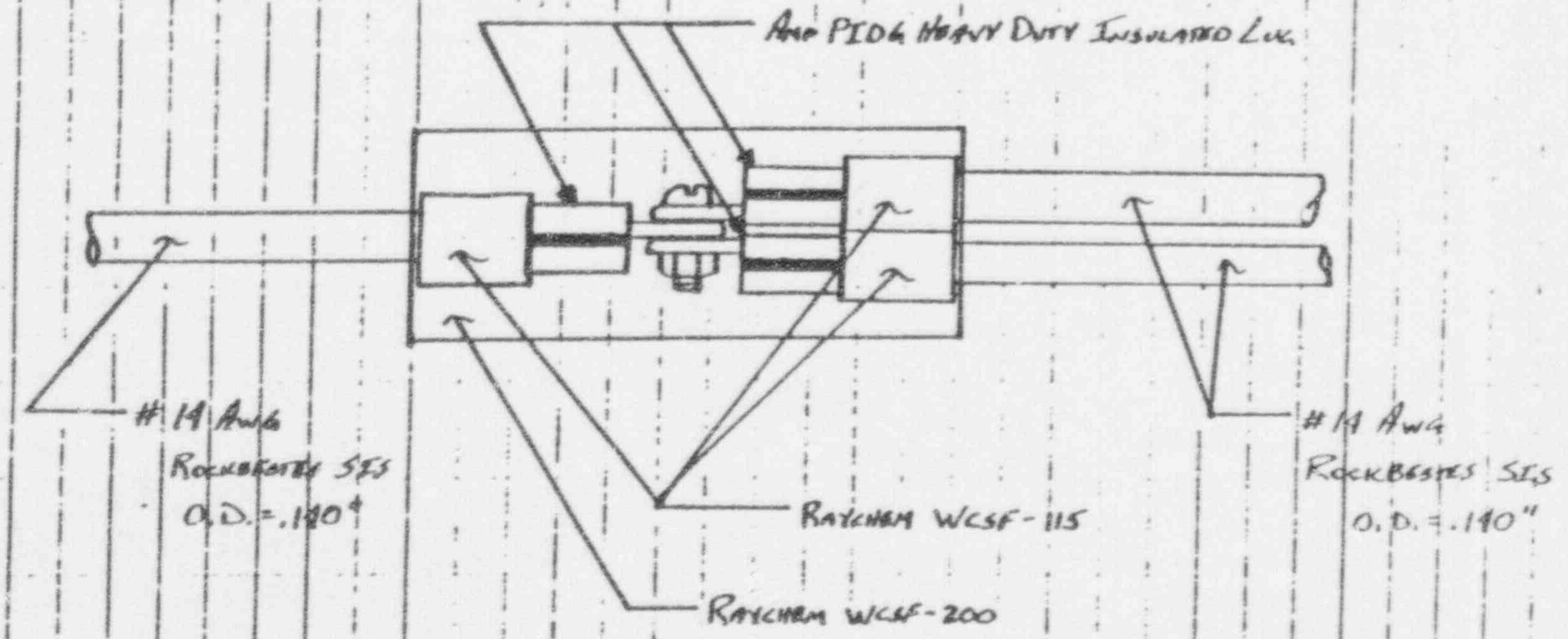
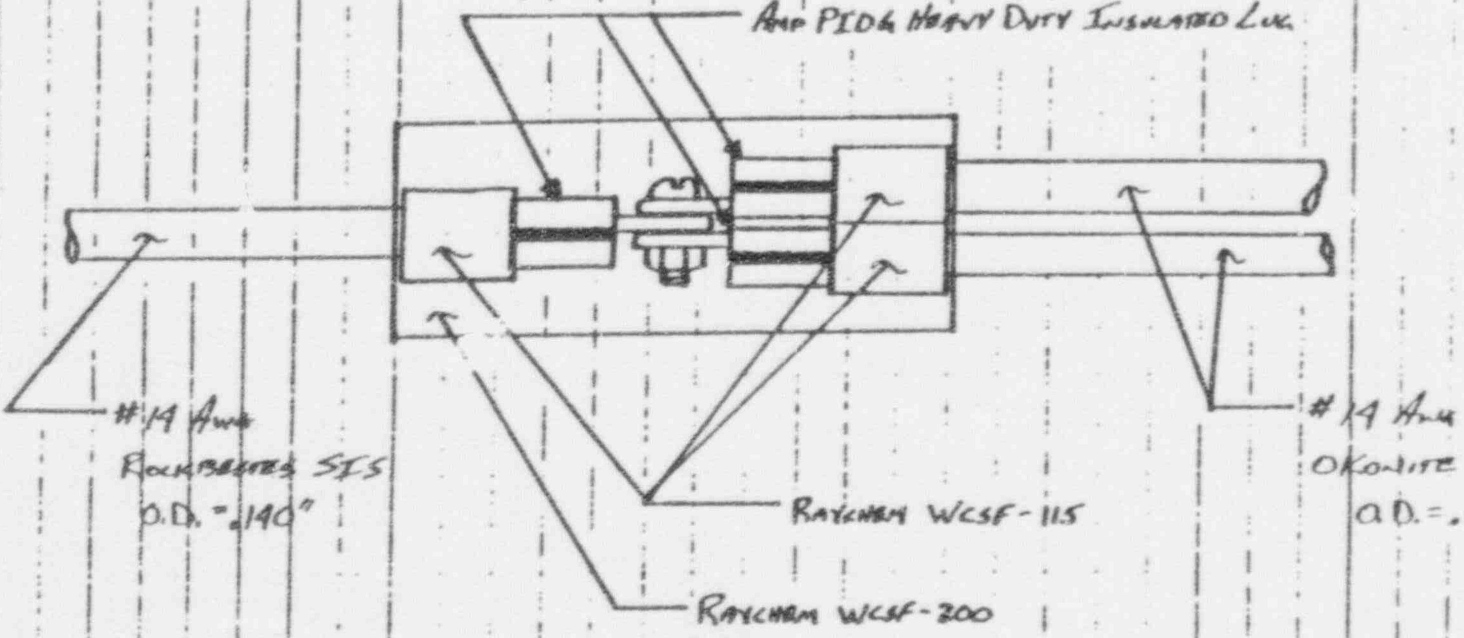


NOTES: 1) RAYCHEM TUBING IS NUCLEAR GRADE
2) WCSF-200 FLATTENED OVER SPLICE WHILE HEATED
3) WCSF-200 IS APPROX. 2 3/4" LONG
4) WCSF-115 ARE APPROX. 1/2"
5) PIDG LUGS ARE FOR #16-14 AWG

SPECIMEN B1

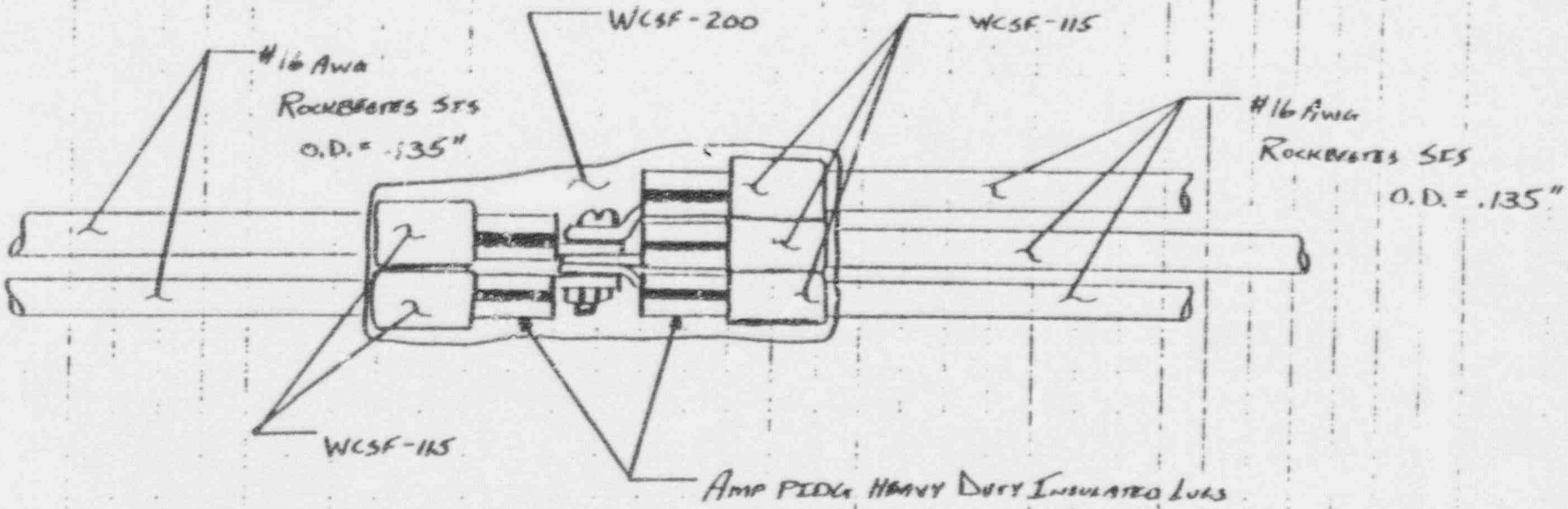
FIGURE 1



Notes:
1) Raychem Tubing is Nuclear Grade
2) WCSF-200 Flattened over Splice When Heated
3) WCSF-200 is Approx. 2 3/4" Long
4) WCSF-115 Are [illegible]" Long
5) PIDG Lugs Are For #16-14 AWG

Specimen B2

FIGURE 2



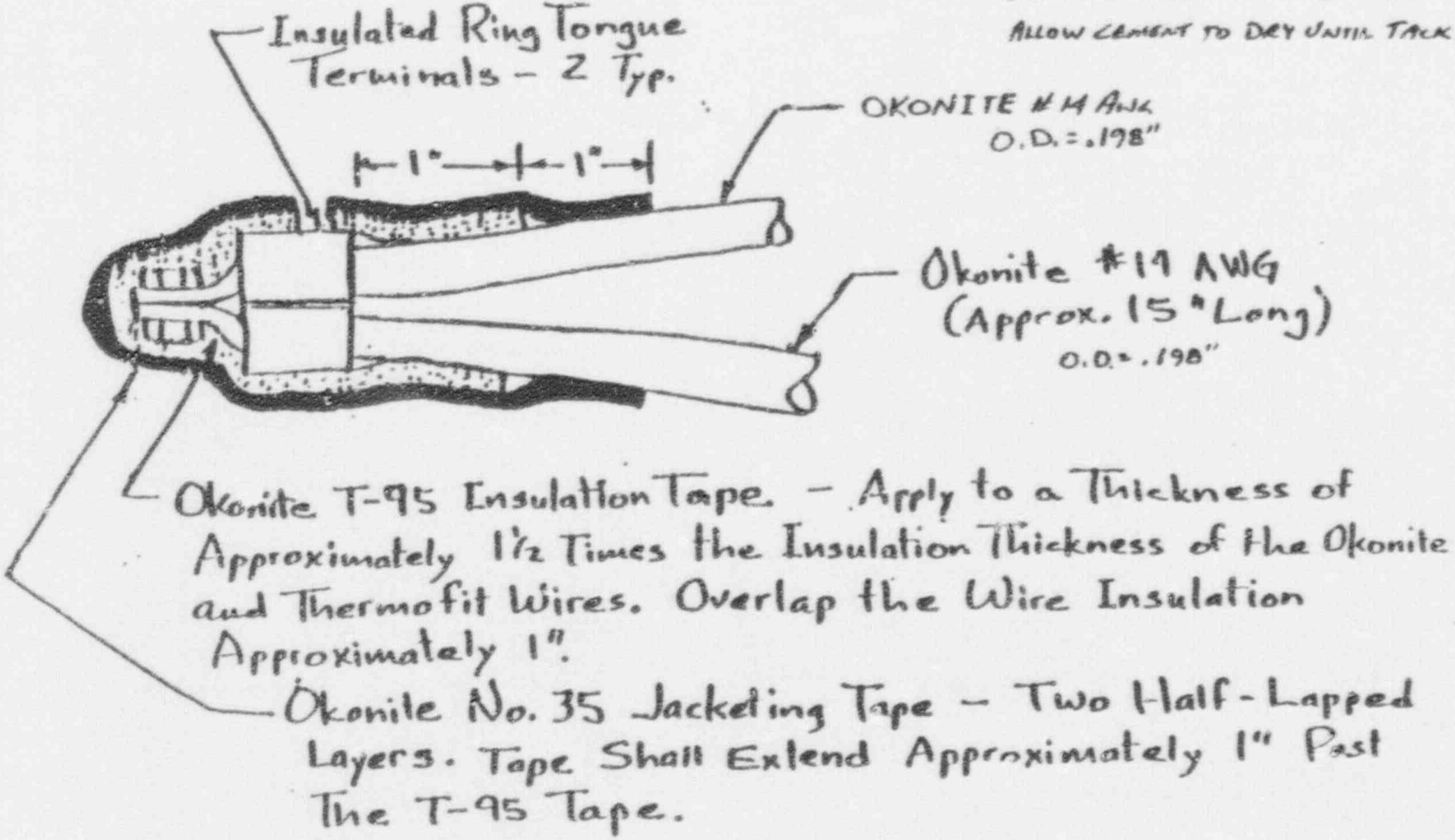
Notes: 1) Raychem tubing is Nuclear Grade
2) WCSF-200 is flattened over splice while heated
3) WCSF-200 is Approx. 2 5/8" Long
4) WCSF-115 are Approx. 1/2" Long
5) PIDG Lugs are for #16-14 AWG

Specimen · No

FIGURE 3

Note:

PRIOR TO TAPING APPLY OKONITE NUCLEAR SPLICING CEMENT OVER CABLE AND LUGS. ALLOW CEMENT TO DRY UNTIL TACKY



Okonite T-95 Insulation Tape. - Apply to a Thickness of Approximately 1½ Times the Insulation Thickness of the Okonite and Thermofit Wires. Overlap the Wire Insulation Approximately 1".

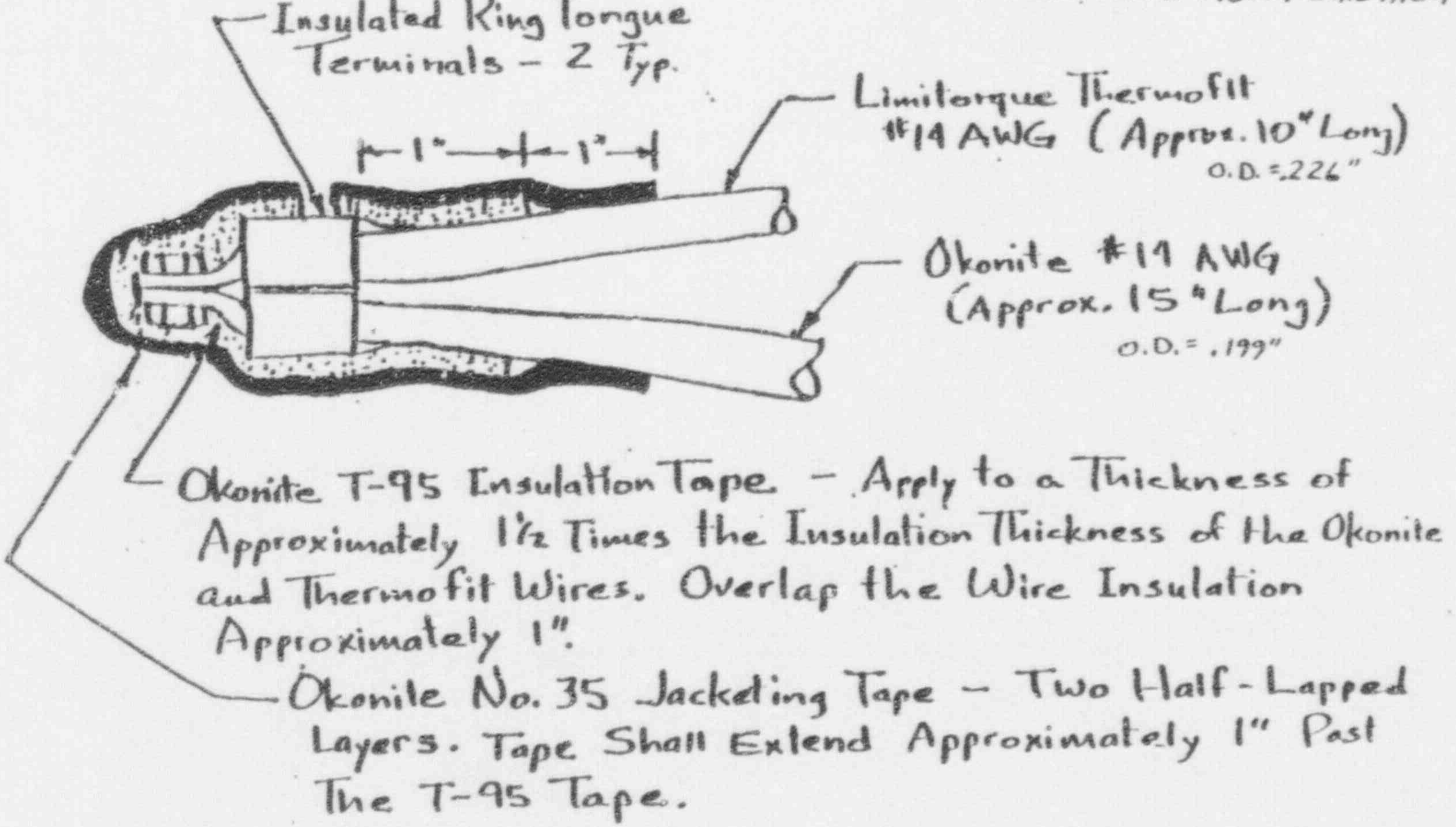
Okonite No. 35 Jacketing Tape - Two Half-Lapped Layers. Tape Shall Extend Approximately 1" Past The T-95 Tape.

SPECIMEN B4

FIGURE

NOTE:

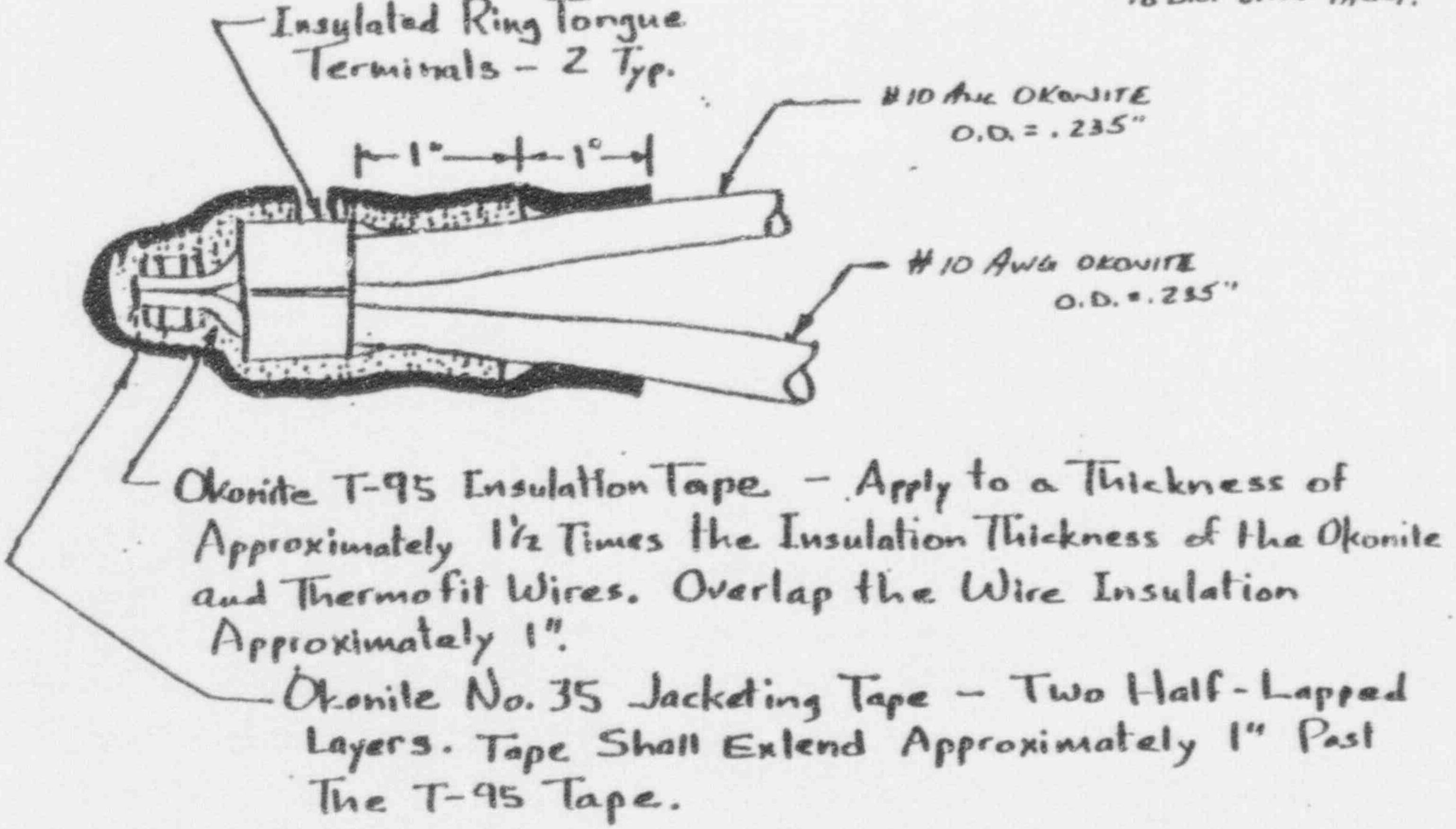
PRIOR TO TAPING APPLY OKONITE NUCLEAR SPLICING CEMENT TO CABLE AND LUGS. ALLOW CEMENT TO DRY UNTIL TACKY



SPECIMEN B5

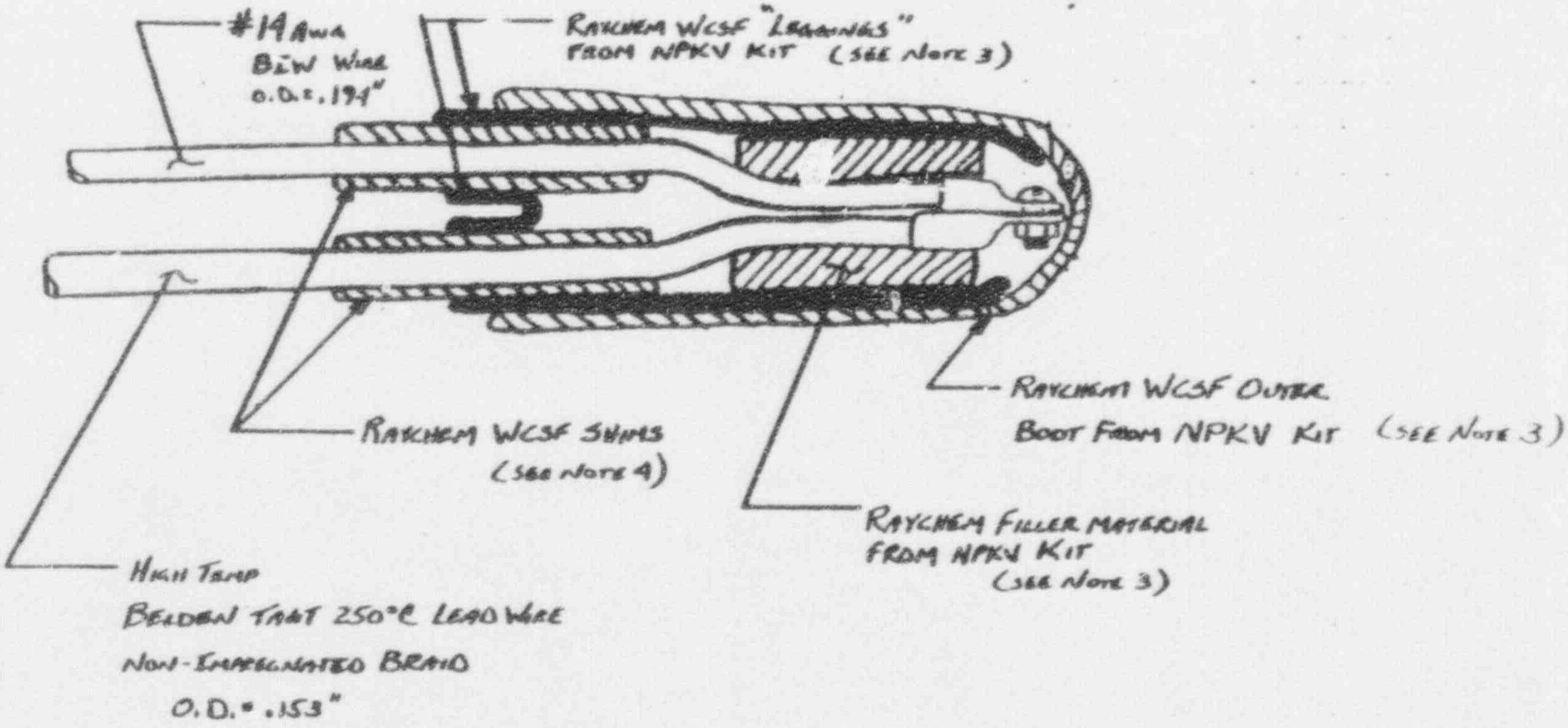
FIGURE 5

NOTE: PRIOR TO APPLYING TAPE APPLY OKONITE NUCLEAR SPLICING CEMENT TO CABLE AND LUGS, ALLOW CEMENT TO DRY UNTIL TACKY.



SPECIMEN B6

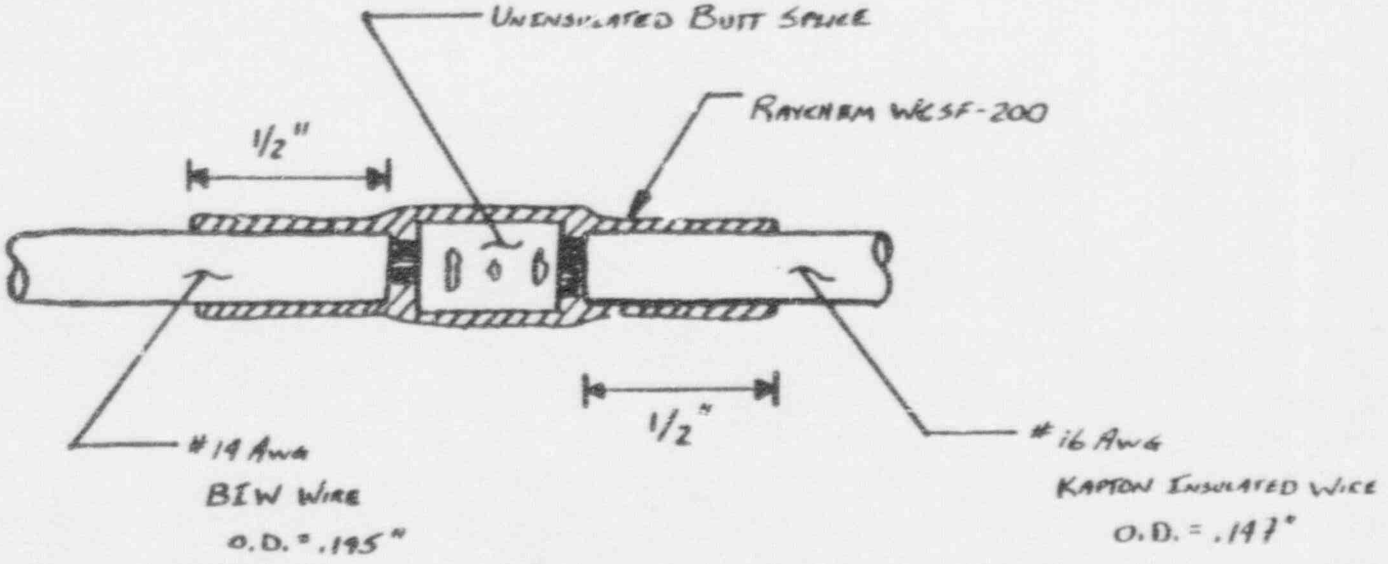
FIGURE 6



Notes:
1) WCSF Material is Nuclear Grade
2) Belden Wire Removed From Asco Solenoid
3) Raychem NPKV-2-10A Kit
4) Shims Supplied With Kit and Sized For Wire

Specimen Z1

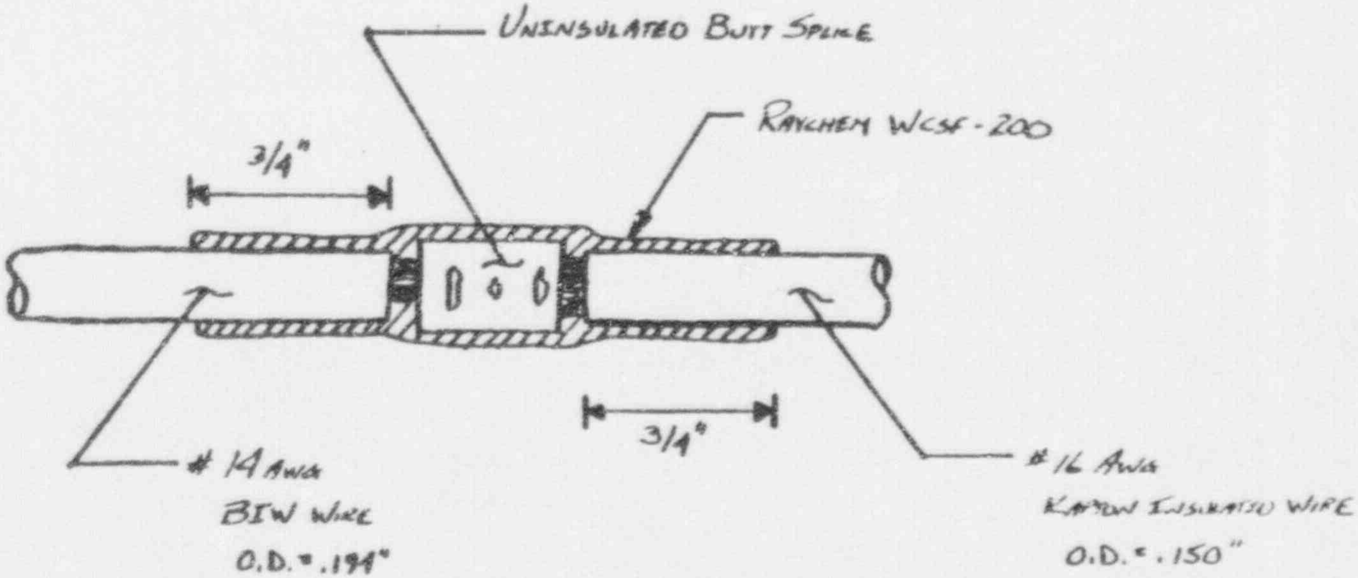
FIGURE 7



NOTES: 1) RAYCHEM TUBING IS NUCLEAR GRADE

SPECIMEN Z2

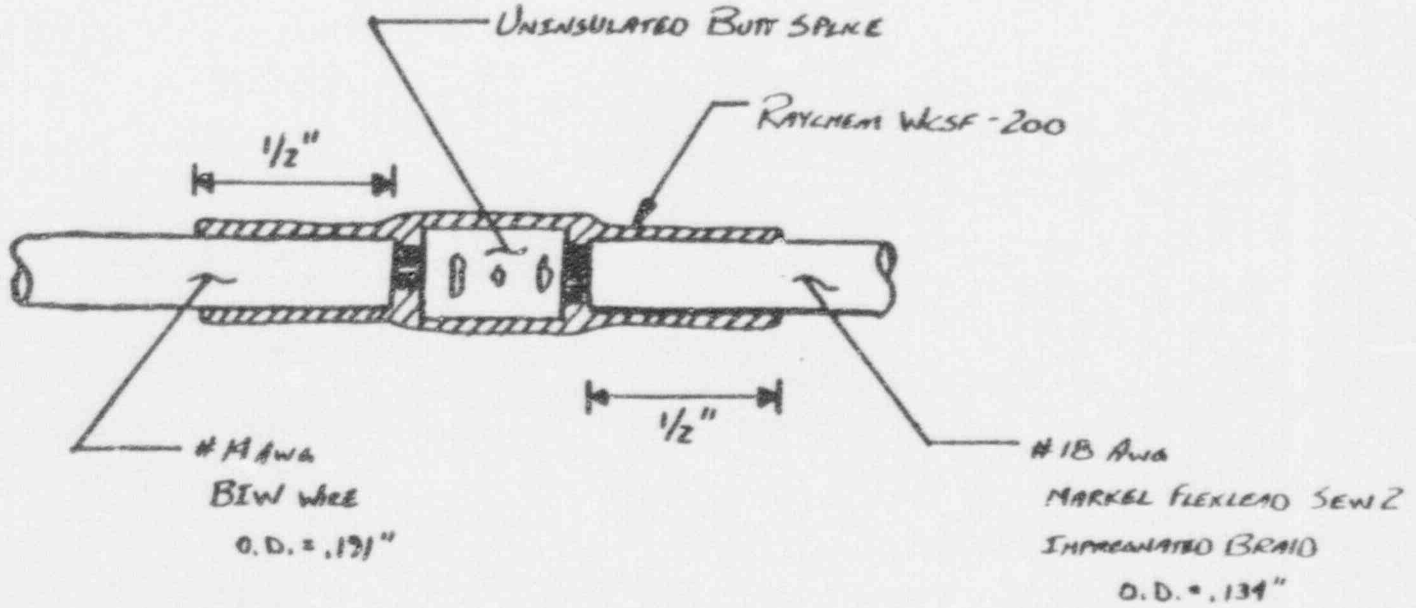
FIGURE 8



NOTES: 1) RAYCHEM TUBING IS NUCLEAR GRADE

SPECIMEN Z3

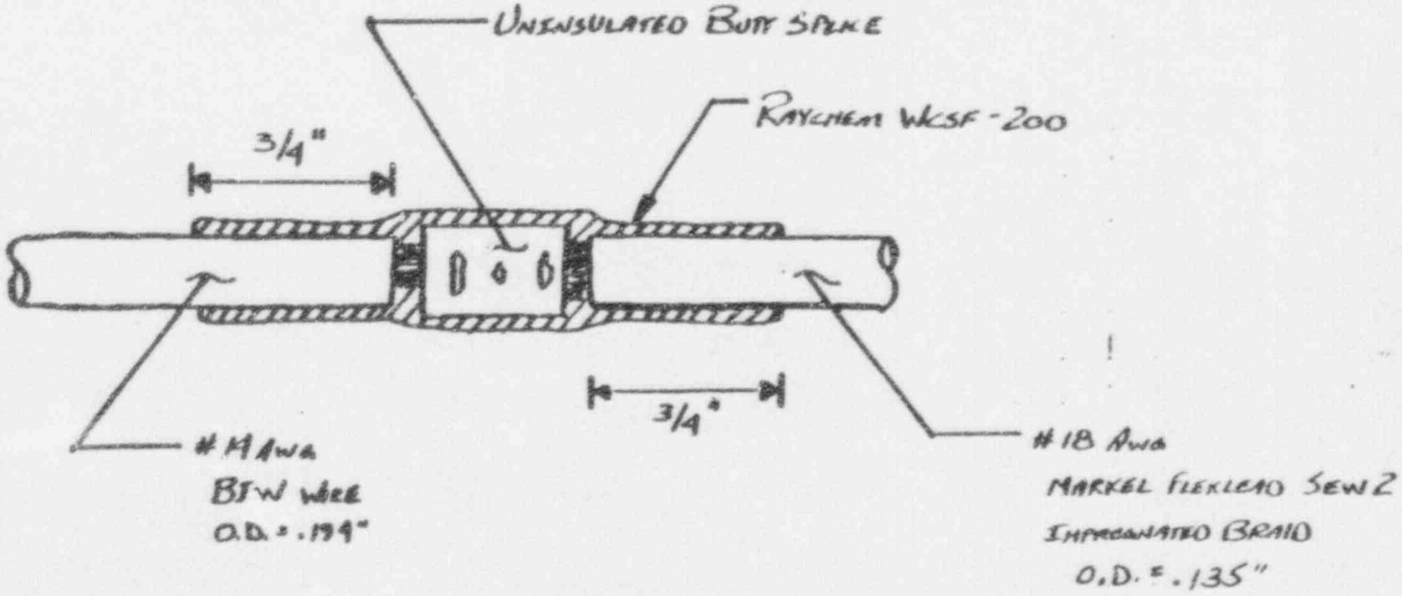
FIGURE 9



Note: 1) Raychem Tubing is Nuclear Grade
2) Markel Braided Lead Wire was
Removed from Static-O-Ring Switch

Specimen 24

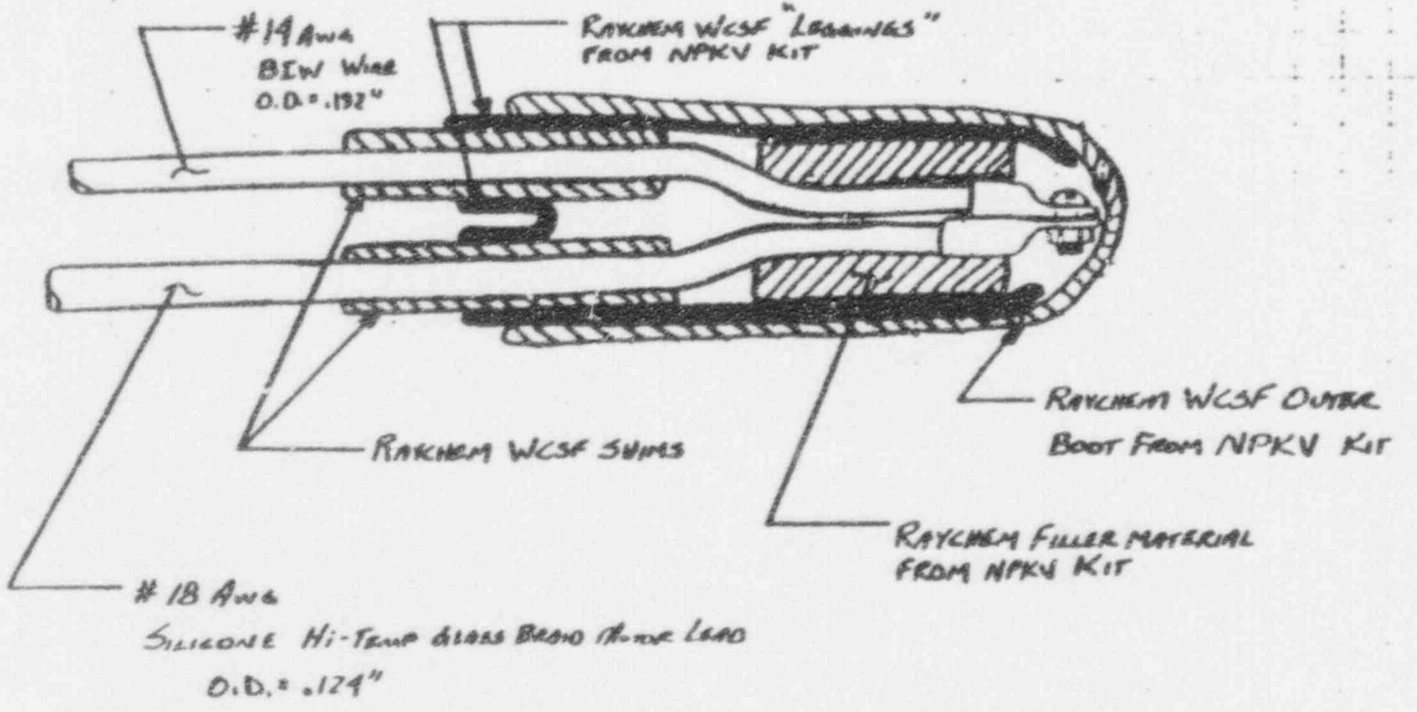
FIGURE 10



NOTE: 1) RAYCHEM TUBING IS NUCLEAR GRADE
2) MARKEL BRAIDED LEAD WIRE WAS REMOVED FROM STATIC-O-RING SWITCH

SPECIMEN 25

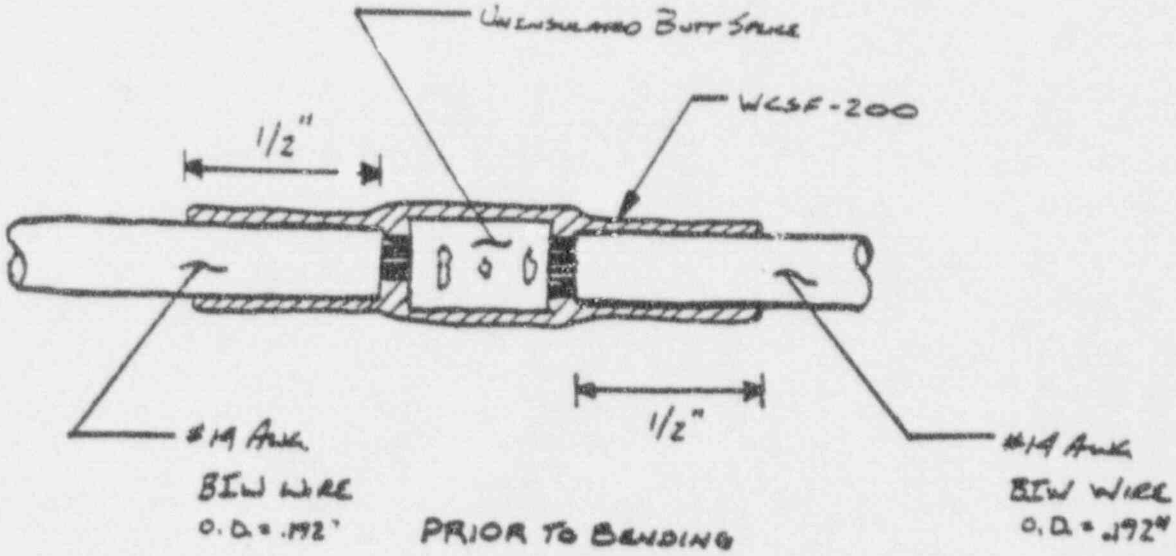
FIGURE 11



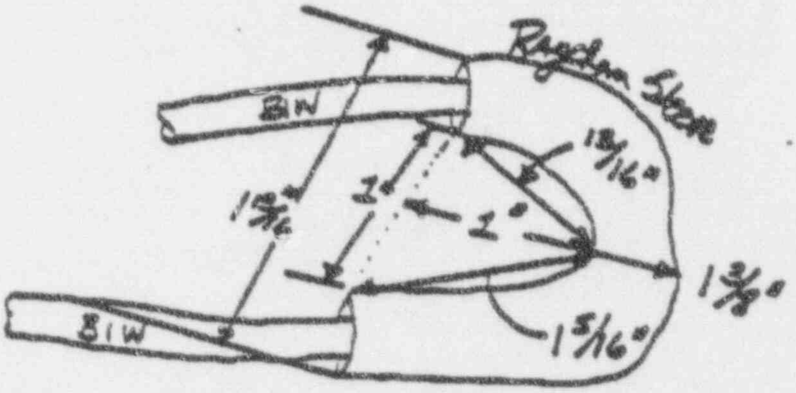
NOTES: 1) WCSF MATERIAL IS NUCLEAR GRADE
2) RAYCHEM KIT # NPKV-2-10A
3) SHIMS SUPPLIED WITH NPKV KIT AND SIZED FOR WIRE

SPECIMEN 26

FIGURE 12



PRIOR TO BENDING

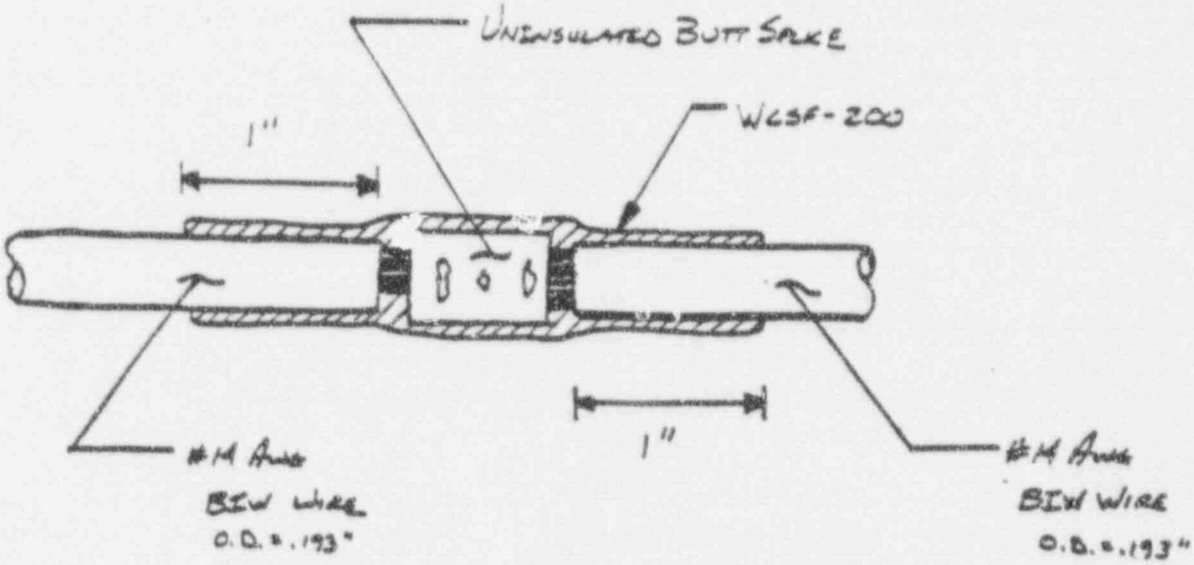


AFTER BENDING

Notes: 1) RAYCHEM TUBING IS NUCLEAR GRADE
2) TUBING BENT WHILE HEATED
3) BENDS MADE ABOVE AND BELOW BUTT SPLICE

SPECIMEN 28

FIGURE 13



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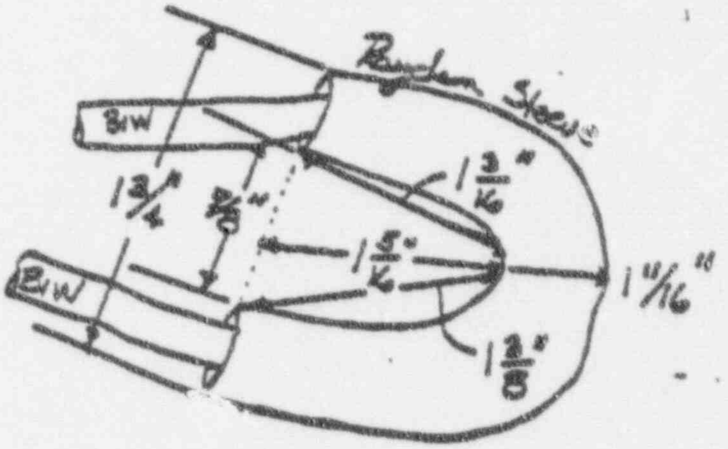
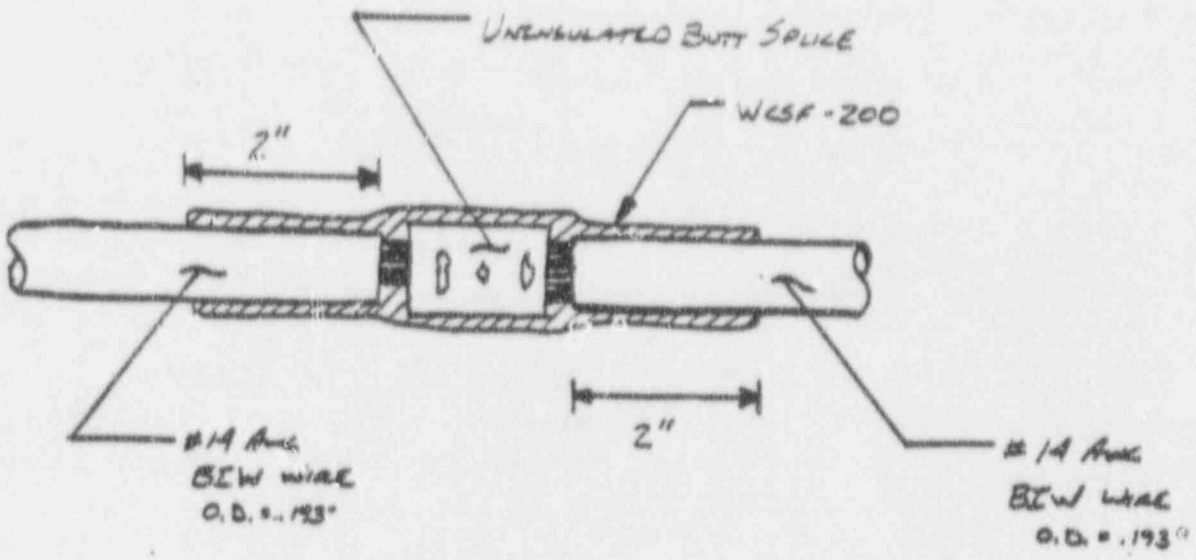


AFTER BENDING

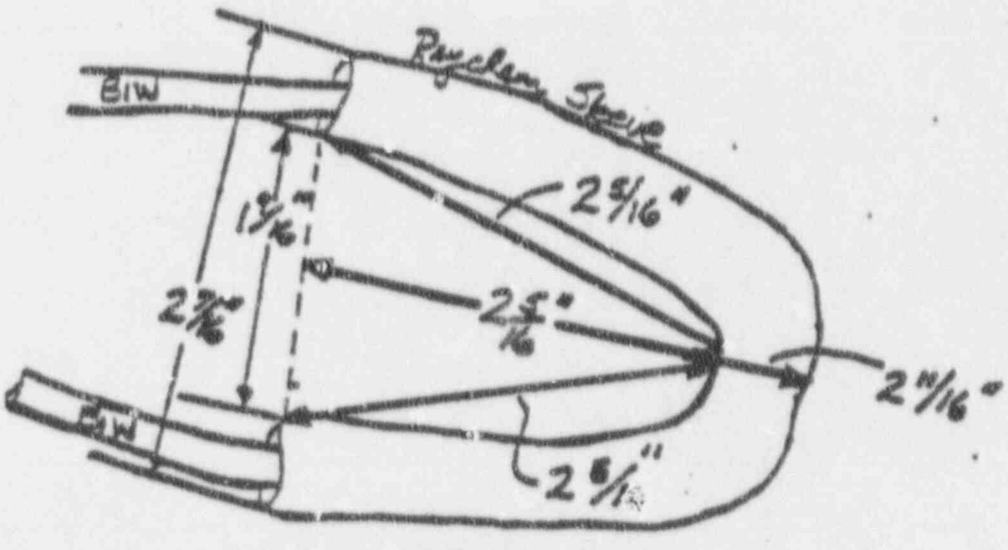
NOTES: 1) RAYCHEM TUBING IS NUCLEAR GRADE
2) TUBING BENT WHILE HEATED
3) BENDS MADE ABOVE AND BELOW BUTT SPLICE

SPECIMEN Z9

FIGURE 14



PRIOR TO BENDING



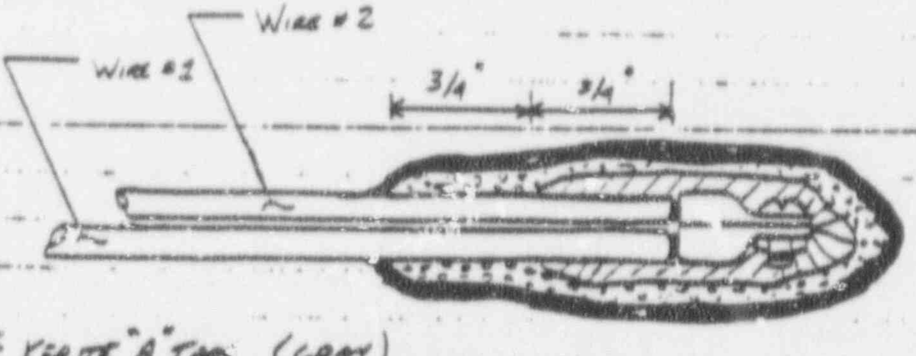
AFTER BENDING

NOTES: 1) RAYCHEM TUBING IS NUCLEAR GRADE
2) TUBING BENT WHILE HEATED
3) BENDS MADE ABOVE AND BELOW BUTT SPLICE

SPECIMEN Z10

FIGURE 15

KERITE SPLICE TAPE PROCEDURE



▬ : KERITE "A" TAPE (GRAY)

▨ : KERITE CONDUCTING FABRIC TAPE

▧ : KERITE INSULATING TAPE (BLACK)

SPECIMEN #	WIRE #1	WIRE #2
Z7	#14 AWG BIW O.D.=.199"	#14 AWG BIW O.D.=.199"
Z11	#14 AWG BIW O.D.=.193"	#14 AWG BELDEN TAFT 250°C HI-TEMP SILICONE BRAID O.D.=.161"
Z12	#14 AWG BIW O.D.=.194"	#14 AWG BELDEN TAFT 250°C HI-TEMP SILICONE BRAID O.D.=.151
Z13	#14 AWG BIW O.D.=.199"	#14 AWG BIW O.D.=.199"

APPLY TAPE IN ACCORDANCE WITH THE FOLLOWING PROCEDURE:

1) APPLY KERITE "A" TAPE ON CABLE INSULATION STARTING APPROXIMATELY 3/4" PAST THE END OF INSULATION ON THE CABLE LUG. WRAP "A" TAPE USING HALF LAPPED LAYERS AROUND THE CABLE AND LUG PAST THE BOLTED END OF THE LUG. CONTINUE WRAPPING TAPE, BRINGING TAPE BACK OVER THE LUG AND CABLE TO STARTING POINT OF "A" TAPE. REPEAT TAPING PROCEDURE BRINGING "A" BACK OVER FIRST TWO LAYERS OF TAPE, EXTENDING PAST END OF LUG, AND RETURNING TO ORIGINAL STARTING POINT.

FIGURE 16

KERITE SPLICE TAPE PROCEDURE

2) APPLY KERITE CONDUCTING FABRIC TAPE ON CABLE INSULATION STARTING APPROXIMATELY 3/4" PAST END OF THE KERITE "A" TAPE. WRAP THE FABRIC TAPE USING HALF LAPPED LAYERS AROUND THE CABLE AND TAPED LUGS UP TO THE END OF THE PREVIOUSLY TAPED SPLICE. CONTINUE WRAPPING TAPE, BRINGING THE TAPE BACK OVER THE TAPED SPLICE TO THE STARTING POINT OF THE FABRIC TAPE. REPEAT THE TAPE PROCEDURE WRAPPING THE FABRIC TAPE BACK OVER THE PREVIOUSLY TAPED LUGS, EXTENDING THE FABRIC TAPE PAST THE END OF THE TAPED SPLICE, THEN RETURNING TO THE STARTING POINT.

3) APPLY THE KERITE INSULATING TAPE STARTING AT THE BOLTED LUG END OF THE SPLICE. WRAP THE INSULATING TAPE USING HALF LAPPED LAYERS DOWN TO THE END OF THE FABRIC TAPE. CONTINUE WRAPPING THE INSULATING TAPE IN HALF LAPPED LAYERS TO BUILD UP A TOTAL OF FIVE LAYERS OF INSULATING TAPE.

PAGE 2 OF 2

FIGURE 16

BASELINE FUNCTIONAL TESTS

SECTION I

BASELINE FUNCTIONAL TESTS

1.0 REQUIREMENTS

The specimens shall be subjected to the Visual Inspection and Insulation Resistance Tests of Paragraph 2.0. The Insulation Resistance shall be measured for information only.

2.0 PROCEDURES

2.1 Visual Inspection

A visual inspection on the assembled test specimens was conducted upon their receipt (or upon completion of assembly) at Wyle Laboratories. This inspection was performed to verify the specimen construction and to document any noticeable damage. Each of the specimens were photographed after mounting in an aluminum cable tray. In addition, all specimens were tagged with Quality Assurance "Test Specimen" tags to facilitate their identification during the test program. The results of the visual inspections are recorded on the "Test Specimen Inspection" forms in Appendix I.

2.2 Test Specimen Preparation

Zion specimens Z1 to Z13 were prepared by CECO technicians and forwarded to Wyle Laboratories. These specimens were mounted inside a 12"W x 6"D x 36"L aluminum cable tray (See Photograph I-4) with nylon tie wraps. This tray was utilized to minimize specimen handling during the aging program.

Byron/Braidwood specimens B1 - B4, B6 and B7 were prepared by CECO technicians and forwarded to Wyle Laboratories. These specimens were mounted inside a 12"W x 6"D x 36"L cable trays, as shown in Photographs I-2 and I-3. These trays were utilized to minimize specimen handling during the aging program.

Byron/Braidwood specimen B5 was prepared by Wyle technicians using the following procedure. The details of the specimen preparation were supervised by the on-site Sargent and Lundy technical representative.*

1. CECO supplied uninsulated ring tongue terminals were attached to one end of a CECO supplied 10-inch long 1/C 14 AWG Nomex lead (from a Limitorque Motor Operated Valve) and a CECO supplied 1/C 14 AWG OKONITE lead.

2. The ring tongue terminals were joined together in a back to back "V" configuration with a number 8 screw and bolt. The excess screw threads were cut off.

*Details on the construction of all CECO-prepared specimens are contained in Paragraph 6.0 of the Summary Section and the splice preparation procedures in the Appendices of Section X.

2.0 PROCEDURES (Continued)

2.2 Test Specimen Preparation (Continued)

3. OKONITE Nuclear Splicing Cement (Catalog No. 604-45-7102) was applied over the lugs and to the jackets of the cables to be spliced. The cement was allowed to dry.

4. OKONITE T-95 insulating tape was applied over the lugs and approximately 1 inch onto the cable jackets. This tape was applied in several 1/2-lapped layers after the tape had been stretched to approximately three-fourths of its original width. This tape was applied until a smooth surface was left of a similar thickness as the lug.

5. OKONITE T-35 jacketing tape was applied over the entire assembly and extended approximately 1 inch past the end of the T-95 tape. This tape was applied in two 1/2-lapped layers after the tape had been stretched to approximately three-fourths of its original width.

6. The completed assembly was photographed.

7. This specimen was mounted in the cable tray containing specimens B1 - B4 and B6.

2.3 Insulation Resistance Test

Insulation Resistance measurements were taken using the following procedure:

1. Both ends of the specimen cable leads were stripped back and an uninsulated butt splice was crimped to the cable ends (Baseline Functional Tests only).

2. Both ends of the cable were bent up away from the cable tray.

3. A potential of 500 VDC was applied from one end of the cable to the aluminum cable tray. (For specimens B1, B2 and B3, the multiple test leads were shorted together for this test.)

4. The Insulation Resistance value was recorded after 60 seconds and the cable de-energized. These measurements were recorded for informational purposes only.

3.0 RESULTS

The test specimens were subjected to the visual inspection, test specimen preparation and Insulation Resistance Tests as described in Paragraph 2.0 and met the requirements of Paragraph 1.0. The data recorded from this phase of testing is presented in Appendices I through IV as noted below.

3.0 RESULTS (Continued)

- Appendix I contains the Test Specimen Inspection Sheets which document specimen construction.
- Appendix II contains Photograph I-1 through I-4 which show the specimens after mounting into their respective trays.
- Appendix III contains the Baseline Functional Test Insulation Resistance Test results.
- Appendix IV contains the Instrumentation Equipment Sheet which lists the equipment used to collect data.

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APPENDIX I

TEST SPECIMEN INSPECTION FORMS

TEST SPECIMEN INSPECTION

CUSTOMER CECO

JOB NO. 17859

SPECIFICATION WLQP 17859-01

DATE August 12, 1986

CHECK AS APPROPRIATE

ITEM NO.	DESCRIPTION	MANUF.	PART/MODEL NO.	SAME I.D. AS SPEC	CONDITION SATISFACTORY	PHOTO TAKEN
B1	1/c 14 AWG ROCKBESTOS	MADE BY	See Description	✓	✓	NO
	FIREWALL SIS WIRE TO	CECO				
	TWO 1/c 14 AWG	TECHNICIANS	ALL 3 LEADS - WHITE			
	ROCKBESTOS FIREWALL SIS					
	WIRES USING Raychem		(1/2" OVERLAP)			
	WCSF-200 (18/8)					
	Sleeve over BOLTED					
	CONNECTION, Raychem shim					
	SLEEVE OVER 1 LEAD ON					
	EACH END					
B2	1/c 14 AWG ROCKBESTOS	MADE by	See Description	✓	✓	NO
	FIREWALL SIS WIRE TO	CECO				
	TWO 1/c 14 AWG LEADS	TECHNICIANS	BLACK LEADS - OKONITE			
	(MARKED "1-BLACK" AND		ROCKBESTOS - WHITE			
	"2-WHITE") USING					
	Raychem Sleeve (only		(1/2" OVERLAP)			
	MARKING 45-1-3) OVER					
	BOLTED CONNECTION. ALL					
	3 LEADS have Raychem					
	Shim on them.					

NOTES: __________

Specimen Failed __________

Specimen Passed ✓

NOA Written __________

Inspected By Date: 8-12-86

Witness Date: 8/12/86

Sheet No. of ~~23~~ 7

Approved 8/12/86

TEST SPECIMEN INSPECTION

CUSTOMER CECO

JOB NO. 17859

SPECIFICATION WLQP 17859-01

DATE August 12, 1986

CHECK AS APPROPRIATE

ITEM NO.	DESCRIPTION	MANUF.	PART/MODEL NO.	SAME I.D. AS SPEC	CONDITION SATISFACTORY	PHOTO TAKEN
B3	TWO 1/C ROCKBESTOS	MADE by	SEE DESCRIPTION	✓	✓	NO
	FIREWALL SIS WIRES TO	CECO				
	THREE 1/C ROCKBESTOS	TECHNICIANS				
	FIREWALL SIS WIRES		ALL LEADS - WHITE			
	USING RAYCHEM SLEEVE					
	(ONLY MARKING: 745-1-3)		(1/2" OVERLAP)			
	OVER BOLTED CONNECTIONS					
B4	1/C 14 AWG OKONITE	MADE by	SEE DESCRIPTION	✓	✓	NO
	CO. BY-242-1979 LEAD	CECO				
	to 1/C 14 AWG OKONITE CO	TECHNICIANS	BOTH LEADS BLACK			
	BY-242-1979 LEAD USING					
	OKONITE TAPE V TYPE					
	SPLICE WITH NO WRAPS					
	IN CRUTCH AREA					
B5	1/C 14 AWG OKONITE CO.	MADE by	SEE DESCRIPTION	✓	✓	YES NO
	BY-242-1979 LEAD to	Wyle				
	NOMEX LEAD 1/C 14 16 AWG	TECHNICIANS				
	USING OKONITE		OKONITE - BLACK			
	TAPE V-TYPE SPLICE		NOMEX - BROWN GLASS			
	WITH NO TAPE IN CROTCH		BRAID OVER BLACK			
	PER FIGURE 3		JACKET ~~INSULATION~~ OVER GREY INSULATION			

NOTES:

Specimen Failed

Specimen Passed ✓

NOA Written

Inspected By 12 Wyle A Date: 8-12-86

Witness Date: 8/12/86

Sheet No. 2 of ~~13~~ 17

Approved 8/12/86

TEST SPECIMEN INSPECTION

CUSTOMER CECO

JOB NO. 17859

SPECIFICATION WLGP 17859-01

DATE August 12, 1986

CHECK AS APPROPRIATE

ITEM NO.	DESCRIPTION	MANUF.	PART/MODEL NO.	SAME I.D. AS SPEC	CONDITION SATISFACTORY	PHOTO TAKEN
B6	1/c 10 AWG OKONITE	Made by	See Description	✓	✓	NO
	Co. BY-91-1984 LEAD	CECO				
	to 1/c 10 AWG OKONITE	TECHNICIANS	Both Leads - Black			
	Co. BY-91-1984 LEAD					
	using OKONITE TAPE					
	V-TYPE SPLICE WITH					
	NO WRAPS IN CROTCH					
B7	1/c 500 MCM OKONITE	Made by	See Description	✓	✓	NO
	Co. BY-29-1979	CECO				
	(FOOTAGE 7009516) to	TECHNICIANS	Both Leads - Black			
	1/c 500 MCM OKONITE					
	Co. BY-29-1979					
	(FOOTAGE 7009508)					
	USING OKONITE TAPE					
	V-type splice with					
	No #-95 tape in crotch					

NOTES:

Specimen Failed

Specimen Passed ✓

NCA Written

Inspected By 32 WY18 A Date: 8-12-86

Witness Date: 8/12/86

Sheet No. 3 of 7

Approved Joseph Hyatt 8/12/86

TEST SPECIMEN INSPECTION

CUSTOMER Commonwealth Edison Company
JOB NO. 17859
SPECIFICATION WLQP 17859-01
DATE August 11, 1986

CHECK AS APPROPRIATE

ITEM NO.	DESCRIPTION	MANUF.	PART/MODEL NO.	SAME I.D. AS SPEC	CONDITION SATISFACTORY	PHOTO TAKEN
Z1	1/C 14AWG BIW P.O.	MADE BY	SEE DESCRIPTION	✓	✓	NO
	ORDER 228320 TO	CECO				
	HIGH TEMP BELDEN THOT	ELECTRICIANS	HIGH TEMP-WHITE			
	250°C LEAD USING		BIW - BLACK			
	Raychem Boot Kit's					
	3 SPLICES					
Z2	1/C 14 AWG BIW P.O.	MADE BY	See Description		1	NO
	228320 TO 1/C 16 AWG	CECO	BIW - BLACK			
	KAPTON USING Raychem	ELECTRICIANS	KAPTON - RUST			
	Sleeve N 3088-3/-2		(1/2" OVERLAP)			
Z3	1/C 14 AWG BIW P.O.	MADE BY	See Description	✓	2	NO
	228320 TO 1/C 16 AWG	CECO	BIW - BLACK			
	KAPTON USING Raychem	ELECTRICIANS	KAPTON - RUST			
	Sleeve WCSF-200		(3/4" OVERLAP)			
Z4	1/C 14 AWG BIW P.O. 18	MADE BY	SEE Description	✓	3	NO
	228320 TO 1/C ~~16~~ AWG	CECO				
	MARKEL FLEXLEAD SEW 2	ELECTRICIANS	BIW - BLACK			
	200°C WIRE USING		HIGH TEMP - BLUE			
	Raychem Sleeve		(1/2" OVERLAP)			

NOTES: 1. NO SEAL IS PRESENT ON THE KAPTON END OF THE SPLICE
2. NO SEAL IS PRESENT ON EITHER END OF THE SPLICE.
3. NO SEAL IS PRESENT ON ~~EITHER~~ HIGH TEMP END OF THE SPLICE

WYLE TECHNICIAN SHRANK Raychem ON BIW END OF Z2 AND HIGH TEMP END OF Z3 AT CECO TECHNICAL REPRESENTATIVES DIRECTION

Specimen Failed
Specimen Passed ✓
NOA Written

Inspected By Date: 8-12-86
Witness Date: 8/12/86
Sheet No. ~~120~~ 4 of ~~123~~ 7
Approved 8/12/86

TEST SPECIMEN INSPECTION

CUSTOMER Commonwealth Edison Company

JOB NO. 17859

SPECIFICATION WLQP 17859-01

DATE August 11, 1986

CHECK AS APPROPRIATE

ITEM NO.	DESCRIPTION	MANUF.	PART/MODEL NO.	SAME I.D. AS SPEC	CONDITION SATISFACTORY	PHOTO TAKEN
Z5	1/c 14 AWG BIW P.O.	MADE BY	SEE DESCRIPTION	✓	✓	NO
	228.320 to 1/c 18 AWG	CECO				
	MARKEL FLEXLEAD SBW-2	TECHNICIANS	BIW - BLACK			
	200°C HIGH TEMP WIRE		HIGH TEMP - RED			
	USING RAYCHEM WCSF-200		(3/4" OVERLAP)			
	(18/5) N 3088 Splice					
~~Z6~~						
Z6	1/c 14 AWG BIW P.O.	MADE BY	SEE DESCRIPTION	✓	✓	NO
	228320 WIRE to 1/c	CECO				
	18 AWG HIGH TEMP GLASS	TECHNICIANS	BIW - BLACK			
	BRAID SILICONE LEAD		HIGH TEMP - BLACK			
	(MARKINGS ILLEGIBLE) USING					
	RAYCHEM BOOT OVER 2 splices					
Z7	1/c 14 AWG BIW P.O.	MADE BY	SEE DESCRIPTION	✓	✓	NO
	228320 WIRE TO 1/c 14	CECO				
	AWG BIW P.O. 228320	TECHNICIANS	BOTH BIW - BLACK			
	WIRE USING KERITE		TAPE - GREY			
	TAPE V SPLICE. NO					
	WRAPS IN CROTCH OF					
	TAPE SPLICE					

NOTES:

Specimen Failed

Specimen Passed ✓

NOA Written

Inspected By [illegible] Wyle Date: 8-12-86

Witness [illegible] Date: 8/12/86

Sheet No. ~~[illegible]~~ 5 of ~~29~~ 7

Approved D. Hazel 8/12/86

TEST SPECIMEN INSPECTION

CUSTOMER Commonwealth Edison Company

JOB NO. 17859

SPECIFICATION WLQP 17859-01

DATE August 11, 1986

CHECK AS APPROPRIATE

ITEM NO.	DESCRIPTION	MANUF.	PART/MODEL NO.	SAME I.D. AS SPEC	CONDITION SATISFACTORY	PHOTO TAKEN
Z8	1/c 14 AWG BIW P.O.	MADE by	SEE DESCRIPTION	✓	✓	NO
	228320 WIRE TO 1/c 14	CECO				
	AWG BIW P.O. 228320	TECHNICIANS	BOTH BIW - BLACK			
	WIRE USING Raychem		(1/2" OVERLAP)			
	WCSF-200 ~~B~~ SLEEVE					
	AND 180° BEND ON					
	EITHER SIDE OF BUTT SPLICE					
Z9	1/c 14 AWG BIW P.O.	Made by	See Description	✓	✓	NO
	228320 WIRE TO 1/c 14	CECO				
	AWG BIW P.O. 228320	TECHNICIANS	BOTH BIW - BLACK			
	WIRE USING RAYCHEM					
	SLEEVE (3088-3-2) AND		(1" OVERLAP)			
	180° BEND ON EITHER SIDE					
	OF BUTT SPLICE					
Z10	1/c 14 AWG BIW P.O.	MADE by	SEE DESCRIPTION	✓	✓	NO
	228320 WIRE TO 1/c 14	CECO				
	AWG BIW P.O. 228320	TECHNICIANS	BOTH BIW - BLACK			
	USING RAYCHEM WCSF					
	200 (18/5) N 3088-3-2		(2" OVERLAP)			
	SLEEVE AND 180° BENDS					
	ON EITHER SIDE OF Butt splice					

NOTES:

12
Wyle
A

Specimen Failed
Specimen Passed ✓
NOA Written

Inspected By Date: 8/12/86
Witness Date: 8/12/86
Sheet No. ~~7~~ 6 of ~~8~~ 7
Approved Hazlett 8/12/86

TEST SPECIMEN INSPECTION

CUSTOMER Commonwealth Edison Company

JOB NO. 17859

SPECIFICATION WLGXP 17859-01

DATE August 11, 1986

CHECK AS APPROPRIATE

ITEM NO.	DESCRIPTION	MANUF.	PART/MODEL NO.	SAME I.D. AS SPEC	CONDITION SATISFACTORY	PHOTO TAKEN
Z11	1/c 14 AWG BIW P.O. 228320 WIRE TO BELDEN 1/c 14 AWG ~~FEP~~ TAGT 250°C HIGH TEMP WIRE USING KERITE TAPE V type Splice	MADE by CECO TECHNICIAN	SEE DESCRIPTION BIW - BLACK HIGH TEMP - WHITE TAPE - GREY	✓	✓	NO
Z12	1/c 14 AWG BIW P.O. 228320 WIRE TO BELDEN 1/c 14 AWG TAGT 250°C HIGH TEMP WIRE USING KERITE TAPE V SPLICE	MADE by CECO TECHNICIANS	SEE DESCRIPTION BIW - BLACK HIGH TEMP - WHITE TAPE - GREY	✓	✓	NO
Z13	1/c 14 AWG BIW P.O. 228370 WIRE TO 1/c 14 AWG BIW P.O 228370 WIRE USING KERITE TAPE V SPLICE	MADE by CECO TECHNICIANS	SEE DESCRIPTION BOTH BIW - BLACK TAPE - GREY			

NOTES:

Specimen Failed

Specimen Passed ✓

NOA Written

Inspected By Date: 8-12-86

Witness Date: 8/12/86

Sheet No. 7 of 9

Approved 8/12/86

APPENDIX II

PHOTOGRAPHS

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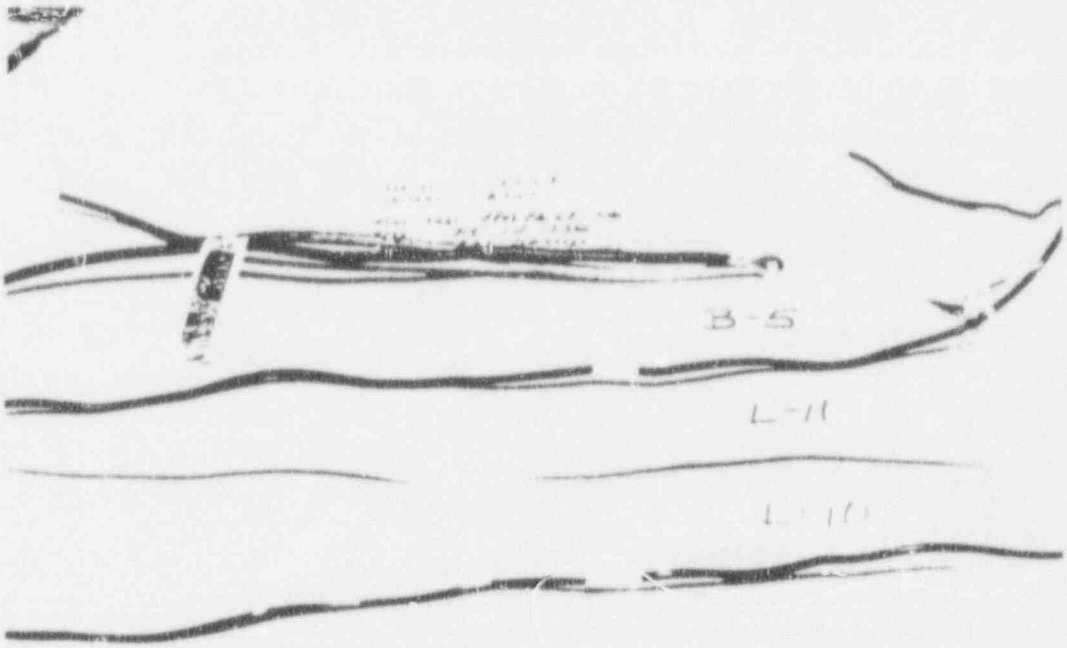
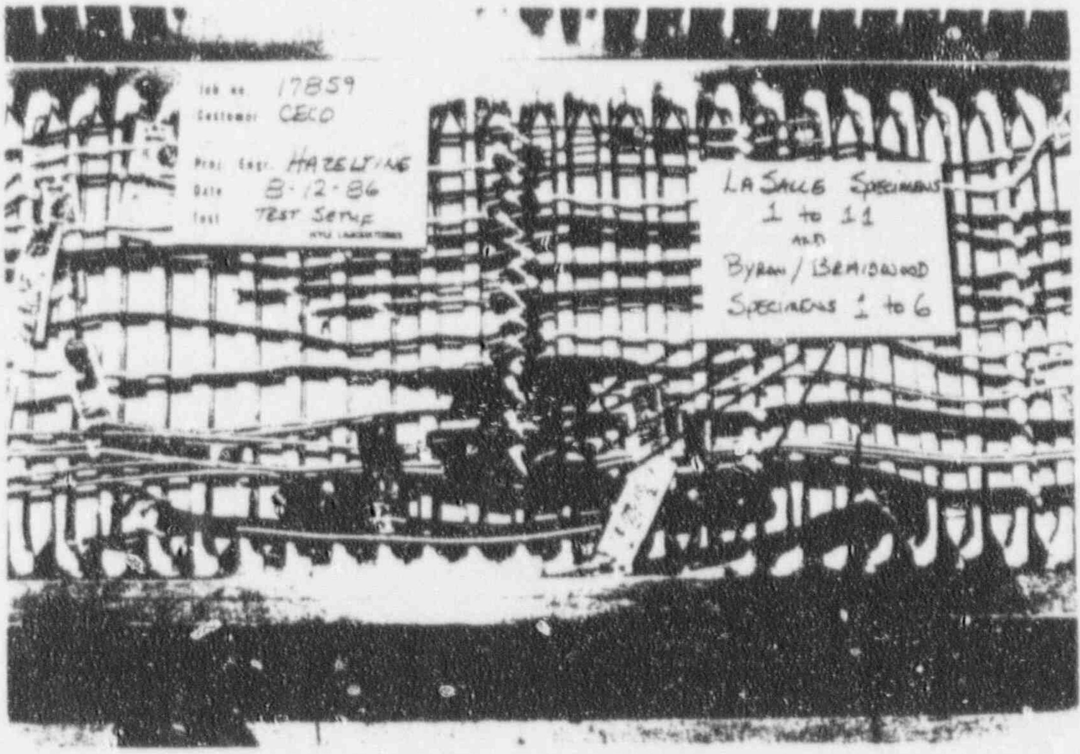


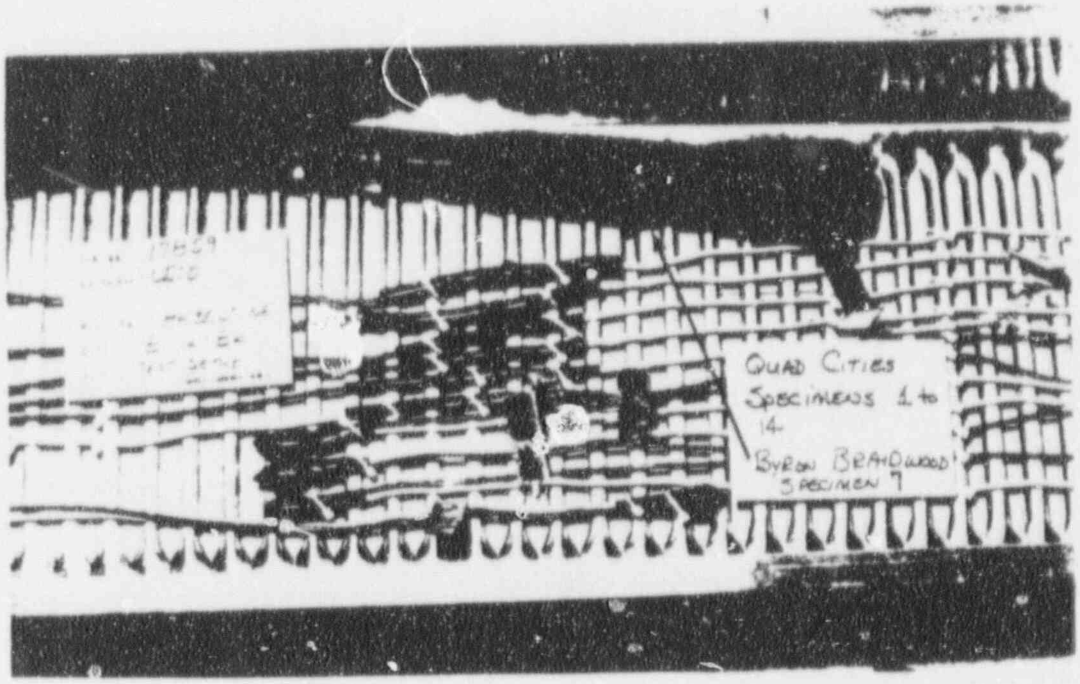
PHOTOGRAPH NO. I-1

BYRON/BRAIDWOOD SPECIMEN B5 PRIOR TO APPLYING THE T-35 AND T-95 TAPES


Job no 17859
Customer CECO
Proj. Engr. HAZELTINE
Date 8-12-86
Test TEST SETUP

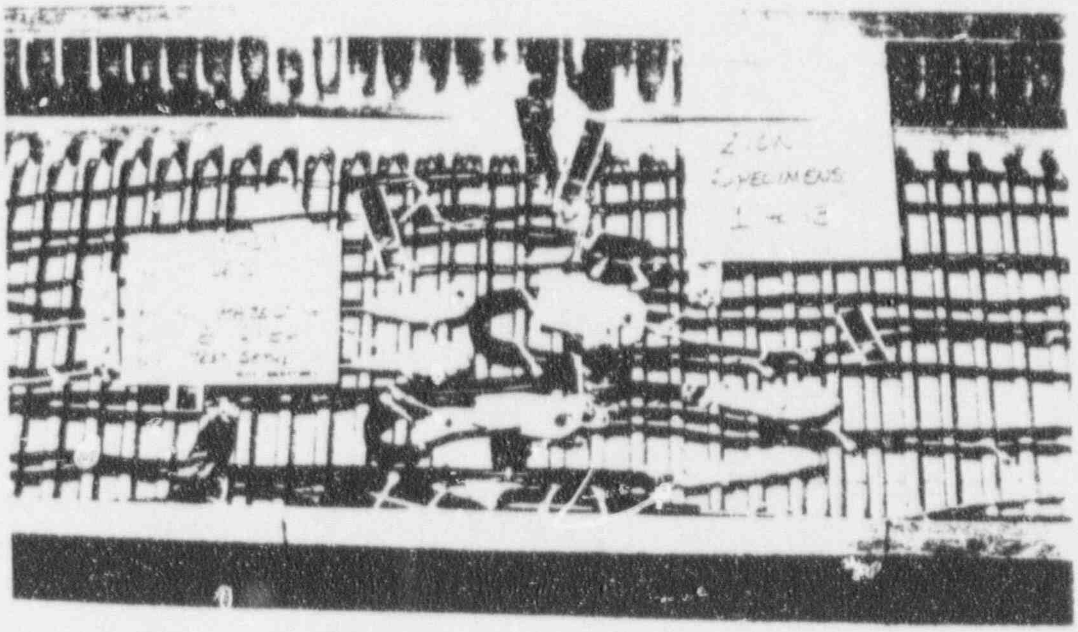
PHOTOGRAPH NO. I-2

BYRON/BRAIDWOOD SPECIMENS B1 (TOP) TO B6 (BOTTOM) MOUNTED IN CABLE TRAY



PHOTOGRAPH NO. I-3

PRE-TEST VIEW OF BYRON/BRAIDWOOD SPECIMEN B7
MOUNTED IN CABLE TRAY



PHOTOGRAPH NO. I-4

ZION SPECIMENS Z1 THROUGH Z13 MOUNTED
IN CABLE TRAY

APPENDIX III

DATA SHEETS

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DATA SHEET

WYLE LABORATORIES

Customer CECo
Specimen Cables and Splices
Part No. Various
Spec. WLQP 17859-01
Para. 3.1.3
S/N N/A
GSI No

Amb. Temp. 73°F
Photo YES
Test Med. Air
Specimen Temp. Ambient

Job No. 17859
Report No. 17859-02
Start Date 8-12-86

Test Title BASELINE FUNCTIONAL TEST

INSULATION RESISTANCE AT 500 VDC

ACCEPTANCE CRITERIA: DATA COLLECTED FOR INFORMATION ONLY

SPECIMEN NO.	READING
B1	2.0×10^{11} Ω
B2	2.0×10^{11} Ω
B3	2.5×10^{11} Ω
B4	3.0×10^{11} Ω
B5	3.5×10^{11} Ω
B6	4.0×10^{11} Ω
B7	$>5.0 \times 10^{11}$ Ω

Notice of Anomaly None

Tested By Barry M. Rachell Date: 8-12-86
Witness None Date:
Sheet No. 1 of 5
Approved J. Hazlett 8-12-86

DATA SHEET

WYLE LABORATORIES

Customer: CECo
Specimen: Cables and Splices
Part No.: Various
Spec.: WLQP 17859-01
Para.: 3.1.3
S/N: N/A
GSI: No
Amb. Temp.: 73°F
Photo: YES
Test Med.: Air
Specimen Temp.: Amb it
Job No.: 17859
Report No.: 17859-02
Start Date: 8-12-86

Test Title: BASELINE FUNCTIONAL TEST

INSULATION RESISTANCE AT 500 VDC

ACCEPTANCE CRITERIA: DATA COLLECTED FOR INFORMATION ONLY

SPECIMEN NO.	READING
Z1	$1.5 \times 10^{9}\,\Omega$
Z2	$1.1 \times 10^{11}\,\Omega$
Z3	$1.3 \times 10^{11}\,\Omega$
Z4	$1.5 \times 10^{11}\,\Omega$
Z5	$1.2 \times 10^{11}\,\Omega$
Z6	$1.7 \times 10^{11}\,\Omega$
Z7	$1.5 \times 10^{11}\,\Omega$
Z8	$1.6 \times 10^{11}\,\Omega$
Z9	$1.8 \times 10^{11}\,\Omega$
Z10	$2.5 \times 10^{11}\,\Omega$
Z11	$9.6 \times 10^{8}\,\Omega$
Z12	$1.2 \times 10^{9}\,\Omega$
Z13	$1.5 \times 10^{11}\,\Omega$

Tested By: Date: 8-12-86
Witness: None Date:
Sheet No. 5 of 5
Approved: 8-12-86

Notice of Anomaly: None

APPENDIX IV

INSTRUMENTATION EQUIPMENT SHEET

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INSTRUMENTATION EQUIPMENT SHEET

PAGE 1 OF 1

DATE 08/12/86 JOB NO. 17859-00 LOCATION ELEC. LAB
TECHNICIAN B. ROCHELL CUSTOMER CECO TYPE TEST BASELINE FUNC.

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE#	RANGE 1	ACCURACY 1	CALDTE	CALDUE
1	MEG MTE TSTR	GEN RADIO	18620	2374	097892	.5-2000KM	+-3%LOWEND	04/28/86	10/28/86

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES, WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION Tony Hozely
8·12·86

CHECKED & RECEIVED BY 8/12/86

Q.A. Rhonda G. Balis 8/12/86

2
Wyle
A

NORMAL RADIATION EXPOSURE

SECTION II

NORMAL RADIATION EXPOSURE

1.0 REQUIREMENTS

The test specimens shall be irradiated to a normal radiation exposure of 1.6×10^7 rads gamma using a Cobalt 60 source.

2.0 PROCEDURES

The test specimens, mounted in their respective trays, were placed in the hot cell at Isomedix, Inc., Parsippany, NJ, radiation facility and radiated as follows:

Specimens	Dose Rate	Time	Total Dose
B1 - B6	6.6×10^5 rads/hr	24.3 hrs	16.04 megarads
B7	6.6×10^5 rads/hr	24.3 hrs	16.04 megarads
Z1 - Z10	6.0×10^5 rads/hr	26.7 hrs	16.02 megarads

The test specimens were rotated 180°, halfway through the exposure, to ensure a more uniform close distribution.

3.0 RESULTS

The test specimens were subjected to the radiation exposures of Paragraph 2.0 which met the requirements of Paragraph 1.0.

No physical changes were noted during the visual inspection following the radiation exposure except that all nylon tie wraps were yellow and brittle and the high temperature wire leads on specimens Z6, Z11 and Z12 were slightly brittle. In addition it was noted that a slight scratch mark was evident on specimen B1 approximately 1/4 inch from the Raychem sleeve. This burn area was assumed to have occurred during specimen preparation.

Appendix I contains the letter of certification on the radiation exposure at Isomedix, Inc.

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APPENDIX I

RADIATION FACILITY CERTIFICATION LETTER

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ISOMEDIX

August 18, 1986

Mr. Dave McGuiness
Wyle Laboratories
7800 Governors Drive West
Huntsville, Alabama 35805

Dear Mr. McGuiness,

This will summarize parameters pertinent to the irradiation of Four (4) each Cable Trays and One (1) each J-Box as per your Purchaxe Order No. 4-9255-S dated 8-14-86.

Cable Tray "A" (see Page Two for I.D. numbers) was exposed to a Cobalt-60 gamma field for a period of 24.3 hours at an average dose rate of 0.66 megarads per hour. The calculated dose based on dosimetry was 16.04 megarads.

Cable Tray "B" was exposed for a period of 24.3 hours at an average dose rate of 0.66 megarads per hour. The calculated dose was 16.04 megarads.

Cable Tray "C" was exposed for a period of 26.7 hours at an average dose rate of 0.60 megarads per hour. The calculated dose was 16.02 megarads.

Cable Tray "D" was exposed for a period of 24.7 hours at an average dose rate of 0.65 megarads per hour. The calculated dose was 16.06 megarads.

The J-Box was exposed for a period of 23.9 hours at an average dose rate of 0.67 megarads per hour. The calculated dose was 16.01 megarads.

Halfway through the exposure the specimens were rotated 180° to insure a more uniform dose distribution. Irradiation was initiated on August 15, 1986 and was completed on August 16, 1986.

Dosimetry was performed using Harwell Red 4034 Perspex (Batch AG) dosimeters utilizing a Bausch and Lomb Model 1001 spectrophotometer as the readout instrument. The Batch AG dosimeters were calibrated traceable to a recognized standards laboratory with the last calibration date being June 5, 1986. The spectrophotometer was calibrated on July 14, 1986 by B&L personnel using standards traceable to NBS.

Isomedix Inc. • 25 Eastmans Road, Parsippany, New Jersey 07054 • (201) 887-2666

Isomedix I.D.	Wyle I.D. Numbers
Cable Tray "A"	Quad Cities #1-#12 Byron #7
Cable Tray "B"	Lasalle #1-#11 Byron #1-#6
Cable Tray "C"	Zion #Z1-#Z13
Cable Tray "D"	Dresden #D1-#D21
J-Box	#Q%, #Q6

Very truly yours,

Eric B. Haft
Facility Manager
ISOMEDIX, INC.

POST-NORMAL RADIATION EXPOSURE FUNCTIONAL TESTS

APPENDIX I

PHOTOGRAPHS

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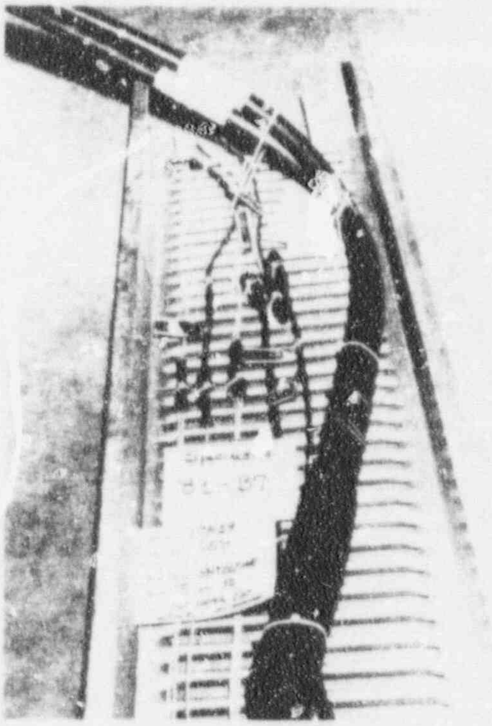
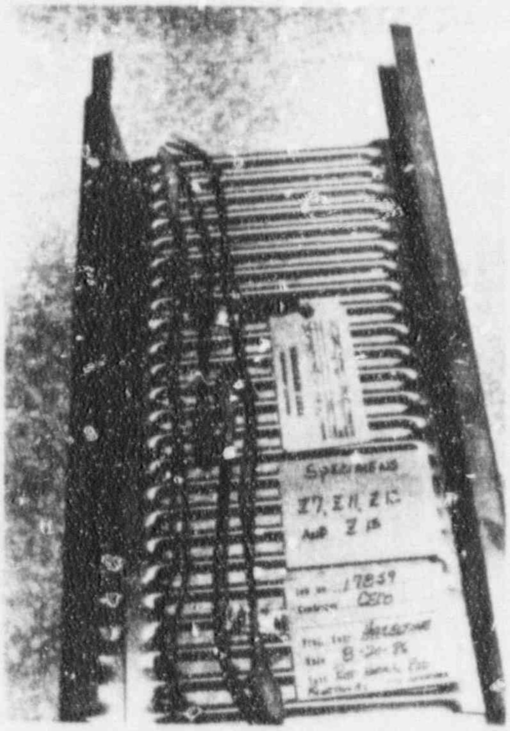


PHOTOGRAPH NO. III-1

BYRON/BRAIDWOOD SPECIMENS B1 - B7 (LEFT TO RIGHT) IN CABLE TRAY AFTER NORMAL RADIATION EXPOSURE (SPECIMENS WERE MOUNTED IN A NEW TRAY FOR THERMAL AGING)



PHOTOGRAPH NO. III-2

ZION SPECIMENS Z7, Z11 AND Z12 (LEFT TO RIGHT) MOUNTED IN CABLE TRAY AFTER NORMAL RADIATION EXPOSURE (SPECIMENS WERE MOUNTED IN A NEW TRAY FOR THERMAL AGING)

PHOTOGRAPH NO. III-3

ZION SPECIMENS Z1 - Z6, Z8 - Z10 MOUNTED IN CABLE TRAY AFTER NORMAL RADIATION EXPOSURE (SPECIMENS WERE MOUNTED IN A NEW TRAY FOR THERMAL AGING)

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APPENDIX II

DATA SHEETS

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DATA SHEET

WYLE LABORATORIES

Customer: CECo
Specimen: Cables and Splices
Part No.: Various
Spec.: WLQP 17859-01
Para.: 3.1.3
S/N.: N/A
GSI: No

Amb. Temp.: 72°F
Photo: YES
Test Med.: Air
Specimen Temp.: Ambient

Job No.: 17859
Report No.: 17859-02
Start Date: 8-19-86

Test Title: POST-NORMAL RADIATION FUNCTIONAL TEST

INSULATION RESISTANCE AT 500 VDC

ACCEPTANCE CRITERIA: DATA COLLECTED FOR INFORMATION ONLY

SPECIMEN NO.	READING
B1	$>5.0 \times 10^{11}$ Ω
B2	$>5.0 \times 10^{11}$ Ω
B3	2.5×10^{11} Ω
B4	5.5×10^{10} Ω
B5	$>2.0 \times 10^{12}$ Ω
B6	$>1.0 \times 10^{12}$ Ω
B7	6.0×10^{10} Ω

Tested By: Pritchard Date: 8-19-86
Witness: None Date: –
Sheet No 1 of 2
Approved 8/19/86

Notice of Anomaly: None

Wyle Form WH 614A, Rev. APR '84

DATA SHEET

WYLE LABORATORIES

Customer CECo
Specimen Cables and Splices
Part No. Various
Spec. WLQP 17859-01
Para. 3.1.3
S/N N/A
GSI No

Amb. Temp. 72°F
Photo YES
Test Med. Air
Specimen Temp. Ambient

Job No. 17859
Report No. 17859-02
Start Date 8-19-86

Test Title POST-NORMAL RADIATION FUNCTIONAL TEST

INSULATION RESISTANCE AT 500 VDC

ACCEPTANCE CRITERIA: DATA COLLECTED FOR INFORMATION ONLY

SPECIMEN NO.	READING
Z1	2.5×10^9 Ω
Z2	$>5.0 \times 10^{11}$ Ω
Z3	$>5.0 \times 10^{11}$ Ω
Z4	4DP ~~3.0×10^{11} Ω~~ 2.5×10^{11} Ω
Z5	4R ~~2.5×10^{11} Ω~~ 3.0×10^{11} Ω
Z6	3.5×10^{11} Ω
Z7	$>5.0 \times 10^{11}$ Ω
Z8	$>5.0 \times 10^{11}$ Ω
Z9	$>5.0 \times 10^{11}$ Ω
Z10	$>5.0 \times 10^{11}$ Ω
Z11	3.0×10^{11} Ω
Z12	3.5×10^{11} Ω
Z13	$>5.0 \times 10^{11}$ Ω

Tested By Date: 8-19-86
Witness None Date:
Sheet No. 3-2 of 3-3
Approved 8/19/86

Notice of Anomaly None

Wyle Form WH 614A, Rev. APR '84

APPENDIX III

INSTRUMENTATION EQUIPMENT SHEET

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INSTRUMENTATION EQUIPMENT SHEET

PAGE 1 OF 1

DATE 08/19/86 JOB NO. 17589-00 LOCATION LOCA
TECHNICIAN D. COMPTON CUSTOMER CECO TYPE TEST POST RAD. I-R

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE#	RANGE 1	ACCURACY 1	CALDTE	CALDUE
1	MEG MTR	GR	1864	657113180	011898	50K-50TOHM	2-5%RANGE	04/23/86	10/23/86

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES, WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION R.E. Archer
8-19-86

CHECKED & RECEIVED BY 8/19/86

Q.A. RS Bakes 8/19/86

2
Wyle
A

SECTION III

POST-NORMAL RADIATION EXPOSURE FUNCTIONAL TESTS

1.0 REQUIREMENTS

Insulation Resistance Values were taken for informational purposes only.

2.0 PROCEDURES

The test specimens were subjected to the testing per Paragraph 2.3 of Section I.

3.0 RESULTS

The test specimens were subjected to the Insulation Resistance Test of Paragraph 2.0 which met the requirements of Paragraph 1.0. The data collected during these tests is presented in Appendices I through III as noted below.

- Appendix I contains Photographs III-1 through III-3 which show the specimens mounted in their respective trays.
- Appendix II contains the Insulation Resistance Test Data Sheets.
- Appendix III contains the Instrumentation Equipment Sheet which lists the equipment used to collect data.

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THERMAL AGING

SECTION IV

THERMAL AGING

1.0 REQUIREMENTS

The test specimens shall be thermally aged as follows:

Specimen No.	Aging Temperature (°C)	Time (Hours)	Equivalent Life Years
Z1, Z6, Z8, Z10	115	149	40
Z7, Z11, Z13	115	190	40
B1 - B3	115	149	40
B4 - B7	115	179	40

2.0 PROCEDURES

The test specimens, mounted in their respective trays, were placed inside a large chest type thermal aging chamber and subjected to the aging program of Paragraph 1.0.

3.0 RESULTS

The test specimens possessed sufficient integrity to complete the thermal aging program without evidence of excessive degradation. All of the Raychem nuclear insulating products showed no visual evidence of change during thermal aging. However, all of the test specimen cables and the outer layer of the OKONITE and Kerite tapes became brittle. There was no evidence of cracking in any of the splices or cable insulations.

Appendices I through III contain the following data from thermal aging:

- Appendix I contains Photographs IV-1 through IV-4 which show the thermal aging chamber and the post-thermal aging condition of the specimens.
- Appendix II contains a typical thermal aging circular chart from 115°C aging chamber.
- Appendix III contains the Instrumentation Equipment Sheet for the thermal aging chamber instrumentation.

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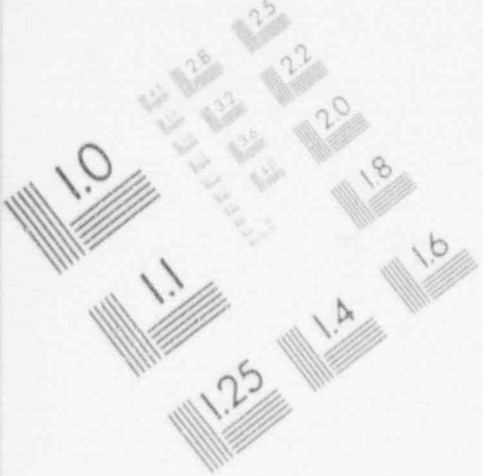
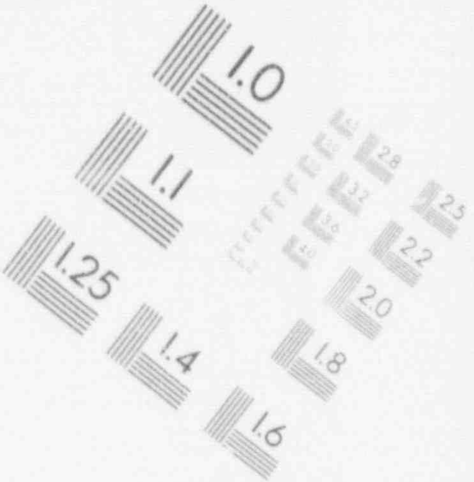
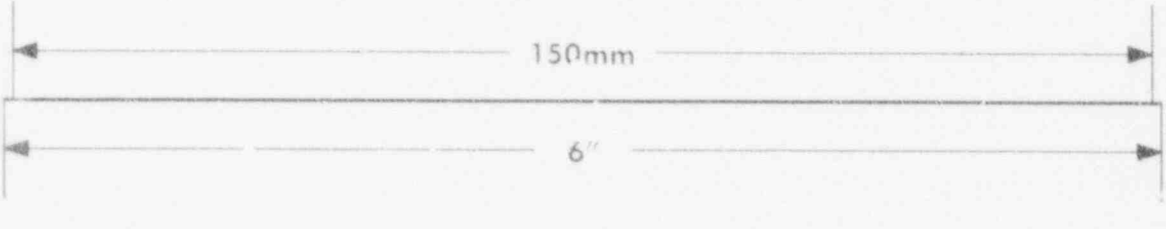
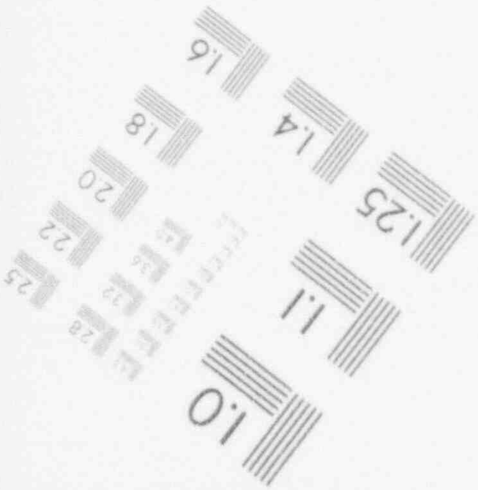
2

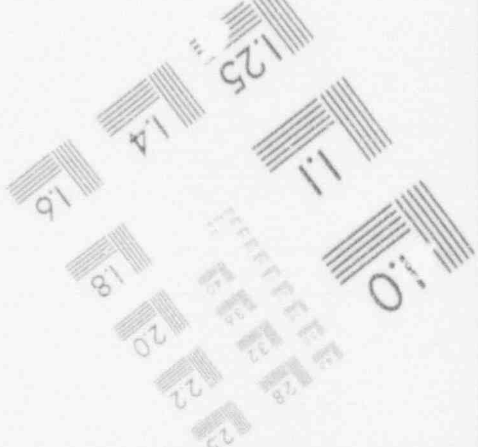
IMAGE EVALUATION
TEST TARGET (MT-3)







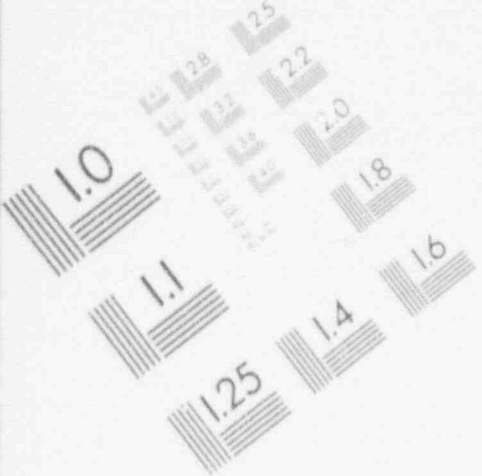


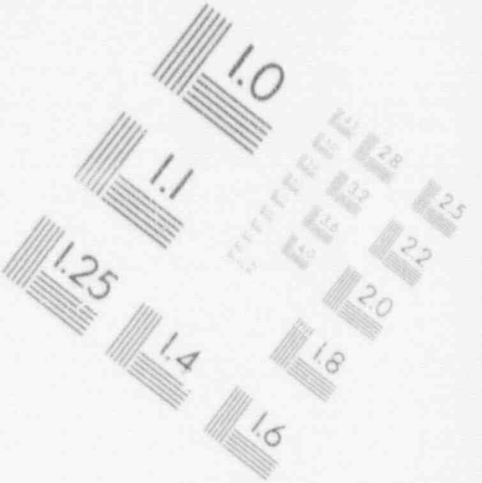


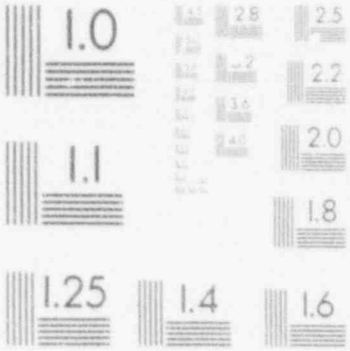
PHOTOGRAPHIC SCIENCES CORPORATION
770 BASKET ROAD
P.O. BOX 338
WEBSTER, NEW YORK 14580
(716) 265-1600

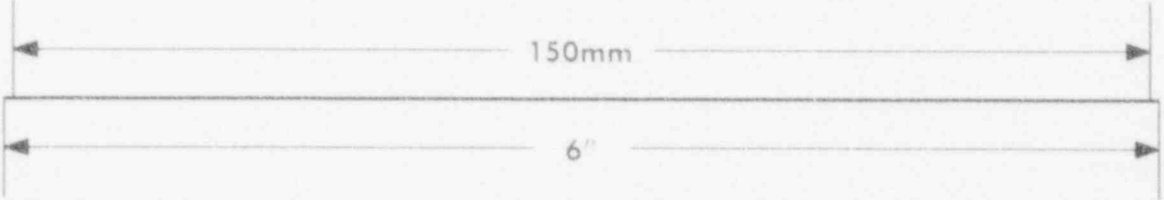
2

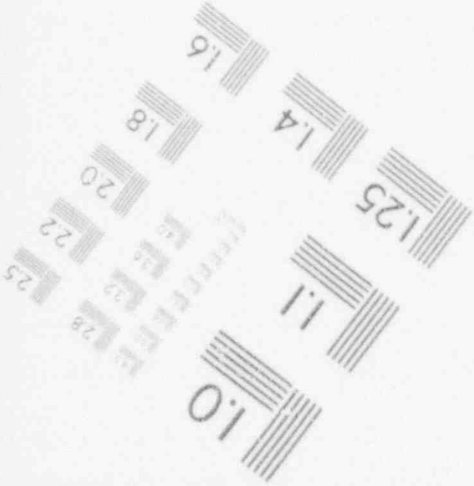
IMAGE EVALUATION TEST TARGET (MT-3)

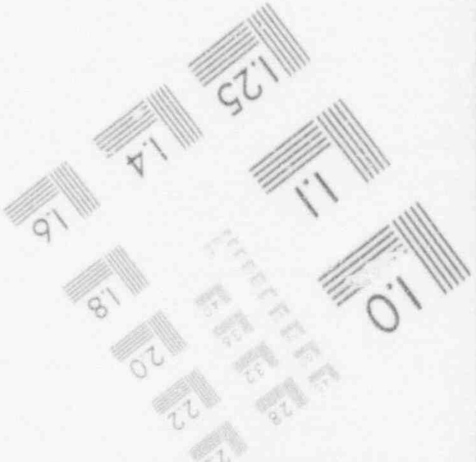












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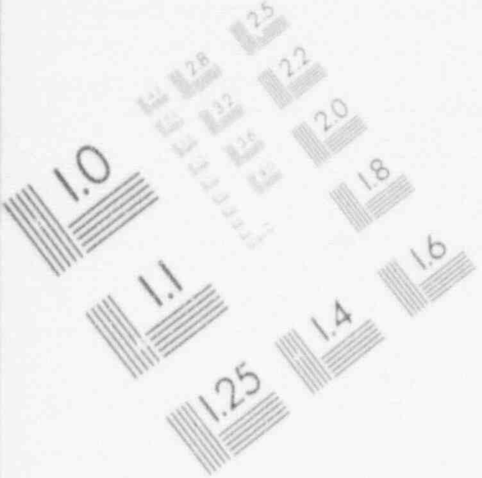
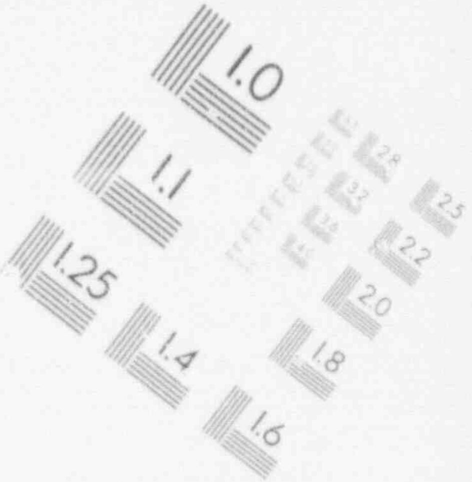
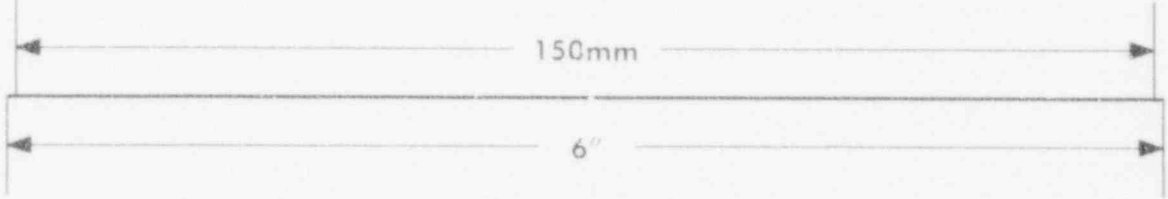
770 BASKET ROAD
P.O. BOX 338
WEBSTER, NEW YORK 14580
(716) 265-1600

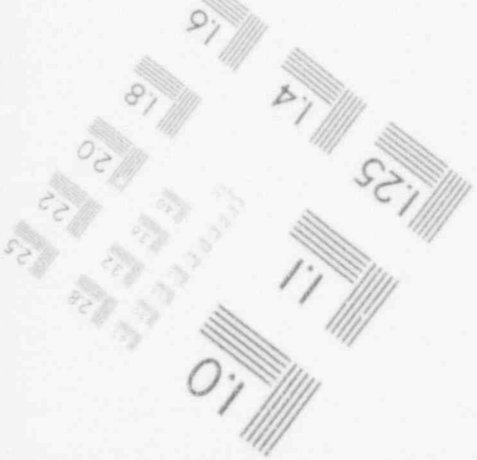
2

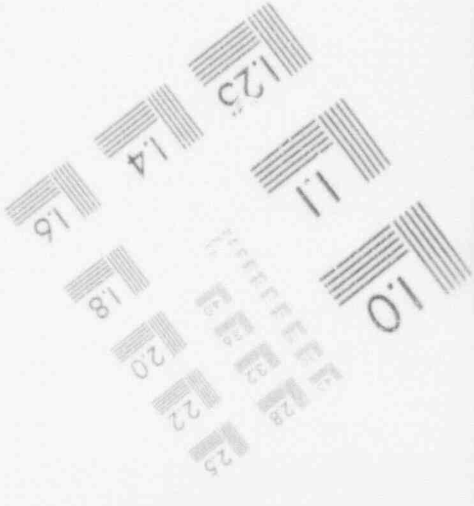
IMAGE EVALUATION
TEST TARGET (MT-3)











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(716) 265-1600

APPENDIX I

PHOTOGRAPHS

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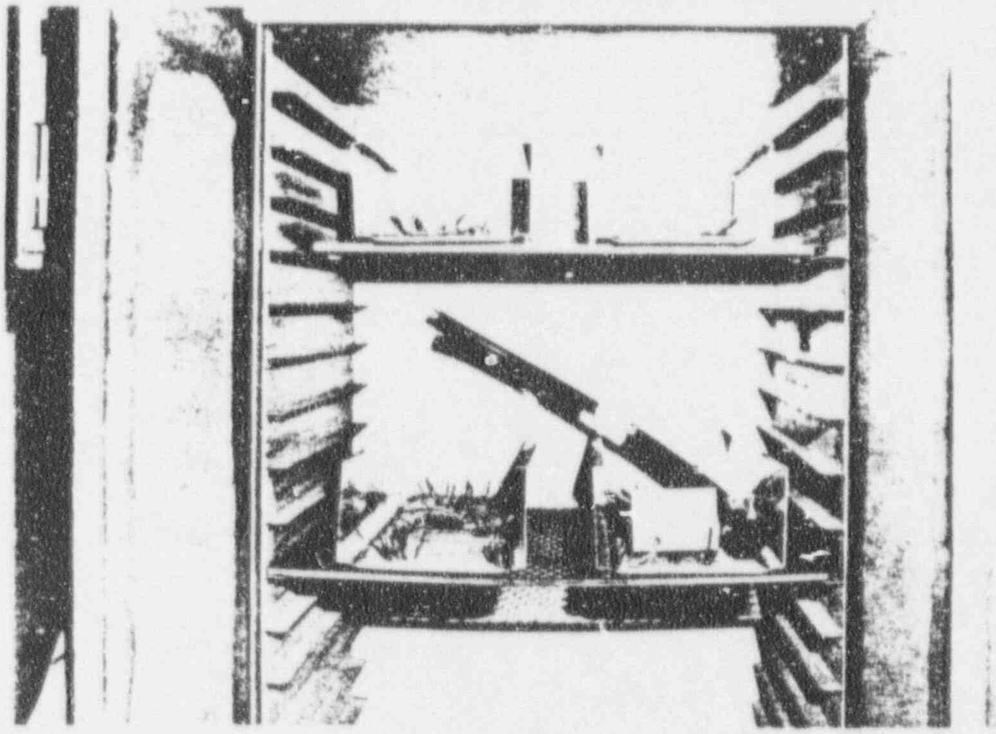
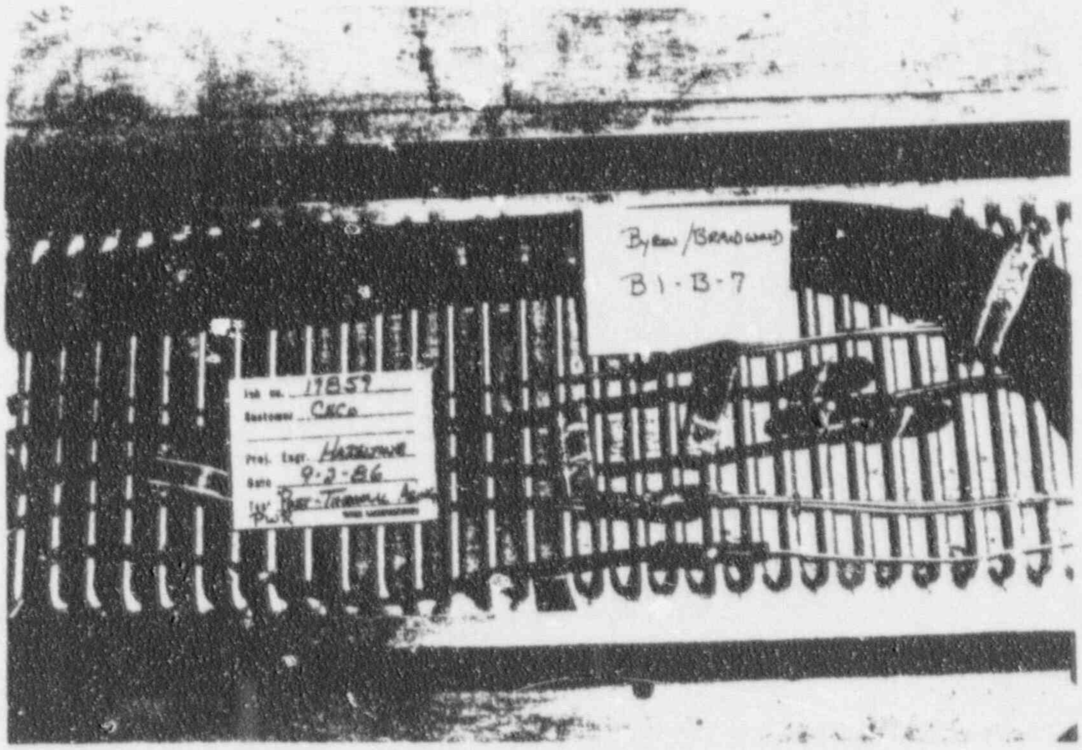


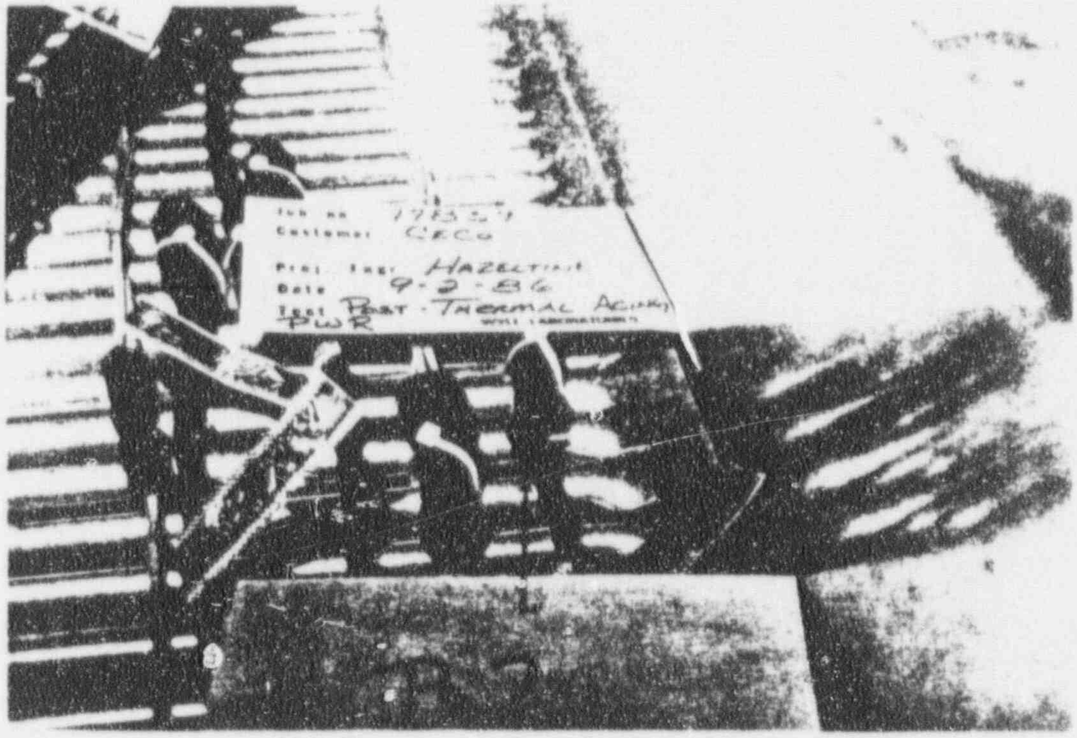
PHOTOGRAPH NO. IV-1

TEST SPECIMENS PLACED INSIDE THE 115°C
THERMAL AGING CHAMBER



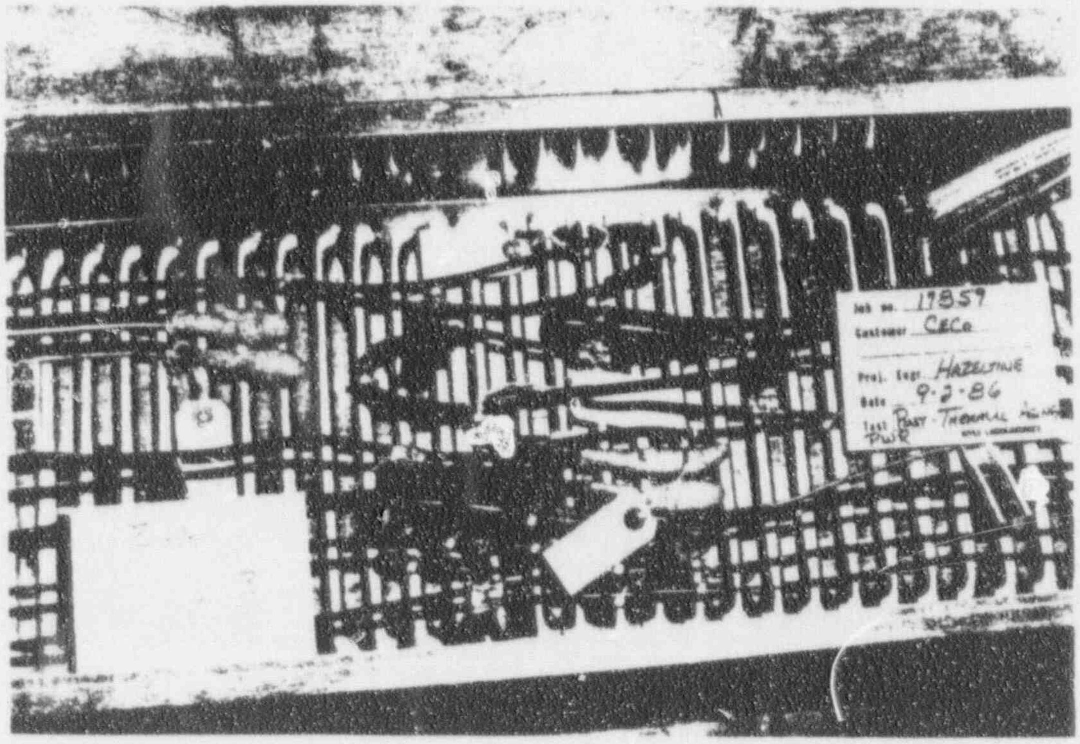
PHOTOGRAPH NO. IV-2

POST-THERMAL AGING VIEW OF BYRON/BRAIDWOOD
SPECIMENS B1 - B7



PHOTOGRAPH NO. IV-3

CLOSEUP VIEW SHOWING SLIGHT CHARRING TO SPECIMEN B2 THAT OCCURRED DURING SPECIMEN PREPARATION



PHOTOGRAPH NO. IV-4

POST-THERMAL AGING VIEW OF ZION SPECIMENS Z1 - Z13

APPENDIX II

TYPICAL THERMAL AGING CIRCULAR CHART

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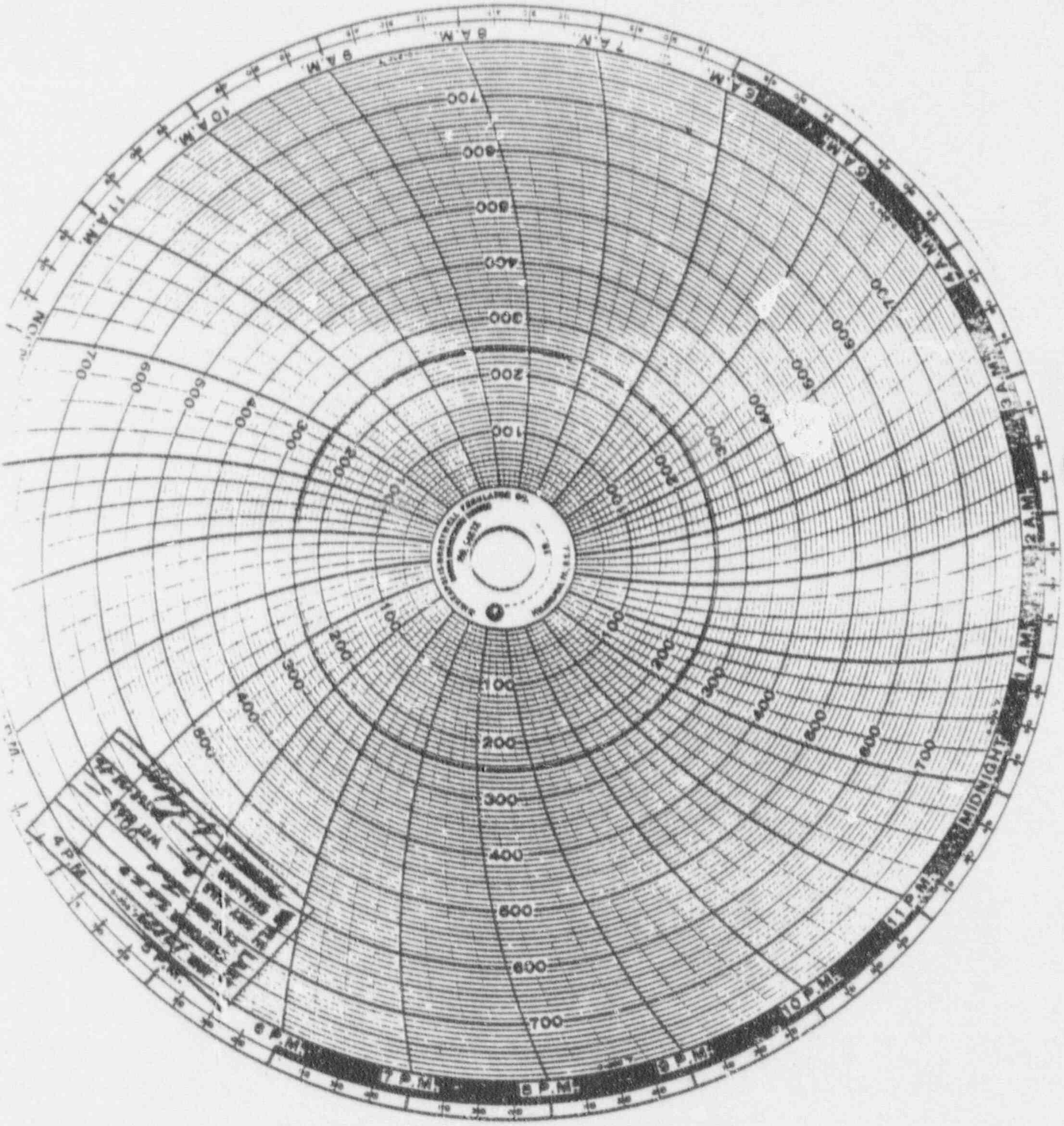

TYPICAL THERMAL AGING CIRCULAR CHART FROM 115°C CHAMBER

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APPENDIX III

INSTRUMENTATION EQUIPMENT SHEET

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INSTRUMENTATION EQUIPMENT SHEET

PAGE 1 OF 1

DATE 08/20/86 JOB NO. 17859-00 LOCATION ENV.#84#21
TECHNICIAN JOE LAXSON CUSTOMER CECO TYPE TEST THERMAL AGING

NO.	INSTRUMENT	MANUFACTURER	MODEL #	SERIAL #	WYLE#	RANGE 1	ACCURACY 1	CALDTE	CALDUE
1	CONTR TEMP	RESEARCH	61011	25-061	000737	-125-375#F T	+-0.5%	06/11/86	12/11/86
2	RECORD TEMP	HONEYWELL	45	8050310384010	094790	0+400#F T	+-0.5%	07/25/86	10/25/86
3	TEMP ALARM	RESEARCH	61034	31524-01-49	094525	-175+375#F T	+-0.5%	03/25/86	09/25/86
4	RECORD TEMP	HONEYWELL	45	8009283019003	092811	0+800#F K	+-0.5%	06/04/86	09/04/86
5	CONTR TEMP	RESEARCH	61011	825061	000731	-125+375#F T	+-.5%	03/17/86	09/17/86
6	TEMP ALARM	RESEARCH INC.	61034	240167	000736	0-1000#F K	+-0.5%	03/10/86	09/10/86
7	Recorder	Honeywell	45		94790		+-.5%	9/4/86	12/4/86

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES, WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION Paul Wadsworth 8/20/86

CHECKED & RECEIVED BY 8/20/86

Q.A. 8/20/86

POST-THERMAL AGING FUNCTIONAL TESTS

SECTION V

POST-THERMAL AGING FUNCTIONAL TESTS

1.0 REQUIREMENTS

Insulation Resistance Values were taken for informational purposes only.

2.0 PROCEDURES

The test specimens were subjected to the testing per Paragraph 2.3 of Section I.

3.0 RESULTS

The test specimens were subjected to the Insulation Resistance Test of Paragraph 2.0 which met the requirements of Paragraph 1.0. The data collected during these tests is presented in Appendices I and II as noted below.

- Appendix I contains the Insulation Resistance Test Data Sheets.
- Appendix II contains the Instrumentation Equipment Sheet which lists the equipment used to collect data.

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APPENDIX I

DATA SHEETS

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APPENDIX II

INSTRUMENTATION EQUIPMENT SHEET

DATA SHEET

WYLE LABORATORIES

Customer CECo
Specimen Cables and Splices
Part No. Various
Spec. WLQP 17859-01
Para. 3.1.3
S/N N/A
GSI No
Amb. Temp. ≈78°F
Photo yes
Test Med. Air
Specimen Temp. Ambient
Job No. 17859
Report No. 17859-02
Start Date 9-2-86

Test Title POST-THERMAL AGING FUNCTIONAL TEST

INSULATION RESISTANCE AT 500 VDC

ACCEPTANCE CRITERIA: DATA COLLECTED FOR INFORMATION ONLY

SPECIMEN NO.	READING
B1	6.0×10^{12} Ω
B2	5.0×10^{11} Ω
B3	4.5×10^{11} Ω
B4	4.0×10^{11} Ω
B5	3.5×10^{11} Ω
B6	5.8×10^{11} Ω
B7	2.2×10^{11} Ω

Tested By D. Lounsbury Date: 9/[illegible]6
Witness None Date:
Sheet No. 1 of 2
Approved 9/2/86

Notice of Anomaly None

Wyle Form WH 614A, Rev. APR '84

DATA SHEET

WYLE LABORATORIES

Customer CECo
Specimen Cables and Splices
Part No. Various
Spec. WLQP 17859-01
Para. 3.1.3
S/N N/A
GSI No
Amb. Temp. 78°F
Photo YES
Test Med. Air
Specimen Temp. Ambient
Job No. 17859
Report No. 17859-02
Start Date 9-2-86

Test Title POST-THERMAL AGING FUNCTIONAL TEST

INSULATION RESISTANCE AT 500 VDC

ACCEPTANCE CRITERIA: DATA COLLECTED FOR INFORMATION ONLY

SPECIMEN NO.	READING
Z1	$2,4 \times 10^{10}$ Ω
Z2	7.0×10^{11} Ω
Z3	8.8×10^{11} Ω
Z4	5.0×10^{11} Ω
Z5	4.5×10^{11} Ω
Z6	$5,6 \times 10^{11}$ Ω
[illegible]	5.0×10^{11} Ω
Z8	3.5×10^{11} Ω
Z9	4.0×10^{11} Ω
Z10	5.0×10^{11} Ω
Z11	4.0×10^{11} Ω
Z12	1.5×10^{10} Ω
Z13	$5,4 \times 10^{11}$ Ω

Tested By P. Compton Date: 9/2/86
Witness None Date:
Sheet No. 2 of 2
Approved J. Hazlett 9/2/86

Notice of Anomaly None

Wyle Form WH 614A, Rev. APR '84

INSTRUMENTATION EQUIPMENT SHEET

PAGE 1 OF 1

DATE 09/02/86 JOB NO. 17859-00 LOCATION LOCA

TECHNICIAN D. COMPTON CUSTOMER CECO TYPE TEST POST T-A

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE#	RANGE 1	ACCURACY 1	CALDTE	CALDUE
1	MEG MTR	GR	1864	657113180	011898	50K-50TOHM	2-5%RANGE	04/23/86	10/23/86

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES, WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION R.E. Archer
9-2-86

CHECKED & RECEIVED BY J Hazlett 9/2/86

Q.A. 9-2-86

12 Wyle A

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INSTRUMENTATION EQUIPMENT SHEET

PAGE 1 OF 1

DATE 09/02/86
JOB NO. 17859-00
LOCATION LOCA
TECHNICIAN D. COMPTON
CUSTOMER CECO
TYPE TEST POST T-A

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE#	RANGE 1	ACCURACY 1	CALDTE	CALDUE
1	MEG MTR	GR	1864	657113180	011898	50K-50TOHM	2-5%RANGE	04/23/86	10/23/86

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES, WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION R.E. Archer
9-2-86

CHECKED & RECEIVED BY J. Hazlett 9/2/86

Q.A. 9-2-86

12
Wyle

ACCIDENT RADIATION EXPOSURE

SECTION VI

ACCIDENT RADIATION EXPOSURE

1.0 REQUIREMENTS

The test specimens shall be irradiated to an accident radiation exposure of 1.84×10^8 rads, gamma, using a Cobalt 60 source.

2.0 PROCEDURES

The test specimens, mounted in their respective trays, were placed in the hot cell at the Georgia Institute of Technology's Neely Nuclear Research Center, Atlanta, Georgia and radiated for 79.0 hours at a dose rate of 2.33×10^6 rads/hr for a total dose of 184.07 megarads.

3.0 RESULTS

The test specimens were subjected to the radiation exposure of Paragraph 2.0 which met the requirements of Paragraph 1.0.

No physical changes were evident on the Raychem and Kerite tape splice specimens. The Okonite Tape Splice specimens, specimens B4 - B7, developed a shiny film and very small cracks on the outer jacketing tape. These cracks did not extend past the outer layer of tape. All of the cables, connected to the splices, were very brittle after the radiation exposure but no cracks in the insulation were noted.

Appendix I contains the letter of certification on the radiation exposure from the Georgia Institute of Technology.

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APPENDIX I

RADIATION FACILITY CERTIFICATION LETTER

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Georgia Institute of Technology
Neely Nuclear Research Center
Atlanta, Georgia 30332
(404) 894-3600

GEORGIA TECH 1885-1985
DESIGNING TOMORROW TODAY

October 8, 1986

Wyle Laboratories
7800 Governors Drive
Huntsville, Alabama 35805

Attention: Mr. Joe Hazeltine

Reference: 4-9534-P
610962

Gentlemen:

The items covered by the above number have been irradiated in accordance with quality assurance requirements using Cobalt 60 (gamma energies 1.173 Mev, 1.332 Mev) to the total dose requested.

We certify the specifics of the irradiation as follows:

Irradiation Period:	Interval on September 7 to September 10, 1986 as shown on the enclosed Gamma Irradiation Log Sheet
Dose Rate:	2.33 E6 rads/hr (air)
Total Dose:	1.84 E8 rads (air)
Dosimetry:	Victoreen Model 500B-1 Integrating/Rate Electrometer System with ionization chamber probe. Calibration by Victoreen traceable to NBS Cobalt-60.

Calculations, a sketch, and a photograph of the arrangement are enclosed. Please let us know if any additional information is needed.

Yours truly,

R. A. Karam

Dr. R. A. Karam
Director

RAK:jlr

Enclosures

GEORGIA INSTITUTE OF TECHNOLOGY

Nuclear Research Center
900 Atlantic Drive, N.W.
Atlanta, Georgia 30332
(404) 894-3608

GAMMA IRRADIATION LOG

Client: Wyle Laboratories

NRC Reference: 610962

Reference: 4-9534

Total Dose: 1.84 E8

Item: 2 ea. cable trays containing (20) splices

Dose Rate: No set maximum rate

Start	Stop	Lapsed Hours	Dose Rate Rads/hour	Total Dose Rads	Cumulative Dose - Rads
9/7/86	9/10/86				
1054	1754	79.0	2.33 E6	1.84 E8	1.84 E8

Date

Performed Jerry E. Taylor 9-10-86

Reviewed 9-10-86

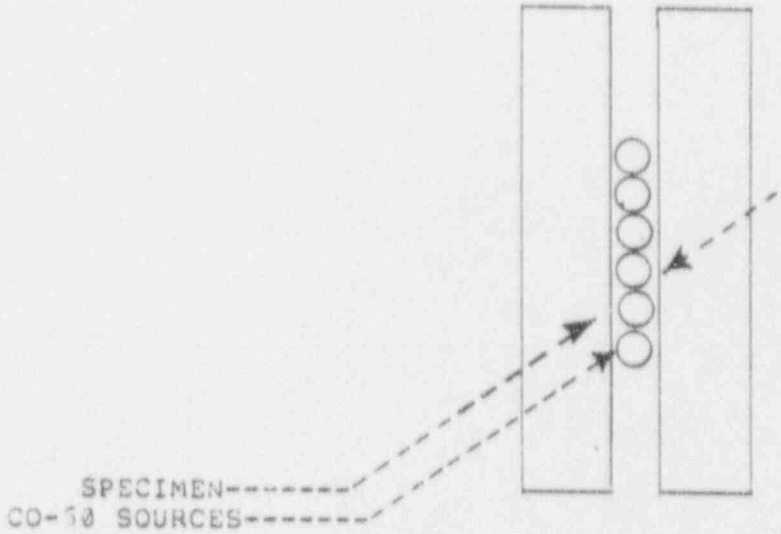
DOSE RATE DETERMINATION

E x P x D x T x M x H x R = Dose rate, rads/hr (air equivalent)

E = Electrometer high level conversion
P = Probe efficiency
D = Dose conversion, roentgen to rad
T = Temperature correction to 0 degree Celsius
M = Pressure correction to 760 mm Hg
H = Time conversion, min. to hr.
R = Electrometer reading

E	P	D	T	M	H	R	Dose rate, rads/hr
100	0.928	0.869	1.081	1.025	60	435.22	2.33 E6

WYLE # 4-9534
GEORGIA TECH# 510962



TRACEABILITY DATA

Victoreen Electrometer
Model #500B-1
Serial #340

Calibrated: October 28, 1985
By: Neely Nuclear Research Center
Georgia Institute of Technology
Atlanta, Georgia 30332
Next Calibration Due: October 28, 1986

Instruments Used:
Keithley Picoampere Source
Model #261
Serial #71987

Calibration: April 12, 1985
By: General Electric Company
Integrated Communication Services Operation
2825 Pacific Drive, Suite A
Norcross, Georgia 30071
Next Calibration Due: April 12, 1986

General Electric Traceability
FLU-8505A #3195029
Dated January 7, 1985 Due July 7, 1985
KEI-515 #23666
Dated June 4, 1984 Due June 4, 1985

Hewlett Packard Digital Voltmeter
Model #3460B
Serial #709-00133

Calibration: October 22, 1985
By: Hewlett Packard
Product Support Division
2000 South Park Place
Atlanta, Georgia 30339
Next Calibration Due: April 22, 1986

Hewlett Packard Traceability
N.B.S. #234494 Dated April 30, 1985 Due October 30, 1985

VICTOREEN PROBE
MODEL #550-6A
SERIAL #499

CALIBRATION: JUNE 13,1986
BY: VICTOREEN, INC.
10101 WOODLAND AVENUE
CLEVELAND, OHIO 44104
NEXT CALIBRATION DUE: JUNE 13, 1987

VICTOREEN TRACEABILITY
TEST NUMBER DG8118/83
CALIBRATION: SEPTEMBER 29, 1983
PTW CHAMBER MODEL 30-343
SERIAL NUMBER N23361-142

POST-ACCIDENT RADIATION EXPOSURE FUNCTIONAL TESTS

APPENDIX I

DATA SHEETS

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DATA SHEET

WYLE LABORATORIES

Customer: CECo
Specimen: Cables and Splices
Part No.: Various
Spec.: WLQP 17859-01
Para.: 3.1.3
S/N: N/A
GSI: No
Amb. Temp.: 70°F
Photo: yes
Test Med.: Air
Specimen Temp.: Ambient
Job No.: 17859
Report No.: 17859-02
Start Date: 9-15-86

Test Title: POST-ACCIDENT RADIATION FUNCTIONAL TEST

INSULATION RESISTANCE AT 500 VDC

ACCEPTANCE CRITERIA: DATA COLLECTED FOR INFORMATION ONLY

SPECIMEN NO.	READING
B1	$2.6 \times 10^{11}\ \Omega$
B2	$4.0 \times 10^{11}\ \Omega$
B3	$3 \times 10^{11}\ \Omega$
B4	$1 \times 10^{8}\ \Omega$
B5	$1.4 \times 10^{12}\ \Omega$
B6	$2.0 \times 10^{8}\ \Omega$
B7	$3.0 \times 10^{11}\ \Omega$

Tested By: J. Rehage Date: 9-15-86
Witness: None Date:
Sheet No. 1 of 2
Approved: 9-15-86

Notice of Anomaly: None

DATA SHEET

WYLE LABORATORIES

Customer CECo
Specimen Cables and Splices
Part No. Various
Spec. WLQP 17859-01
Para. 3.1.3
S/N N/A
GSI No
Amb. Temp. 70°F
Photo YES
Test Med. Air
Specimen Temp. Ambient
Job No. 17859
Report No. 17859-02
Start Date 9-15-86
Test Title POST-ACCIDENT RADIATION FUNCTIONAL TEST

INSULATION RESISTANCE AT 500 VDC

ACCEPTANCE CRITERIA: DATA COLLECTED FOR INFORMATION ONLY

SPECIMEN NO.	READING
Z1	1.5×10^{10} Ω
Z2	2×10^{8} Ω
Z3	3×10^{11} Ω
Z4	1.5×10^{11} Ω
Z5	1.2×10^{11} Ω
Z6	1.4×10^{11} Ω
Z7	1.6×10^{11} Ω
Z8	1.3×10^{11} Ω
Z9	1.4×10^{11} Ω
Z10	1.4×10^{11} Ω
Z11	2.2×10^{11} Ω
Z12	2.2×10^{11} Ω
Z13	1.6×10^{11} Ω

Tested By J. Rehage Date: 9-15-86
Witness None Date:
Sheet No. 2 of 2
Approved 9-15-86

Notice of Anomaly None

Wyle Form WH 614A, Rev. APR '84

ACCIDENT (LOCA) TEST

SECTION VIII

ACCIDENT (LOCA) TEST

1.0 REQUIREMENTS

1.1 Acceptance Criteria

The acceptance criteria for the test specimen assemblies is to demonstrate, during accident and post-accident simulation, electrical integrity. Circuit currents of Table 1 of Section X shall be applied while powered at Table 1 of Section X voltages to the appropriate fused circuits.

1.2 Leakage Currents

Leakage currents to ground on each specimen shall be measured continuously for informational purposes only during the LOCA test.

2.0 PROCEDURES

2.1 Test Specimen Preparation

The test specimen leads, except for specimen B7, were connected to Wyle supplied 1/C 14 AWG Teflon insulated wire through un-insulated butt splices covered with Raychem WCSF-N 070 or 115, as appropriate, nuclear sleeves. Specimen B7, with 1/C 500 MCM cable ends, was connected to 1/C 10 AWG Teflon insulated wire by inserting the 1/C 10 AWG wire between the strands on the 500 MCM cable and compressing inside a compression lug barrel. The 1/C 10 AWG wire was built up to the required splice diameter with Raychem WCSF-N 115, 300 and 500 nuclear sleeves. A Raychem WCSF-N 650 nuclear sleeve connected the 500 MCM cable and the built-up 10 AWG cable.

After being connected to the Wyle test leads the test specimen metal tags were removed and the specimens mounted in the following tray or enclosure:

Specimen No.	Enclosure or Tray
Z2, Z3 & Z11	36"L x 12"W x 6"D Solid Bottom Cable Tray
Z1 and Z4-Z10	18" x 18" Nema 3 Enclosure
B1-B7, Z12 and Z13	20" x 16" Nema 12 Enclosure

Both enclosures contained a 1/4" weep hole in the lower right corner and a 1 1/2" LB fitting with an 18" long 1 1/2" OD unsealed conduit stub out of the center of the top of the enclosure. All of the Wyle test leads exited the enclosure through this LB fitting and conduit.

2.0 PROCEDURES (Continued)

2.2 Chamber Preparation

The test specimens were mounted to carbon steel test frames which were inserted inside a 30" diameter 10 foot long cylindrical LOCA test chamber. The test frames were tack welded to the chamber to ensure a solid ground connection existed for leakage currents to ground. The Wyle supplied Teflon wiring was routed through multiple chamber penetrations, at the front of the test chamber, which were sealed with Scotchcast No. 9 potting compound.

The chamber door was partially sealed and the chamber water level control valve was adjusted to ensure that the specimens did not become submerged during the chemical spray period in the test. In addition, the chemical spray system was adjusted to deliver 3.75 gallons per minute (0.15 gallons per square foot over a 25 square foot area). Chemicals were prepared as described in Appendix VII of this section.

2.3 Instrumentation Setup

The instrumentation setup for this test consisted of 66 electrical and environmental channels. These signals were split between two different acquisition systems. The environmental parameters and specimen leakage currents to ground signals were fed into a Daytronics CM12 Data Acquisition System (DAS) which displayed requested information on a color monitor, fed a Texas Instruments 810R0 high speed line printer and fed a Hewlett Packard Model 1000 minicomputer. The input voltage and load current signals were fed into a Fluke 2240B Datalogger which fed a Texas Instruments high speed line printer. The channels' numbers, specimens, and signals monitored were as described below:

DAYTRONICS DATA ACQUISITION SYSTEM CHANNELS

Channel No.	Specimen No.	Units	Signal Monitored
1	N/A	°F	Chamber control thermocouple
2	N/A	°F	Chamber control thermocouple
3	N/A	°F	Chamber control thermocouple
4	N/A	psig	Chamber pressure control transducer
5	N/A	°F	Average chamber temperature -average of channels 1, 2 and 3
6	N/A	GPM	Chemical Spray Flowrate (3.5-4.0 GPM)
7	N/A	PH	Chemical Spray PH (10.2-10.8)
8	Z2, Z3	psig	Input pressure to Wyle Omega PX114 transmitter used as a load
9	B1	mA	Leakage current to ground
10	B2	mA	Leakage current to ground
11	B3	mA	Leakage current to ground
12	B4	mA	Leakage current to ground
13	B5	mA	Leakage current to ground

APPENDIX II

INSTRUMENTATION EQUIPMENT SHEET

INSTRUMENTATION EQUIPMENT SHEET

PAGE 1 OF 1

DATE 09/15/86
JOB NO. 17859-00
LOCATION LOCA
TECHNICIAN J.REHAGE
CUSTOMER CECO
TYPE TEST I.R.

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE#	RANGE 1	ACCURACY 1	CALDTE	CALDUE
1	MEG MTR	GR	1864	657113180	011898	50K-50TOHM	2-5%RANGE	04/23/86	10/23/86

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES,WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION Richard [illegible] 9/15/86

CHECKED & RECEIVED BY J Hezlett 9/15/86

Q.A. RSBolin 9-15-86

2 Wyle

SECTION VII

POST-ACCIDENT RADIATION EXPOSURE FUNCTIONAL TESTS

1.0 REQUIREMENTS

Insulation Resistance Values were taken for informational purposes only.

2.0 PROCEDURES

The test specimens were subjected to the testing per Paragraph 2.3 of Section I.

3.0 RESULTS

The test specimens were subjected to the Insulation Resistance Test of Paragraph 2.0 which met the requirements of Paragraph 1.0. The data collected during these tests is presented in Appendices I and II as noted below.

- o Appendix I contains the Insulation Resistance Test Data Sheets.
- o Appendix II contains the Instrumentation Equipment Sheet which lists the equipment used to collect data.

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2.0 PROCEDURES (Continued)

2.3 Instrumentation Setup (Continued)

Channel No.	Specimen No.	Units	Signal Monitored
14	Z1	mA	Leakage current to ground
15	Z2	mA	Leakage current to ground
16	Z3	mA	Leakage current to ground
17	Z4	mA	Leakage current to ground
18	Z5	mA	Leakage current to ground
19	Z6	mA	Leakage current to ground
20	Z7	mA	Leakage current to ground
21	Z8	mA	Leakage current to ground
22	Z9	mA	Leakage current to ground
23	Z10	mA	Leakage current to ground
24	Z11	mA	Leakage current to ground
25	Z12	mA	Leakage current to ground
26	Z13	mA	Leakage current to ground

FLUKE 2240 DATALOGGER CHANNELS

Channel No.	Specimen No.	Units	Signal Monitored (Range)
1	B1	VAC	Input Voltage (132-136 VAC)
2	B1	Amps	Load Current (6.0-7.4A)
3	B2	VAC	Input Voltage (132-136 VAC)
4	B2	Amps	Load Current (6.0-7.4A)
5	B3	VAC	Input Voltage (132-136 VAC)
6	B3	Amps	Load Current (5.0-7.0A)
7	B4	VAC	Input Voltage (528-544 VAC)
8	B4	Amps	Load Current (6.0-7.4A)
9	B5	VAC	Input Voltage (528-544 VAC)
10	B5	Amps	Load Current (6.0-7.4A)
11	B6	VAC	Input Voltage (528-544 VAC)
12	B6	Amps	Load Current (9.0-11.0A)
13	B7	VAC	Input Voltage (528-544 VAC)
14	B7	Amps	Load Current (13.5-16.5A)
15	Z1	VAC	Input Voltage (132-136 VAC)
16	Z1	Amps	Load Current (6.0-7.4A)
17	Z2	VDC	Input Voltage (34.5-37 VDC)
18	Z2	mA	Load Current (36-44 mA)
19	Z3	VDC	Input Voltage (34.5-37 VDC)
20	Z3	mA	Load Current (36-44 mA)
21	Z4	VAC	Input Voltage (132-136 VAC)
22	Z4	Amps	Load Current (6.0-7.4A)
23	Z5	VAC	Input Voltage (132-136 VAC)
24	Z5	Amps	Load Current (6.0-7.4A)

2.0 PROCEDURES (Continued)

2.3 Instrumentation Setup (Continued)

Channel No.	Specimen No.	Units	Signal Monitored (Range)
25	Z6	VAC	Input Voltage (528-544 VAC)
26	Z6	Amps	Load Current (6.0-7.4A)
27	Z7	VAC	Input Voltage (528-544 VAC)
28	Z7	Amps	Load Current (6.0-7.4A)
29	Z8	VAC	Input Voltage (132-136 VAC)
30	Z8	Amps	Load Current (6.0-7.4A)
31	Z9	VAC	Input Voltage (132-136 VAC)
32	Z9	Amps	Load Current (6.0-7.4A)
33	Z10	VAC	Input Voltage (132-136 VAC)
34	Z10	Amps	Load Current (6.0-7.4A)
35	Z11	VAC	Input Voltage (528-544 VAC)
36	Z11	Amps	Load Current (6.0-7.4A)
37	Z12	VAC	Input Voltage (528-544 VAC)
38	Z12	Amps	Load Current (6.0-7.4A)
39	Z13	VAC	Input Voltage (528-544 VAC)
40	Z13	Amps	Load Current (6.0-7.4A)

Data was acquired at the maximum possible rate for the first 12 minutes (approximately 1 line of data every 2 seconds on the DAS and every 5 seconds on the datalogger), every 20 seconds for the next hour and then every 5 minutes until the end of the test. Due to a programming error, the Hewlett-Packard 1000 computer did not acquire data during the 13 minutes of the test. The DAS did, however, feed the line printer for the entire test duration.

2.4 Specimen Operability

The test specimens were energized to the currents and voltages listed the Fluke 2240 Datalogger Channels of Paragraph 2.3. The test specimen circuitry was as shown in Appendix III of this section.

The specimens were energized at their required voltages and currents approximately one hour prior to the start of the temperature/pressure ramp. The acquisition system was started, at five second intervals, 15 minutes before the LOCA test commenced. The test chamber was preheated to 120°F, with saturated steam, at this point.

2.5 Accident Simulation

The test specimens were subjected to the test profile of Figure VIII-5 in Appendix IV. The temperature ramp was met in 20 seconds and the pressure ramp was met in 14 seconds. The chemical spray flow was initiated at the 5 minute 46 second point and continued to the 24 hour 13 minute point in the test.

3.0 RESULTS

All of the test specimens, except for Z11, Z12 and B4, demonstrated the capability to conduct the specified currents at the specified voltages throughout the LOCA simulation in an end of life condition. It is therefore concluded that specimens B1-B3, B5-B7, Z1-Z10 and Z13 are qualified to the intent of IEEE Standard 323-1974.

Two anomalies occurred during this test program and were documented as Notices of Anomaly Numbers 1 and 2. Notice of Anomaly No. 1 documents the inability of Specimens Z11, Z12, and B4 to hold their specified voltage, without blowing fuses, during the LOCA Test. Z11 failed 5 seconds into the test; Z12 failed 10 minutes and 28 seconds into the test; and B4 failed after 14 hours and 26 minutes. The fuses to these specimens were replaced and each specimen blew the new fuse immediately after insertion. These specimens did not demonstrate qualification to IEEE Standard 323-1974 during this test program.

Notice of Anomaly No. 2 documents a circuitry change to Specimen Z2 which occurred because the Omega PX114 transmitter, used as the load device for Z2, was damaged due to an operator error. The circuitry was revised to use a fixed precision rheostat as the load, since another calibrated transmitter was not readily available at this time of the day (1700).

The peak recorded leakage currents recorded during this test were as follows:

Specimen Number	Peak Leakage* Current (mA)	Notes
Z1	157	
Z2	0	
Z3	0	
Z4	0	
Z5	0	
Z6	5	
Z7	1	
Z8	0	
Z9	0	
Z10	0	
Z11	250	(1)
Z12	250	(1)
Z13	1	
B1	1	
B2	38	
B3	35	
B4	250	(1)
B5	7	
B6	Not measured	(2)
B7	Not measured	(2)

Notes: (1) Specimen blew, repeatedly, a 1/4 ampere fuse to ground.
(2) Leakage current to ground signals were not measured because these specimens would not be overly affected by small current signals.

3.0 **RESULTS (Continued)**

*Leakage current signals were calibrated with a ±1 milliampere accuracy. It should be noted that the Daytronics System 10 Data Acquisition System scanned all channels at a 2500 sample per second rate. The peak leakage current signals were thus monitored approximately 96 times per second. These peak values were held in memory and continuously displayed on the color monitor. The individual specimen leakage current data were scanned and printed only at the intervals noted in Paragraph 2.3 (i.e., every 5 minutes for the majority of the test). Therefore, these peak leakage values are more accurate than those plotted in Appendix V.

The data from this test is presented in Appendices I through VIII. These appendices contain:

- Appendix I contains Notices of Anomaly Numbers 1 and 2.
- Appendix II contains Photographs VIII-1 through VIII-10 which show the test specimen, chamber and instrumentation setups.
- Appendix III contains Figures VIII-1 through VIII-4 which show the electrical circuitry utilized during this test.
- Appendix IV contains Figure VIII-5 which plots the temperature and pressure profiles for the LOCA test and Figure VIII-6 which shows the required test conditions.
- Appendix V contains plots of voltage, load current and leakage current to ground versus test time for each of the test specimens. The leakage current to ground for specimen Z1 is plotted for 4 time intervals since this was the only specimen to exhibit high levels of leakage current for an extended period of time.
- Appendix VI contains Insulation Resistance and High Potential Test data taken on specimens Z11, Z12 and B4 during the LOCA test to troubleshoot their apparent test failure.
- Appendix VII contains calculations on the chemical spray composition.
- Appendix VIII contains the Instrumentation Equipment Sheets which list the equipment used to take data during the LOCA test.

APPENDIX I

NOTICES OF ANOMALY

WYLE LABORATORIES (Eastern Operations)

NOTICE OF ANOMALY

DATE: 9-25-86

NOTICE NO: 1 P.O. NUMBER: 806121/Release NU-2 CONTRACT NO: N/A

CUSTOMER: Commonwealth Edison Company (CECo) WYLE JOB NO: 17859

NOTIFICATION MADE TO: John Regan/Jerry DeYoung NOTIFICATION DATE: 9-18-86

NOTIFICATION MADE BY: Joe Hazeltine VIA: Verbal/on-site

CATEGORY: ☒ SPECIMEN ☐ PROCEDURE ☐ TEST EQUIPMENT DATE OF ANOMALY: 9-18-86

PART NAME: Kerite Tape Splices and Okonite Tape Splice PART NO. N/A

TEST: PWR LOCA Test I.D. NO. Items Z11, Z12 and B4

SPECIFICATION: WLQP 17859-01, Rev. B PARA. NO. 3.3.1

REQUIREMENTS:

The acceptance criteria for the test specimen assemblies is to demonstrate, during accident and post-accident simulation, electrical integrity. Circuit currents of Table 1* will be applied while powered at Table 1* voltages to the appropriate fused circuits.

*Table 1 values for Z11, Z12 and B4 are 6.7 amperes at 528 VAC.

DESCRIPTION OF ANOMALY:

Specimens Z11, Z12 and B4 blew their 1/4-ampere polarization voltage fuses, indicating high leakage currents to ground. The 1/4-ampere fuses were replaced with 1-ampere fuses which blew immediately after being energized. Z11 failed 5 seconds into the test, Z12 failed after 10 minutes and 28 seconds, and B4 failed after 14 hours and 26 minutes.

DISPOSITION - COMMENTS - RECOMMENDATIONS:

The Customer was on-site and directed that the faulty specimens be disconnected and Insulation Resistance and High Potential measurements be taken from each specimen to ground.

NOTE: IT IS THE CUSTOMER'S RESPONSIBILITY TO ANALYZE ANOMALIES AND COMPLY WITH 10 CFR PART 21.

VERIFICATION:

TEST WITNESS: John Regan/Jerry DeYoung

REPRESENTING: S&L / CECo

QUALITY ASSURANCE: RSBalio 9-26-86

PROJECT ENGINEER: T Hnott 9/25/86

PROJECT MANAGER: 9/25/86

INTERDEPARTMENTAL COORDINATION: 9/25/86

NOTICE OF ANOMALY NO. 1
CECO
Wyle J/N 17859
9-24-86

DISPOSITION - COMMENTS - RECOMMENDATIONS: (Continued)

These readings were taken with the following results:

Specimen	Insulation Resistance	Breakdown Voltage
Z11	<50K Ω @ 10 VDC	>0 VAC
Z12	<50K Ω @ 10 VDC	>0 VAC
B4	<50K Ω @ 10 VDC	>0 VAC

The specimens were then reconnected to the current transformer and energized with 6.7 amperes at low voltage for the remainder of the test.
At the completion of the test, the specimens were visually inspected with the following observations:

Specimen	Observation
Z11	Kerite tape outer jacket is split but inner tape is intact. The point of arcing to the tray was on the high temperature lead approximately 6 inches from the splice.
Z12	Kerite tape outer jacket is split but inner tape is intact. The point of arcing to the enclosure was approximately 6 inches from the splice on the high temperature lead where the Wyle aluminum specimen tag was applied.
B4	Okonite tape outer layer cracked. The point of failure was at the "V" splice where the leads exit the tapes.

The specimens were photographed and testing was continued.

WYLE
LABORATORIES

(Eastern Operations)

NOTICE OF ANOMALY

DATE: 9-25-86

NOTICE NO: 2 P.O. NUMBER: 806121/Release NU-2 CONTRACT NO: N/A

CUSTOMER: Commonwealth Edison Company (CECo) WYLE JOB NO: 17859

NOTIFICATION MADE TO: John Regan/Jerry DeYoung NOTIFICATION DATE: 9-18-86

NOTIFICATION MADE BY: Joe Hazeltine VIA: Verbal/on-site

CATEGORY: ☐ SPECIMEN ☐ PROCEDURE ☒ TEST EQUIPMENT DATE OF ANOMALY: 9-18-86

PART NAME: Omega Differential Transmitter PART NO. PX114

TEST: PWR LOCA Test I.D. NO. N/A

SPECIFICATION: WLQP 17859-01, Rev. B PARA. NO. 3.3.1

REQUIREMENTS:

The test specimens shall be powered as described in Table 1.*

*Table 1 value for Specimen Z2, for which the Omega transmitter was the load, was 20mA at 36 VDC.

DESCRIPTION OF ANOMALY:

Due to an operator error, when adjusting the input voltage to the transmitter, the Omega PX114 transmitter was damaged, which resulted in an output voltage of 37 VDC and a current of greater than 100mA.

DISPOSITION · COMMENTS · RECOMMENDATIONS:

The Customer was on-site and directed that the damaged transmitter be replaced with a precision rheostat.

Testing was continued.

NOTE: IT IS THE CUSTOMER'S RESPONSIBILITY TO ANALYZE ANOMALIES AND COMPLY WITH 10 CFR PART 21.

VERIFICATION:

TEST WITNESS: John Regan/Jerry DeYoung

REPRESENTING: S&L / CECo

QUALITY ASSURANCE: RSBalis 9-26-86

PROJECT ENGINEER: 9/25/86

PROJECT MANAGER: 9/25/86

INTERDEPARTMENTAL COORDINATION: 9/25/86

APPENDIX II

PHOTOGRAPHS

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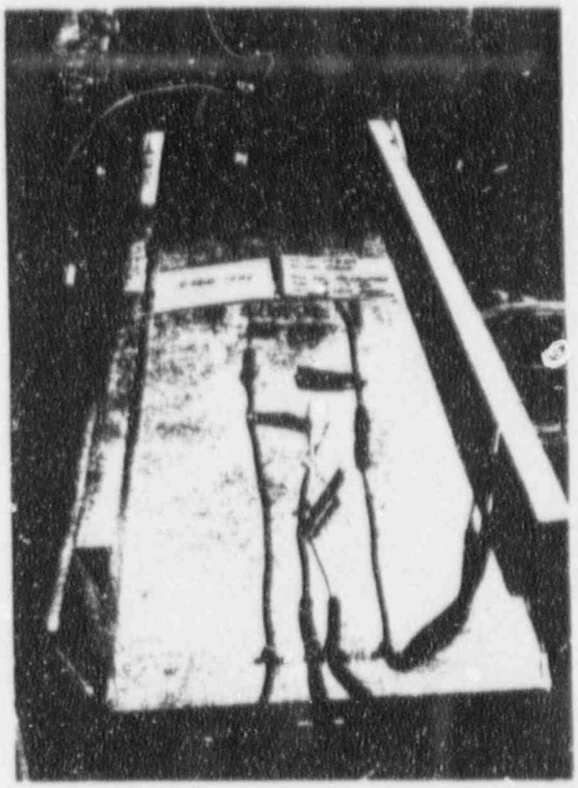
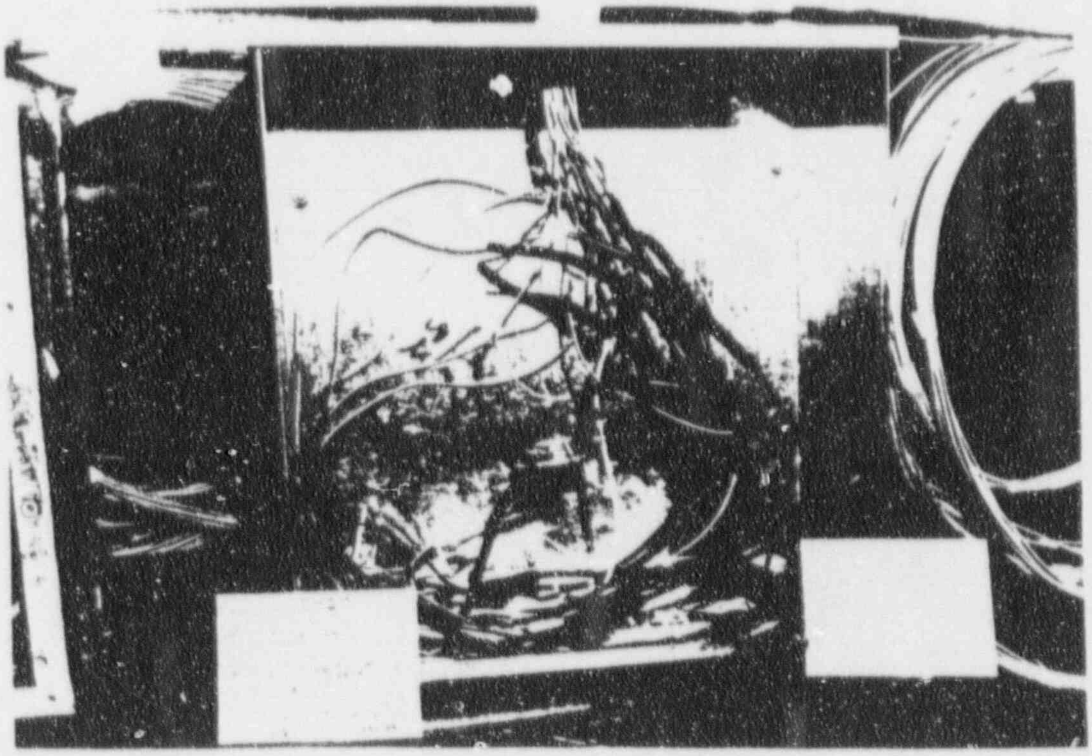


PHOTOGRAPH NO. VIII-1

SPECIMENS Z2, Z3 AND Z11 MOUNTED IN A CECO SUPPLIED SOLID BOTTOM CABLE TRAY PRIOR TO LOCA TEST

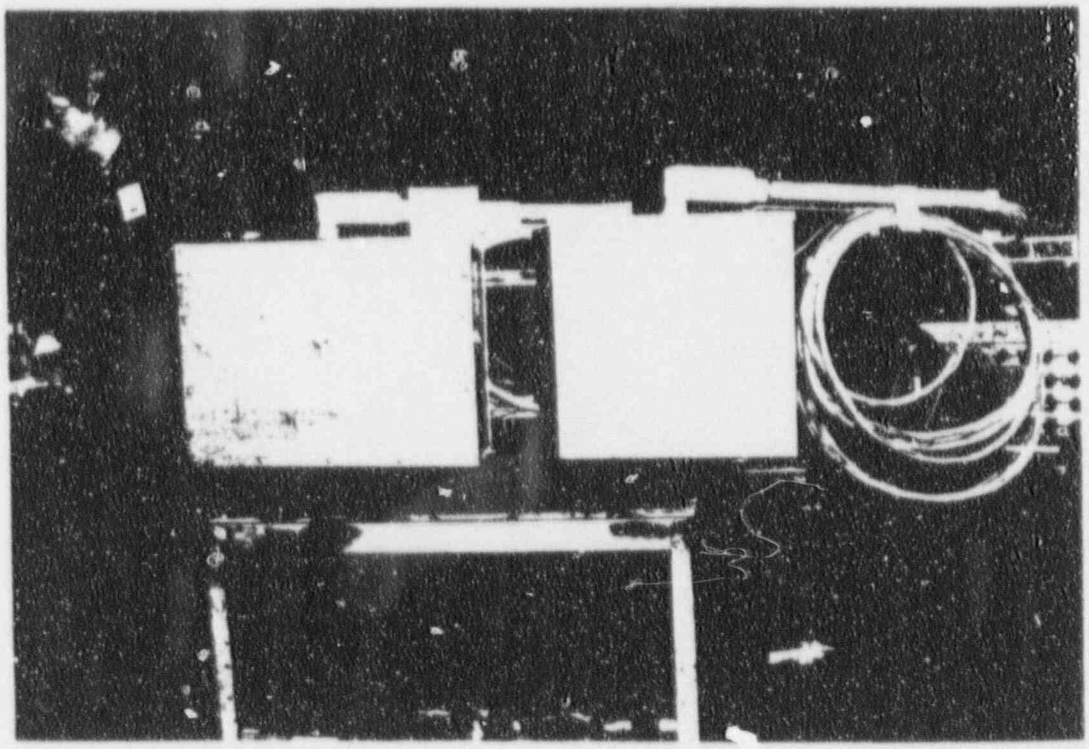


PHOTOGRAPH NO. VIII-2

INTERNAL VIEW OF NEMA 3 ENCLOSURE WITH SPECIMENS Z1 AND Z4-Z10 MOUNTED ON LOWER LEDGE

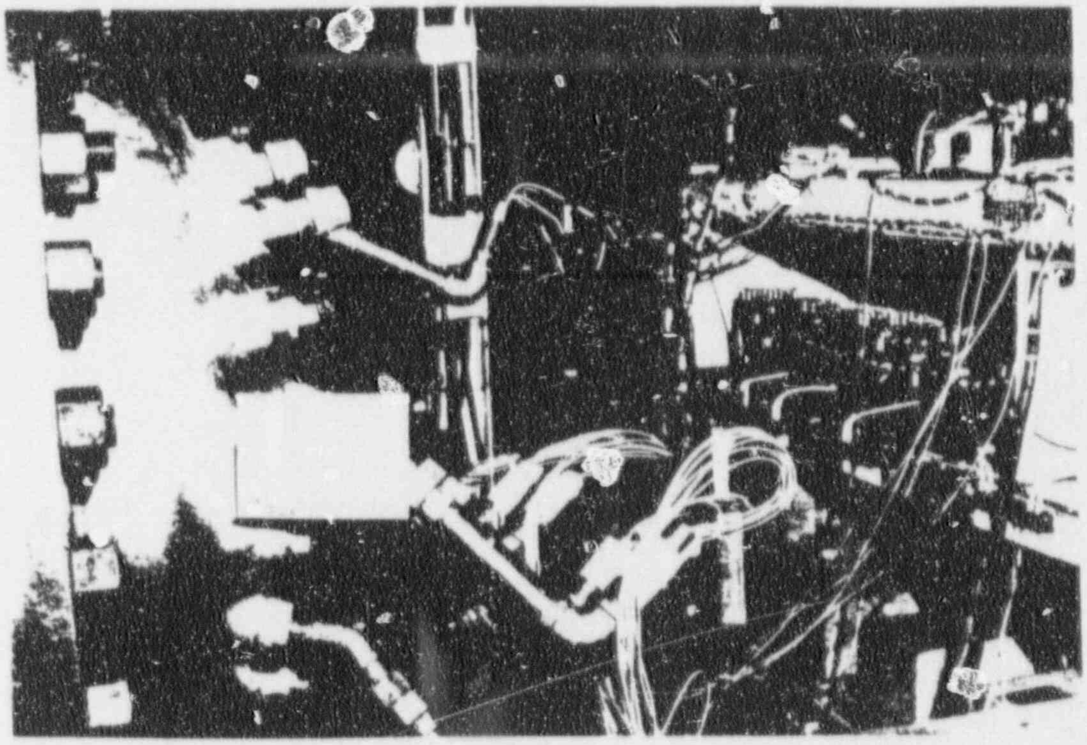
PHOTOGRAPH NO. VIII-3

INTERNAL VIEW OF NEMA 12 ENCLOSURE WITH SPECIMENS B1-B6, Z12 AND Z13 MOUNTED ON LOWER LEDGE. B7 WAS MOUNTED WITH THE SPLICE END VERTICAL IN THE ENCLOSURE



PHOTOGRAPH NO. VIII-4

EXTERNAL VIEW OF NEMA 3 AND NEMA 12 ENCLOSURES ON TEST FRAME

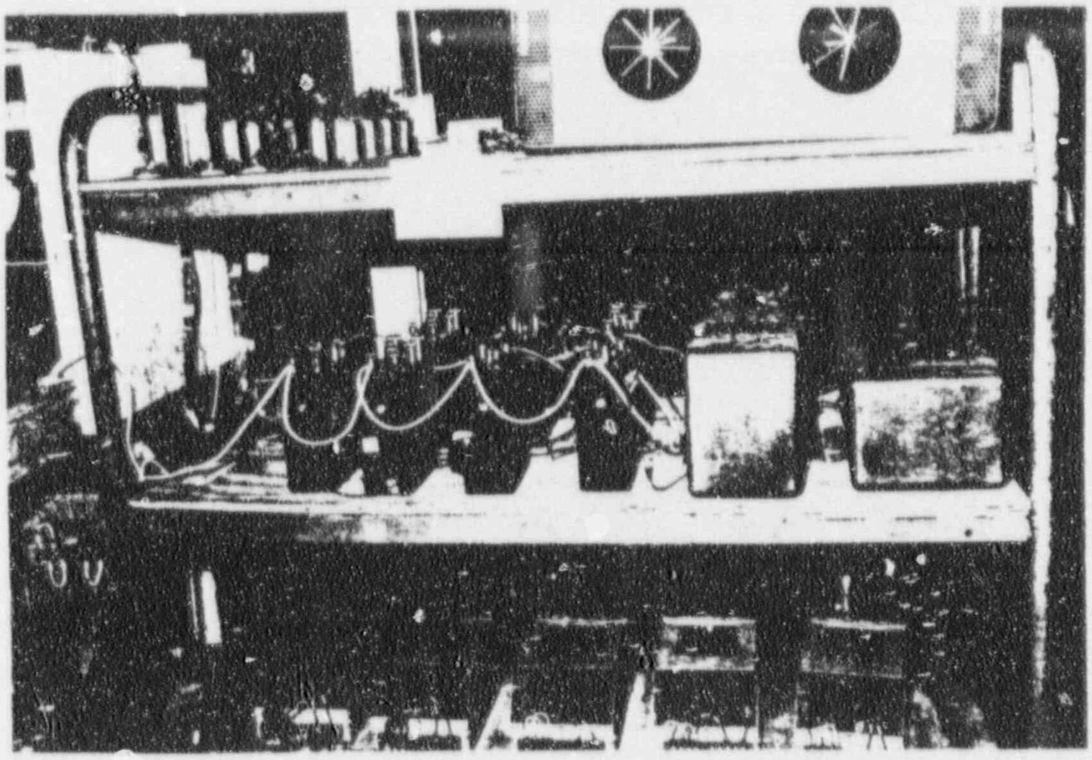


PHOTOGRAPH NO. VIII-5

TEST SETUP VIEW OF END OF LOCA CHAMBER WITH SEALED PENETRATIONS

PHOTOGRAPH NO. VIII-6

FRONT VIEW OF POWER SUPPLY AND INSTRUMENTATION SETUP

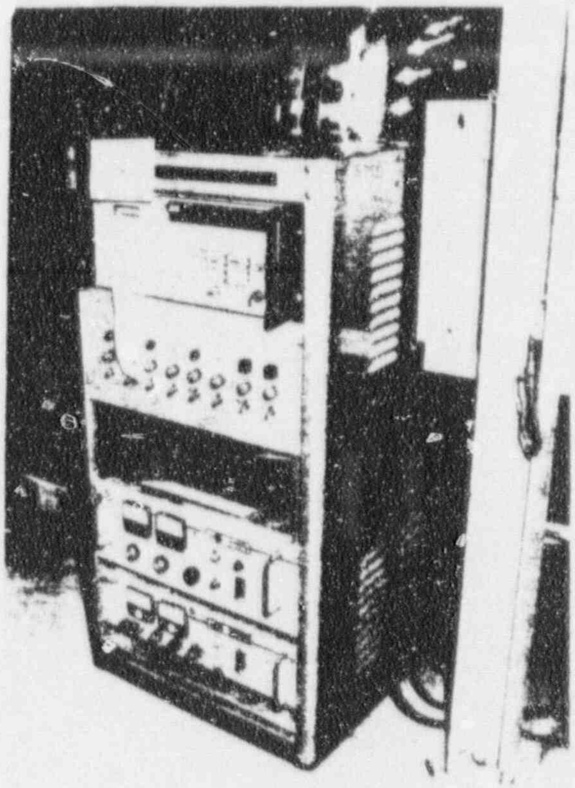


PHOTOGRAPH NO. VIII-7

REAR VIEW OF POWER SUPPLY AND INSTRUMENTATION SETUP SHOWING LEAKAGE CURRENT AND ISOLATION TRANSFORMERS

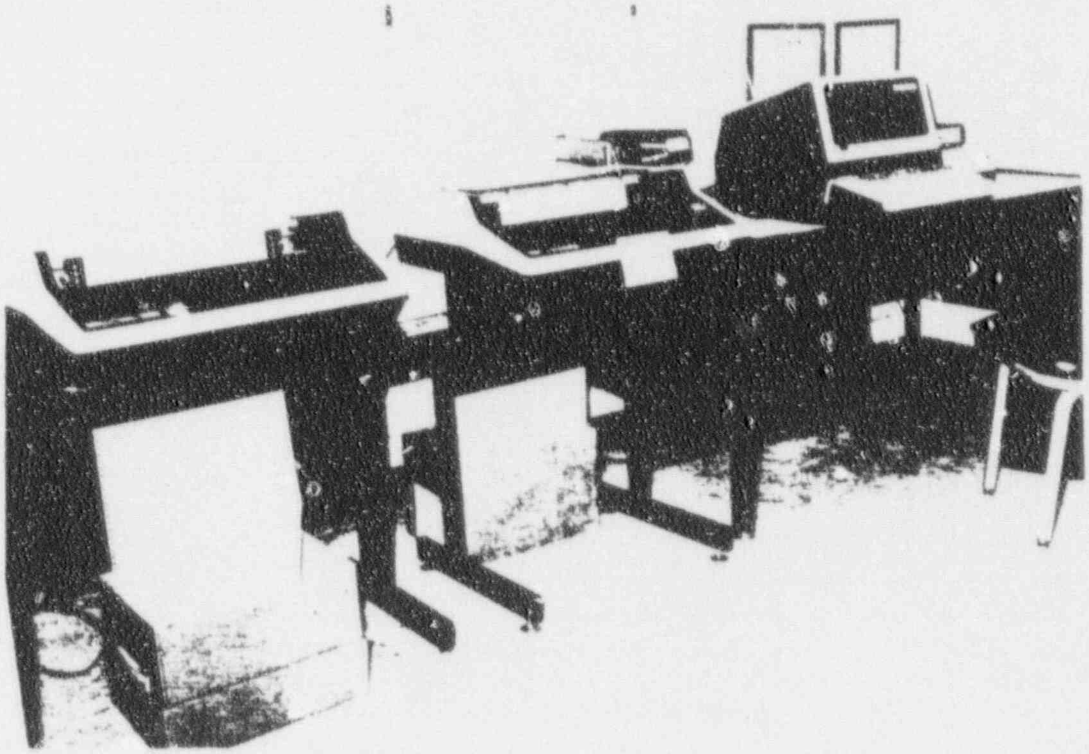
PHOTOGRAPH NO. VIII 8

DAYTRONICS MODEL 10VCM12 DATA ACQUISITION SYSTEM USED TO MONITOR ALL ENVIRONMENTAL AND LEAKAGE CURRENT SIGNALS



PHOTOGRAPH NO. VIII-9

FLUKE MODEL 2240B DATALOGGER USED TO MONITOR ALL SPECIMEN VOLTAGES AND LOAD CURRENTS. ALSO SHOWN ARE THE TWO DC POWER SUPPLIES FOR SPECIMENS Z2 AND Z3



PHOTOGRAPH NO. VIII-10

TEXAS INSTRUMENTS HIGH SPEED LINE PRINTERS AND HEWLETT PACKARD MODEL 1000 COMPUTER TERMINAL

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APPENDIX III

ELECTRICAL CIRCUITRY FIGURES

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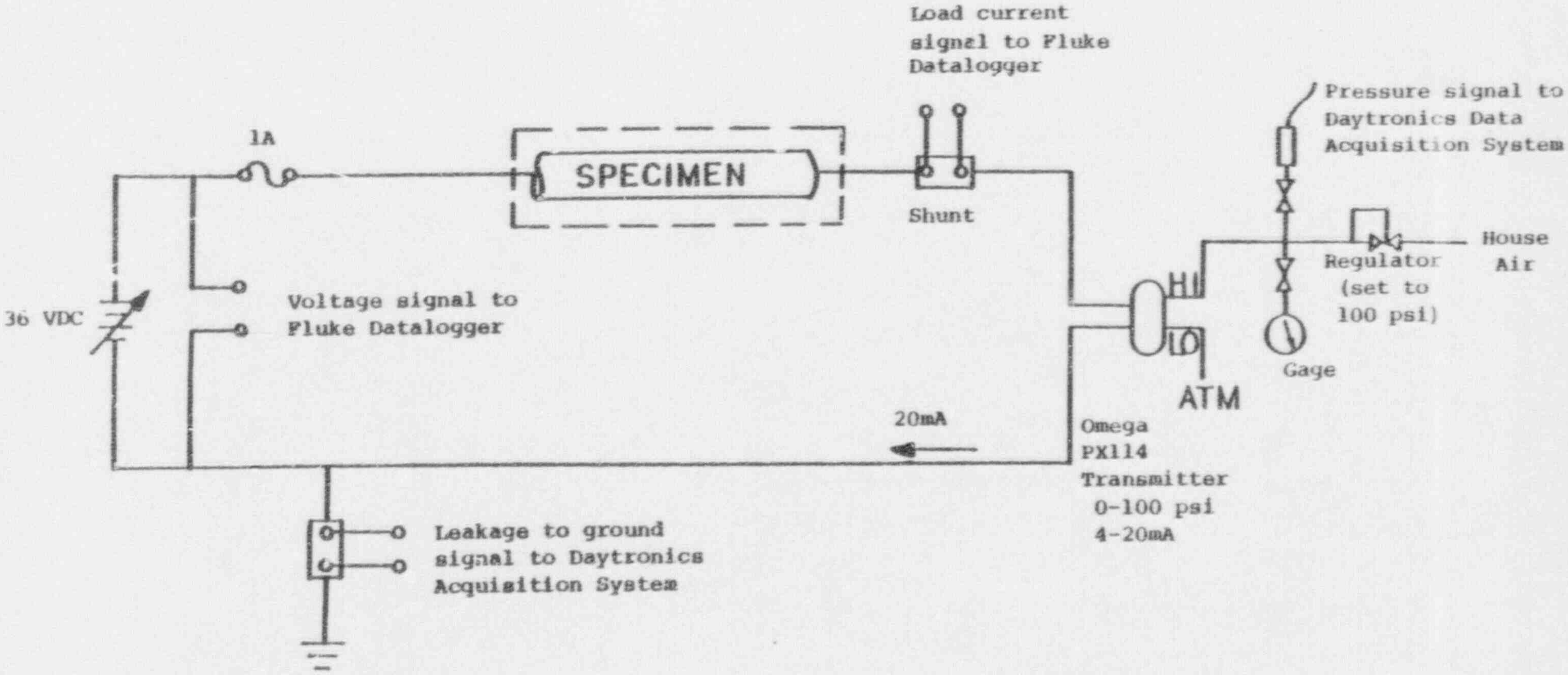


FIGURE VIII-1 TYPICAL ELECTRICAL SETUP FOR SPECIMENS Z2 AND Z3

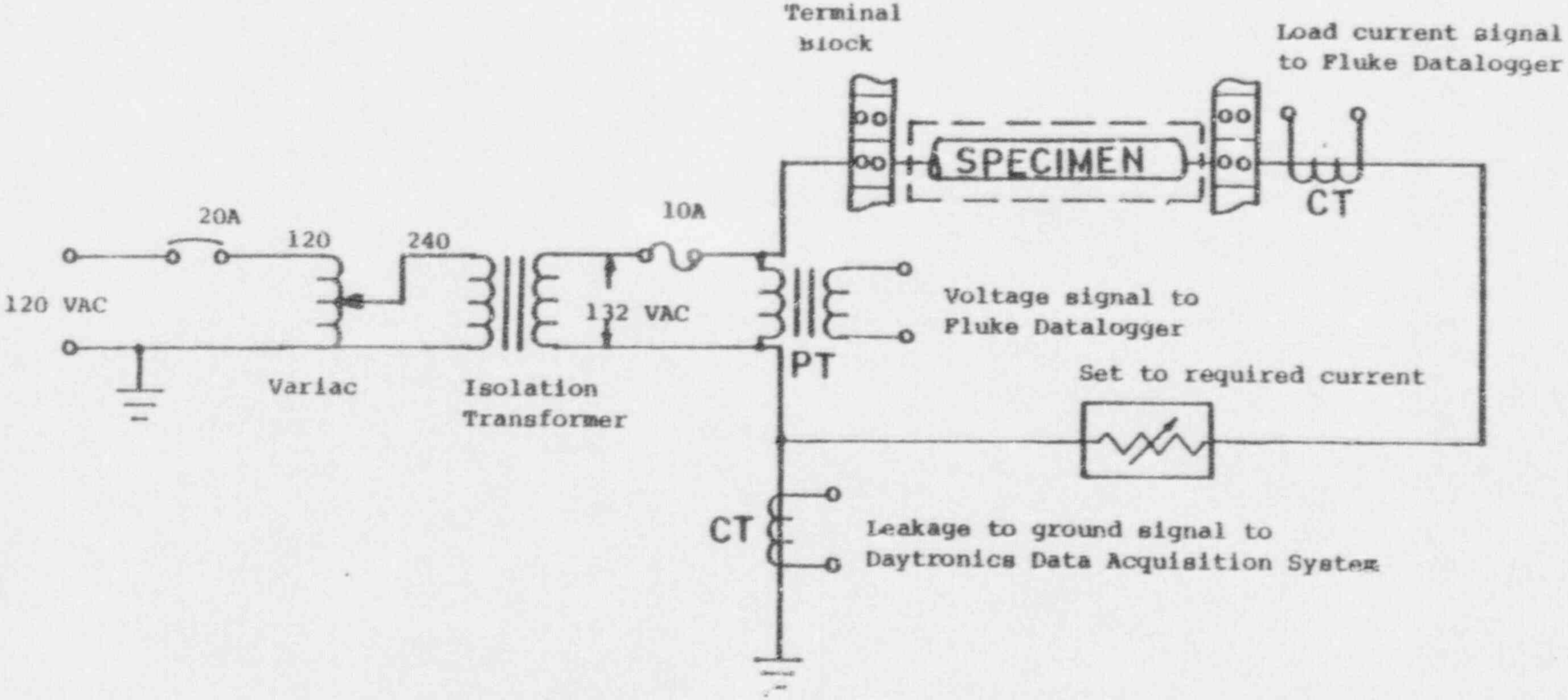
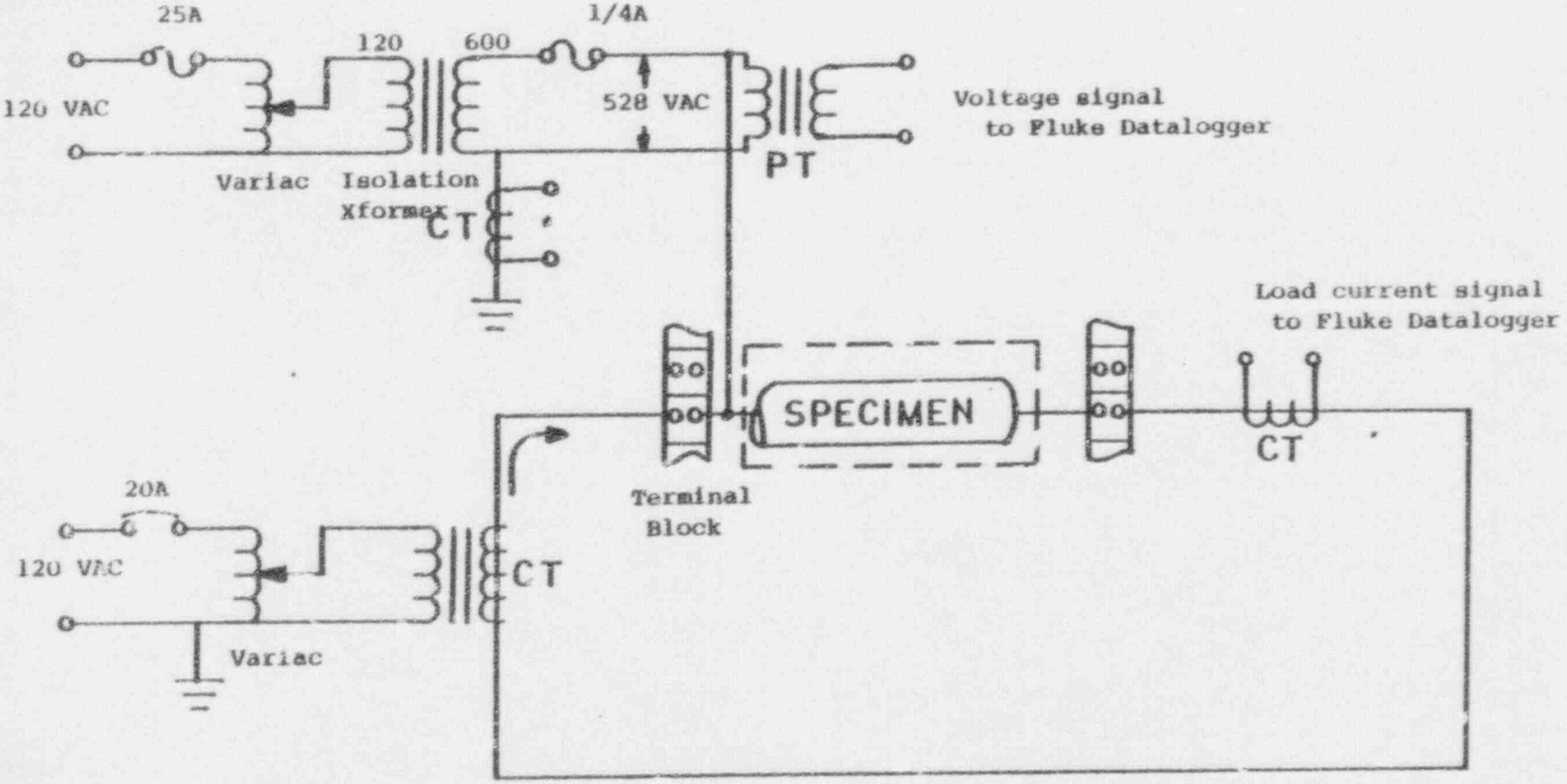
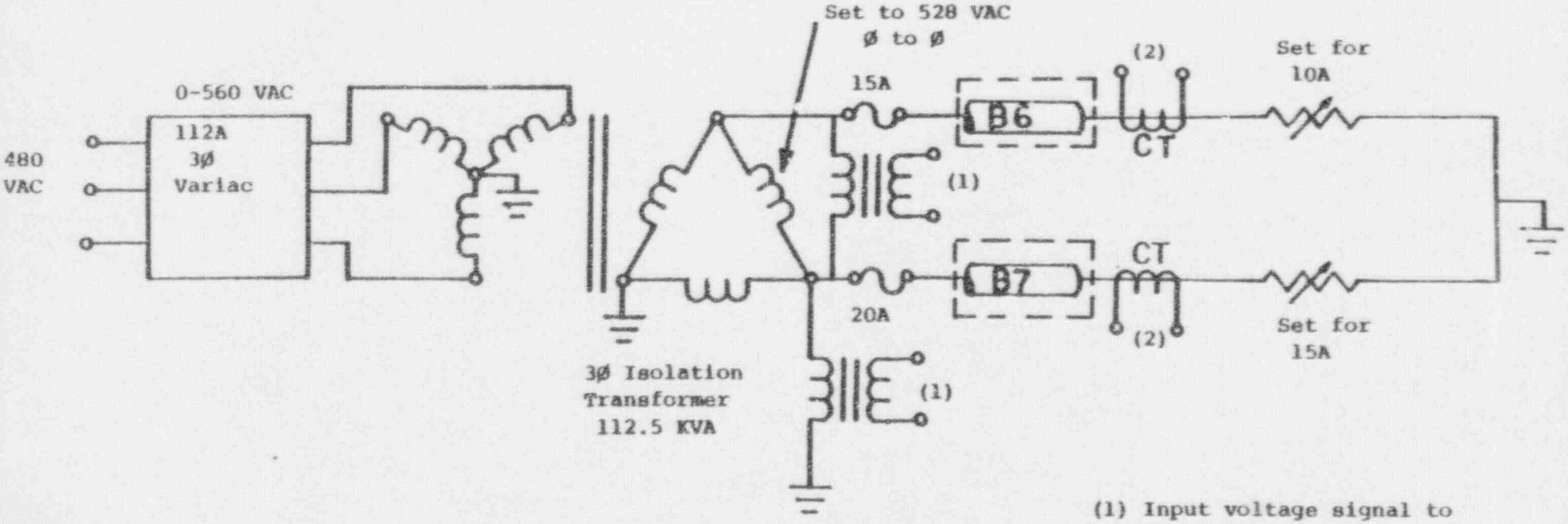


FIGURE VIII-2 TYPICAL ELECTRICAL SETUP FOR 132 VAC CIRCUITS



*Leakage current to ground signal to Daytronics Data Acquisition System.

FIGURE VIII-3 TYPICAL ELECTRICAL SETUP FOR 528 VAC AND 6.7A OR 5A CIRCUITS



(1) Input voltage signal to Fluke Datalogger

(2) Applied current signal to Fluke Datalogger

FIGURE VIII-4 ELECTRICAL SETUP FOR SPECIMENS B6 AND B7

APPENDIX IV

TEMPERATURE/PRESSURE PROFILE

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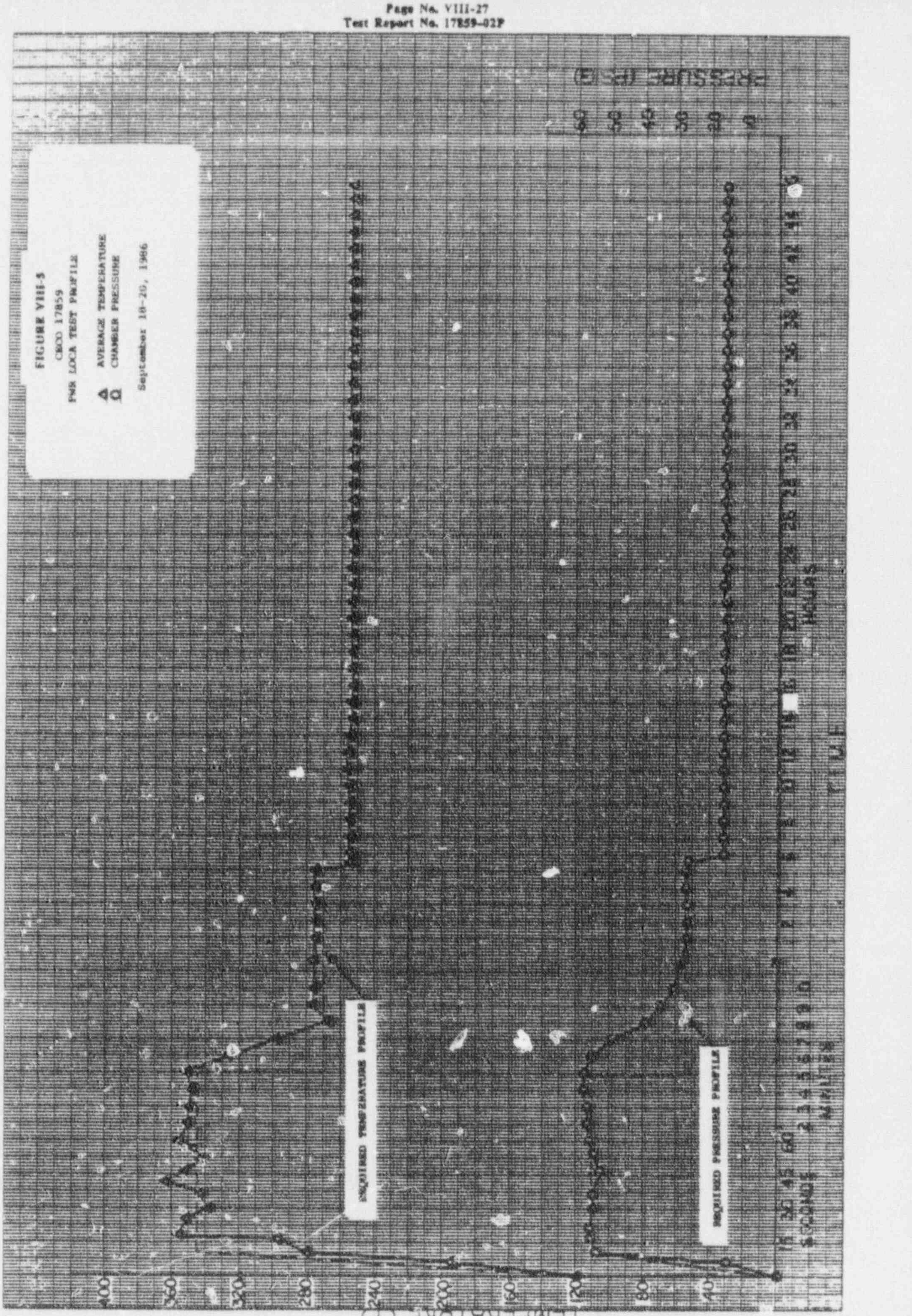
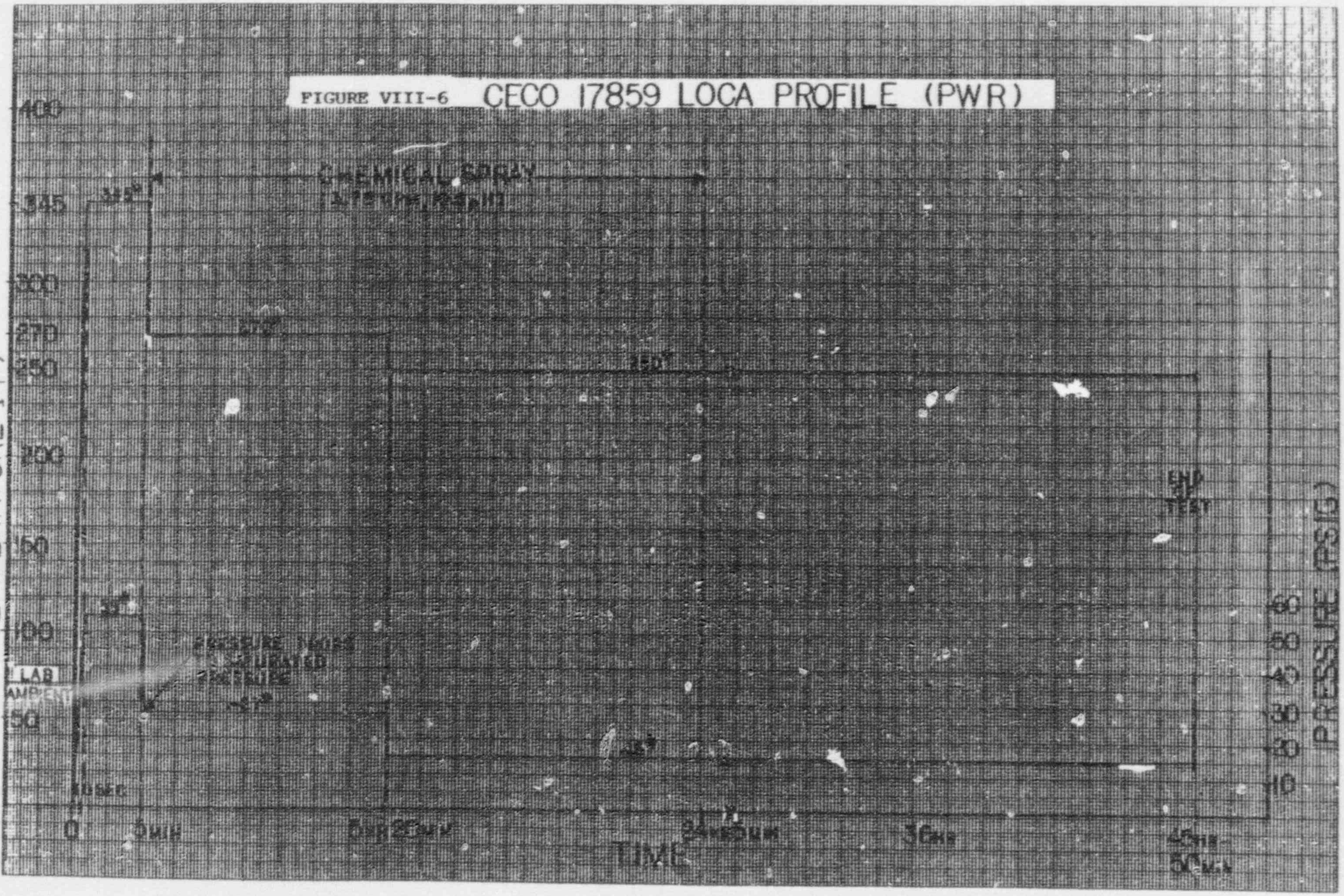


FIGURE VIII-5
CECO 17859
PWR LOCA TEST PROFILE

△ AVERAGE TEMPERATURE
○ CHAMBER PRESSURE

September 18-20, 1986

FIGURE VIII-6 CECO 17859 LOCA PROFILE (PWR)



APPENDIX V

VOLTAGE, LOAD CURRENT AND LEAKAGE CURRENT TO GROUND PLOTS FOR EACH SPECIMEN

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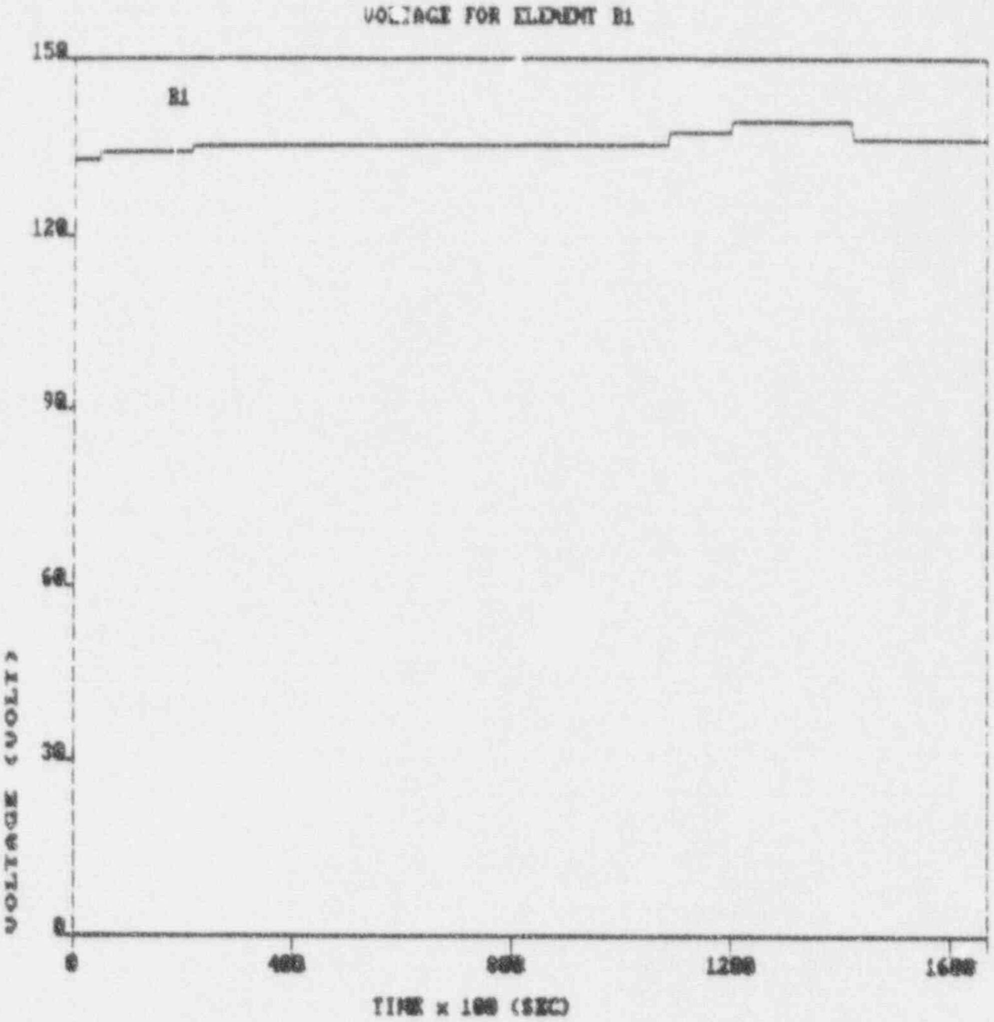

FIGURE VIII-7. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER B1

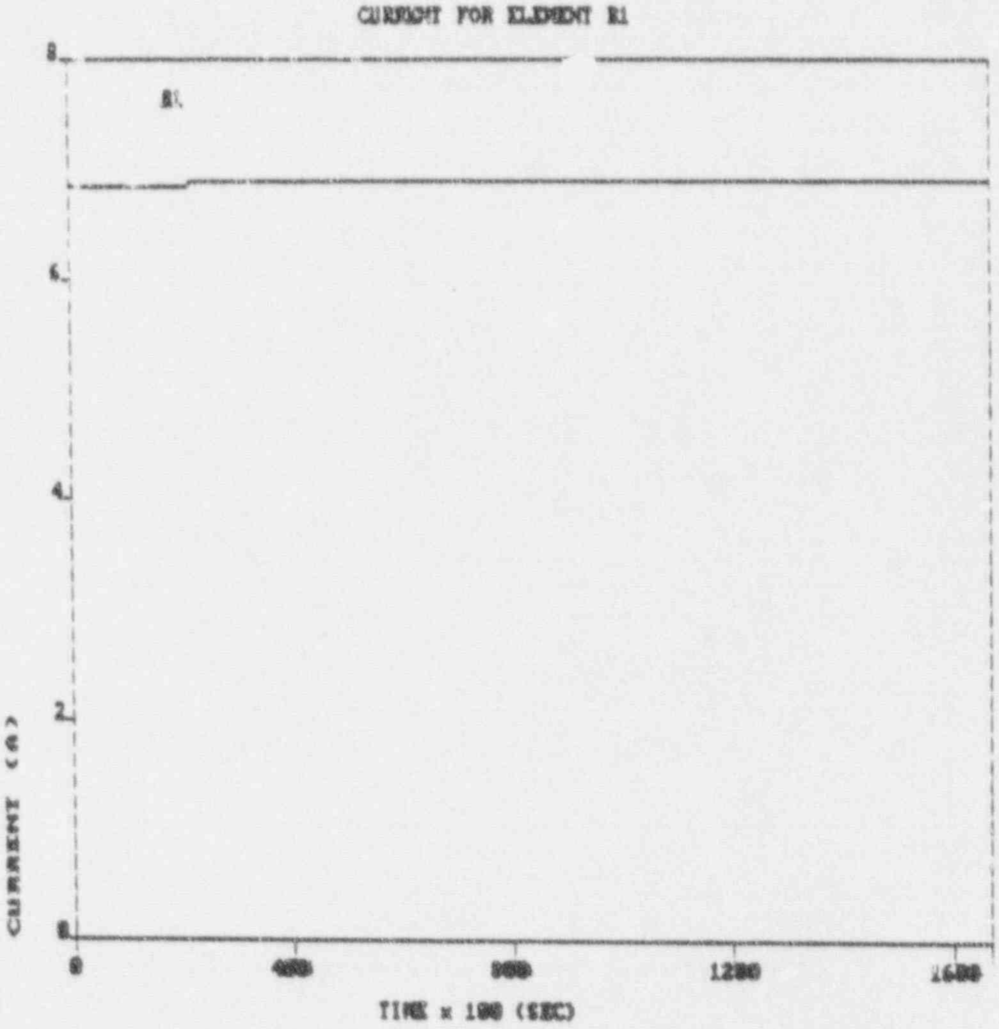

FIGURE VIII-8. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER B1

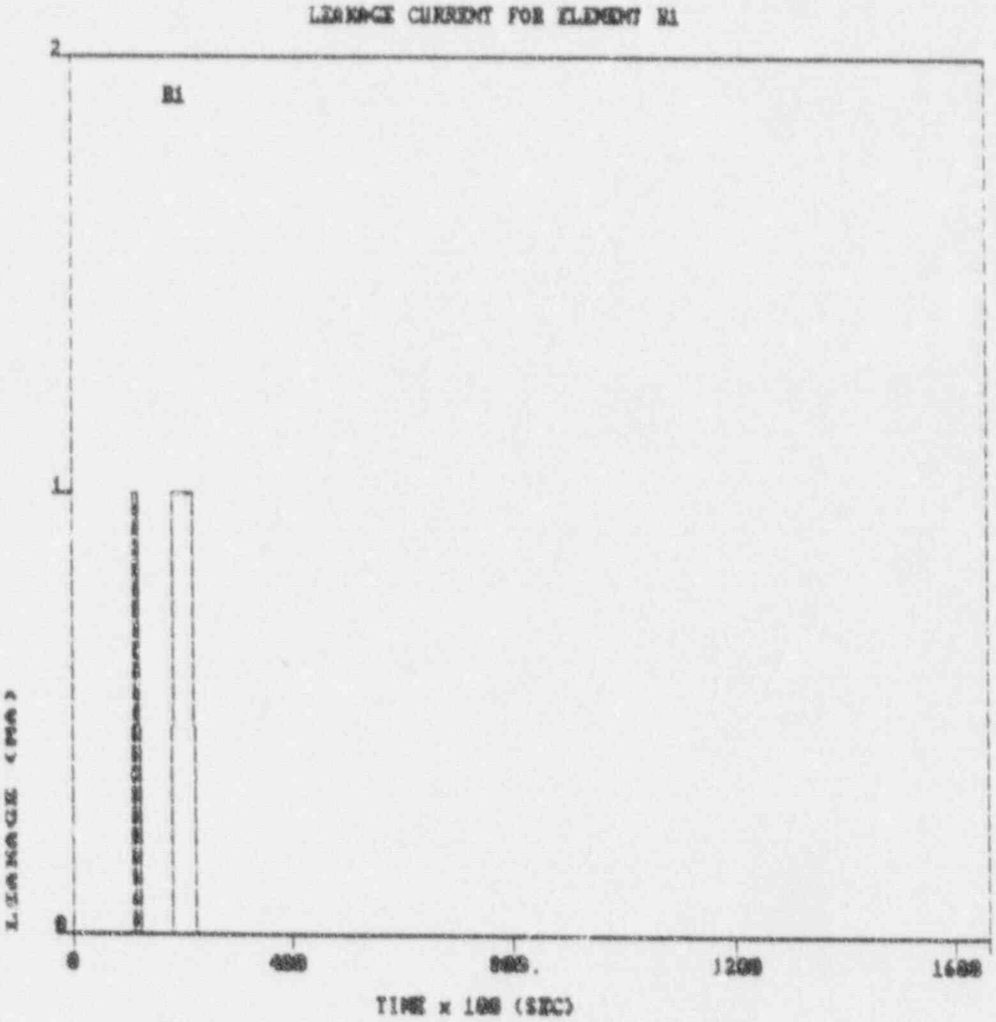

FIGURE VIII-9. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER B1

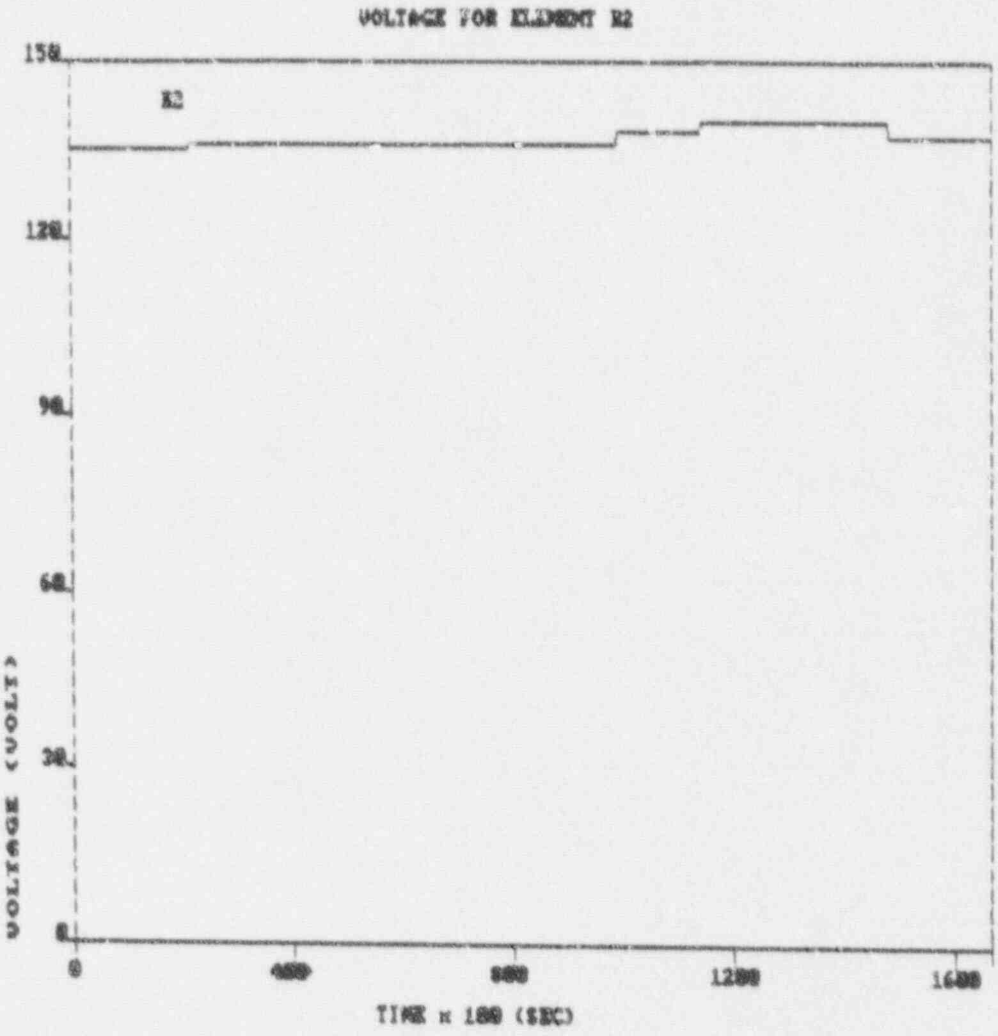

FIGURE VIII-10. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER B2

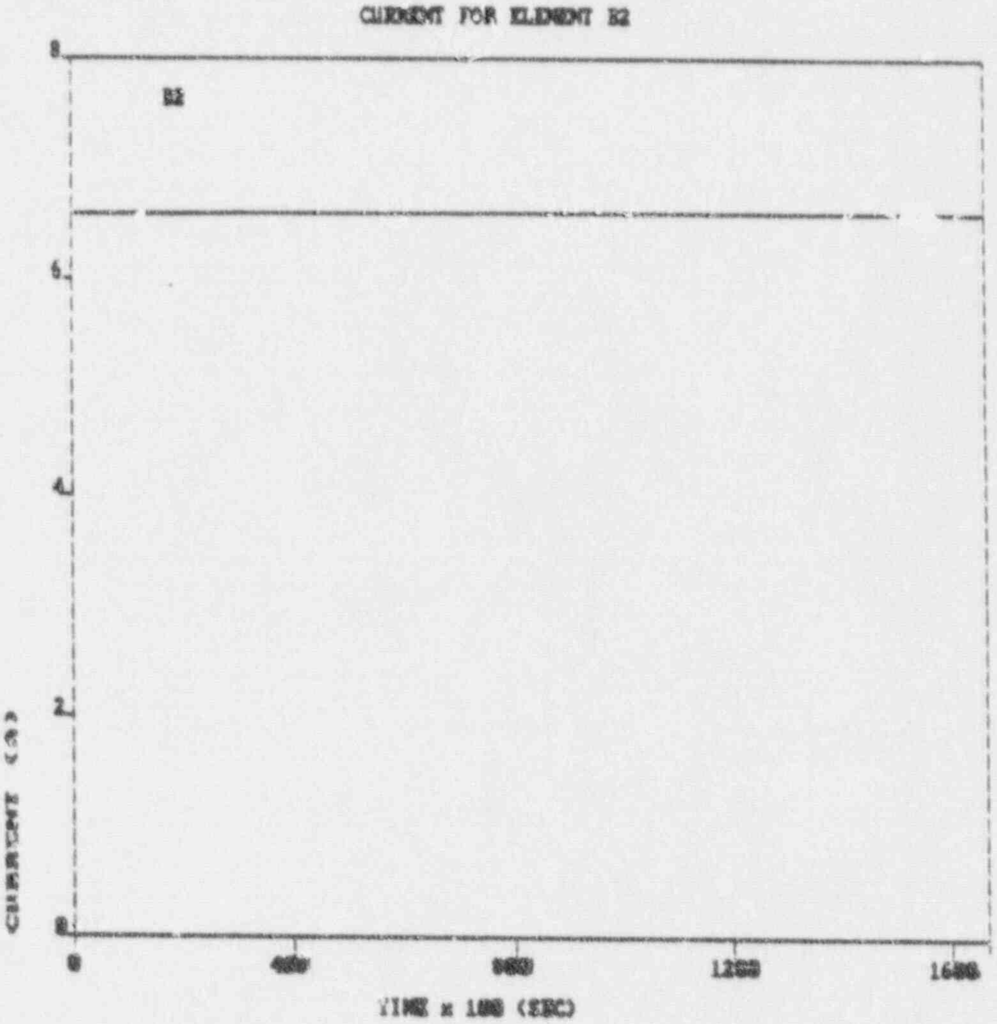

FIGURE VIII-11. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER B2

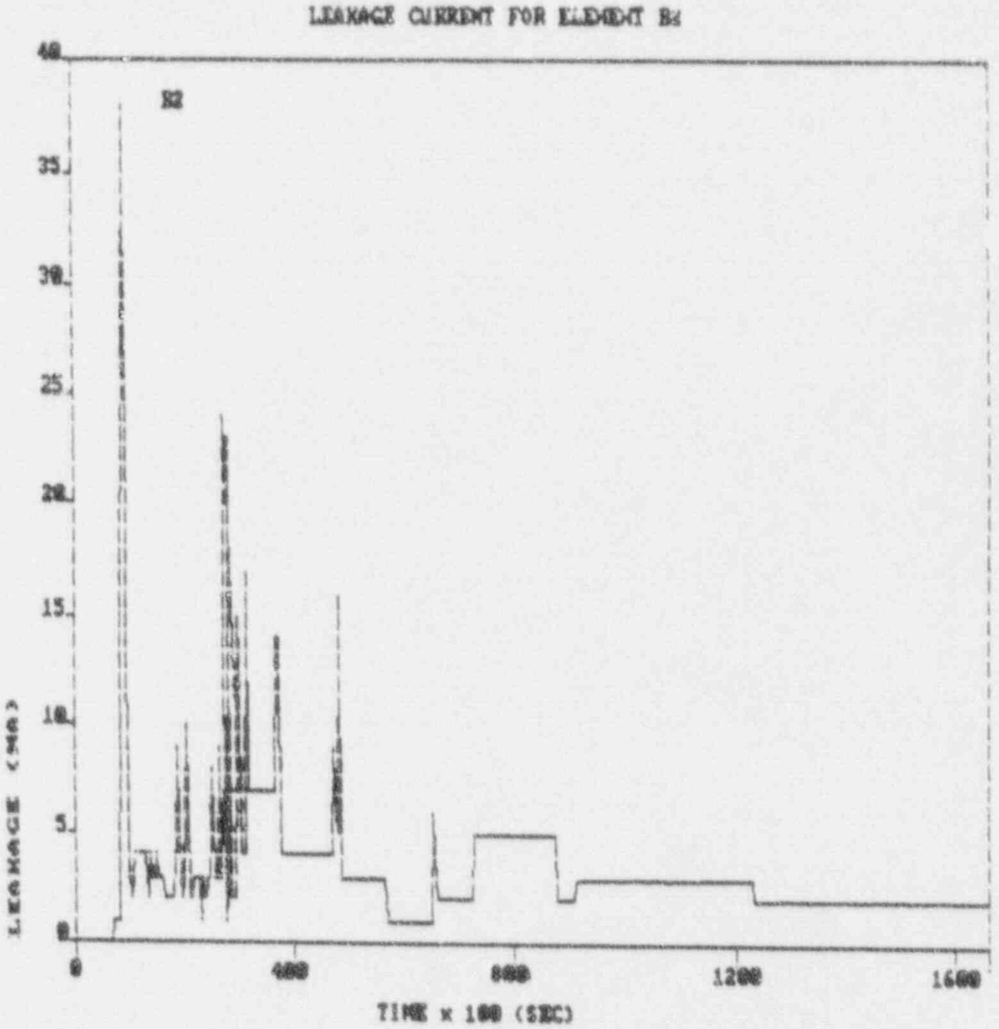

FIGURE VIII-12. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER B2

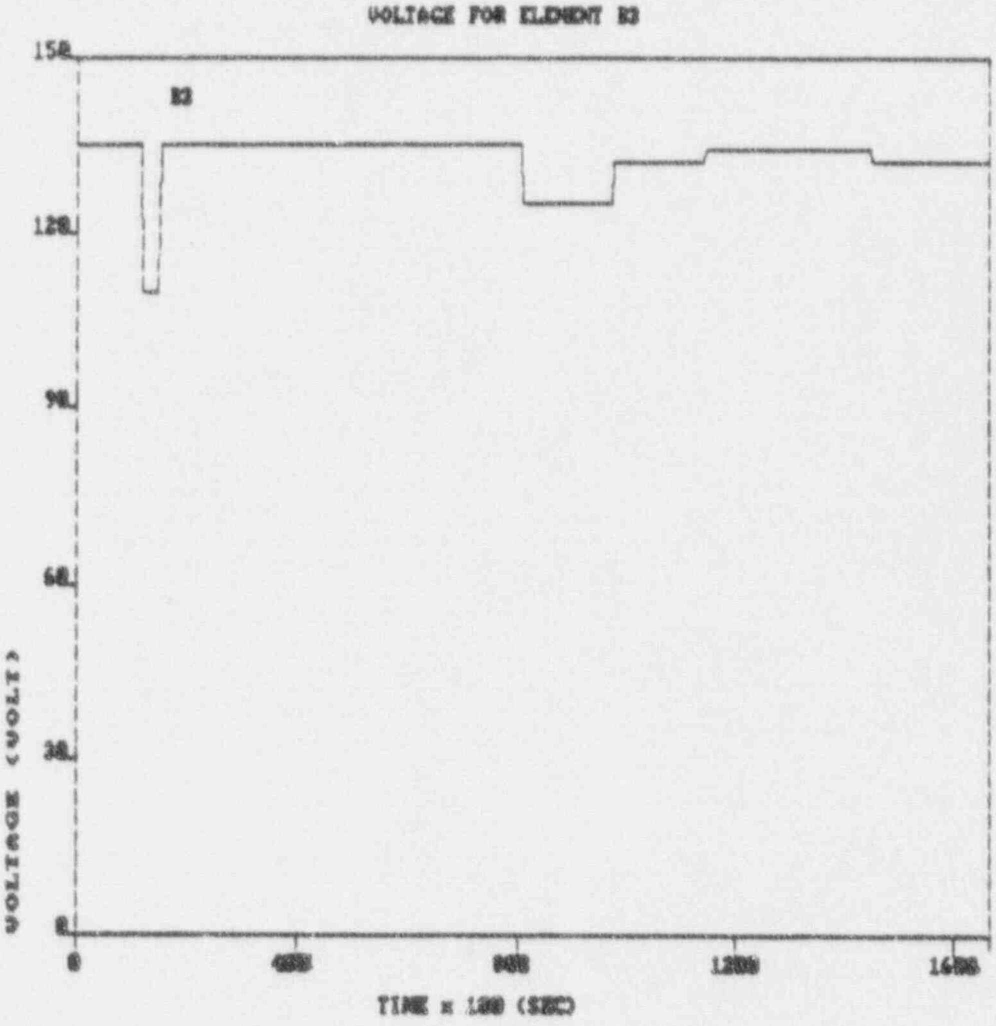

FIGURE VIII-13. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER B3

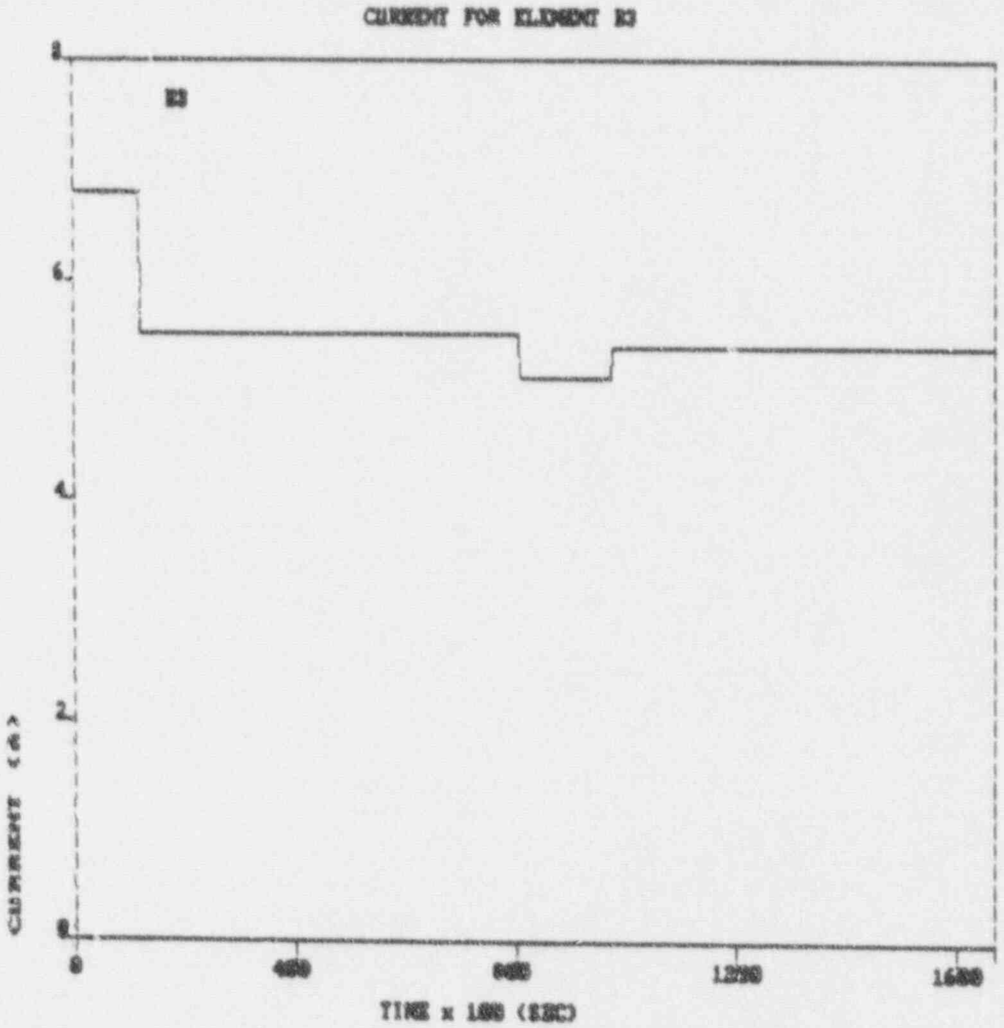

FIGURE VIII-14. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER B3

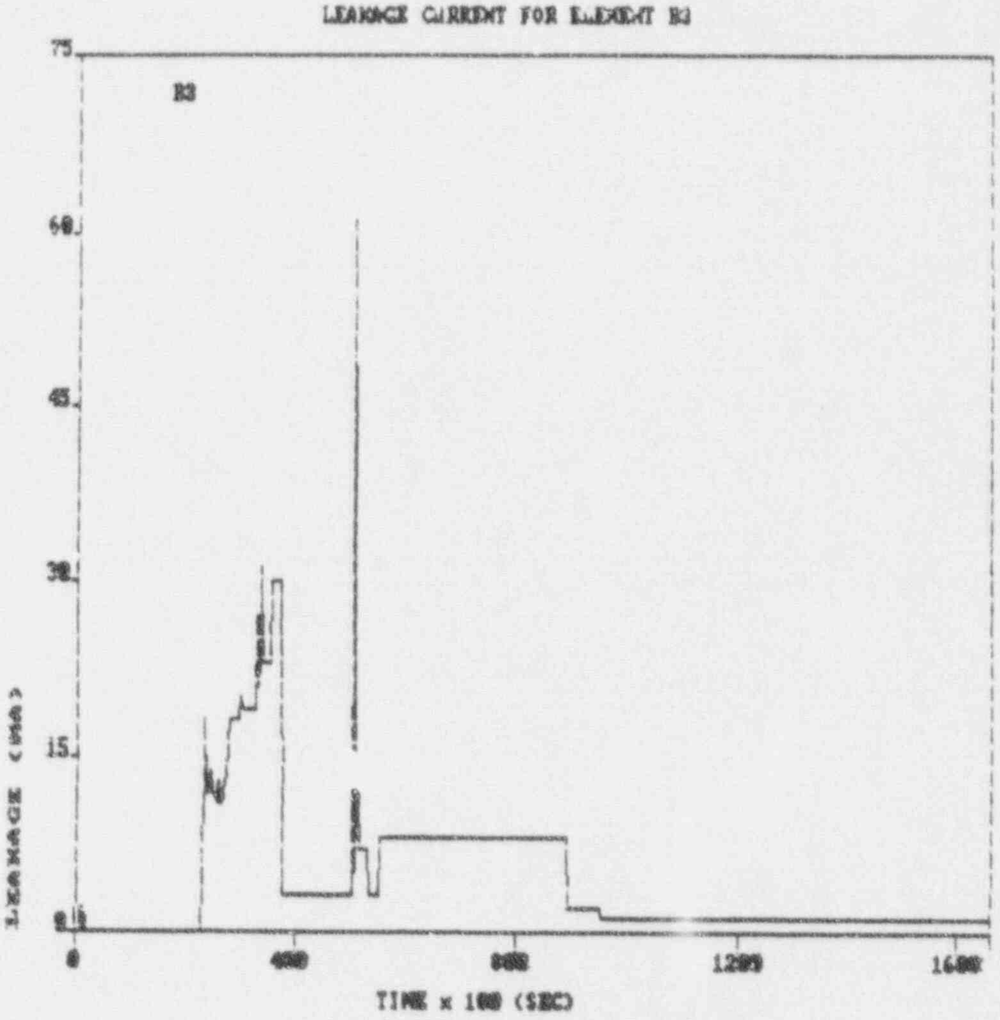

FIGURE VIII-15. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER B3

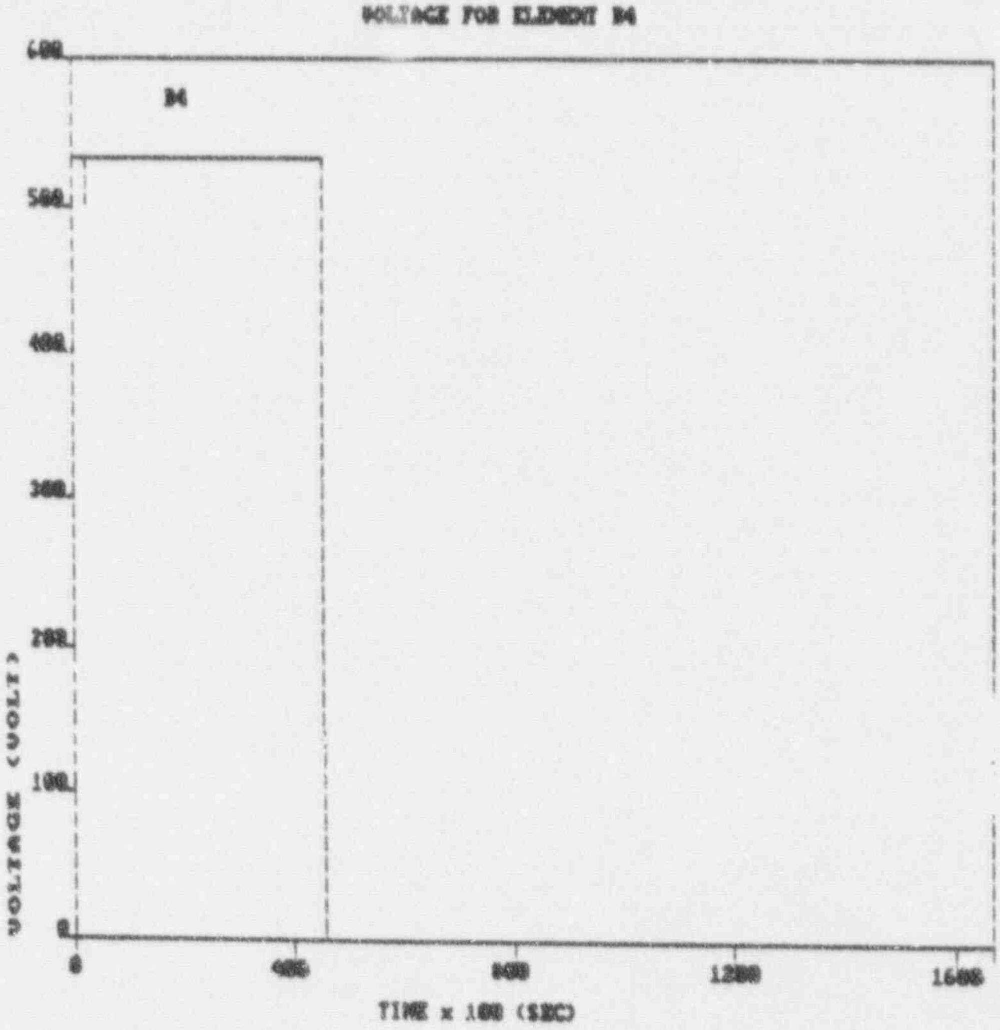

FIGURE VIII-16. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER B4

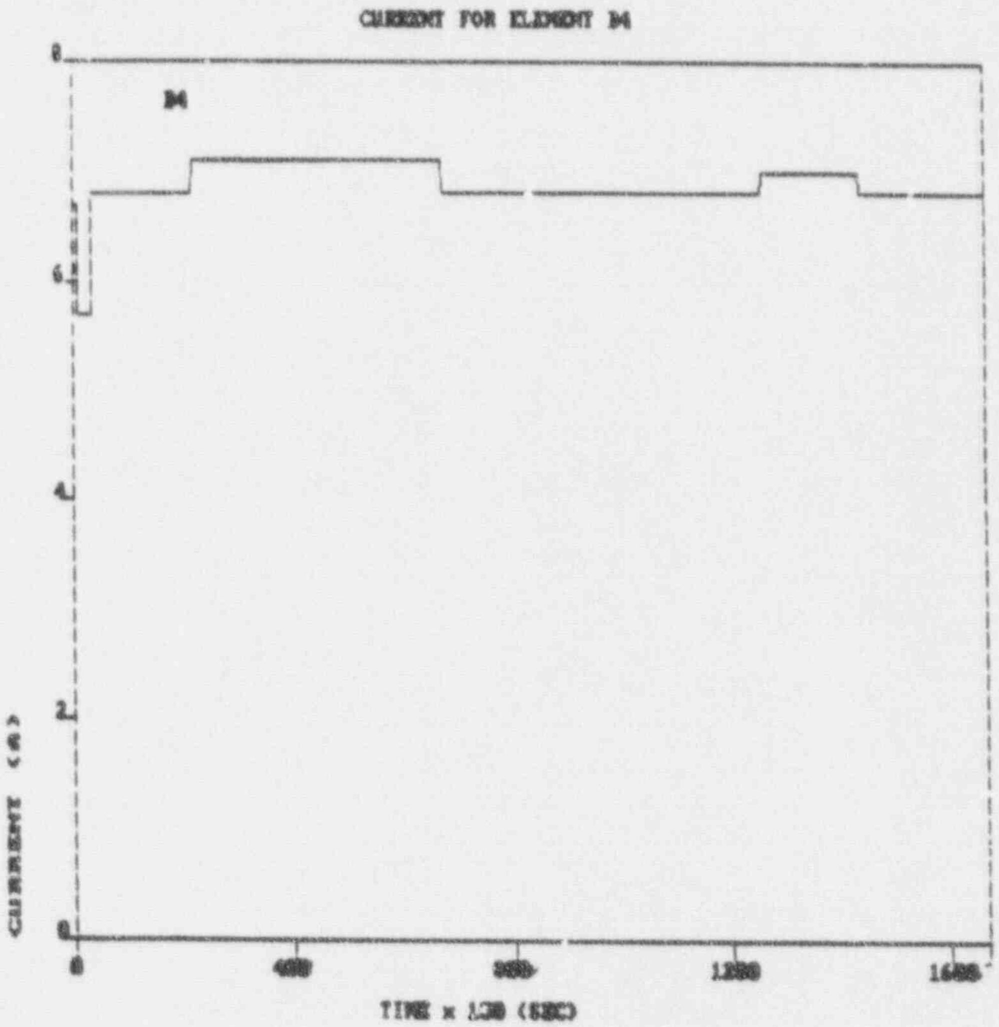

FIGURE VIII-17. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER B4

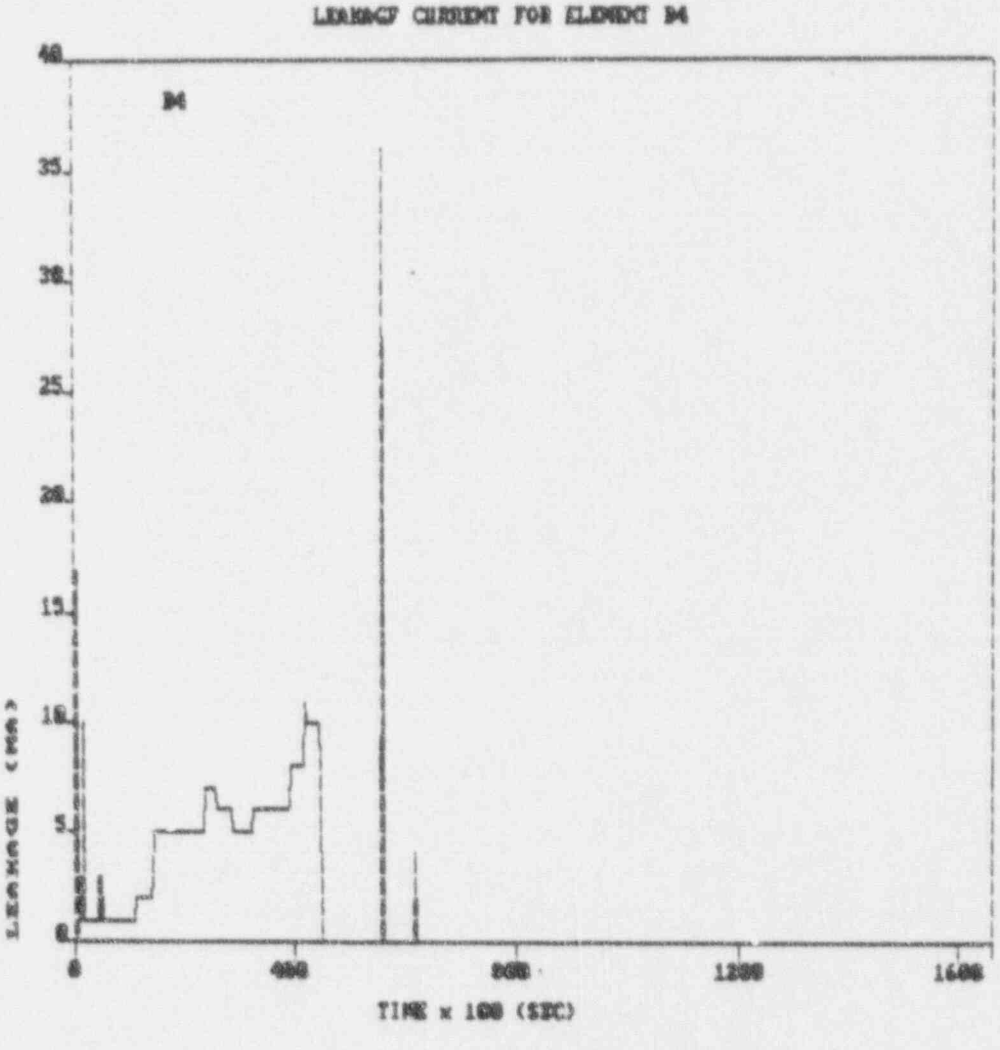

FIGURE VIII-18. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER B4

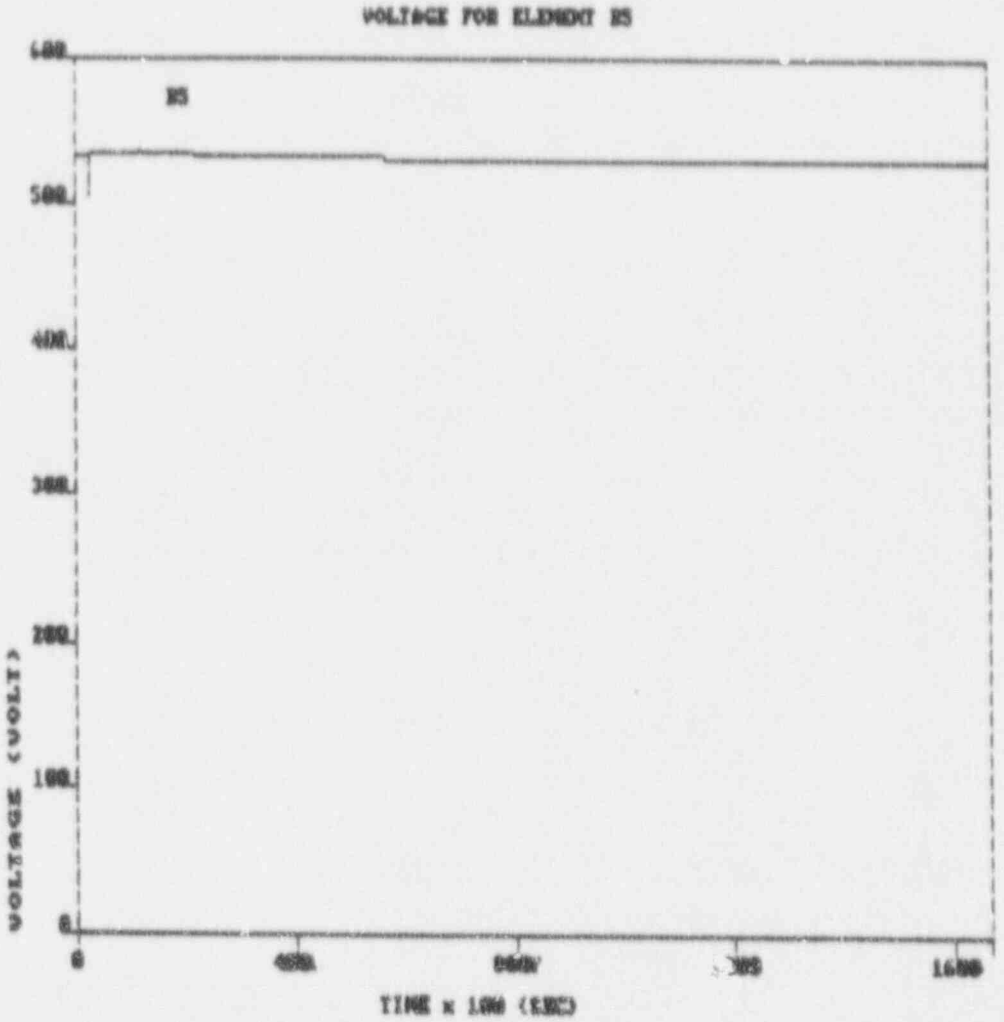

FIGURE VIII-19. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER B5

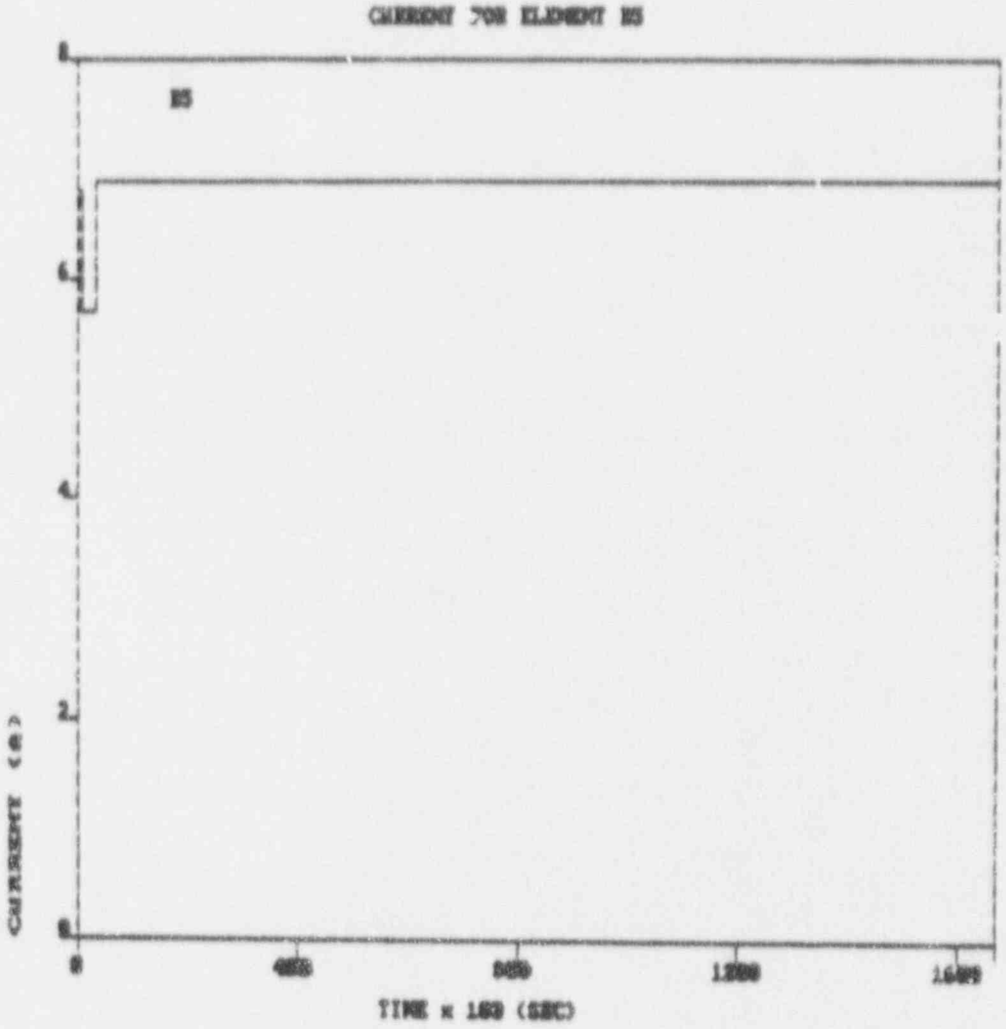

FIGURE VIII-20. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER B5

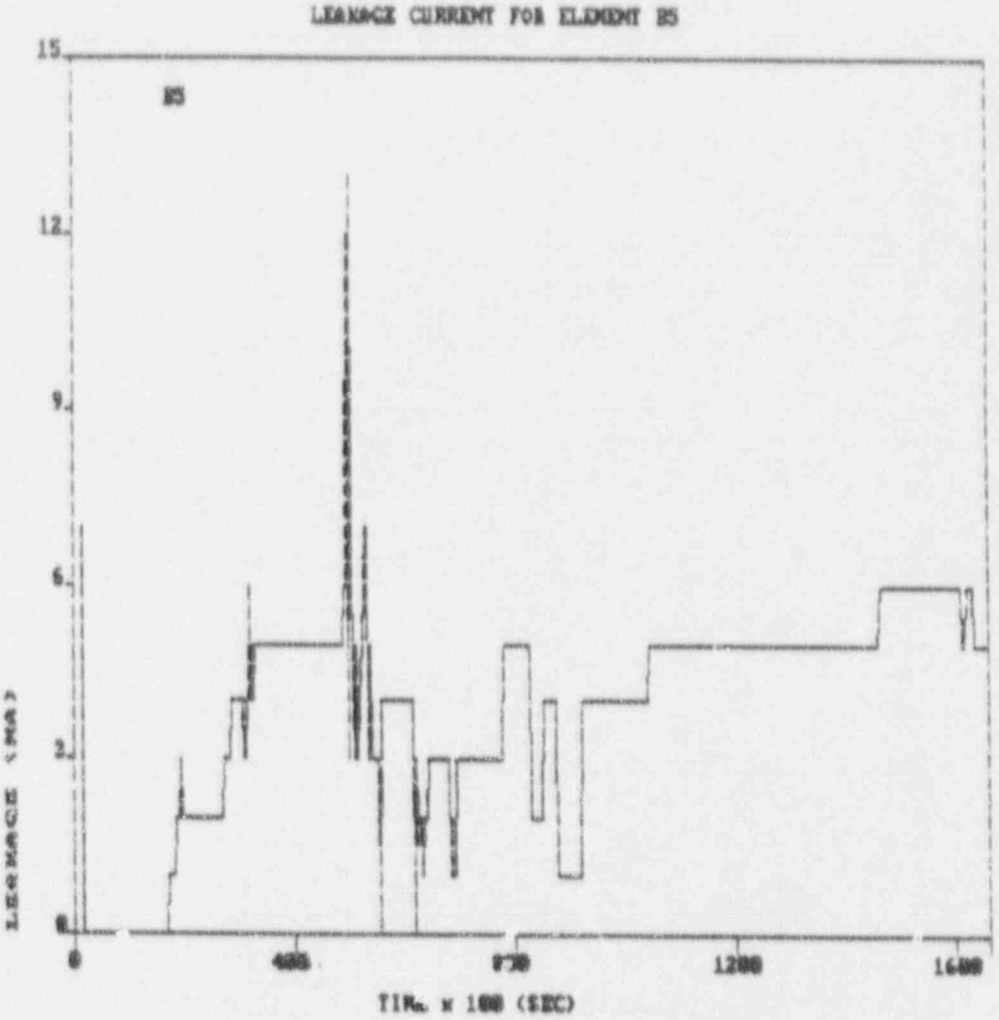

FIGURE VIII-21. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER B5

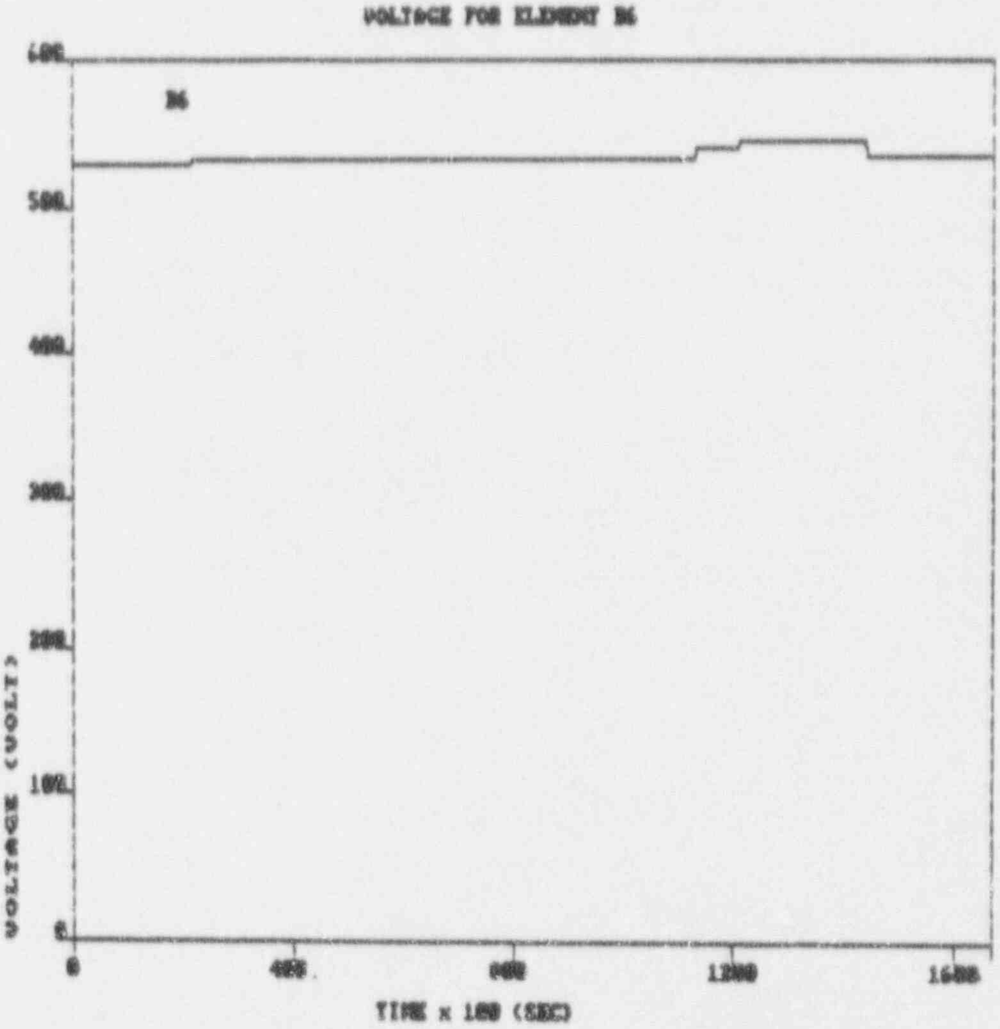

FIGURE VIII-22. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER B6

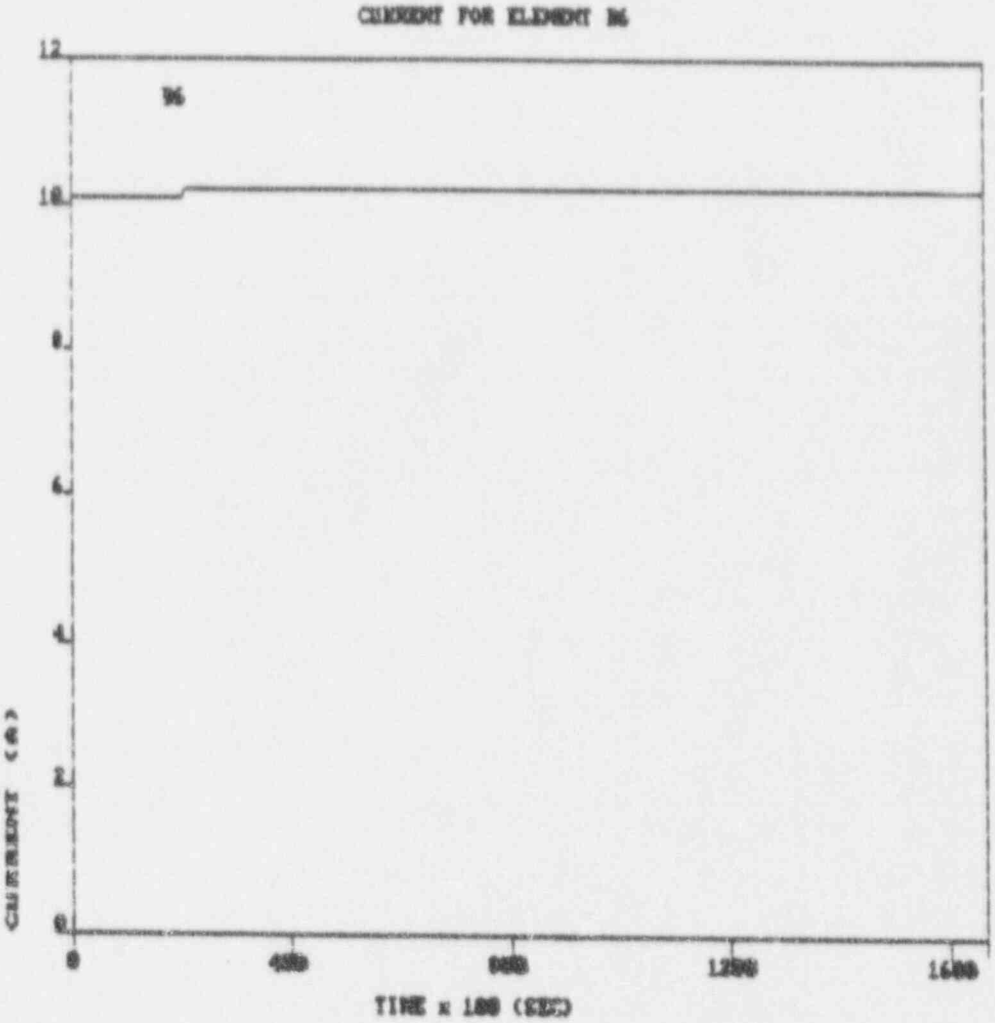

FIGURE VIII-23. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER B6

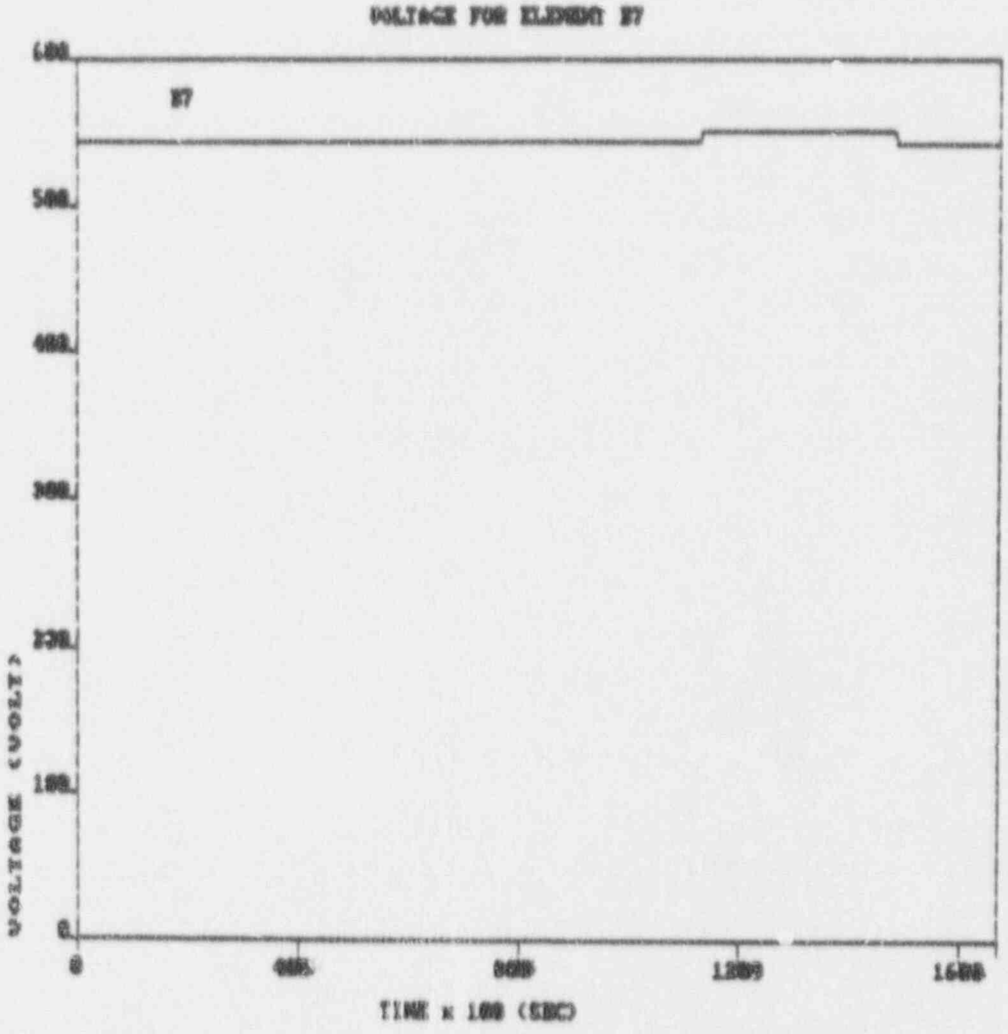

FIGURE VIII-24. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER B7

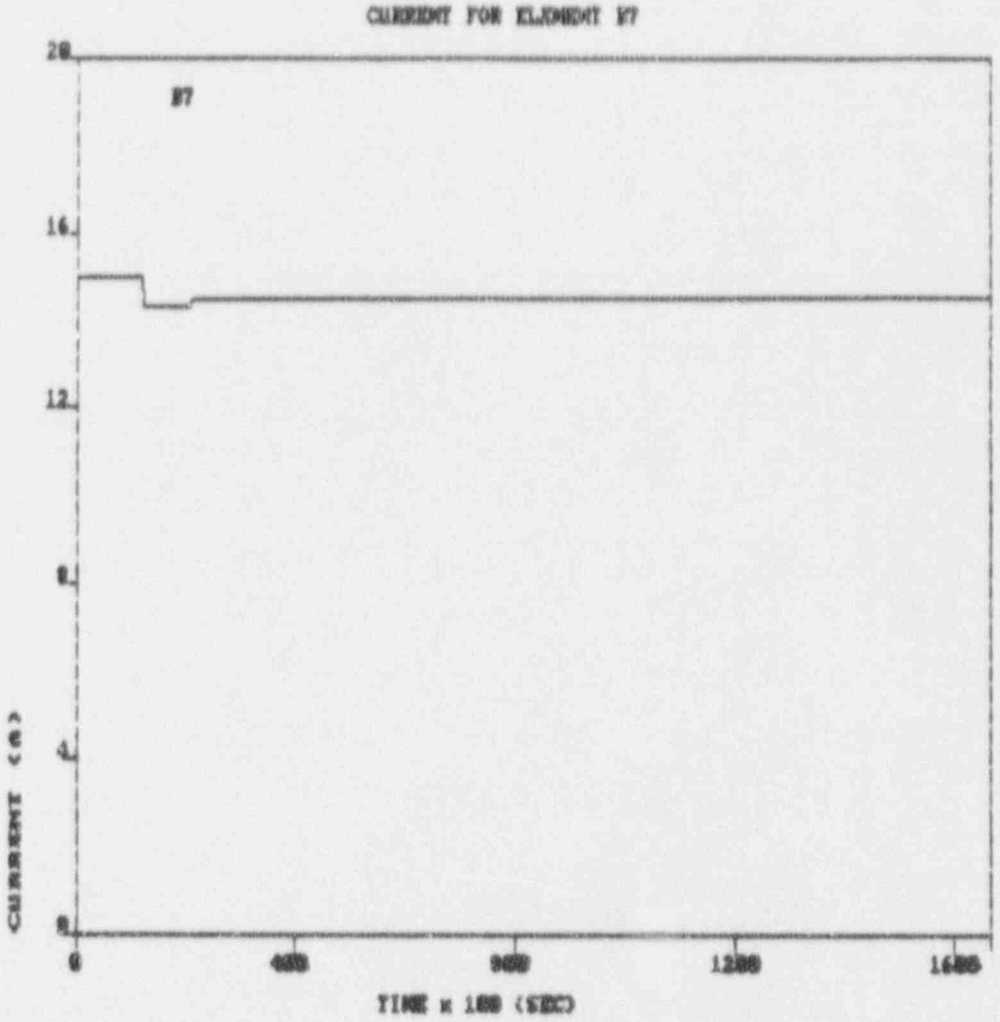

FIGURE VIII-25. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER B7

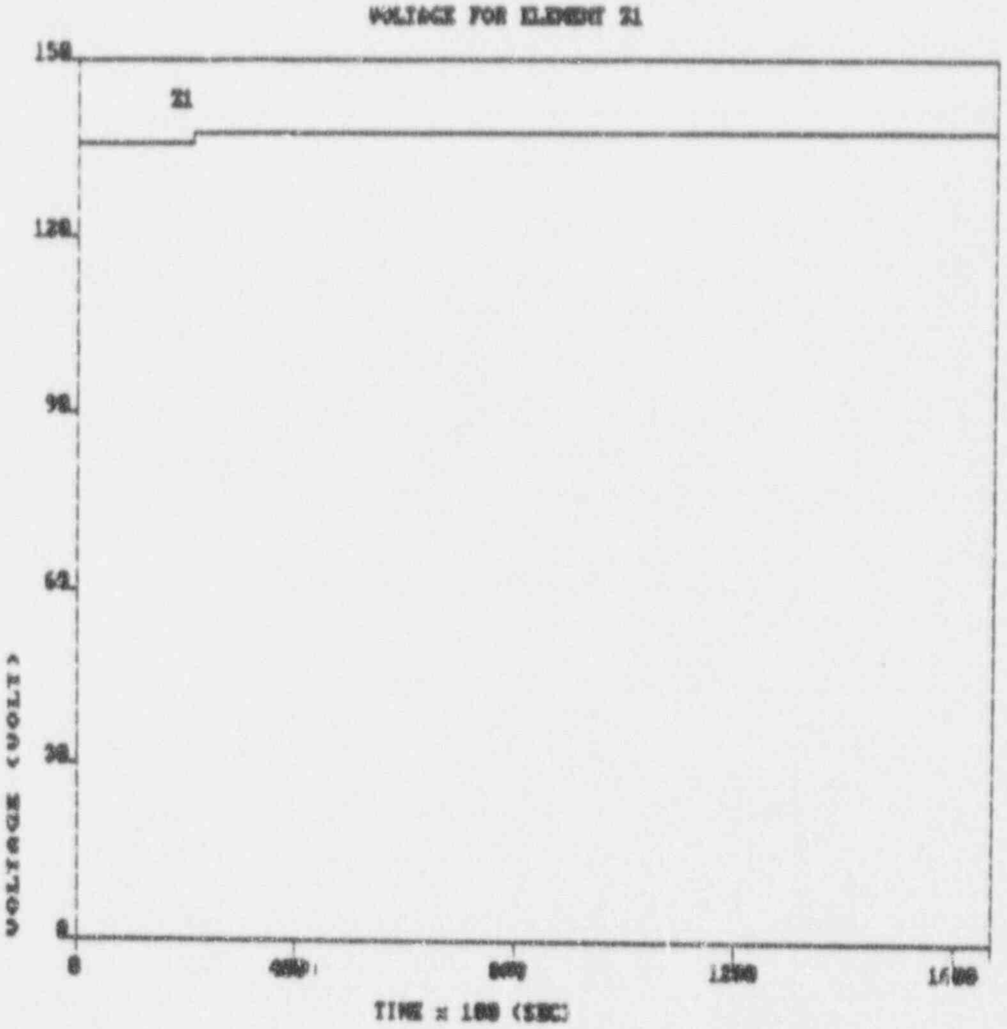

FIGURE VIII-26. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER Z1

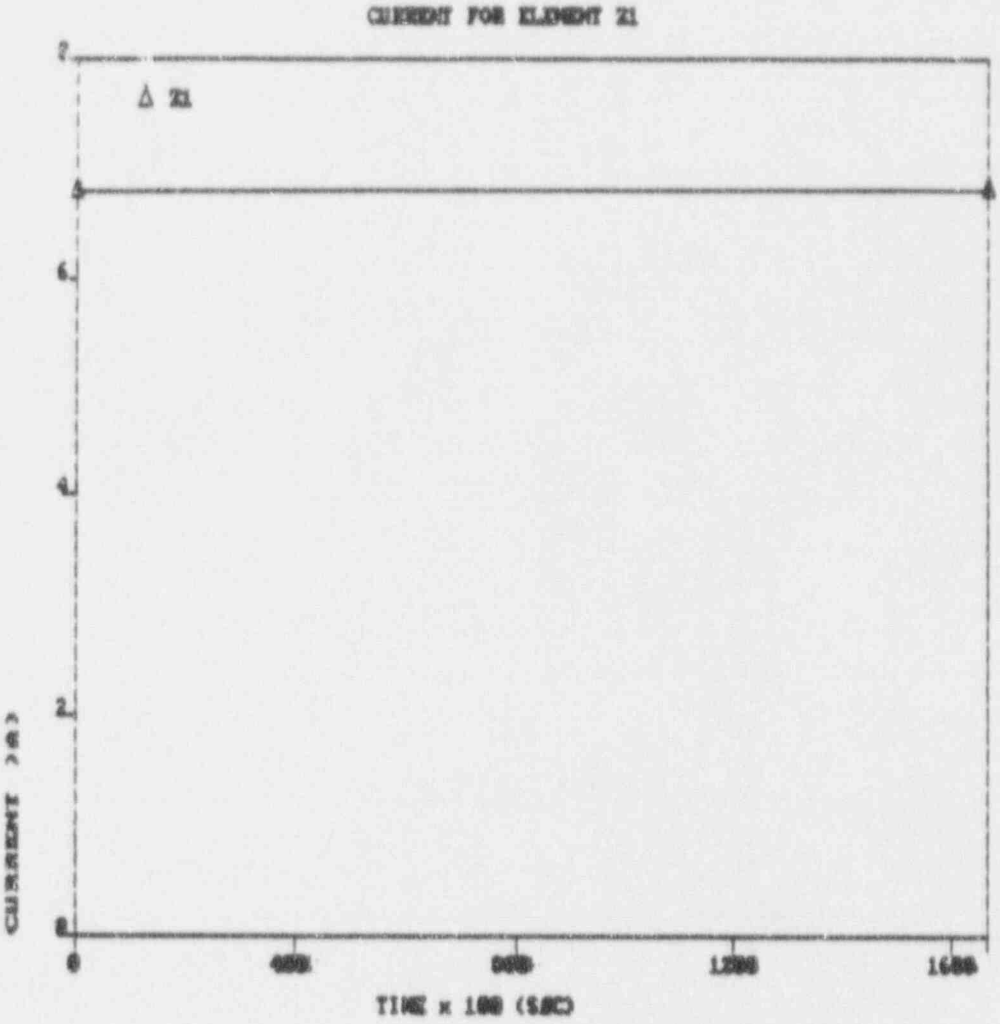

FIGURE VIII-27. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER Z1

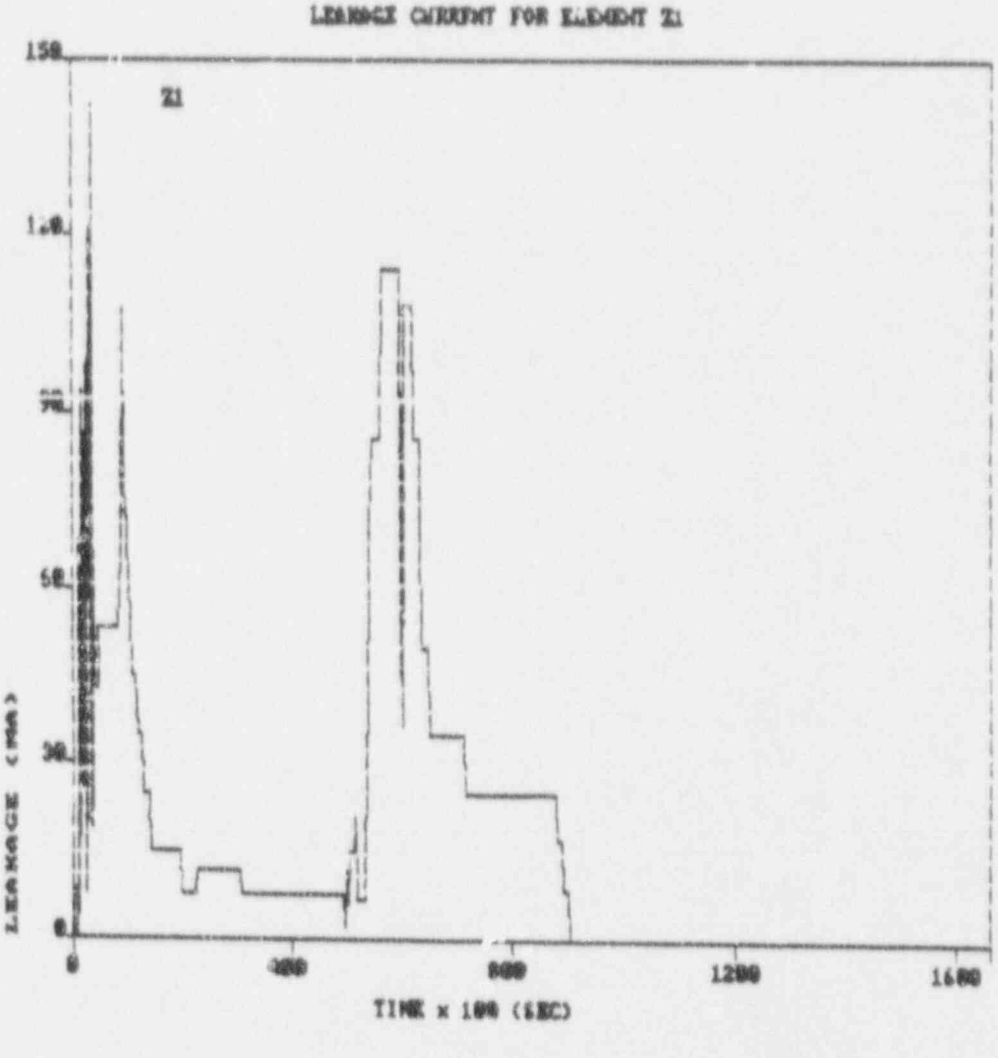

FIGURE VIII-28. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER Z1 (ENTIRE TEST)

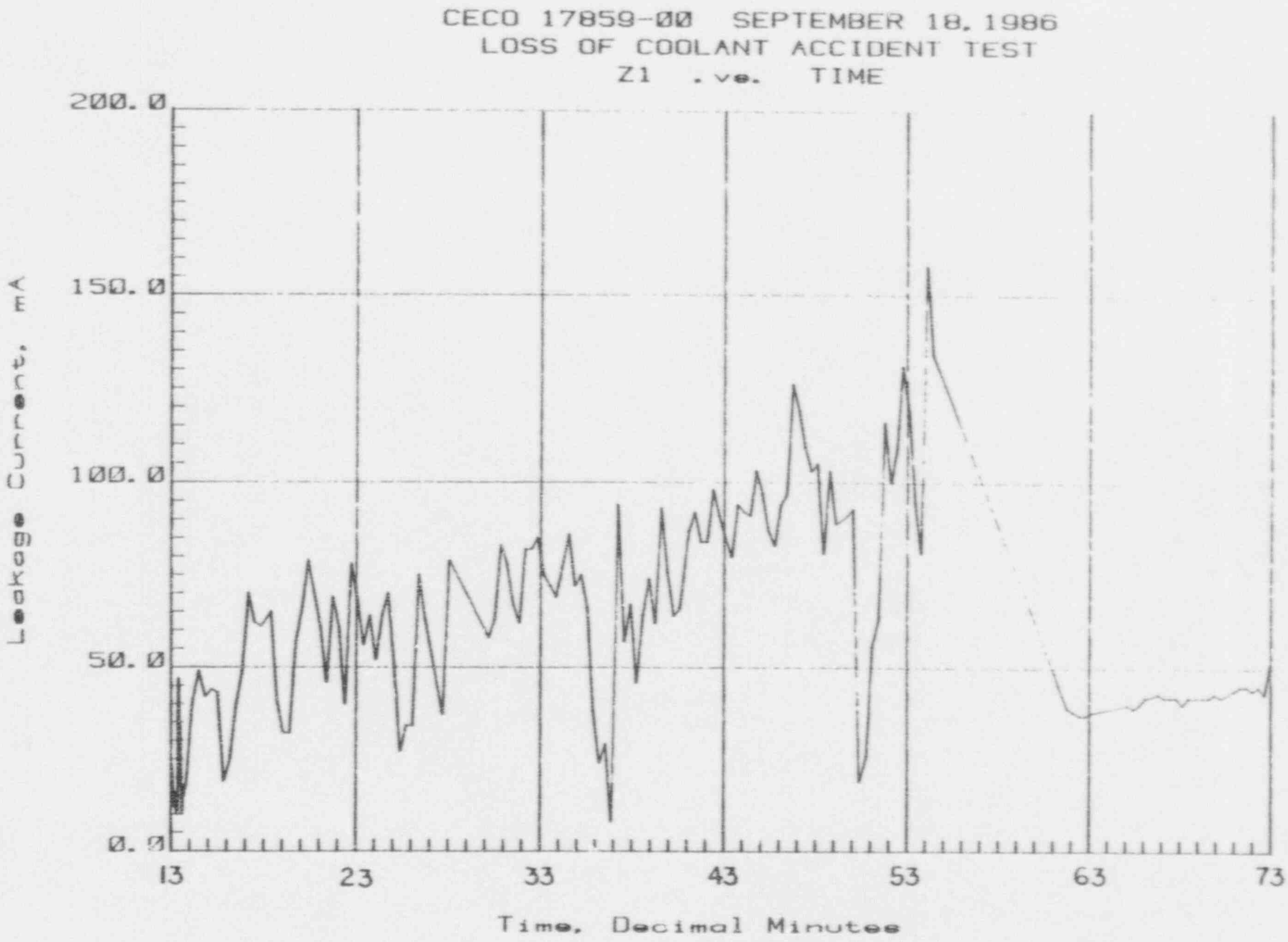

FIGURE VIII-29. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER Z1 (13 MINUTES - 73 MINUTES)

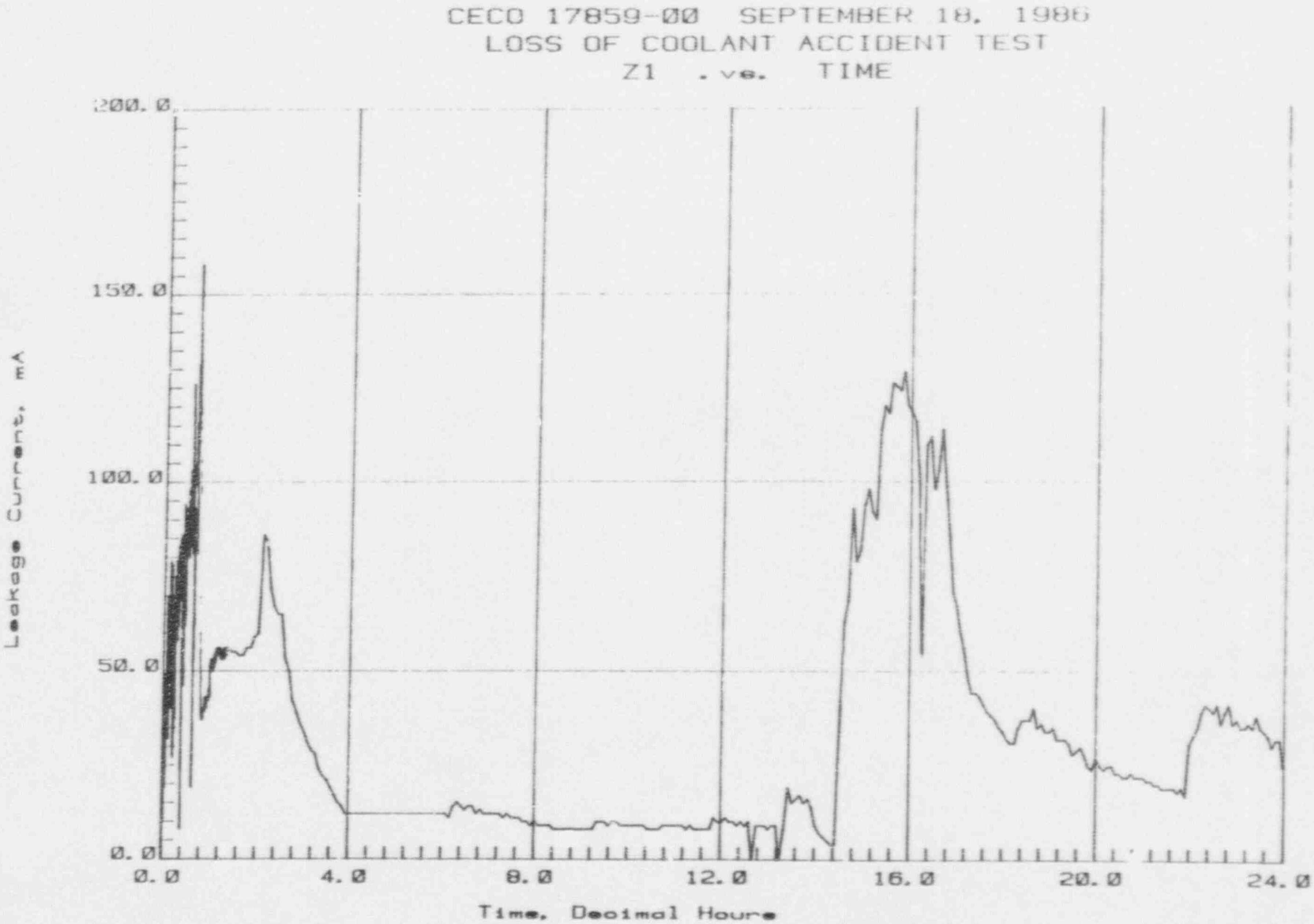

FIGURE VIII-30. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER Z1 (13 MINUTES - 24 HOURS)

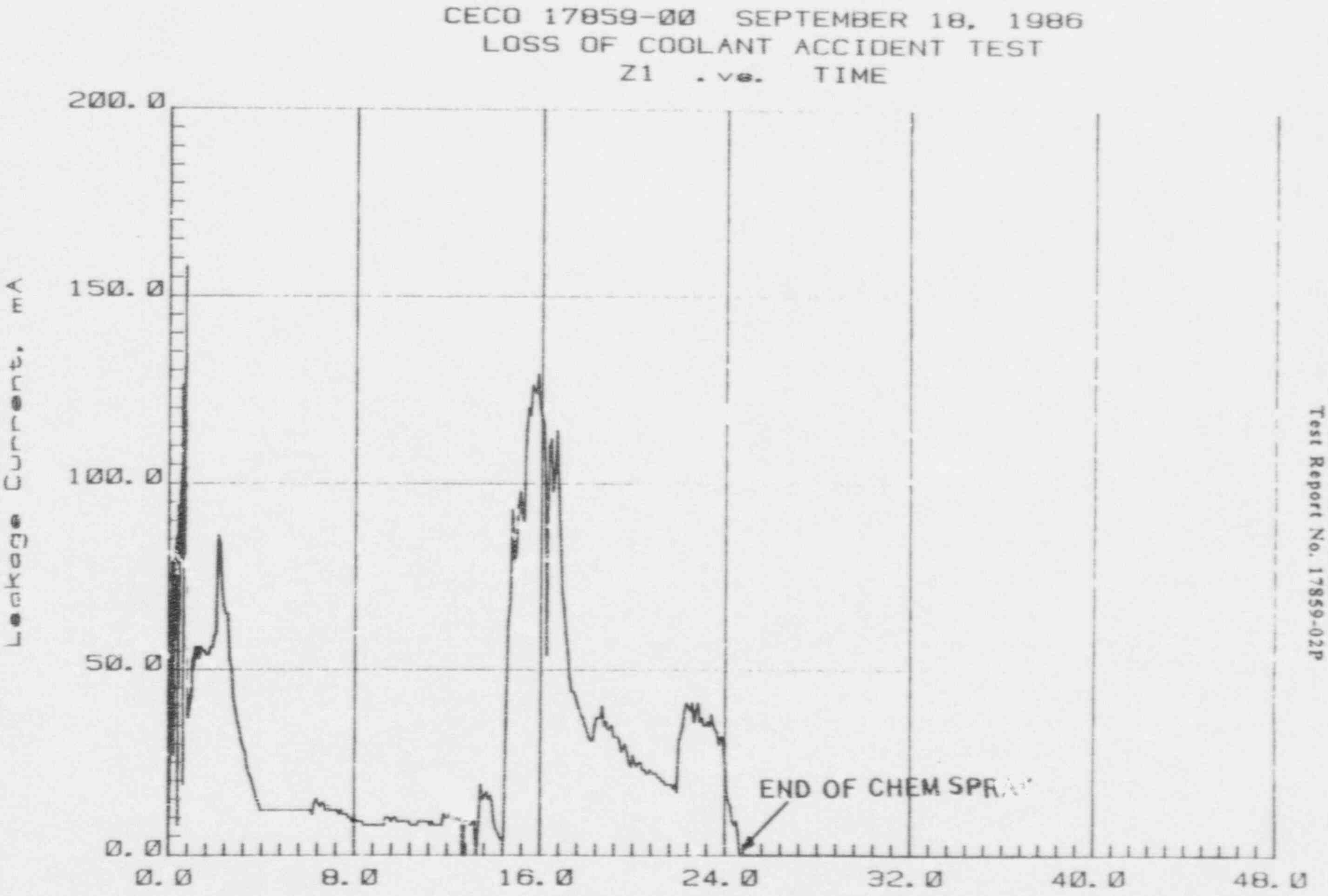

FIGURE VIII-31. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIME NUMBER Z1 (13 MINUTES TO 46 HOURS)

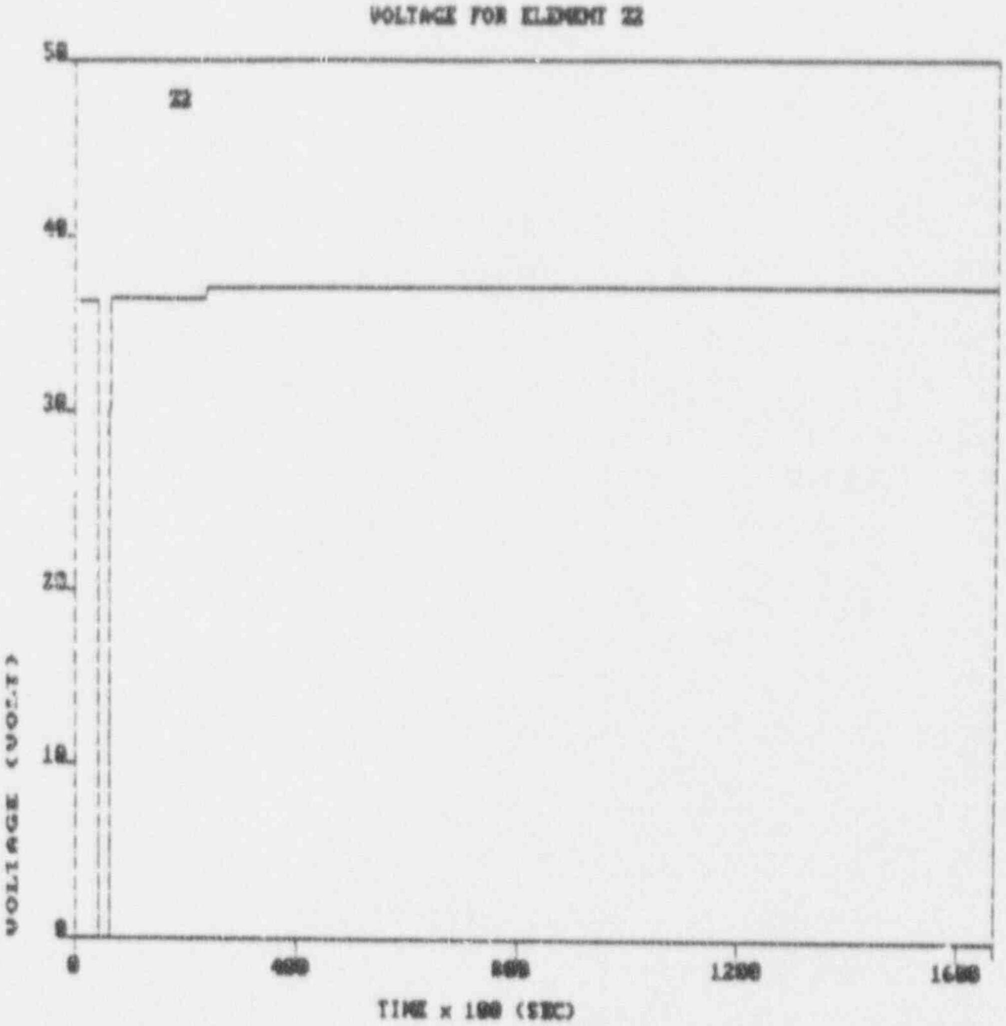

FIGURE VIII-32. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER Z2

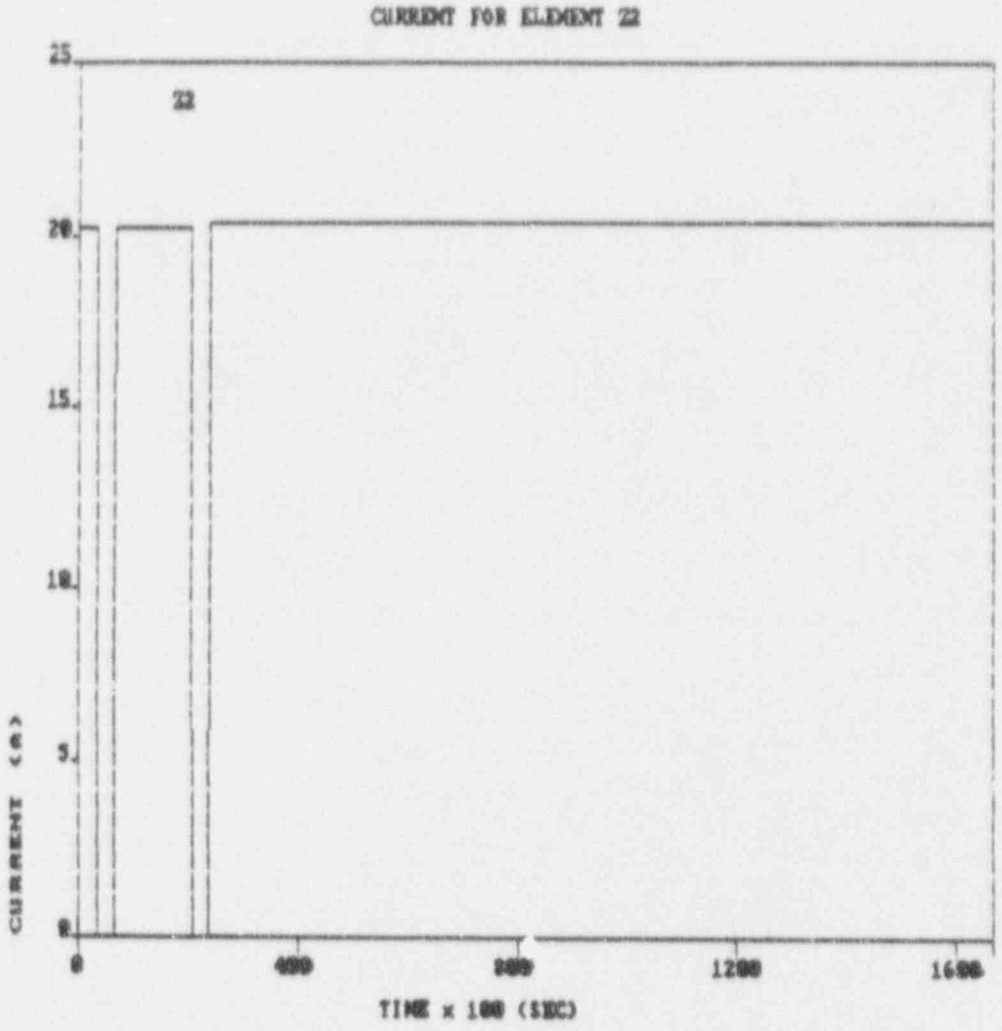

FIGURE VIII-33. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER Z2

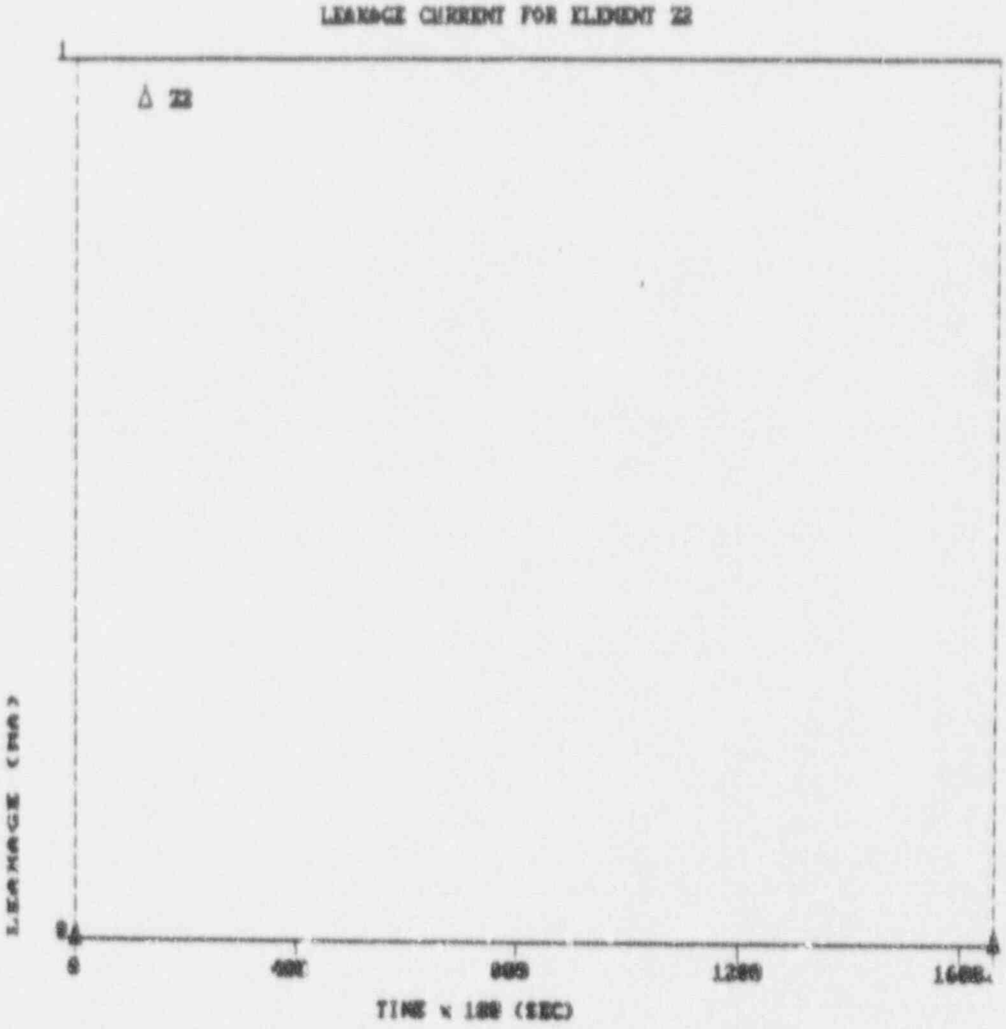

FIGURE VIII-34. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER Z2

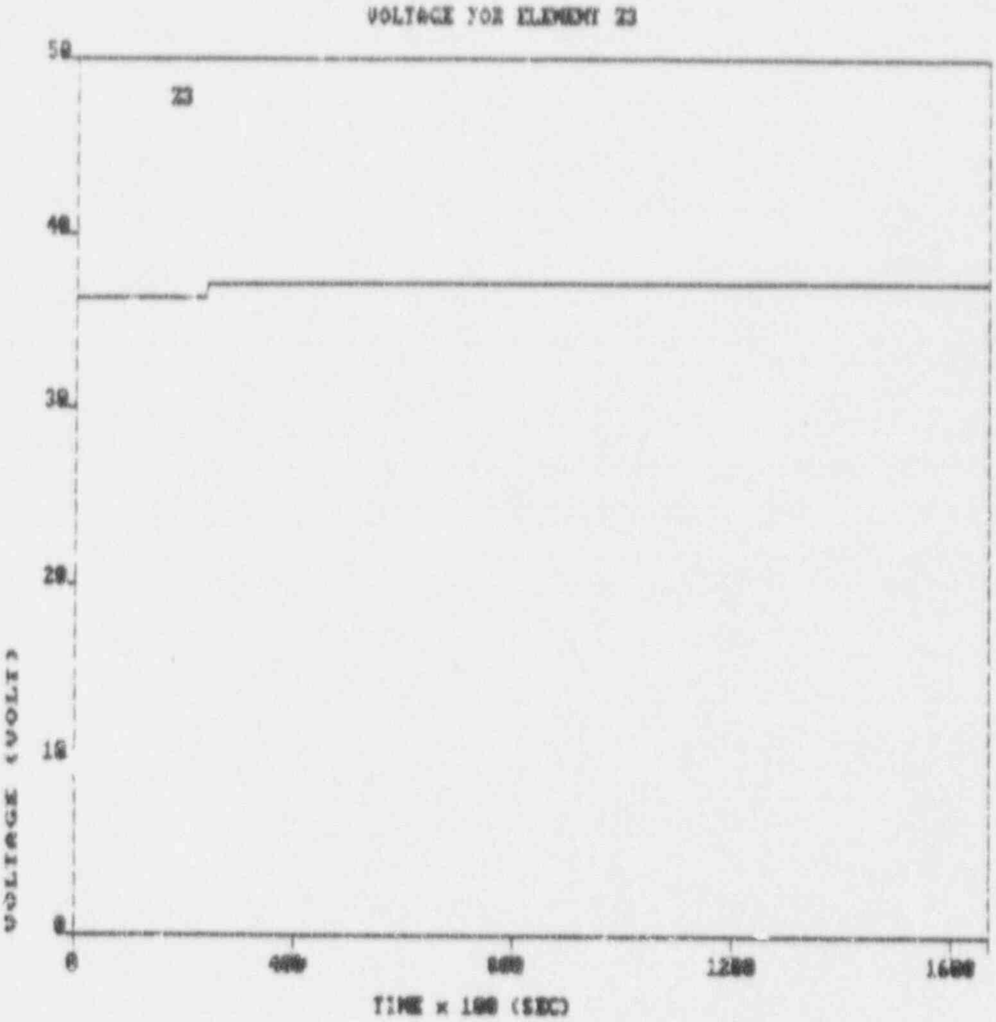

FIGURE VIII-35. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER Z3

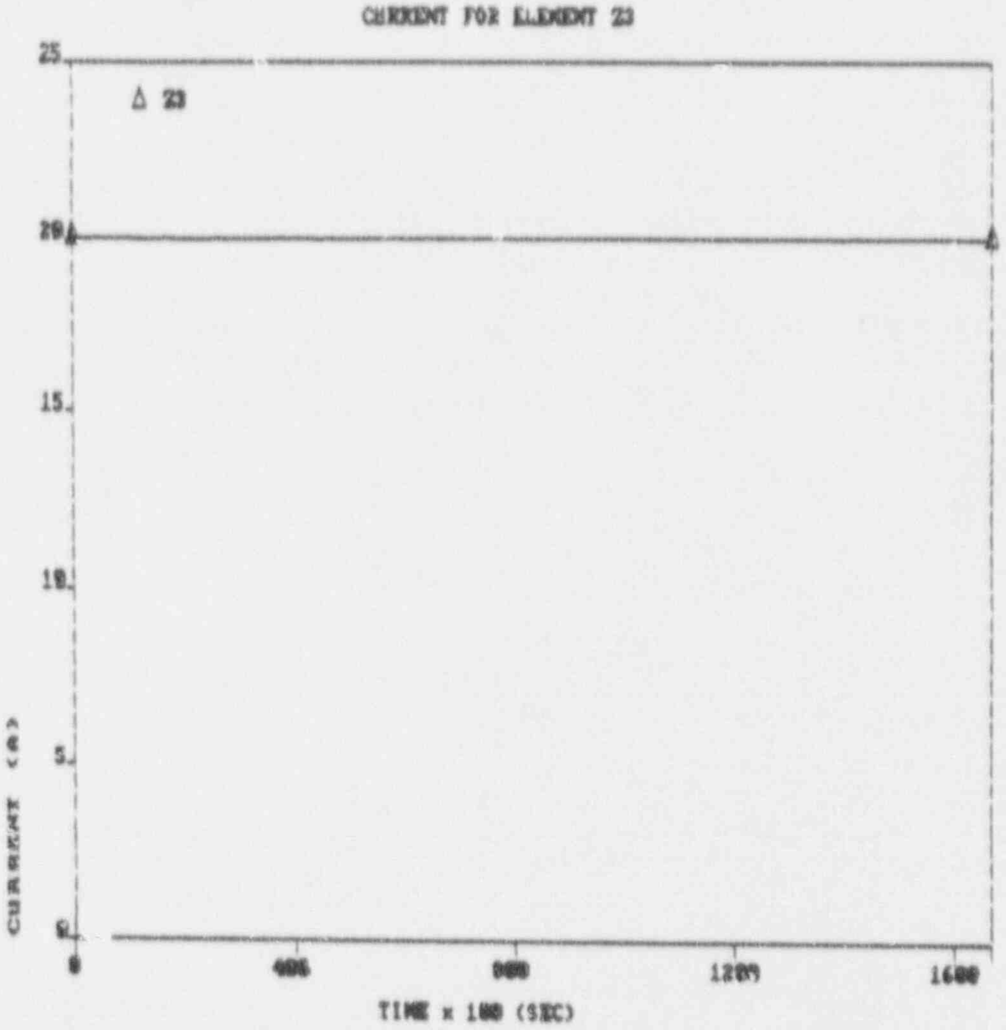

FIGURE VIII-36. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER Z3

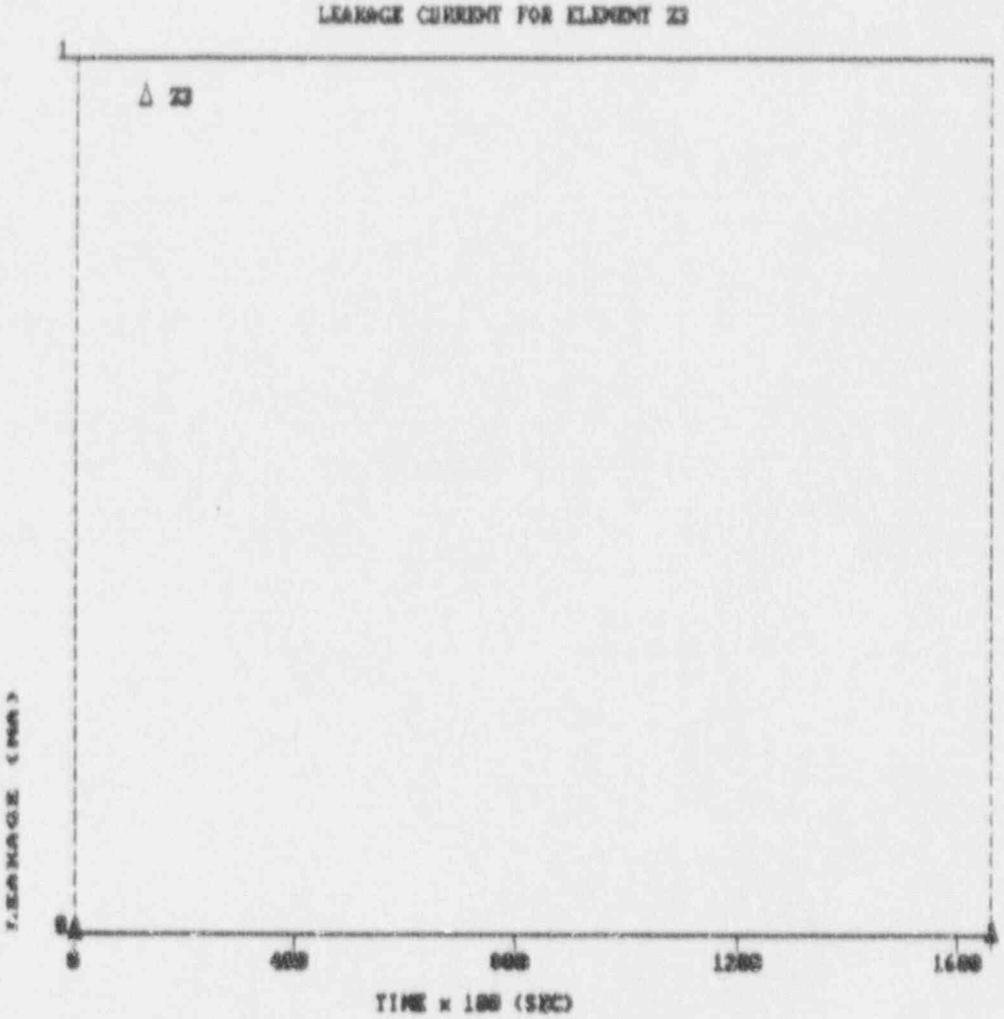

FIGURE VIII-37. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER Z3

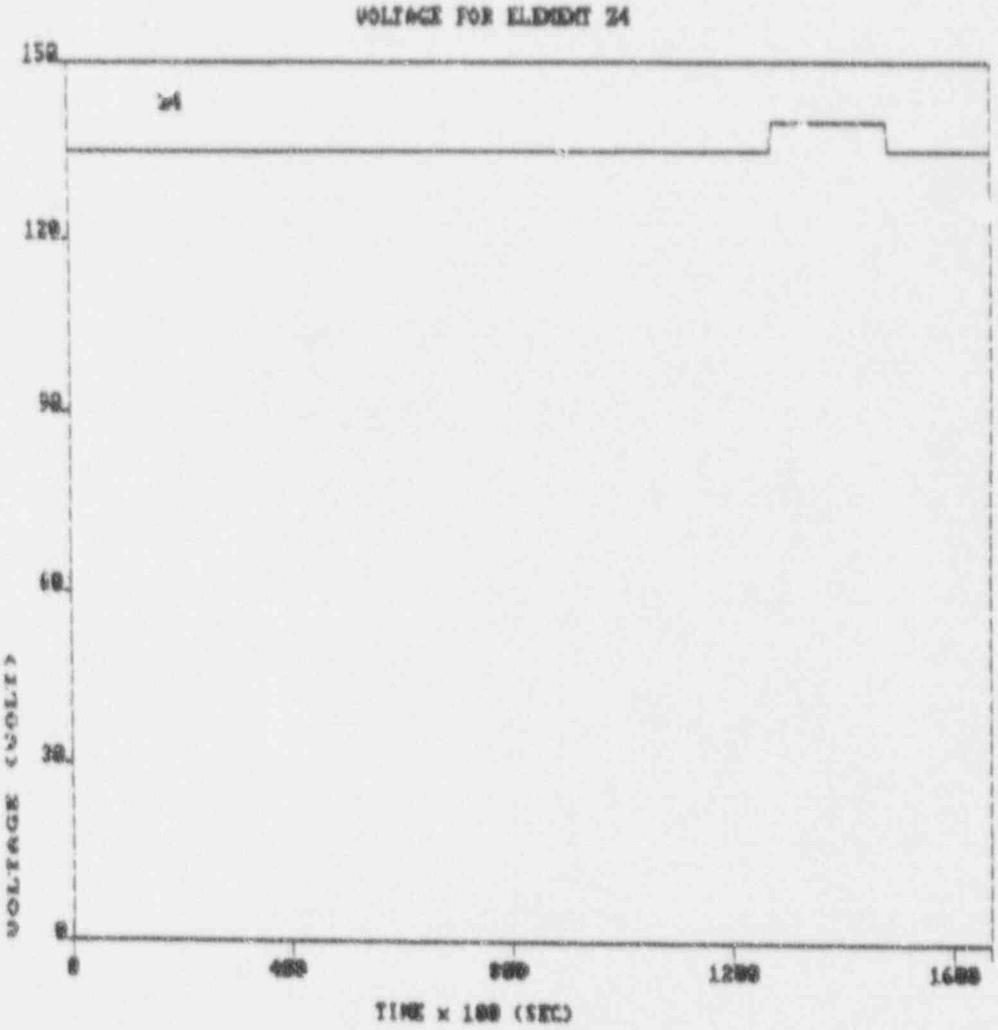

FIGURE VIII-38. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER Z4

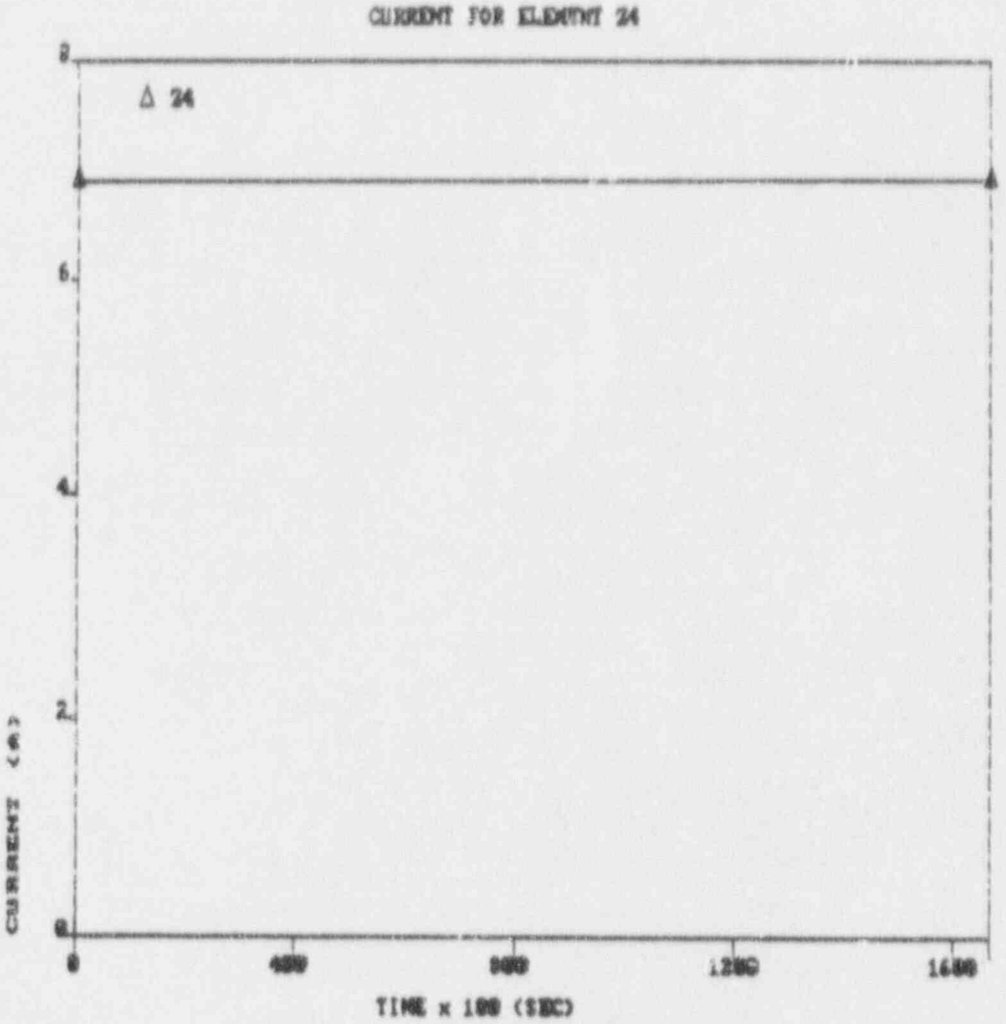

FIGURE VIII-39. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER Z4

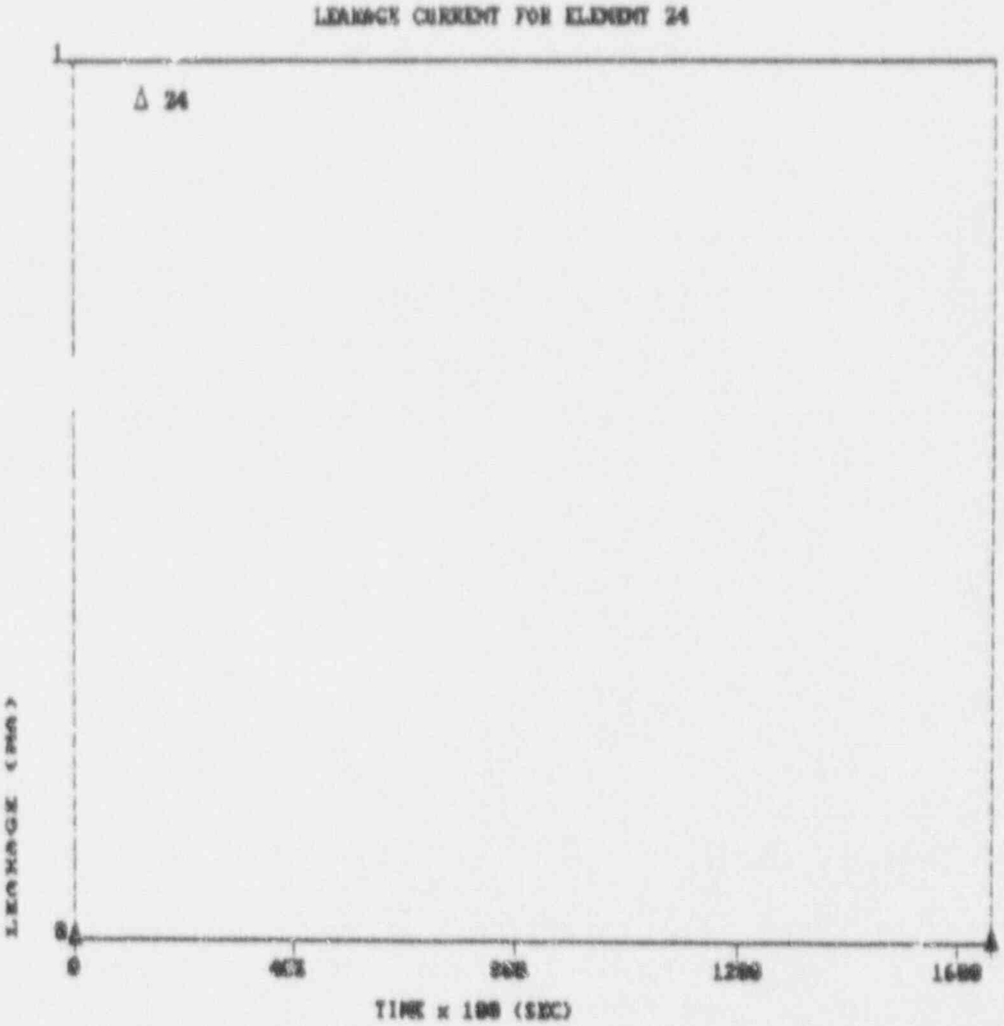

FIGURE VIII-40. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER Z4

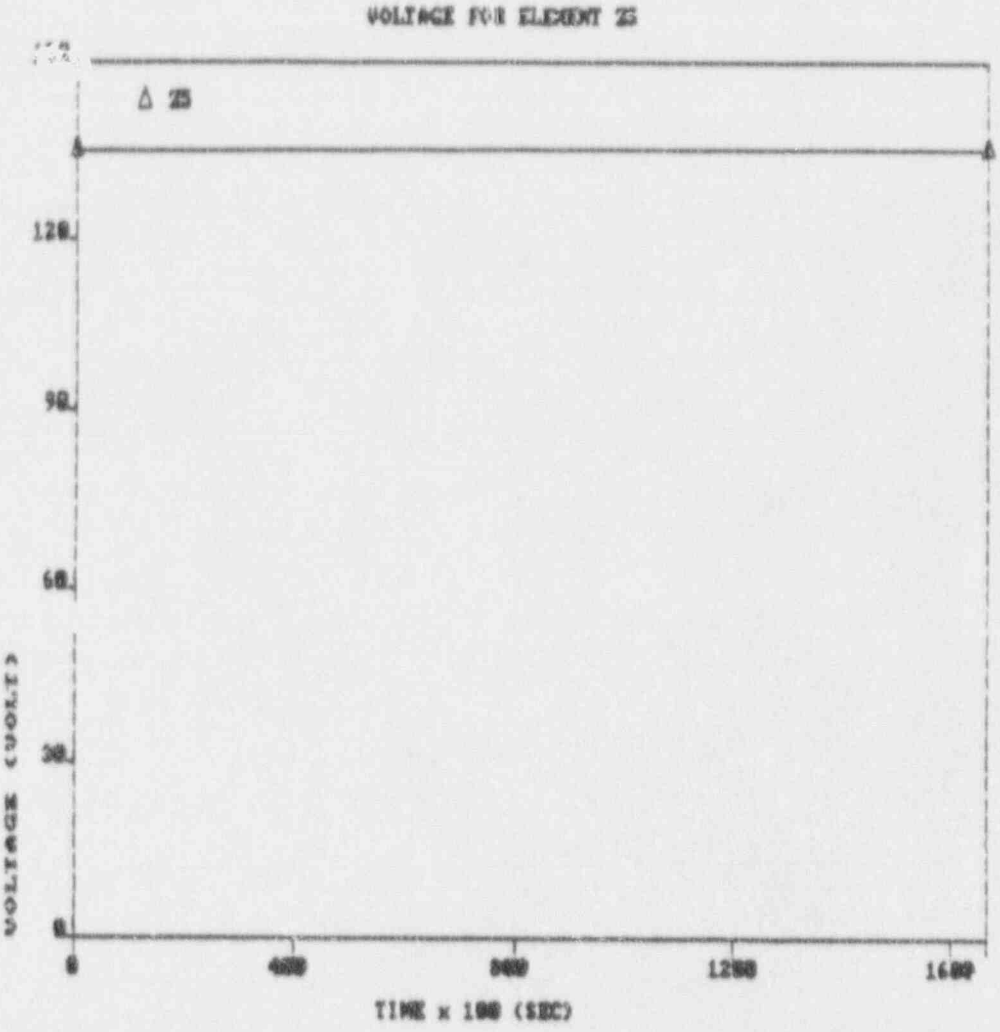

FIGURE VIII-41. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER Z5

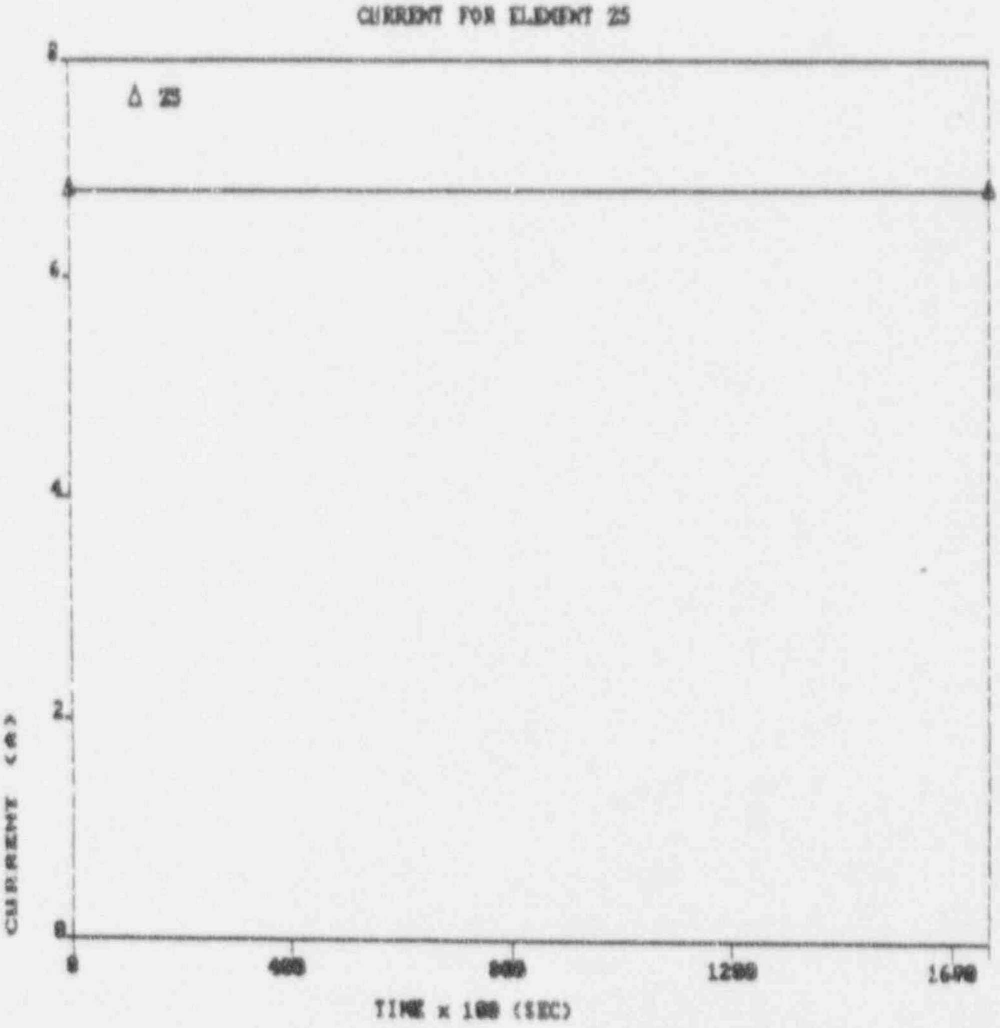

FIGURE VIII-42. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER Z5

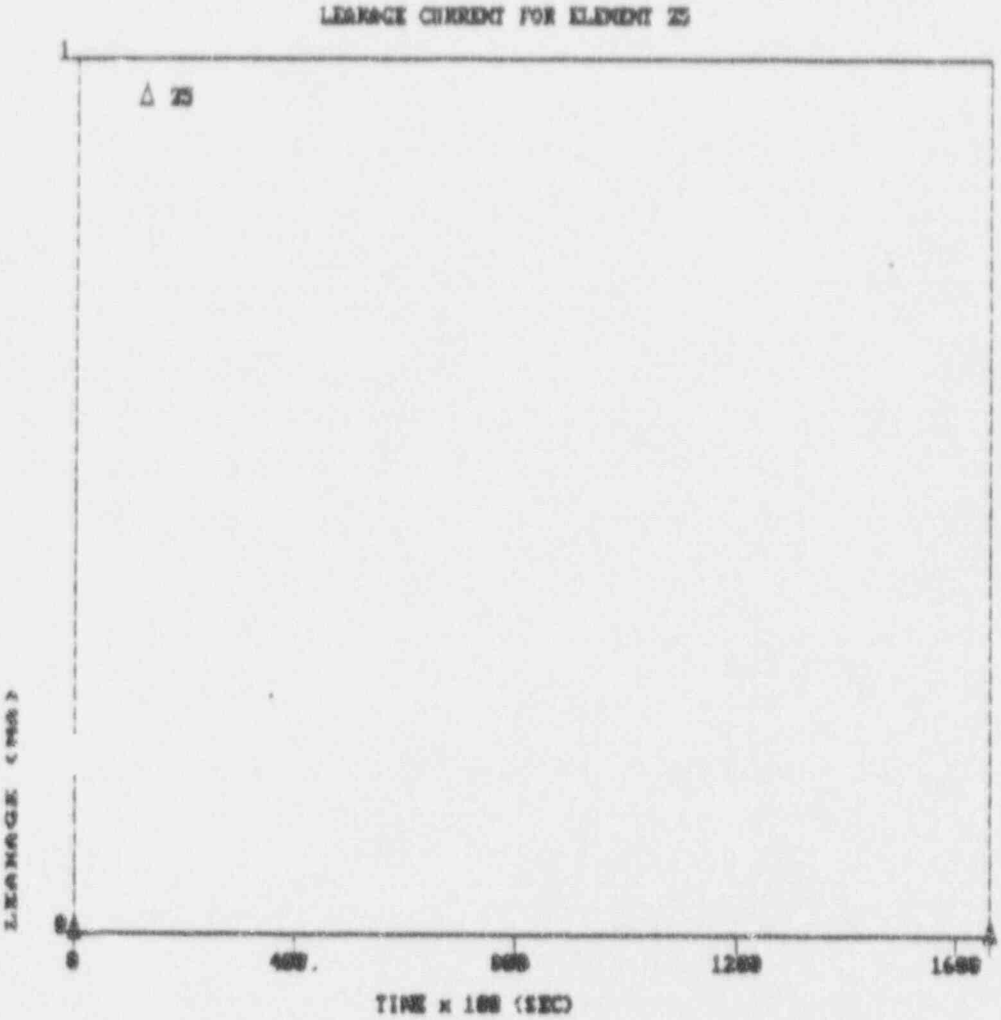

FIGURE VIII-43. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER Z5

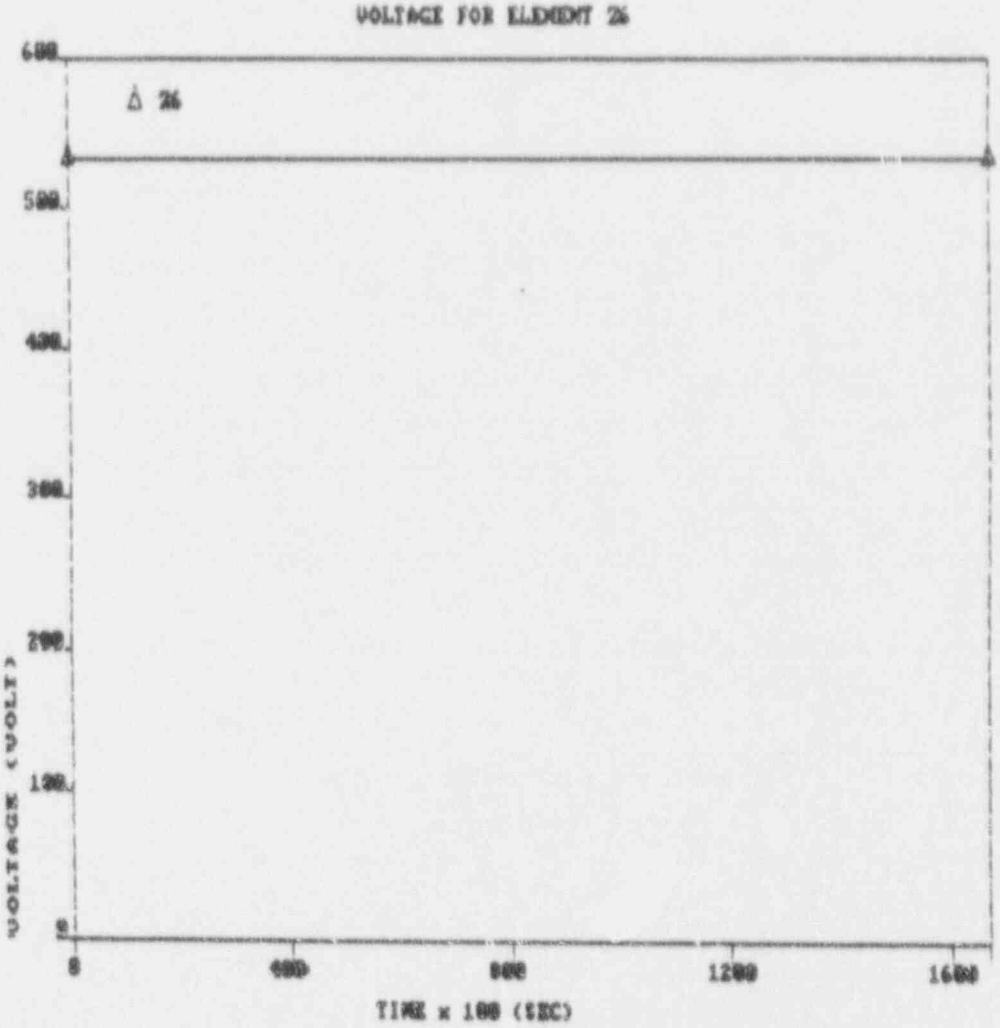

FIGURE VIII 44. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER 26

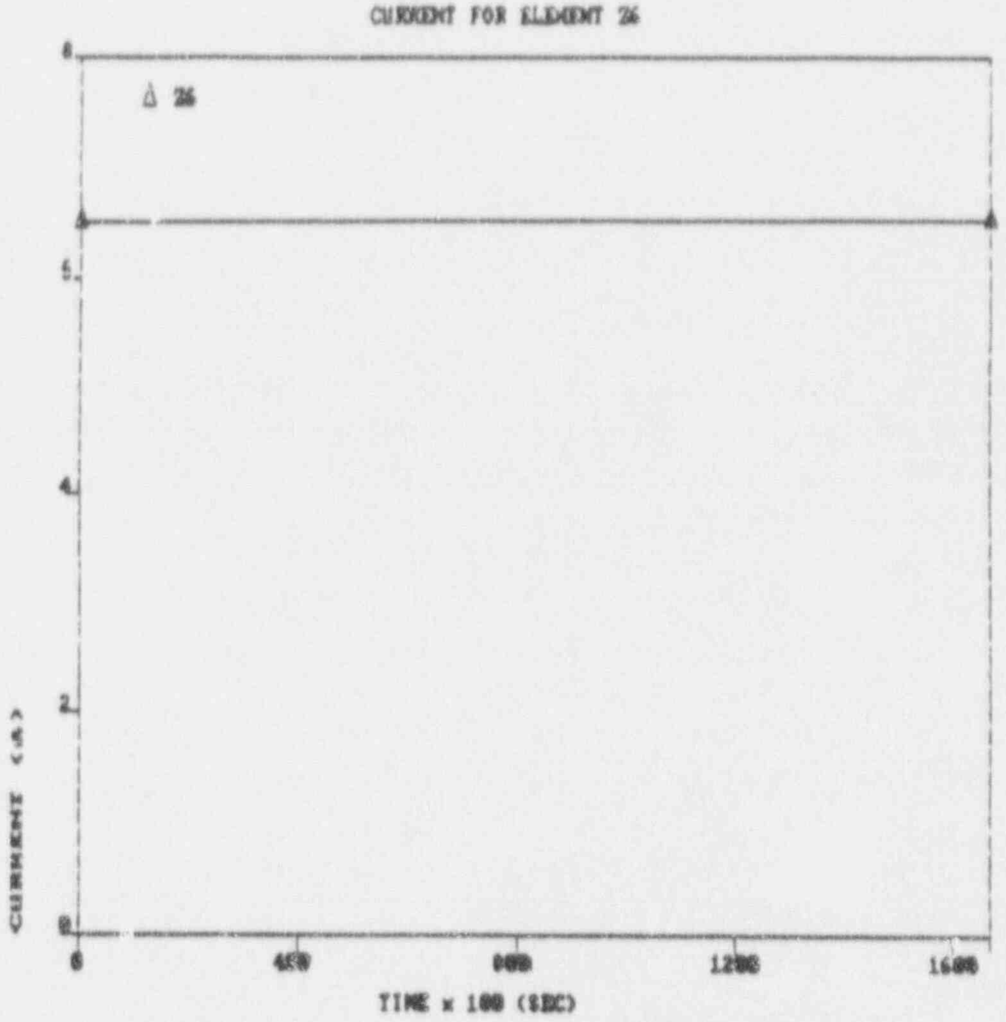

FIGURE VIII-45. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER Z6

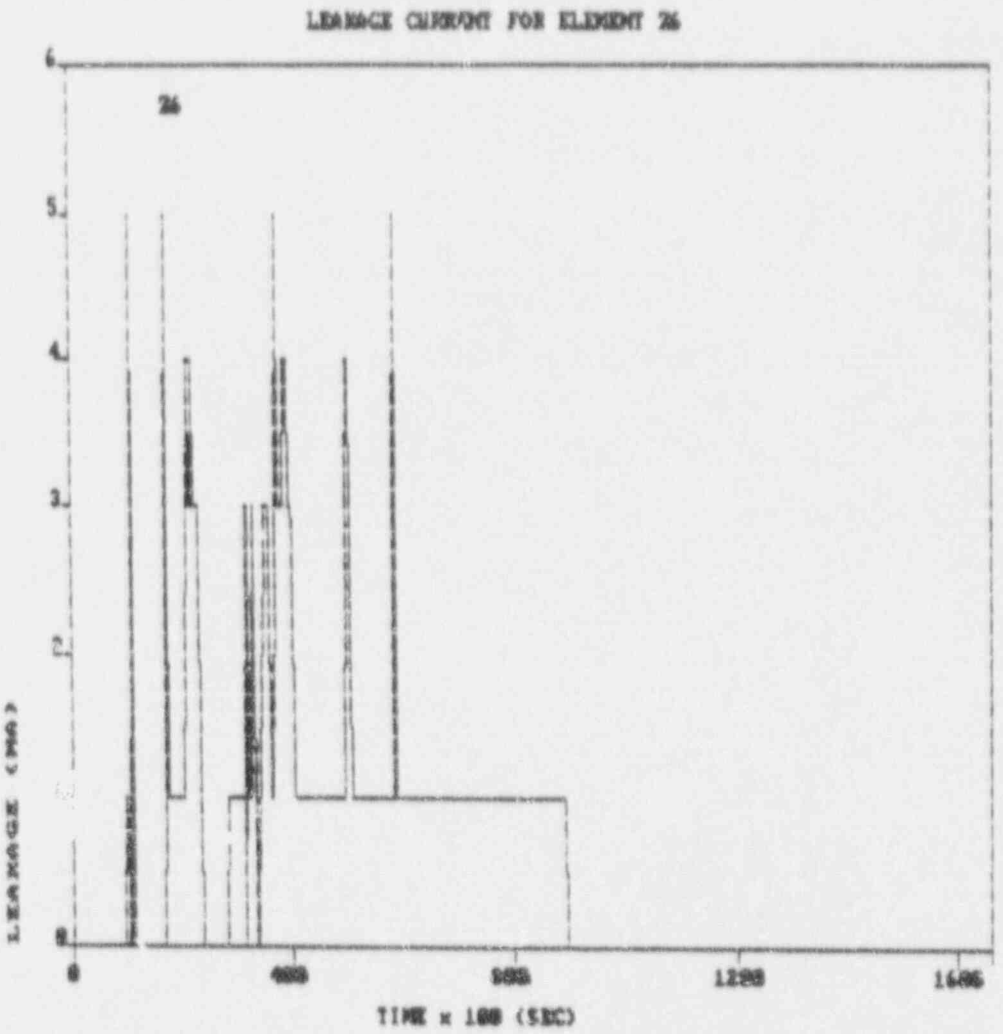

FIGURE VIII-46. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER Z6

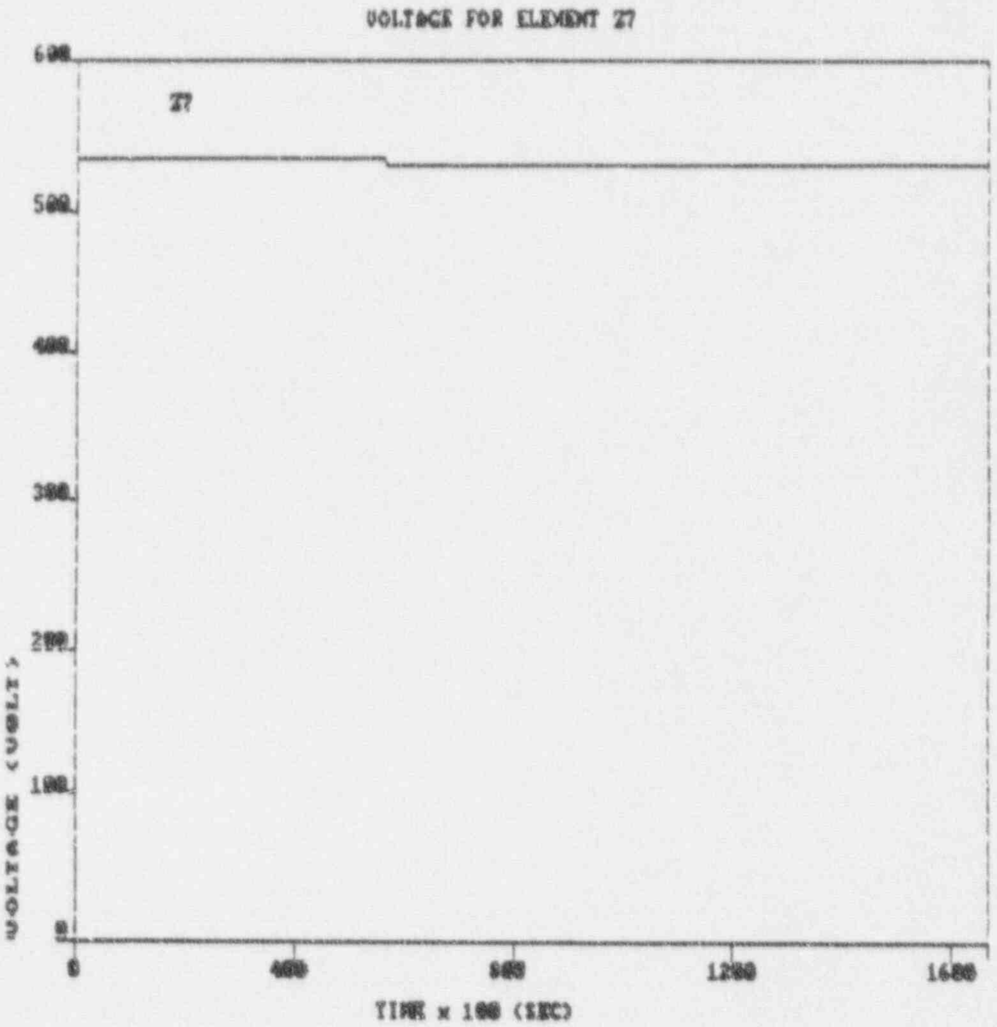

FIGURE V[illegible] VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER Z7

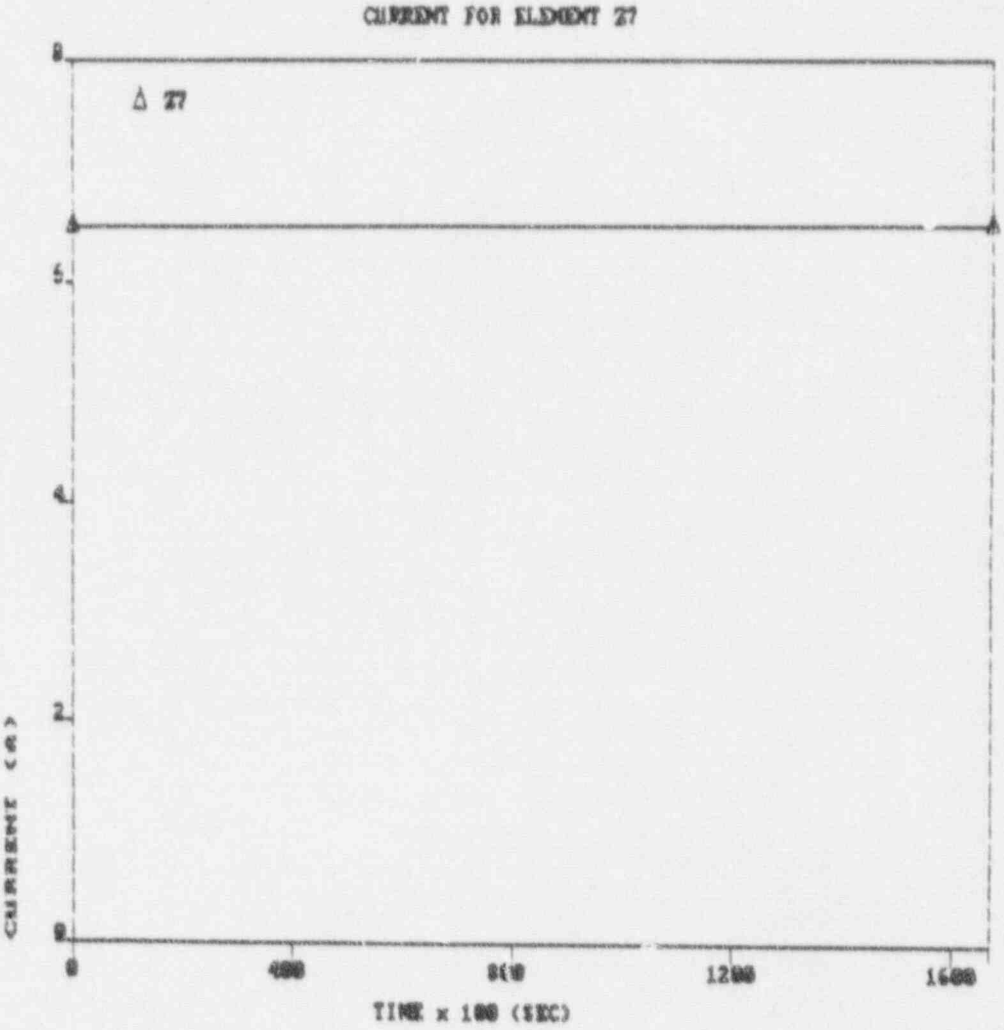

FIGURE VIII-48. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER Z7

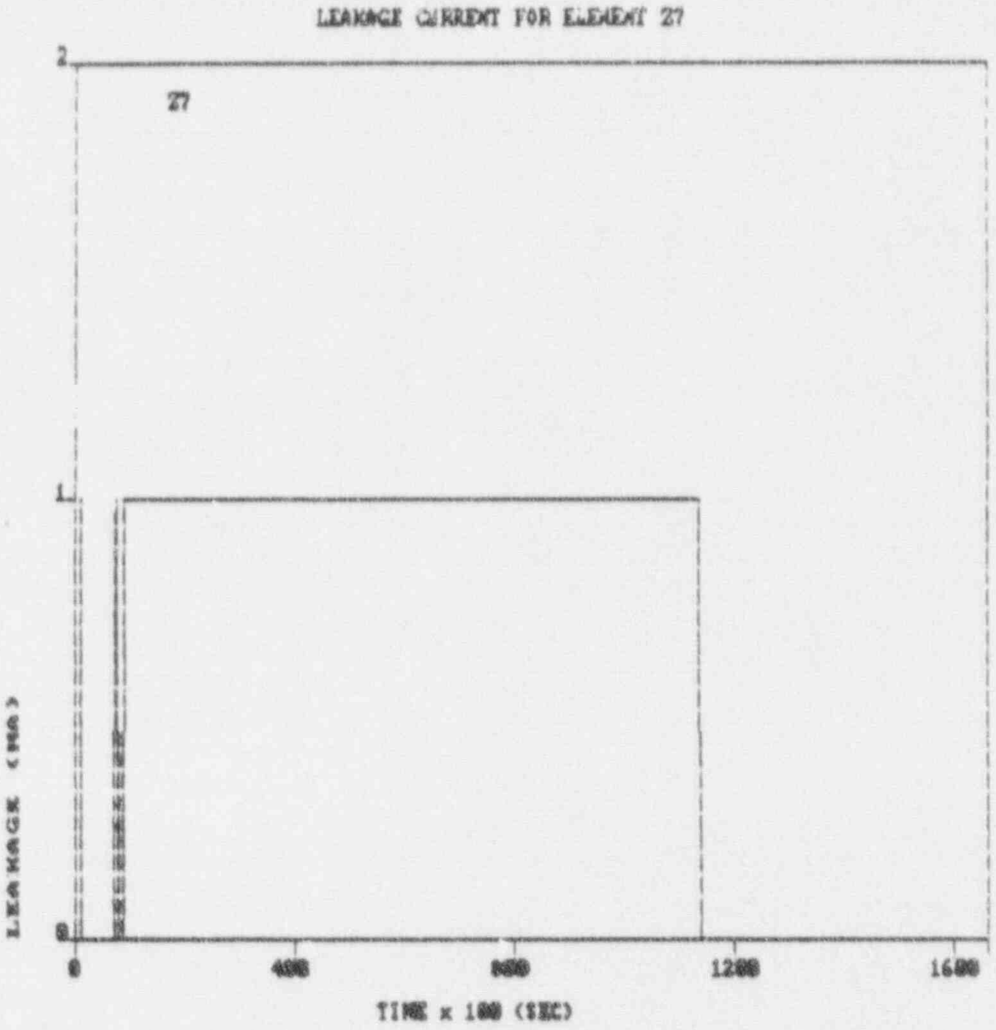

FIGURE VIII-49. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER Z7

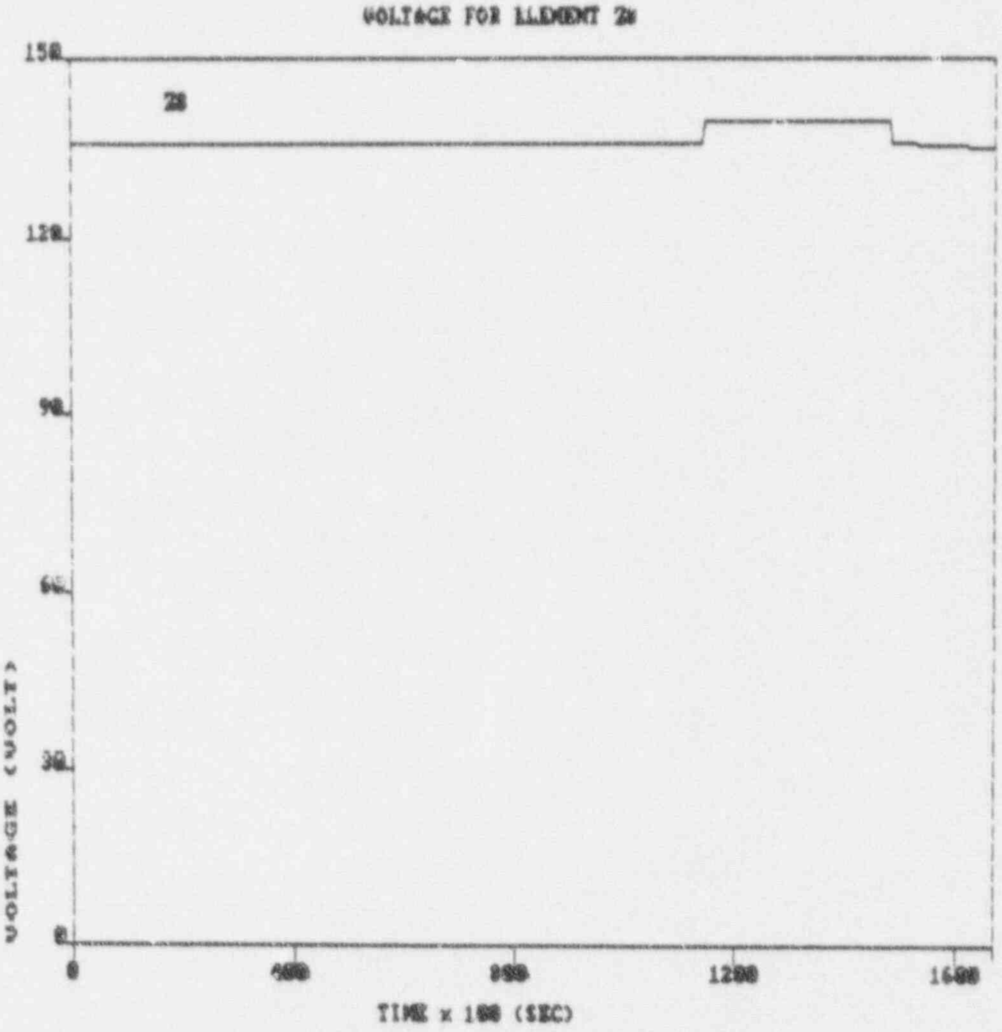

FIGURE VIII-50. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER Z8

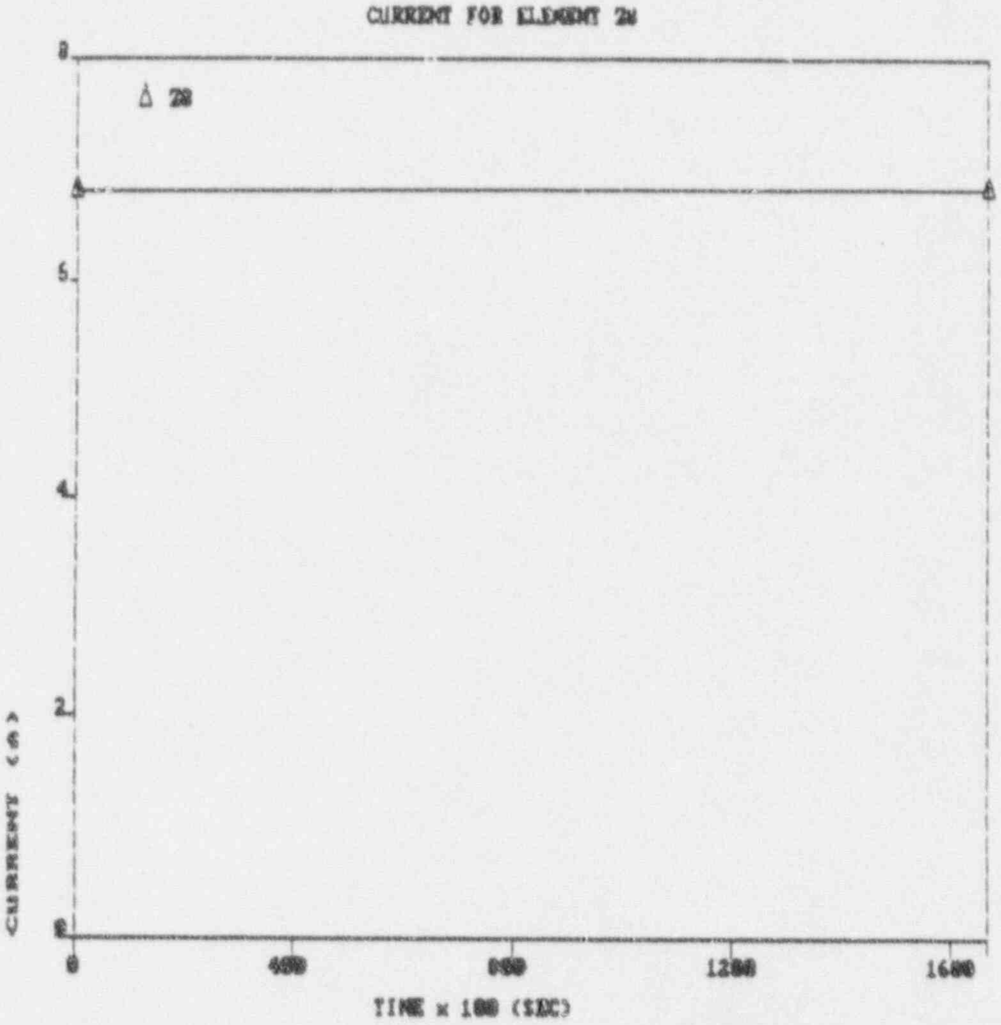

FIGURE VIII-51. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER Z8

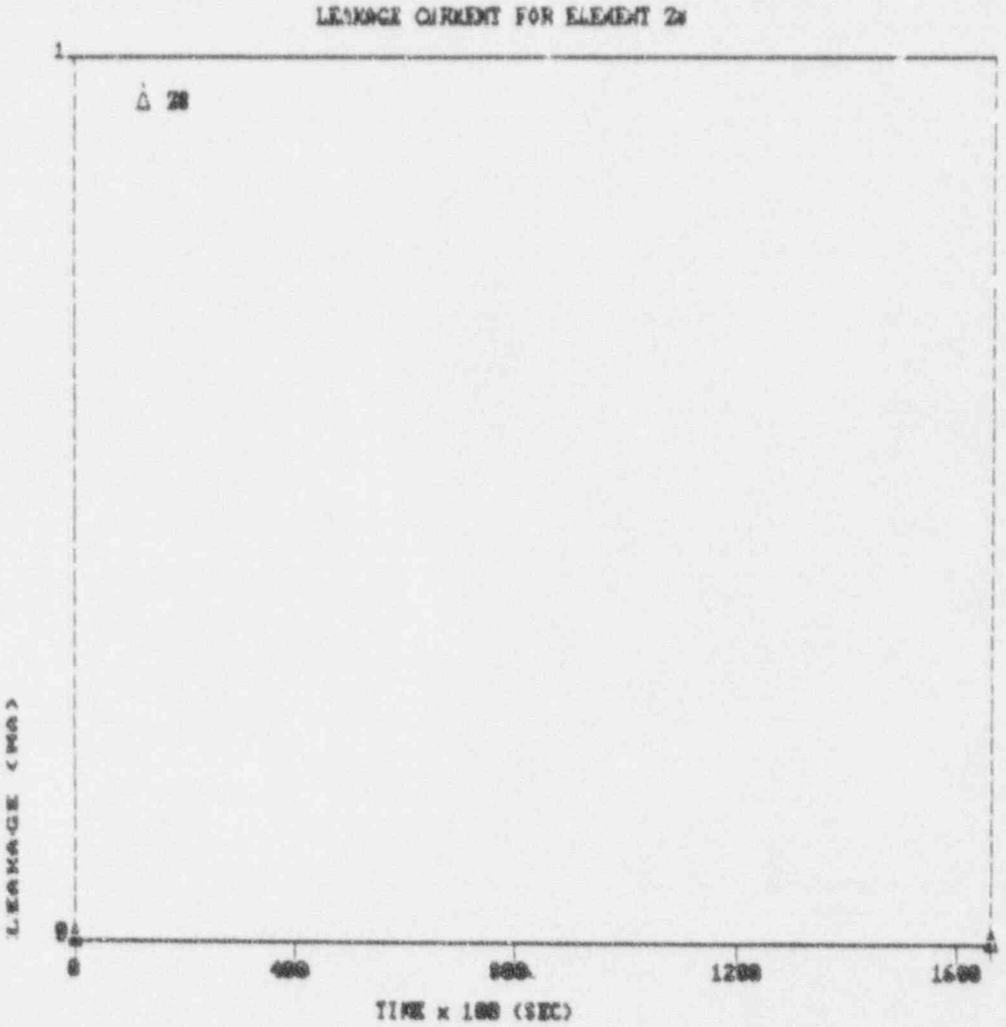

FIGURE VIII-52. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER Z8

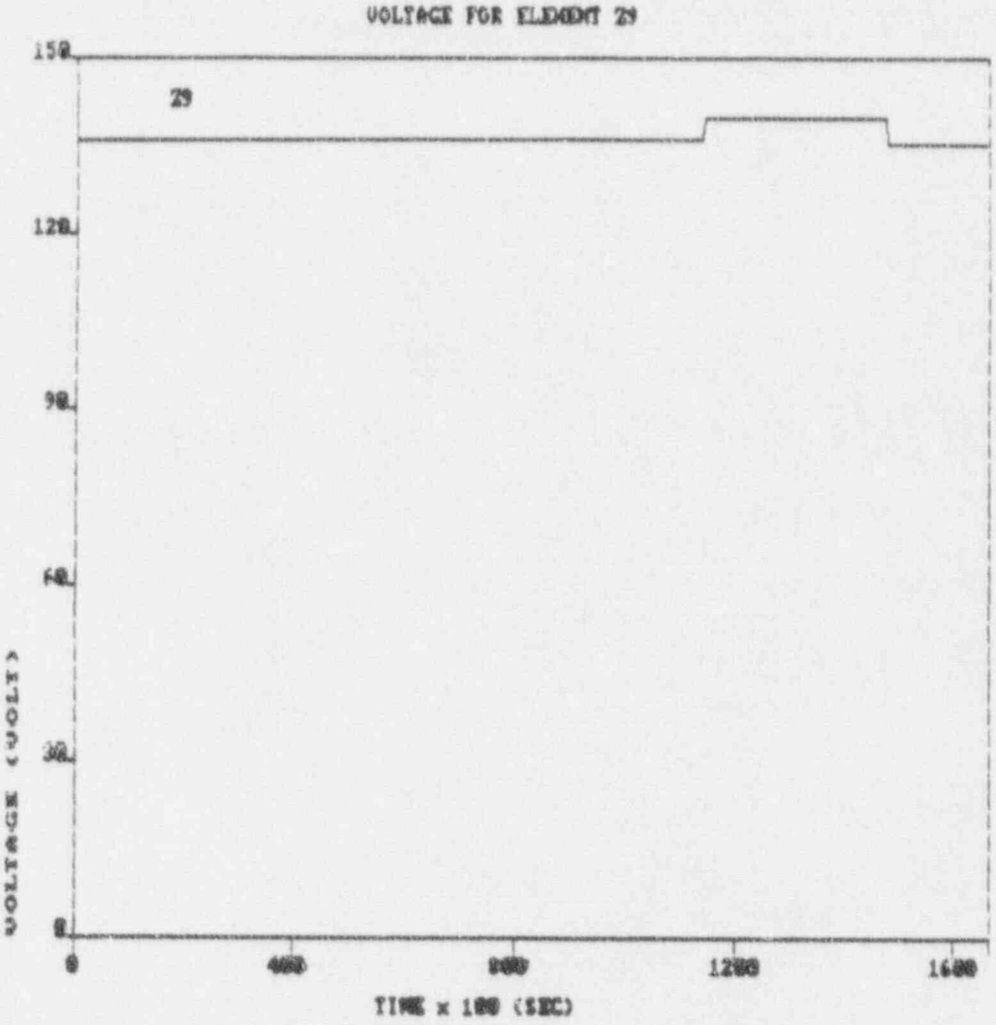

FIGURE VIII-53. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER Z9

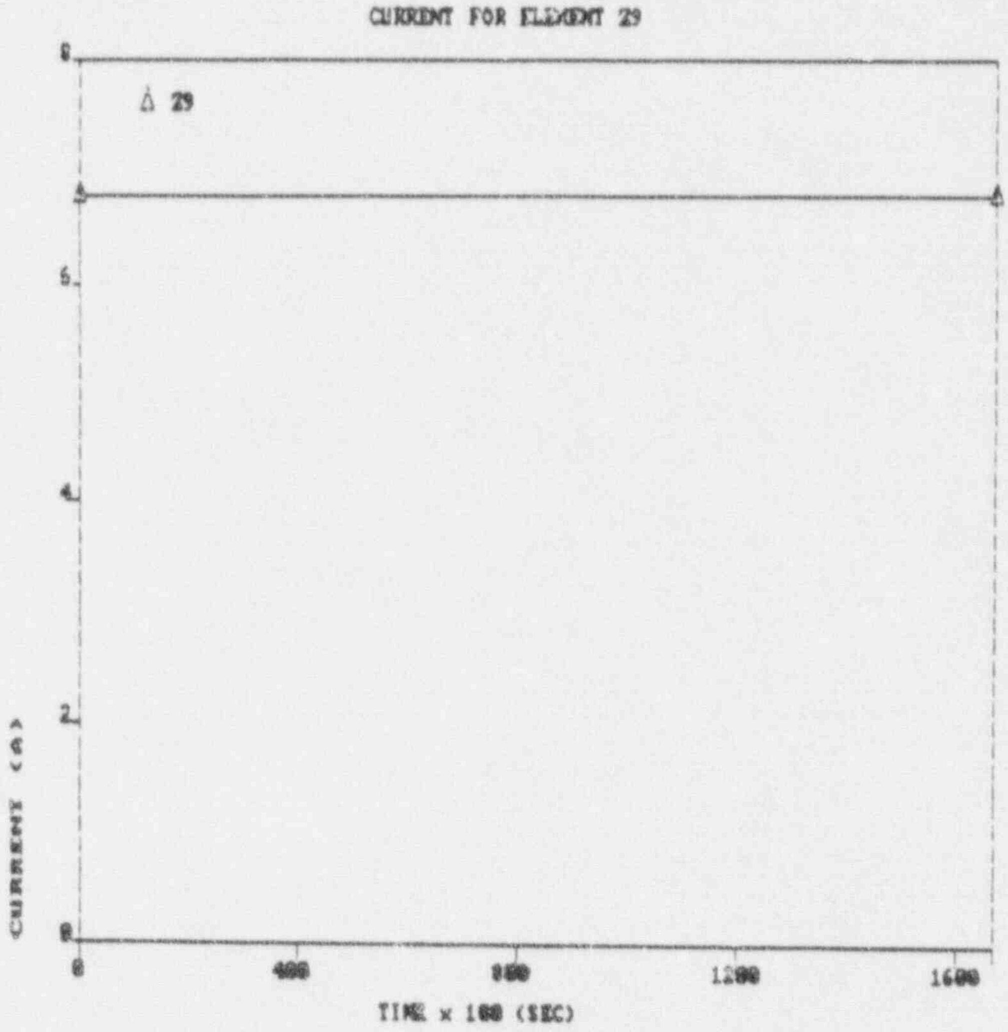

FIGURE VIII-54. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER Z9

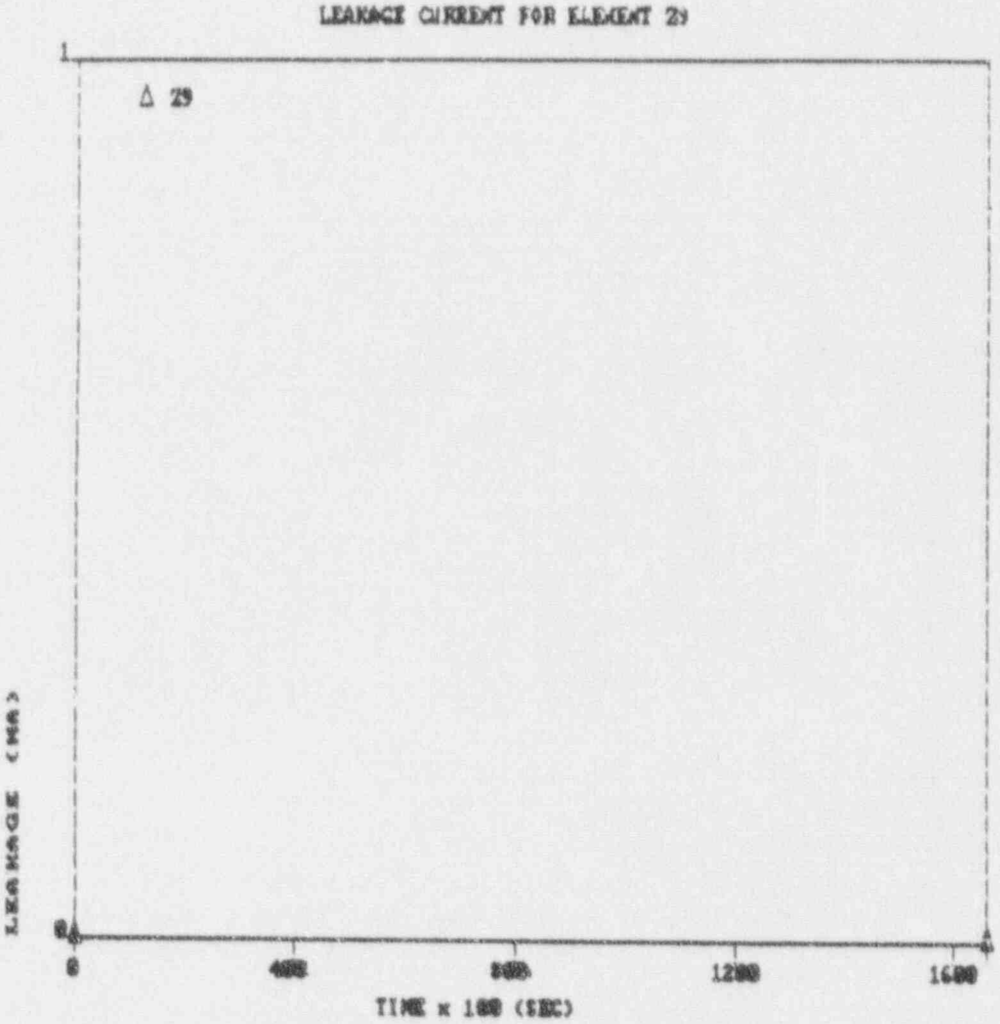

FIGURE VIII-55. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER Z9

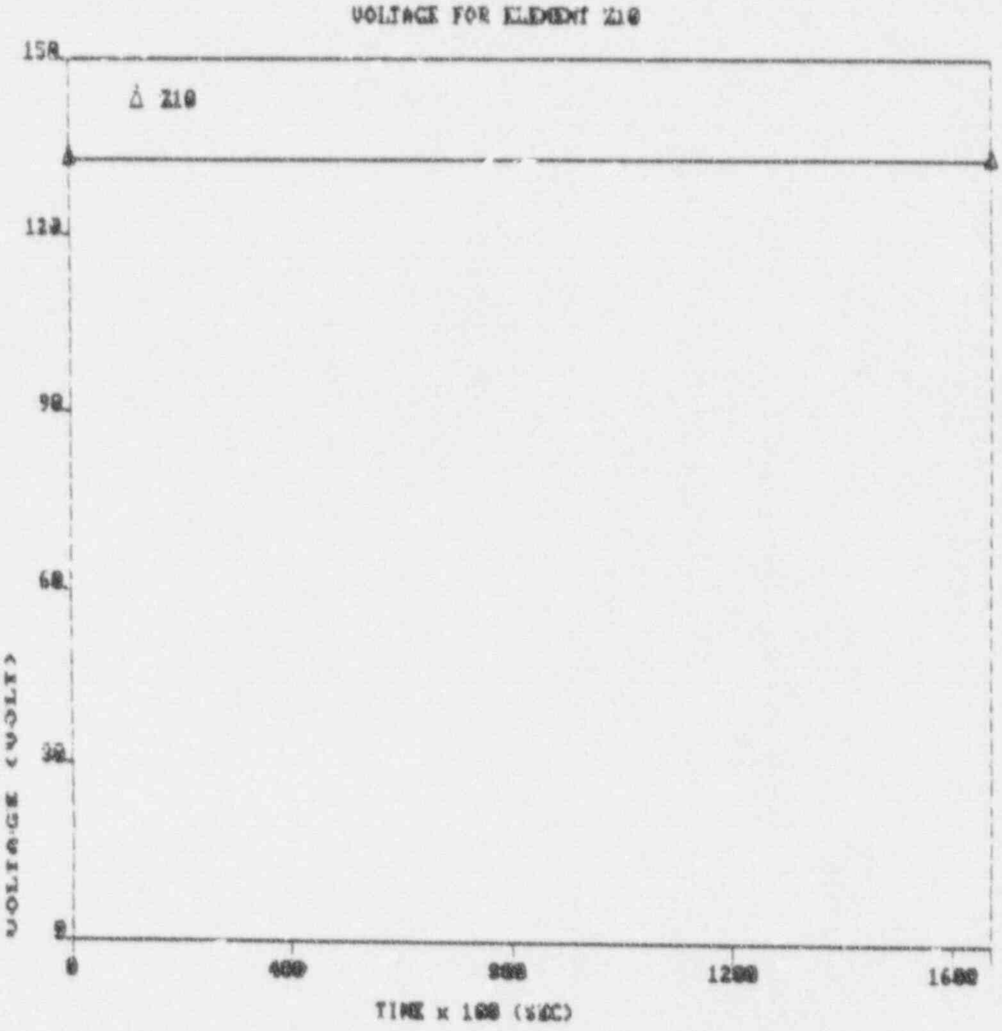

FIGURE VIII-56. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER Z10

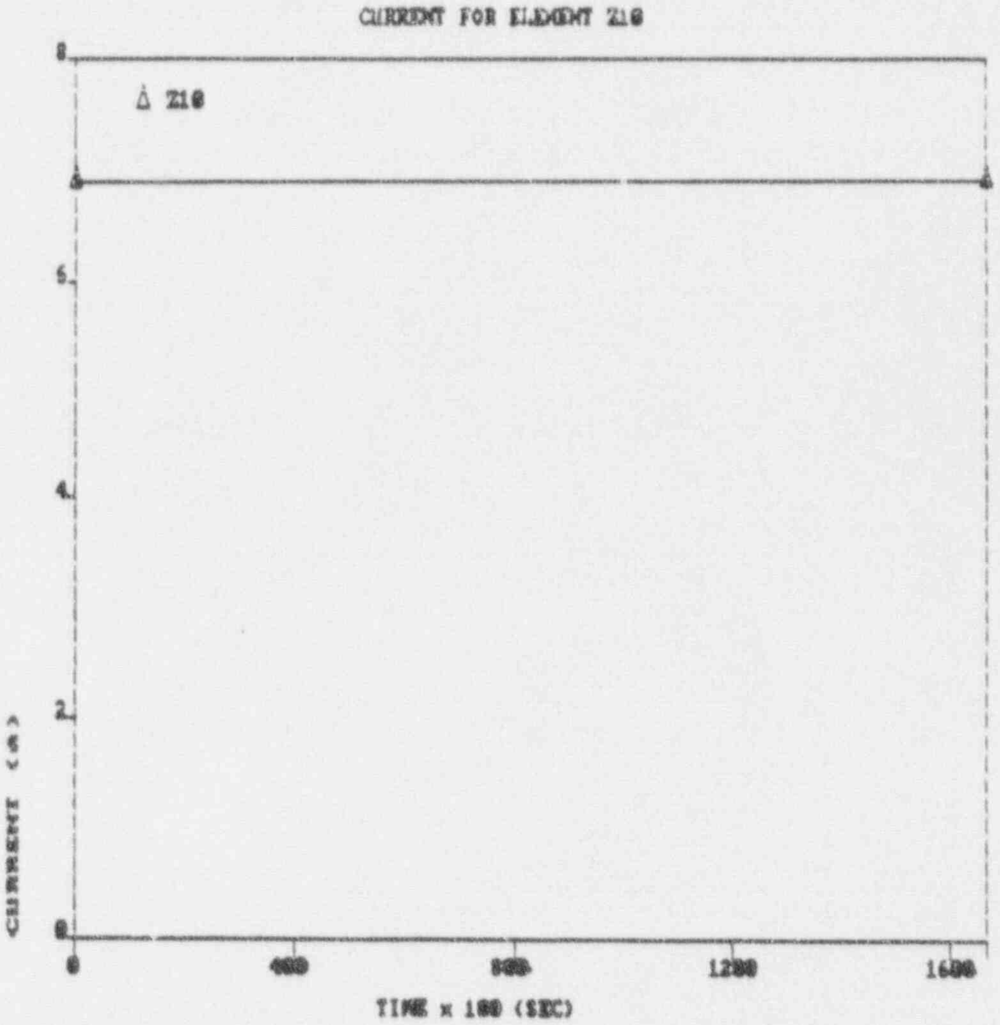

FIGURE VIII-57. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER Z10

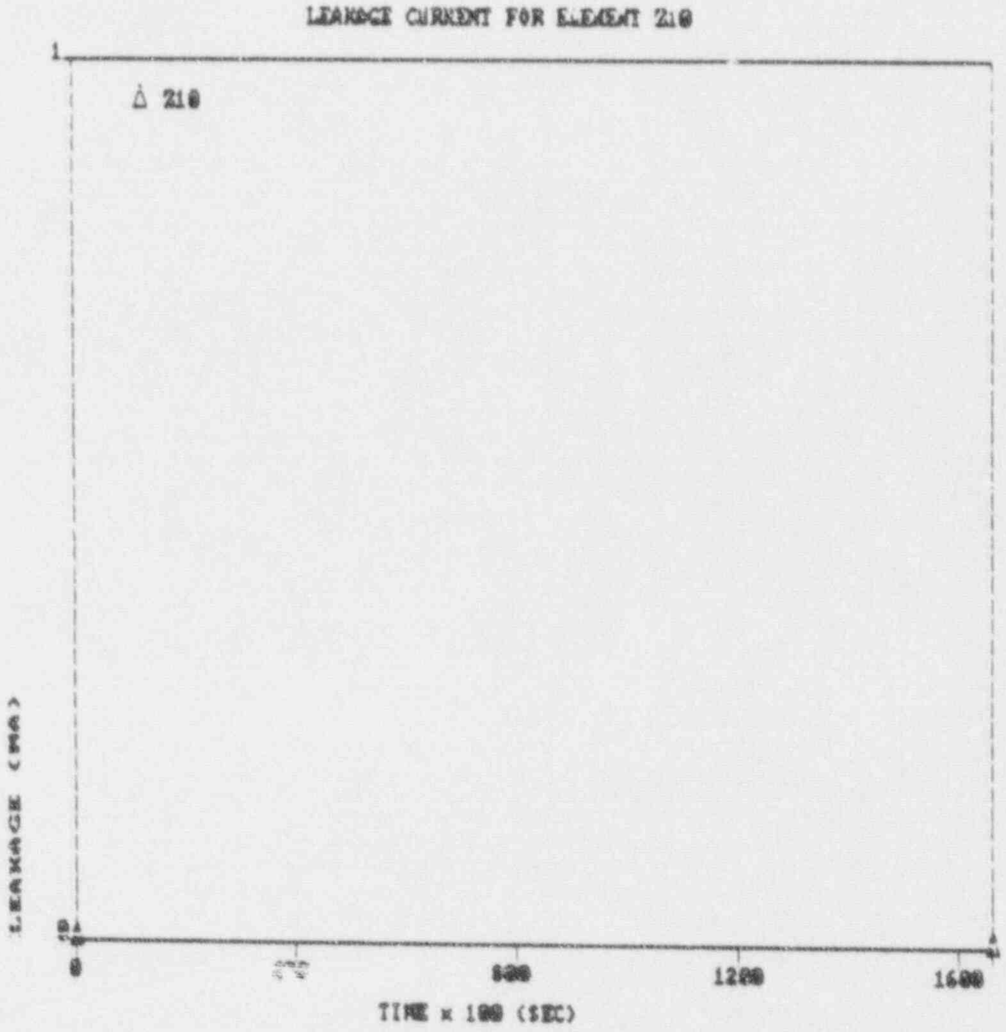

FIGURE VIII-58. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER Z10

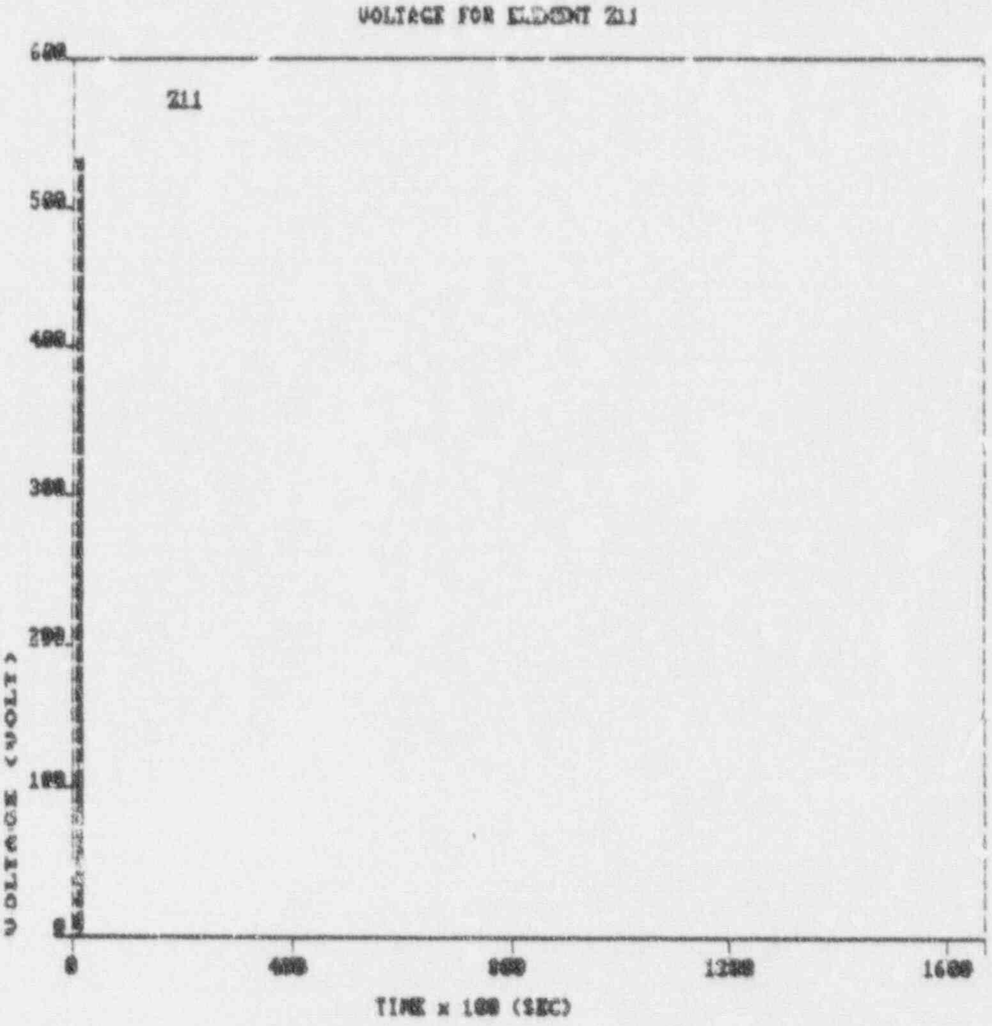

FIGURE VIII-59. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER Z11

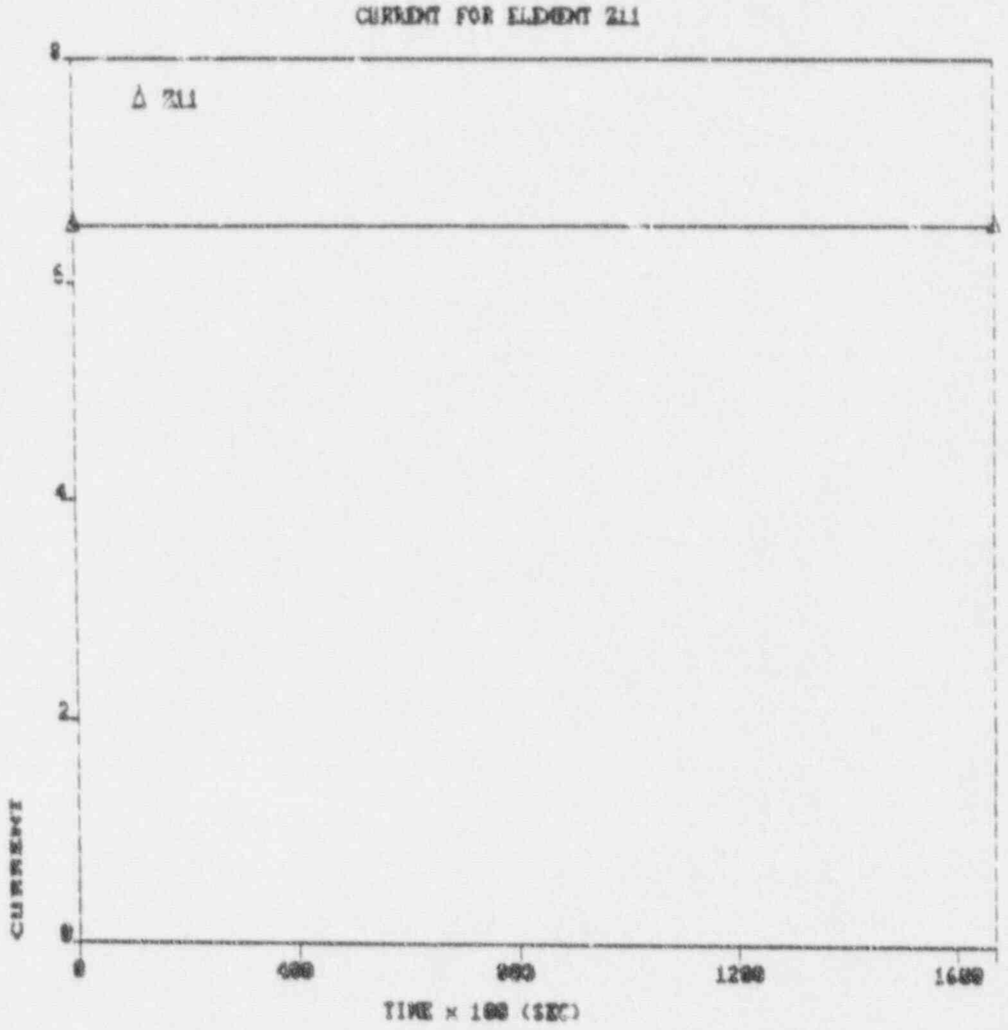

FIGURE VIII-60. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER Z11

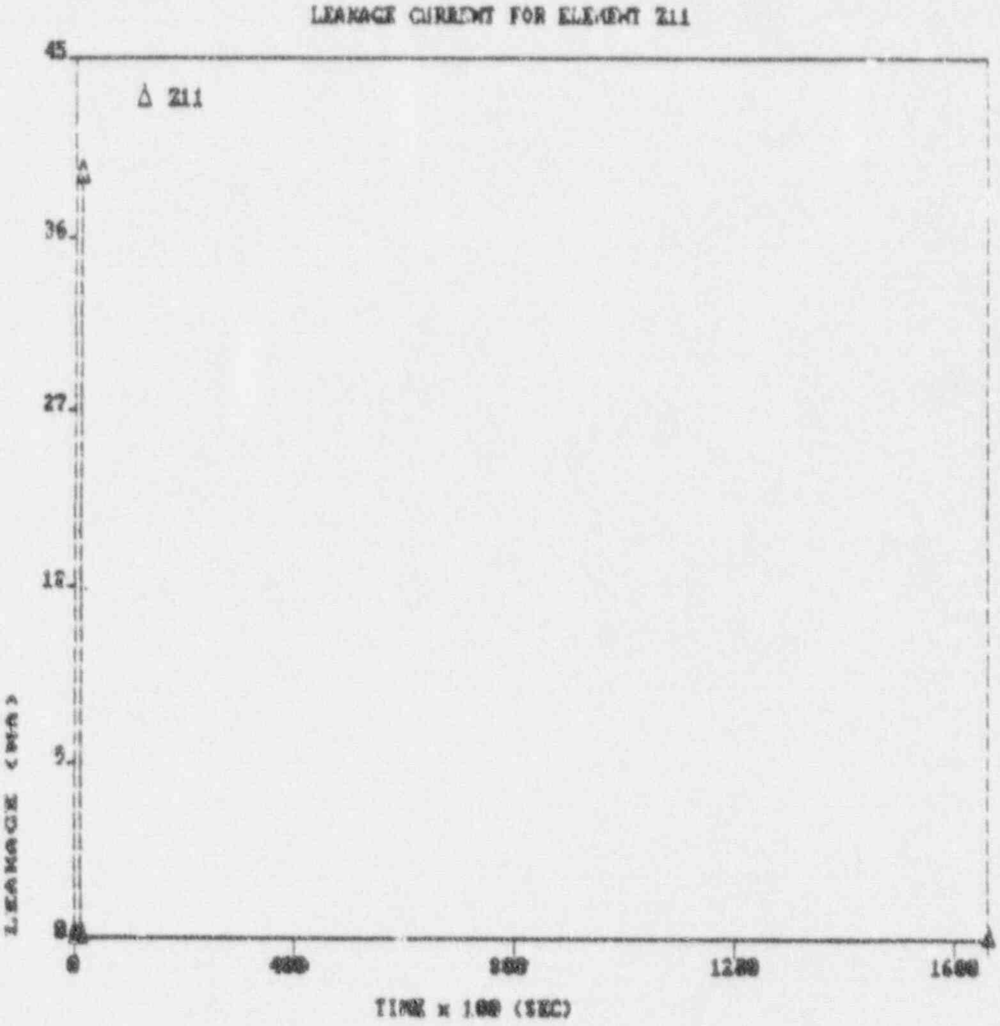

FIGURE VIII-61. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER Z11

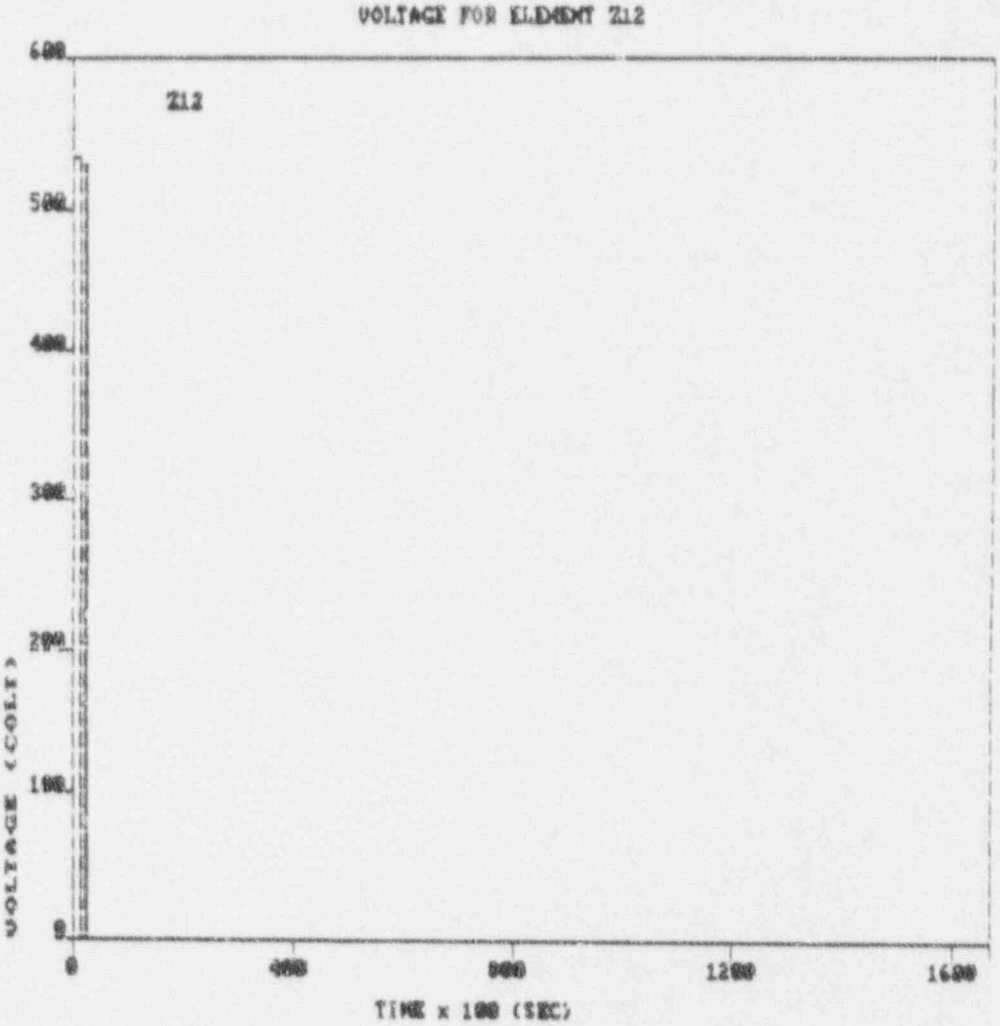

FIGURE VIII-62. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER Z12

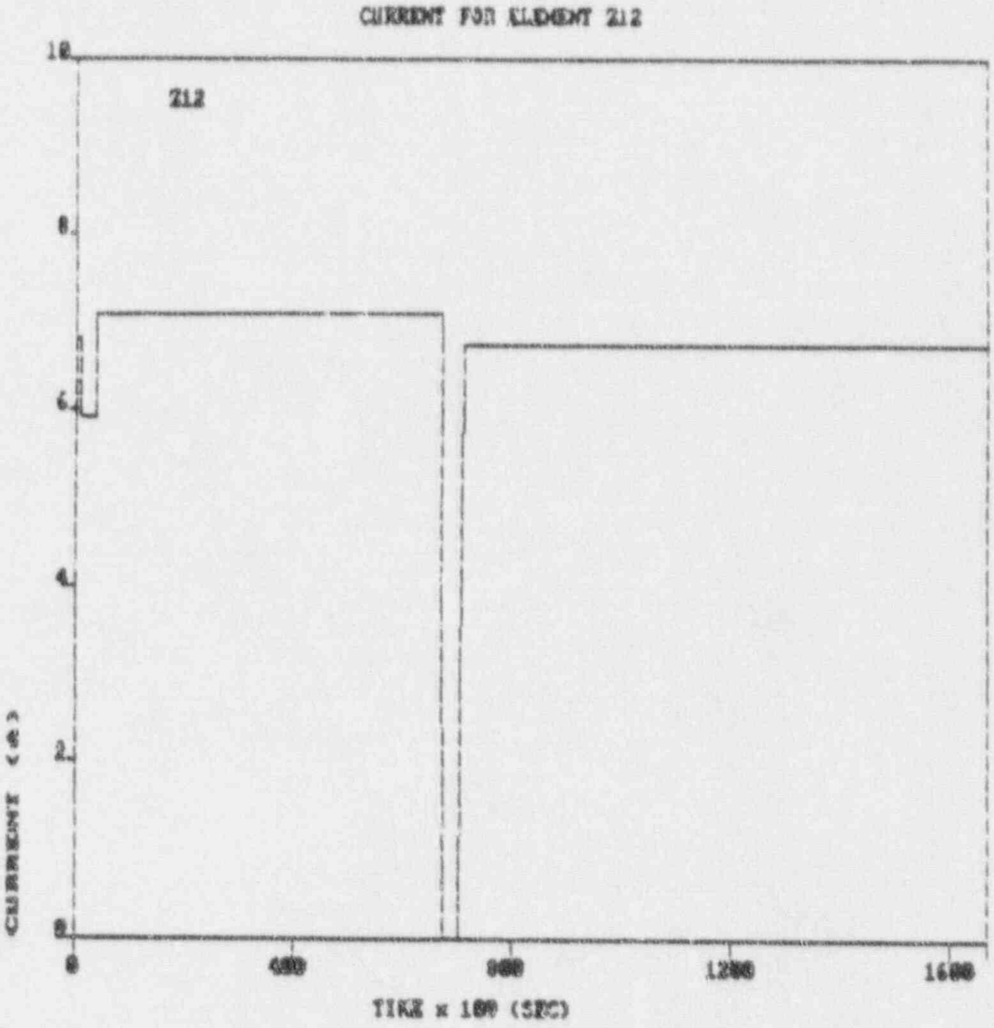

FIGURE VIII-63. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER Z12

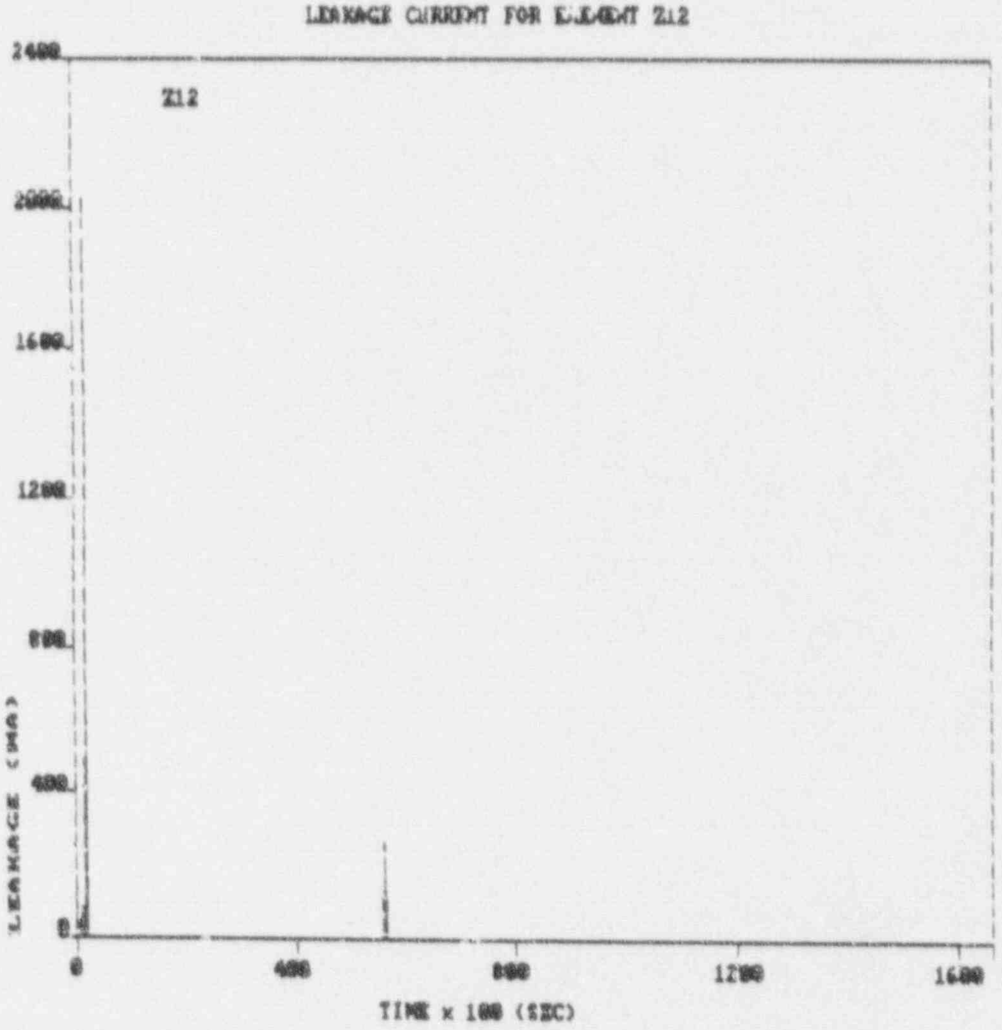

FIGURE VIII-54. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER Z12

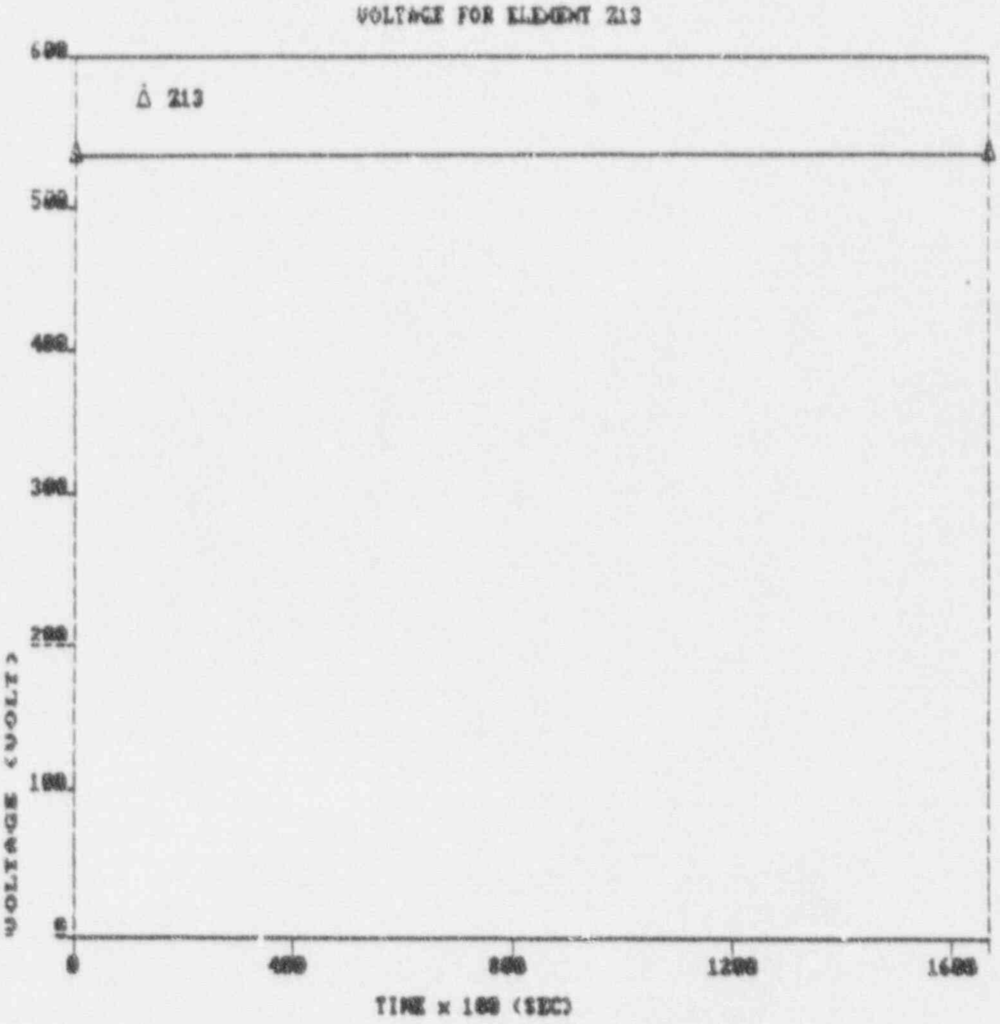

FIGURE VIII-65. VOLTAGE VERSUS TIME FOR SPECIMEN NUMBER Z13

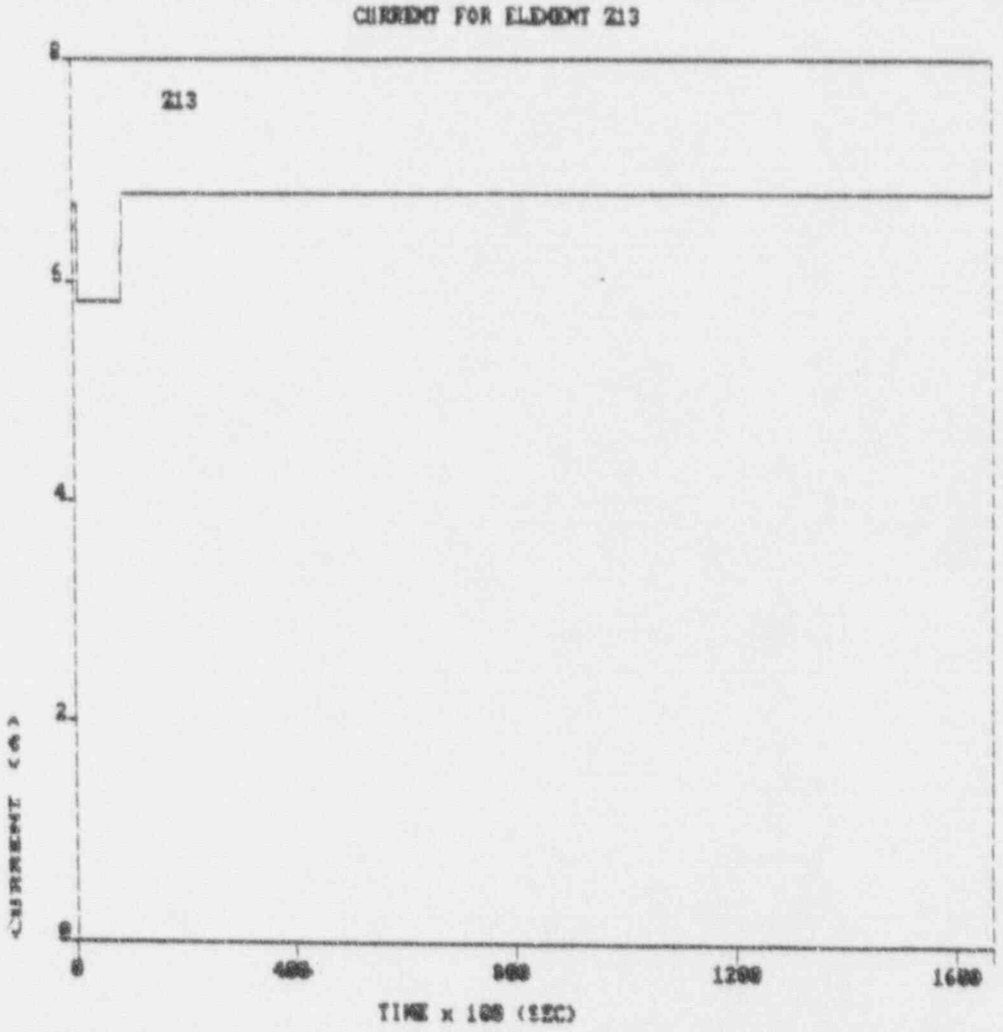

FIGURE VIII-66. LOAD CURRENT VERSUS TIME FOR SPECIMEN NUMBER Z13

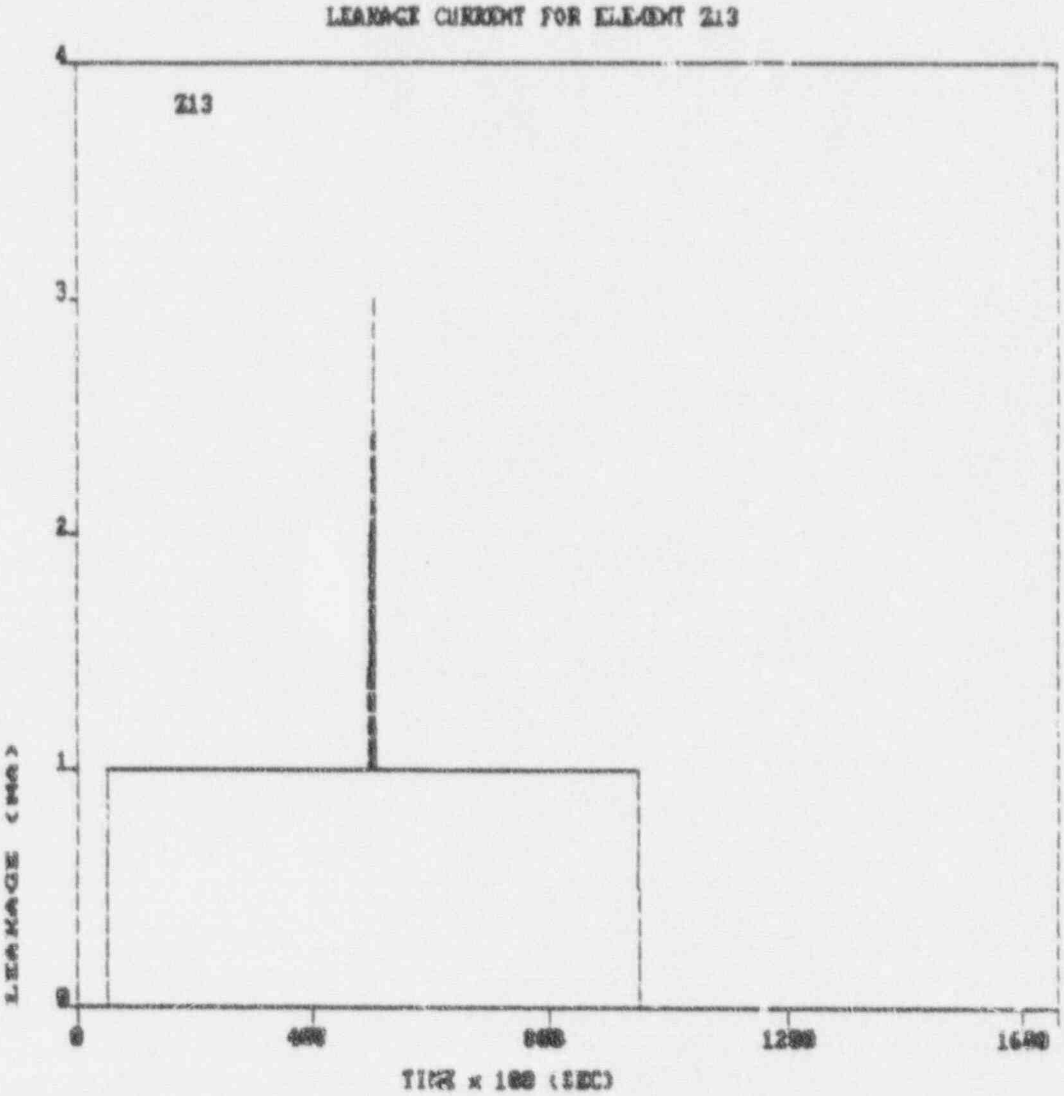

FIGURE VIII-67. LEAKAGE CURRENT TO GROUND VERSUS TIME FOR SPECIMEN NUMBER Z13

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APPENDIX VI

LOCA TROUBLESHOOTING DATA SHEET

DATA SHEET

WYLE LABORATORIES

Customer CECO

Specimen B4, Z11, Z12

Part No. VARIOUS

Spec. WLAP 17859

Para 3.3

S/N N/A

GSI NO

Amb. Temp. ≈85°F

Photo YES

Test Med. STEAM

Specimen Temp. 254°F

Job No. 17859

Report No. 17859

Start Date 9-19-86

Test Title LOCA TEST Troubleshooting

	IR	HIPOT
B4	<50kΩ @ 10VDC	>5000uA @ >0VAC
Z11	<50kΩ @10VDC	>5000 uA @ >0VAC
Z12	<50kΩ @10VDC	>5000 uA @ >0VAC

Tested By Date: 9/19/86

Witness None Date:

Sheet No. 1 of 1

Approved J Hazlett 9/19/86

Notice of Anomaly None

APPENDIX VII

CHEMICAL SPRAY CALCULATIONS

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CALCULATIONS FOR CHEMICAL SPRAY SOLUTION

GIVEN:

Solvent: 100 gallons of water

$Wt_{water\ 100\ gals}$ = 832.5 lbs

Solute:
- o 0.28 molar H_3BO_3 (3000 ppm Boron)
- o 0.064 molar $Na_2S_2O_3$ (Sodium Thiosulfate)
- o NaOH added for a pH of 10.5 at 77°F (about 0.59%)

Calculations:

1) Boron Requirements:

100 $gallons_{water}$ x 8.325 lbs/gal = 832.5 lbs of $solution_{water}$

3000 ppm = 0.003000

832.5 lbs x 0.003 = 2.4975 lbs
= 39.96 oz Boron

1 part Boron in 5.72 parts boric acid
39.96 oz_{Boron} x 5.72 = 228.57 oz
14 lbs 4.57 oz boric acid

2) Sodium Thiosulfate Requirements

Solute's Chemical Formula: $Na_2S_2O_3$

One mole of $Na_2S_2O_3$ =

2 x Na = 2 x 23
2 x S = 2 x 32
3 x 0 = 3 x 16
158_{MW}

100 gallons = 378.5 liters.

If

158 grams of $Na_2S_2O_3$ dissolved in one liter of water yields = 1 molar solution,

a 0.064 molar solution requires

158 grams (0.064) = 10.112 grams of $Na_2S_2O_3$ in 1 liter

since there is 378.5 liters in 100 gallons of water

$$10.112 \frac{\text{grams}}{\text{liter}} \cdot 378.5 \text{ liters} = 3827.392 \text{ grams per 100 gallons}$$

3827.392 gms = 8 lbs 203.39 gms

8 lbs 7.17 oz

Solution:

To 100 gallons of water add:

14 lbs 4.57 oz Boric Acid

8 lbs 7.17 oz Sodium Thiosulfate

and enough NaOH for a pH 10.5 at 77°F.

APPENDIX VIII

INSTRUMENTATION EQUIPMENT SHEETS

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INSTRUMENTATION EQUIPMENT SHEET

PAGE 1 OF 4

DATE 09/18/86 JOB NO. 17859-00 LOCATION LOCA"E"
TECHNICIAN R. ARCHER CUSTOMER CECO TYPE TEST LOCA

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE#	RANGE 1	ACCURACY 1	CALDTE	CALDUE
1	DATA SYS	DAYTRONICS	CM12	N/A	101936	MULT	MFG	06/24/86	06/24/87
2	PRINTERS	TEXAS INSTRUMNT	RO-800	93320	003009	PM	MFG	09/09/86	03/09/87
3	PRINTERS	TEXAS INSTRUMNT	810ro	0471194217	011777	PM	MFG	09/16/86	03/16/87
4	COMB STRAIN	VISHAY	2120	34325	000428	DC-50KHZ	5%F	09/03/86	12/03/86
5	PWR SUPPLY	VISHAY	2110	29261	096721	15VDC	1%REG	09/03/86	12/03/86
6	PH IND CONTR	GREAT LAKES	60	5595	000673	0-14PH	+-0.2%PH	04/25/86	10/25/86
7	GEN SIG	EXACT	340	1863911268-69	011251	1MSEC-99.900	+-0.01%	08/13/86	02/13/87
8	TEMP IND	DORIC	402A	106717	011831	-50+2552#F K	+-2.5#F	08/13/86	02/13/87
9	RECORD TEMP	HONEYWELL	45	8009283019001	092815	0-400#F T	+-.5%	07/07/86	10/07/86
10	PWR SUPPLY	SORENSON	28-4	343	098568	18-36VDC	+-.1% REG	06/04/86	12/04/86
11	CONTR TEMP	RESEARCH	61031	060155	094524	-175+375#F	.5%	09/13/86	03/13/87
12	TEMP ALARM	RESEARCH	61034	N/A	100311	-175+375#F	+-.5%	07/11/86	01/11/87
13	PRESS GAUGE	USG	N/A	N/A	102100	100PSI	+-1%	06/24/86	09/24/86
14	DIGITAL TEMP	FLUKE	2190A	208	094906	MULT	+-0.03%	07/10/86	10/10/86
15	CALIBR VOLT	FLUKE	Y2003	N/A	094907	10-100MV	+-.03%	07/10/86	10/10/86
16	DIG MTR	KEITHLEY	130	000167966	101030	DC	+-0.5%	05/20/86	05/20/87
17	PRESS XDUCER	B&H	4424	2108	101318	150PSIG	+-0.25%	08/01/86	02/01/87
18	PRESS XDUCER	STATHAM	PA418	2950	000509	1500 PSIA	+-2%FS	08/06/86	02/06/87
19	CONV FREQ	DAYTRONIC	3240	1058	102923	0-3VDC	+-0.05%	07/08/86	01/08/87
20	FLOW MTR	FLOW TECH	1/2	860825	096756	.5 IN 5 GPM	1%	11/11/85	05/11/86
21	XFORMER	WESTON	461	16130	003023	1000 AMPS	+-1%	04/04/86	10/04/86
22	XFORMER	WESTON	461	13132	003022	1000 AMPS	+-1%	08/22/86	02/22/87
23	XFORMER	WESTON	461	17795	102377	800/5 RATIO	+-1%	06/20/86	12/20/86
24	XFORMER	WESTON	461	16130	100561	800/5 RATIO	+-1%	06/20/86	09/20/86
25	XFORMER	WESTON	461	17735	102378	800/5 RATIO	+-1%	06/20/86	12/20/86
26	XFORMER	WESTON	461T-1	14981	097427	1000 AMPS	+-1%	04/03/86	10/03/86
27	XFORMER	WESTON	461	18435	102379	800/5 RATIO	+-1%	06/20/86	12/20/86
28	CURRENT XFORMER	WESTON	461	18756	103149	.5-50AMPS	.25%	08/29/86	03/02/87
29	XFORMER	BROWNELL	58FT	N/A	100668	100:5 AMP	+-2%	07/10/86	01/10/87
30	XFORMER	WESTON	461	24979	097428	1000 AMPS	+-1%	04/03/86	10/03/86

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES, WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION 9-18-86

CHECKED & RECEIVED BY J. Hyatt 9/18/86

Q.A. 9/18/86

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INSTRUMENTATION EQUIPMENT SHEET

PAGE 2 OF 4

DATE 09/18/86 JOB NO. 17859-00 LOCATION LOCA"E"
TECHNICIAN R. ARCHER CUSTOMER CECO TYPE TEST LOCA

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE#	RANGE 1	ACCURACY 1	CALDTE	CALDUE
31	XFORMER	BROWNELL	55FT	N/A	100673	100:5 AMP	+-2%	07/10/86	01/10/87
32	CURRENT XFMORER	WESTON	461	25679	103148	.5-50AMPS	.25%	08/29/86	03/02/87
33	XFORMER	BROWNELL	55FT	N/A	100674	100:5 AMP	+-2%	07/10/86	01/10/87
34	CURRENT XFORMER	WESTON	461	7963	103145	0-100AMPS	.25%	08/29/86	03/02/87
35	XFORMER	BROWNELL	55FT	N/A	100021	100/5 AMP	+-10%	06/05/86	12/05/86
36	CURRENT XFMORER	WESTON	461	22869	103147	.5-50AMPS	.25%	08/19/86	03/02/87
37	CURRENT XFMORER	WESTON	461	22870	103146	.5-50AMPS	.25%	08/19/86	03/02/87
38	XFORMER	BROWNELL	55FT	N/A	100022	100:5 AMP	+-2%	07/10/86	01/10/87
39	XFORMER CURR.	WESTON	461-1	15187	103105	2.5KV/5VA	+-1%	04/17/86	10/07/86
40	XFORMER	BROWNELL	55FT	N/A	100657	100:5 AMP	+-2%	07/10/86	01/10/87
41	XFORMER	BROWNELL	55FT	N/A	100671	100/5AMP	+-10%	06/05/86	12/05/86
42	XFORMER	BROWNELL	55FT	N/A	100670	100/5AMP	+-10%	06/05/86	12/05/86
43	XFORMER	BROWNELL	55FT	N/A	100663	100:5 AMP	+-2%	07/10/86	01/10/87
44	XFORMER	BROWNELL	55FT	N/A	100024	100/5 AMP	+-10%	06/05/86	12/05/86
45	XFORMER	BROWNELL	55FT	N/A	100021	100/5 AMP	+-10%	06/05/86	12/05/86
46	XFORMER	WESTON	327	980	011741	1200/5 RATIO	+- 1%	07/09/86	01/09/87
47	XFORMER	BROWNELL	55FT	N/A	100653	100:5 AMP	+-2%	07/10/86	01/10/87
48	XFORMER	WESTON	327	1012	011740	1200/5 RATIO	+-1%	07/09/86	01/09/87
49	XFORMER	BROWNELL	55FT	N/A	100675	100/5AMP	+-10%	06/05/86	12/05/86
50	XFORMER	BROWNELL	55FT	N/A	102783	100/5 AMP	3%	09/09/86	03/09/87
51	XFORMER	BROWNELL	55FT101	N/A	100636	100/5AMP	3%	09/09/86	03/09/87
52	DIG MTR	FLUKE	77	39180645	103023	DC	+-0.3%	02/06/86	02/06/87
53	DIG MTR	FLUKE	77	24069343	101824	AC	2%	07/29/86	01/29/87
54	PRESS XMITTER	ELECT. TRANS	PX114	N/A	102665	100PSIG	+-0.5%	06/27/86	12/27/86
55	PRESS XMITTER	OMEGA	PX114	N/A	102666	0-100PSIG	+-0.5%	06/27/86	12/27/86
56	PRESS GAUGE	USG	N/A	N/A	100815	0-200 PSI	+-1%	06/24/86	09/24/86
57	ACTION PAK	ACTION INSTR	6010	N/A	101891	500MV 10V	.5%S	04/11/86	10/11/86
58	ACTION PAK	ACTION INSTR	6010	N/A	101911	500MV AC	.5%S	07/11/86	01/11/87
59	ACTION PAK	ACTION INSTR	6010	N/A	101913	500MV AC	.5%S	07/11/86	01/11/87
60	ACTION PAK	ACTION INSTR	6010	N/A	101906	500MV AC	.5%S	07/11/86	01/11/87

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PAGE 3 OF 4

DATE 09/18/86 JOB NO. 17859-00 LOCATION LOCA"E"
TECHNICIAN R. ARCHER CUSTOMER CECO TYPE TEST LOCA

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE#	RANGE 1	ACCURACY 1	CALDTE	CALDUE
61	ACTION PAK	ACTION INSTR	6010	N/A	101900	500MV 10V	.5%S	03/26/86	09/26/86
62	ACTION PAK	ACTION INSTR	6020	111614	100915	0-5AMP AC	.5%S	07/11/86	01/11/87
63	ACTION PAK	ACTION INSTR	6020	101862	100989	0-5AMP AC	.5%S	06/23/86	12/23/86
64	ACTION PAK	ACTION INSTR	6020	101861	100988	0-5AMP AC	.5%LIN	06/23/86	12/23/86
65	ACTION PAK	ACTION INSTR	6020	101863	100990	0-5AMP AC	.5%LIN	06/23/86	12/23/86
66	ACTION PAK	ACTION INSTR	6010	N/A	101905	500MV 10V	.5%S	09/12/86	03/12/87
67	ACTION PAK	ACTION INSTR	6010	N/A	101910	0-240VAC	.5%S	09/12/86	03/12/87
68	ACTION PAK	ACTION INSTR	6010	N/A	101892	240VAC/5V	.5%S	09/12/86	03/12/87
69	ACTION PAK	ACTION INSTR	6010	101313	100991	240V 5V	.5%S	09/12/86	03/12/87
70	ACTION PAK	ACTION INSTR	6010	N/A	101895	240 VAC	.5%S	07/11/86	01/11/87
71	ACTION PAK	ACTION INSTR	6010	10[illegible]12	100992	240 VAC	.5%S	07/11/86	01/11/87
72	ACTION PAK	ACTION INSTR	6010	N/A	101904	240 VAC	.5%S	07/11/86	01/11/87
73	ACTION PAK	ACTION INSTR	6010	7923	100917	240V 5V	.5%S	04/11/86	10/11/86
74	ACTION PAK	ACTION INSTR	6010	26	100918	240 VAC	.5%S	07/11/86	01/11/87
75	ACTION PAK	ACTION INSTR	6010	N/A	101903	500MV 10V	.5%S	05/20/86	11/20/86
76	ACTION PAK	ACTION INSTR	6010	N/A	1016[illegible]	500MV 10V	.5%S	04/11/86	10/11/86
77	ACTION PAK	ACTION INSTR	6010	N/A	101897	500MV 10V	.5%S	05/20/86	11/20/86
78	ACTION PAK	ACTION INSTR	6010	N/A	101901	500MV 10V	.5%S	04/11/86	10/11/86
79	ACTION PAK	ACTION INSTR	6010	N/A	101902	500MV AC	.5%S	07/11/86	01/11/87
80	ACTION PAK	ACTION INSTR	6010	N/A	101894	500MVDC/10V	.5%S	05/20/86	11/20/86
81	ACTION PAK	ACTION INSTR	6010	N/A	101907	500MV AC	.5%S	07/11/86	01/11/87
82	ACTION PAK	ACTION INSTR	6010	N/A	101912	500MV AC	.5%S	07/11/86	01/11/87
83	ACTION PAK	ACTION INSTR	6010	N/A	003764	500 MV	.5%S	07/11/86	01/11/87
84	ACTION PAK	ACTION INSTR	6010	A50754	100916	240 VAC	.5%S	07/11/86	01/11/87
85	ACTION PAK	ACTION INSTR	6010	N/A	101899	0-240 VAC	.5%S	07/11/86	01/11/87
86	ACTION PAK	ACTION INSTR	6010	N/A	101915	240 VAC	.5%S	07/11/86	01/11/87
87	ACTION PAK	ACTION INSTR	6010	N/A	101908	240 VAC	.5%S	07/11/86	01/11/87
88	ACTION PAK	ACTION INSTR	6010	N/A	101890	240 VAC	.5%S	07/11/86	01/11/87
89	ACTION PAK	ACTION INSTR	6010	N/A	101888	240 VAC	.5%S	07/11/86	01/11/87
90	ACTION PAK	ACTION INSTR	6010	N/A	101909	240 VAC	.5%S	07/11/86	01/11/87

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Wyle
A

INSTRUMENTATION EQUIPMENT SHEET

PAGE 4 OF 4

DATE 09/18/86 JOB NO. 17859-00 LOCATION LOCA"E"
TECHNICIAN R. ARCHER CUSTOMER CECO TYPE TEST LOCA

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE#	RANGE 1	ACCURACY 1	CALDTE	CALDUE
91	ACTION PAK	ACTION INSTR	6010	A50754	101914	240 VAC	.5%S	07/11/86	01/11/87
92	ACTION PAK	ACTION INSTR	6010	N/A	101898	240V 5V	.5%S	04/11/86	10/11/86
93	DIG MTR	KEITHLEY	130A	193257	100863	DC	+-0.25%	06/24/86	12/24/86
94	XFORMER	BROWNELL	58FT	N/A	100654	100:5 AMP	+-2%	07/10/86	01/10/87
95	DATALOGGER	FLUKE	2240B	2675019	000343	K&T1.3DEG	.02%RD	09/09/86	03/09/87
96	PWR SUPPLY	SORENSON	DRC150	980	000862	200VDC/15A	+-0.1%REG	06/17/86	12/17/86
97	PWR SUPPLY	SORENSEN DCR	150-5	110	011309	150VDC	+-.1%REG	04/03/86	10/03/86
98	PRESS GAUGE	HELICOLD	316	N/A	100713	0-100 PSI	1%	09/03/86	12/03/86
99	PRESS GAUGE	USG	100	N/A	003186	100PSI	+-0.1%	07/08/86	01/08/87
100	DIG MTR	FLUKE	8020A	2580317	100035	0-1000 VDC	.1%	08/06/86	08/06/87
101	RES DECADE	CLAROSTAT	2400	19365	011422	0-999.999 OHMS	2%	06/25/86	06/25/87
102	XFORMER	BROWNELL	58FT101	N/A	100658	100/5AMP	3%	09/09/86	03/09/87
103	XFORMER	BROWNELL	58FT101	N/A	100665	100/5AMP	3%	09/09/86	03/09/87
104	DIG MTR	FLUKE	8804	3150017	[illegible]	0-1000VDC	+-0.1%	01/30/86	01/30/87
105	DIG MTR	FLUKE	77	35505847	[illegible]		+-0.3%	09/15/86	09/15/87

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Q.A. RSBalis 9-18-86

POST-ACCIDENT (LOCA) FUNCTIONAL TESTS

SECTION IX

POST-ACCIDENT (LOCA) FUNCTIONAL TESTS

1.0 REQUIREMENTS

Insulation Resistance measurements were taken for informational purposes only.

2.0 PROCEDURES

The test specimens were subjected to the testing per Paragraph 2.3 of Section I.

3.0 RESULTS

The test specimens were subjected to the Insulation Resistance Test of Paragraph 2.0 which met the requirements of Paragraph 1.0.

Specimens Z11, Z12 and B4 were checked to find locations of a possible short circuit. On specimens Z11 and Z12 the specimen shorted to the tray (or NEMA 12 enclosure) at a point close to where a tie wrap was attached to the cable to either hold the cable in the tray or hold a specimen tag to the cable (See Photographs IX-1 and IX-11). Thus, the point of failure was in the high temperature wire leads and not in the splice itself. The successful performance of Kerite splice specimens Z7 and Z13 (attached to different cable insulations) can be used to qualify the splice alone.

Specimen B4 apparently arced at the crotch of the splice to the NEMA 12 enclosure. This specimen had visual evidence of chemical burns from the chemical spray which apparently concentrated on the bottom ledge of the enclosure. It is not known why this specimen failed the test and two other similar splices (specimens B5 and B6), in the same enclosure, passed.

The observations during the Post-Accident Test Visual Inspection showed that several splice specimens cracked during the test program. The outer layer of tape cracked on all Kerite splice specimens (specimens Z7, Z11, Z12 and Z13) and on all Okonite Tape Splice specimens (specimens B4, B5, B6 and B7). All of these cracks were on the outer jacketing layer only and did not appear to affect the inner layers of tape. No evidence of arcing or insulation breakdown was evident at the splice (except for specimen B4 as noted above) on these specimens. Raychem splice specimens B1 and B3 developed cracks in the center of the outer sleeve layer. Although bare metal was visible through these cracks, there was no evidence of arcing or insulation damage. The electrical data, collected during the LOCA test, did not show a loss of electrical integrity. It is not evident whether the cracks in these specimens occurred due to additional shrinkage of the Raychem sleeve during the LOCA test or due to the thermal shock to the specimens after the LOCA test was completed.

3.0 RESULTS (Continued)

The data from this test is presented in Appendices I through IV as noted below.

- Appendix I contains Photographs IX-1 through IX-19 which show the specimens after the LOCA test.
- Appendix II contains the Insulation Resistance Test Data Sheets.
- Appendix III contains the post-LOCA test Visual Inspection Data Sheets which document the post-test specimen conditions.
- Appendix IV contains the Instrumentation Equipment Sheet which lists the equipment used to collect data.

APPENDIX I

PHOTOGRAPHS

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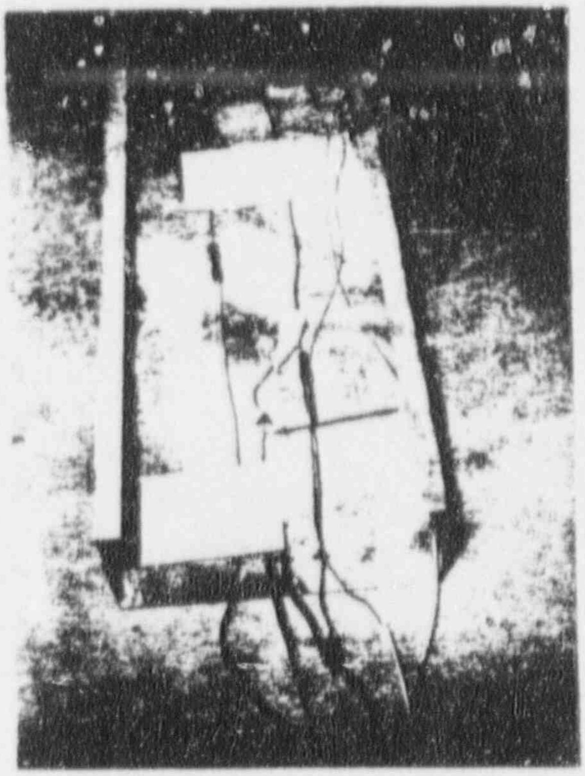
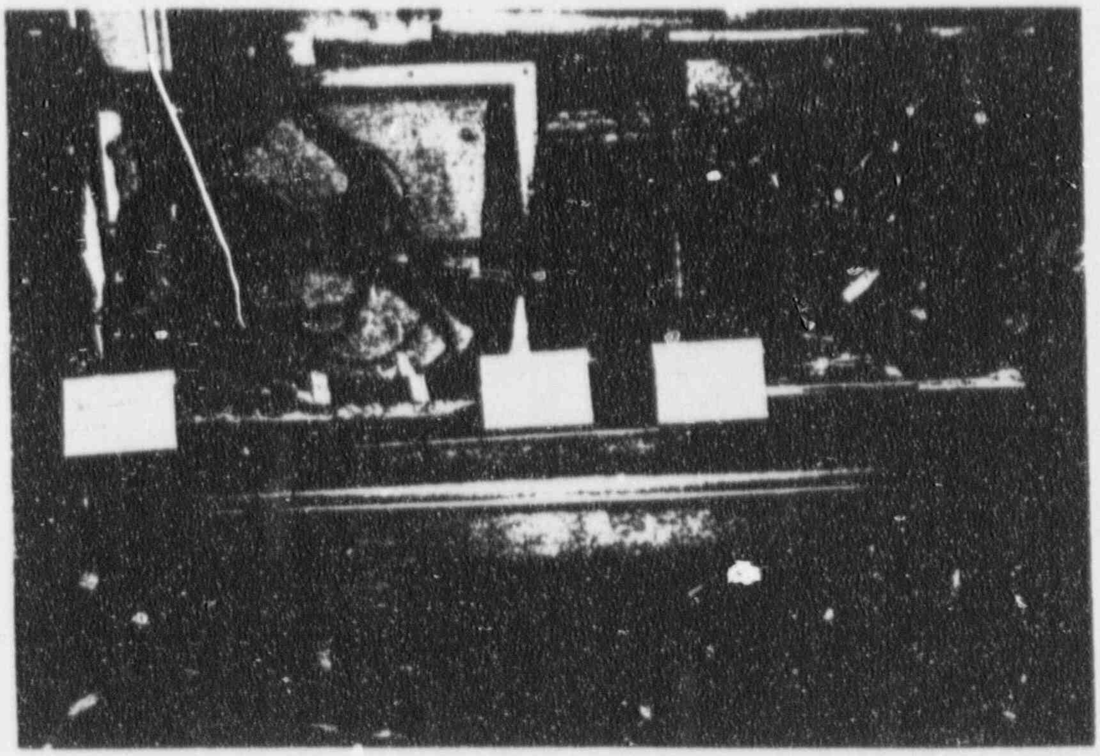


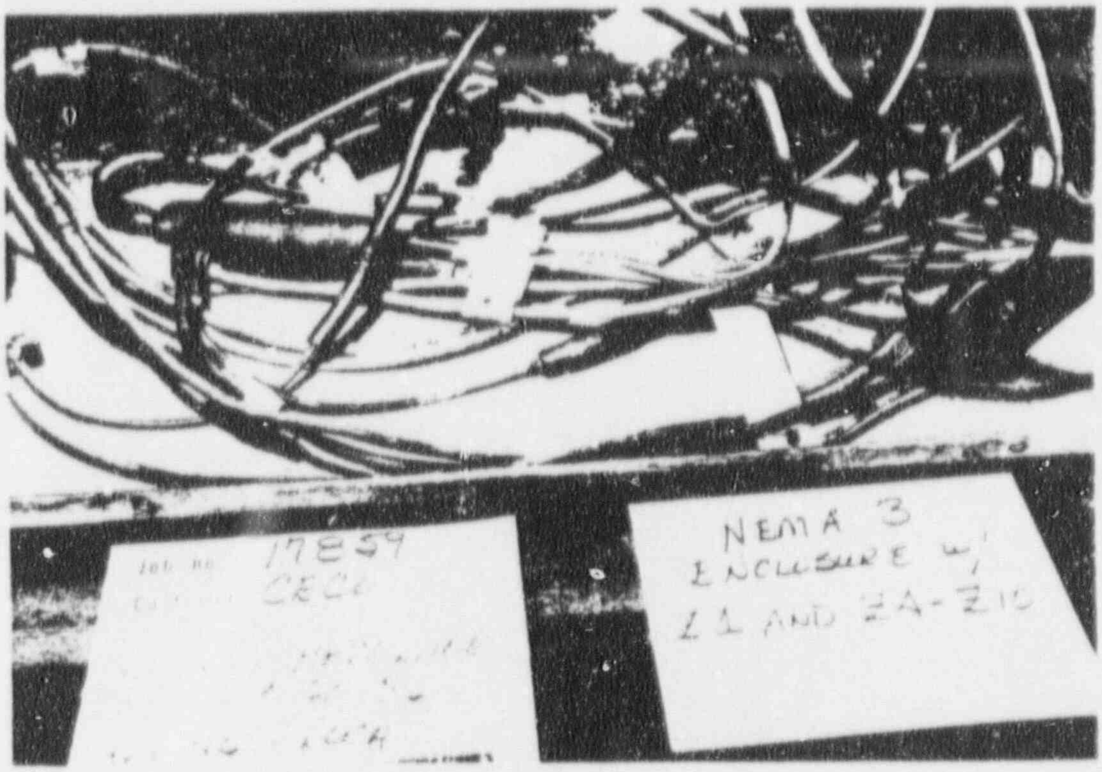
PHOTOGRAPH NO. IX-1

POST-LOCA VIEW OF SPECIMENS Z2, Z3 AND Z11 IN CABLE TRAY. SHORT CIRCUIT LOCATION ON Z11 IS SHOWN BY THE ARROW.



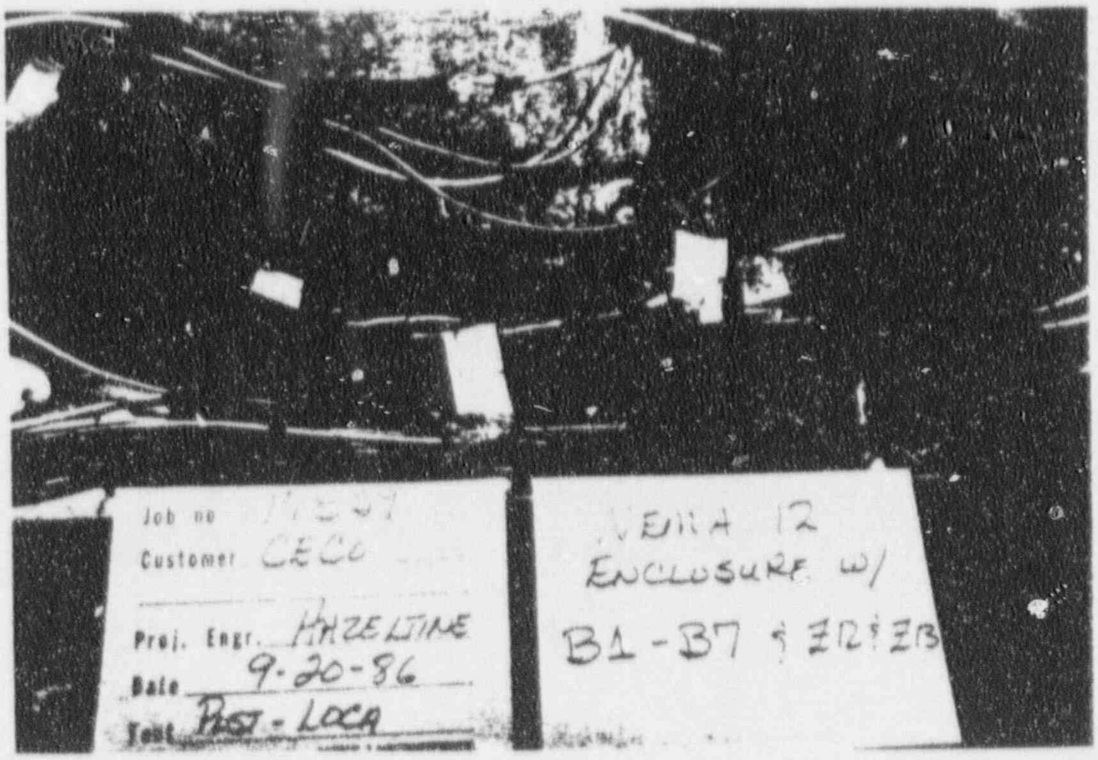
PHOTOGRAPH NO. IX-2

OVERALL VIEW OF THE CONDITIONS INSIDE THE NEMA 12 AND NEMA 3 ENCLOSURES AFTER THE LOCA TEST



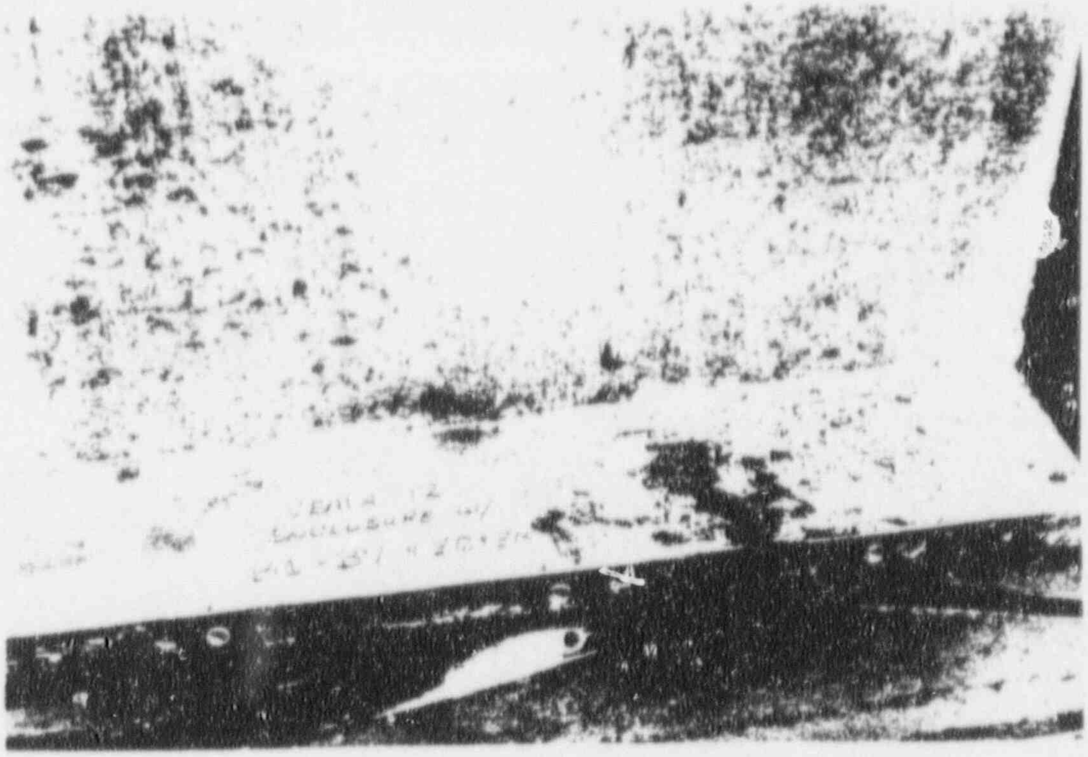
PHOTOGRAPH NO. IX-3

CLOSE-UP VIEW OF THE BOTTOM LEDGE OF
THE NEMA 3 ENCLOSURE



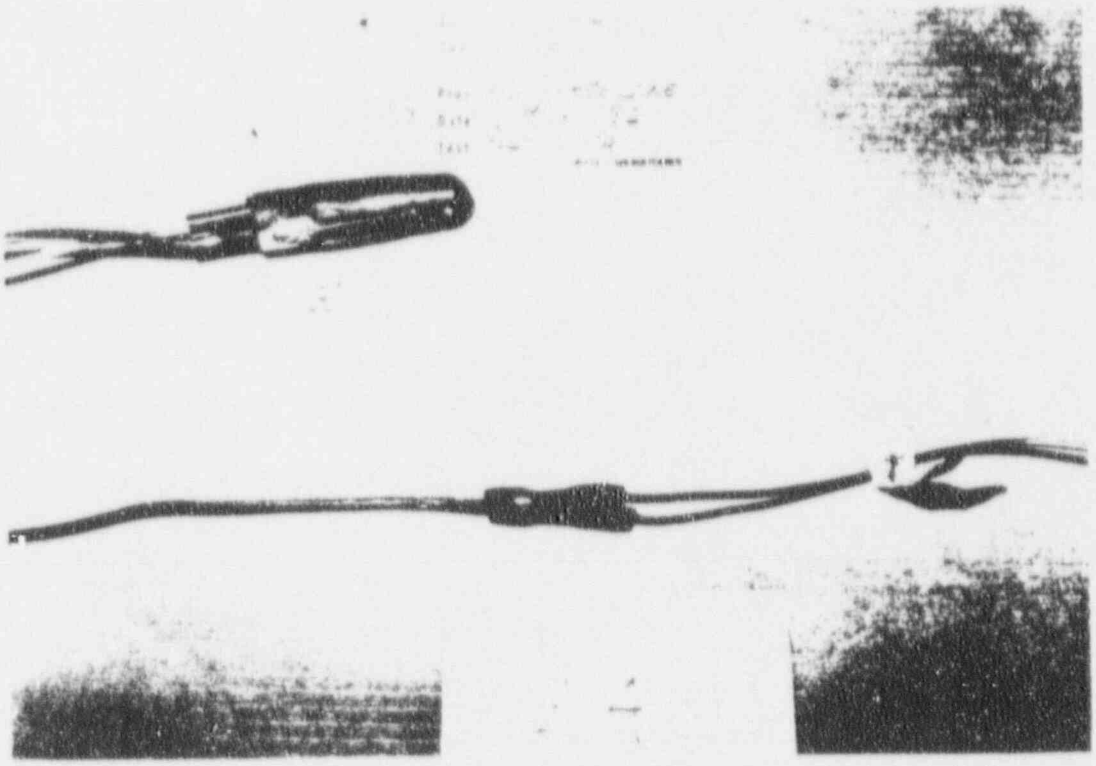
PHOTOGRAPH NO. IX-4

CLOSE-UP VIEW OF THE BOTTOM LEDGE OF
THE NEMA 12 ENCLOSURE



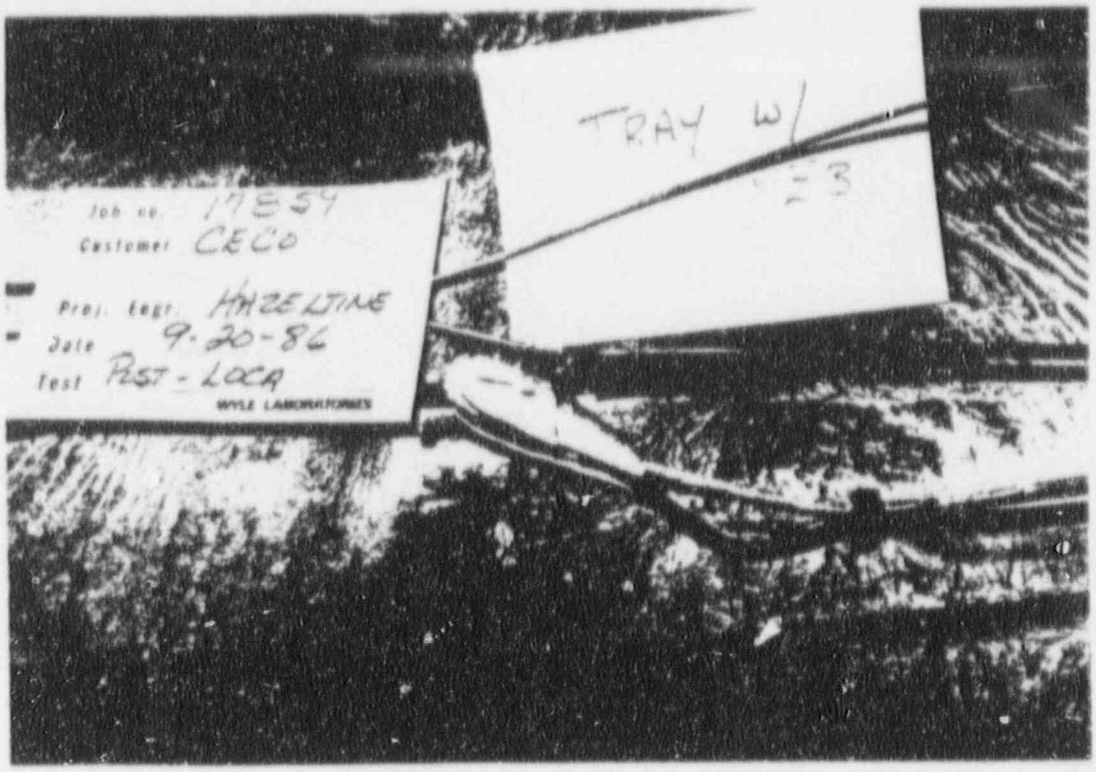
PHOTOGRAPH NO. IX-5

VIEW OF THE BOTTOM LEDGE OF THE NEMA 12 ENCLOSURE AFTER THE SPECIMENS WERE REMOVED



PHOTOGRAPH NO. IX-6

POST-TEST CLOSE-UP VIEW OF SPECIMENS Z1 AND Z4

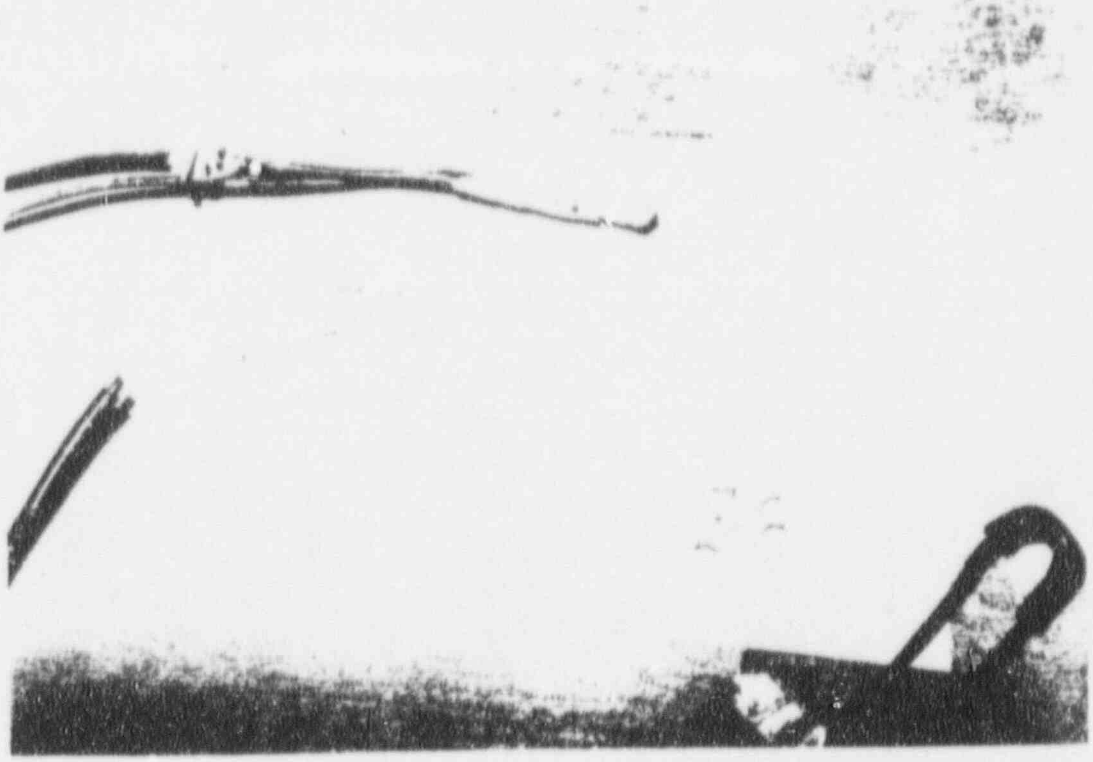


PHOTOGRAPH NO. IX-7

POST-TEST CLOSE-UP VIEW OF SPECIMENS Z2, Z3 AND Z11.
NOTE THE CRACKED OUTER TAPE ON Z11.

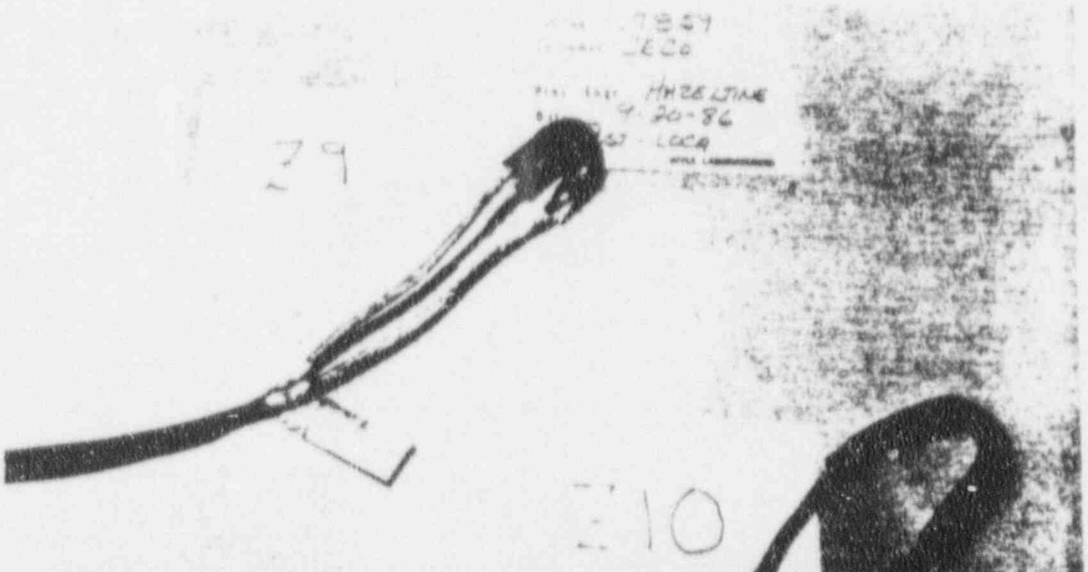
PHOTOGRAPH NO. IX-8

POST-TEST CLOSE-UP VIEW OF SPECIMENS Z5 AND Z6



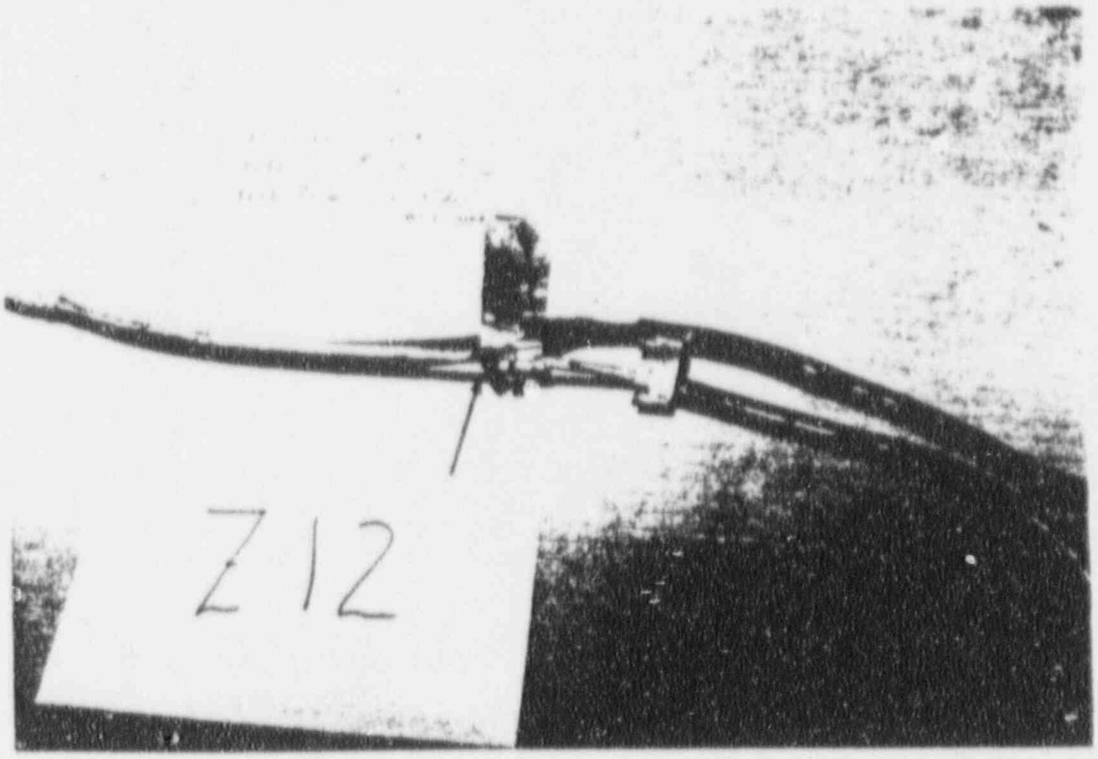
PHOTOGRAPH NO. IX-9

POST-TEST CLOSE-UP VIEW OF SPECIMENS Z7 AND Z8.
NOTE THE CRACKED OUTER TAPE ON Z7.



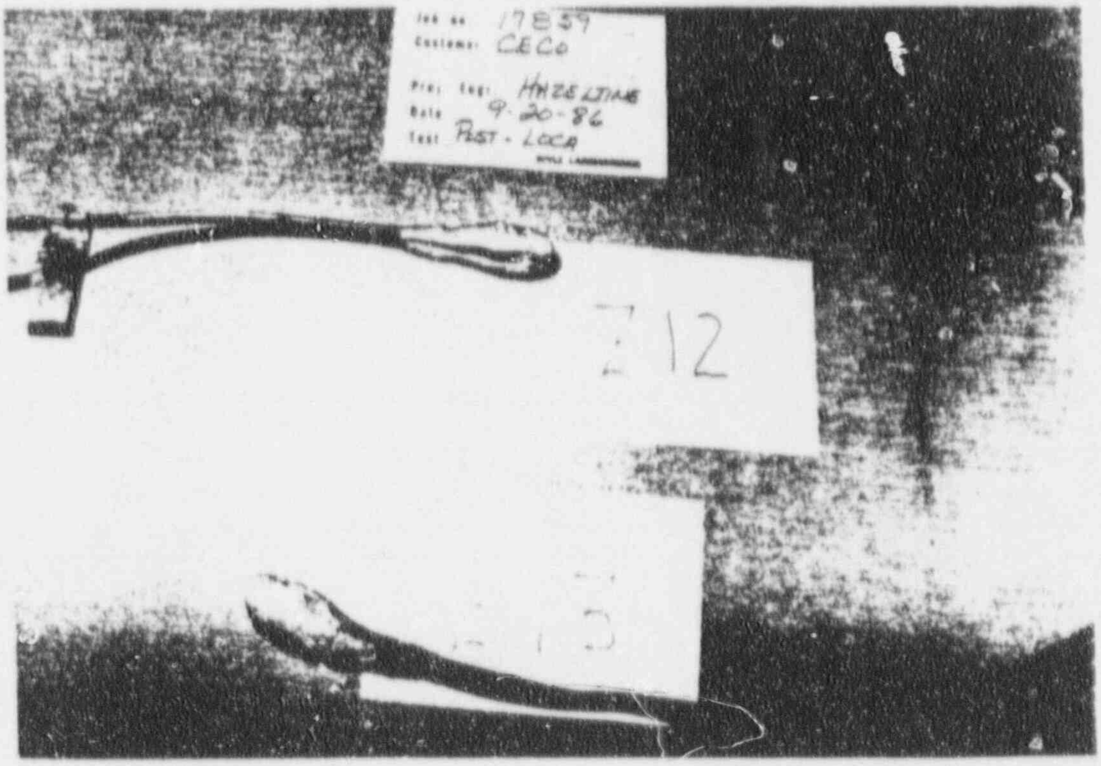
PHOTOGRAPH NO. IX-10

POST-TEST CLOSE-UP VIEW OF SPECIMENS Z9 AND Z10



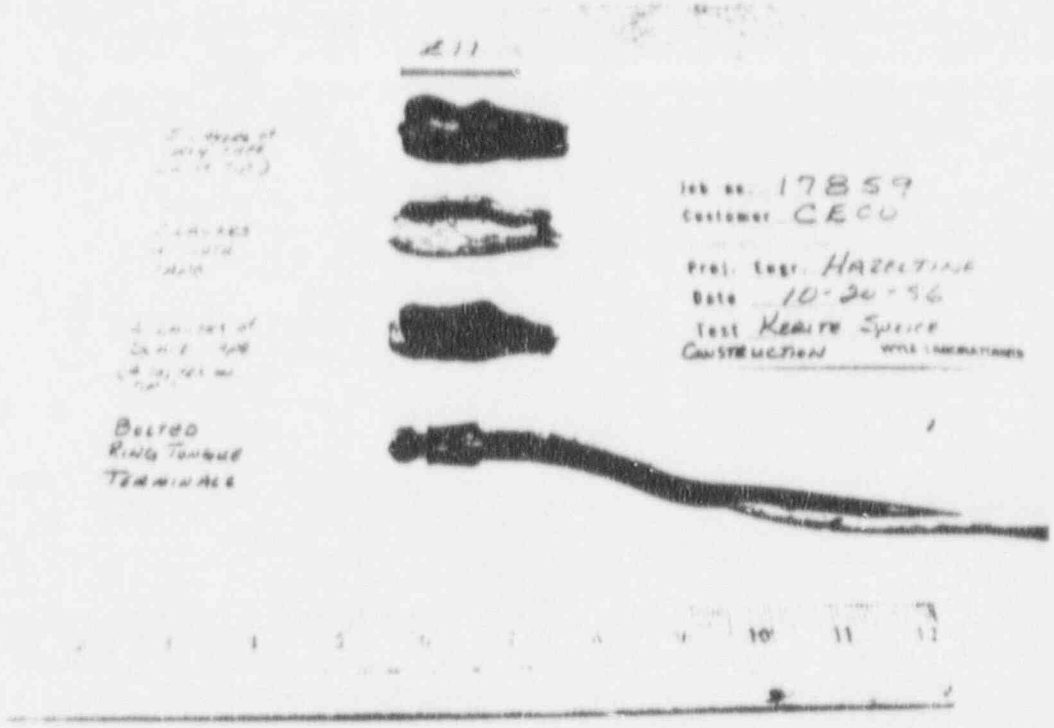
PHOTOGRAPH NO. IX-11

POST-TEST CLOSE-UP VIEW OF SPECIMEN Z12
SHOWING LOCATION OF SHORT CIRCUIT



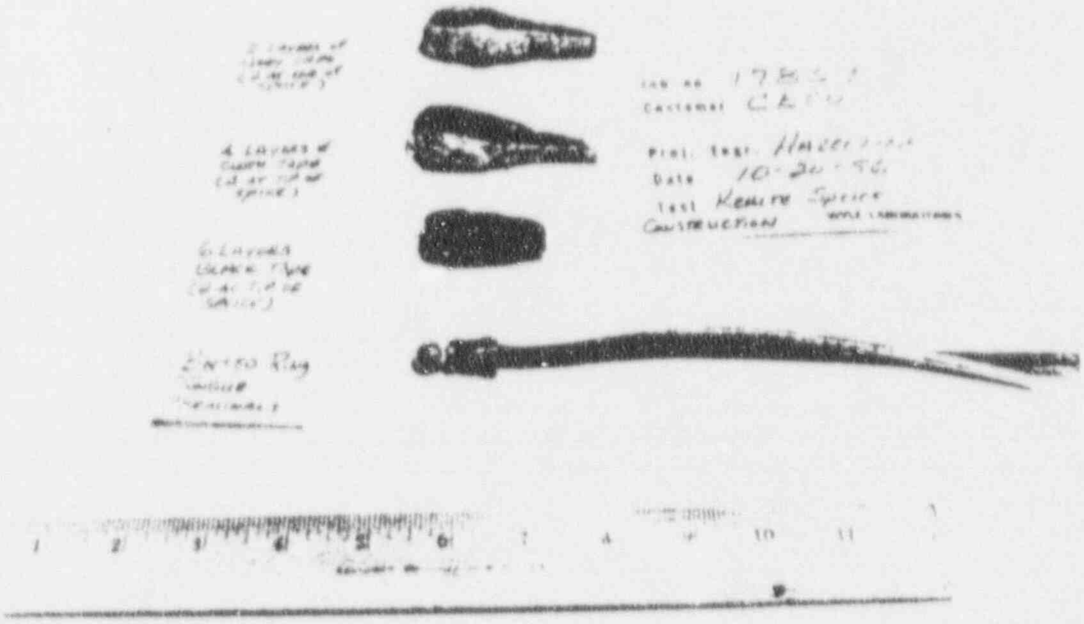
PHOTOGRAPH NO. IX-12

POST-TEST CLOSE-UP VIEW OF SPECIMENS Z12 AND Z13.
NOTE THE CRACKING IN THE OUTER TAPE ON BOTH KERITE SPLICES.



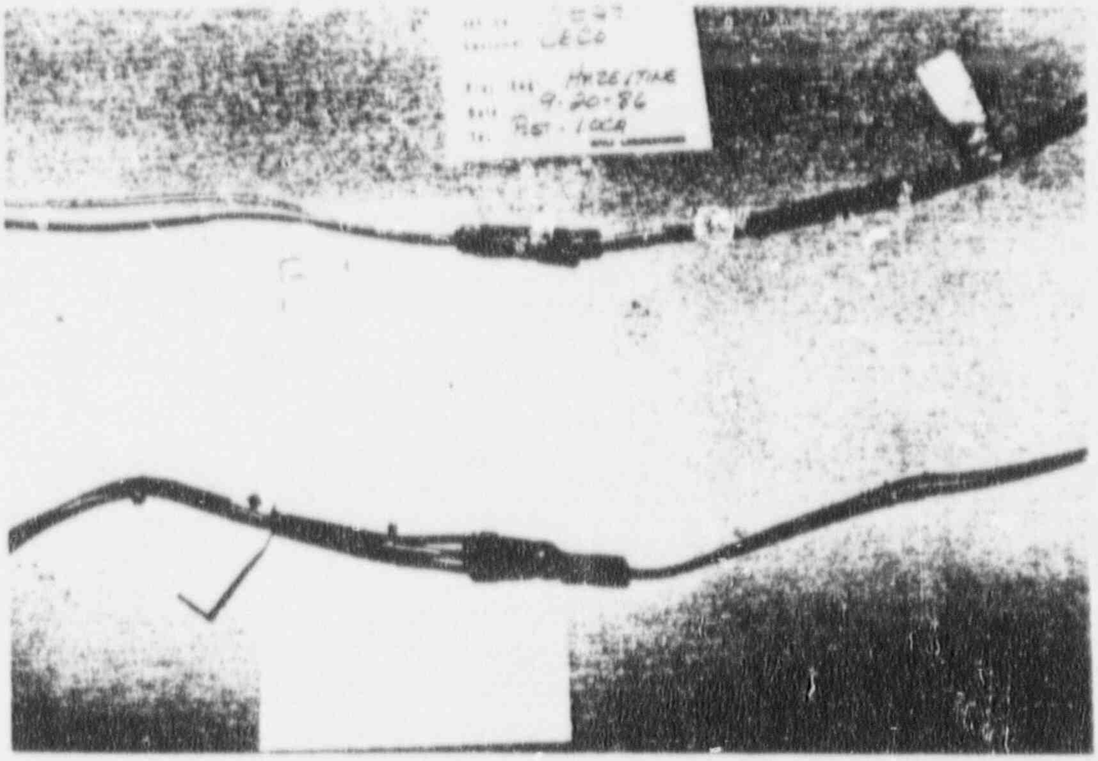
PHOTOGRAPH NO. IX-13

POST-TEST VIEW OF SPECIMEN Z11 DISASSEMBLED FOR INSPECTION



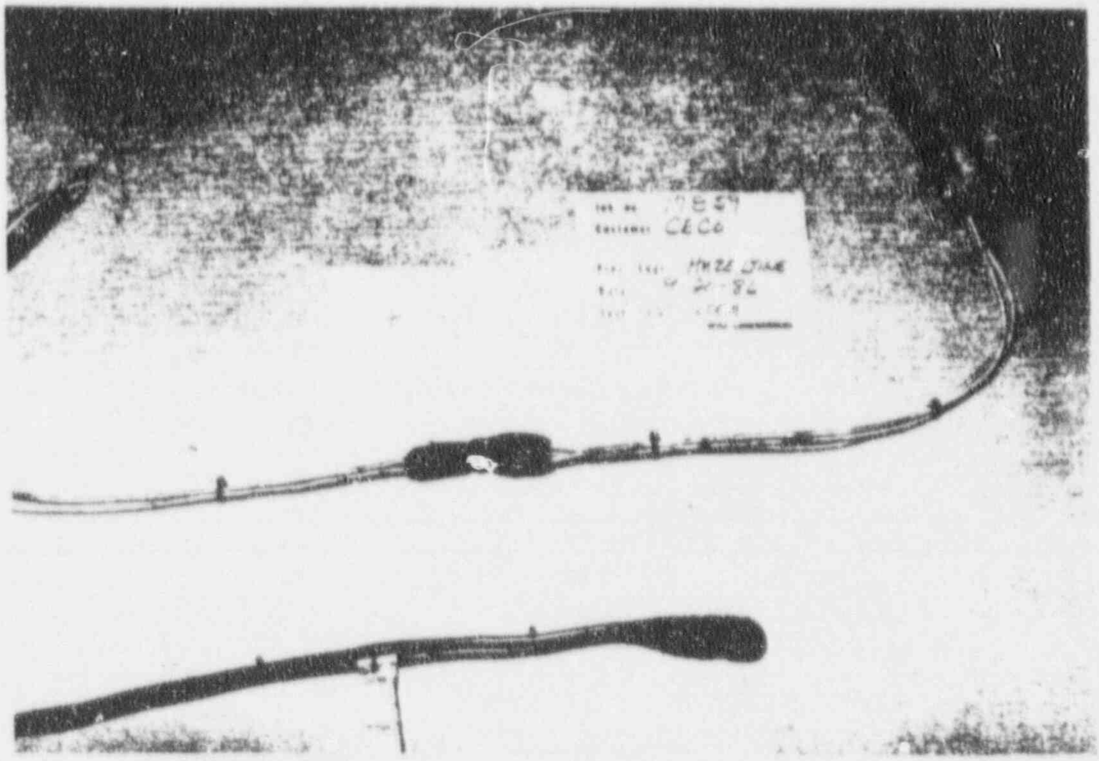
PHOTOGRAPH NO. IX-14

POST-TEST VIEW OF SPECIMEN Z12 DISASSEMBLED FOR INSPECTION



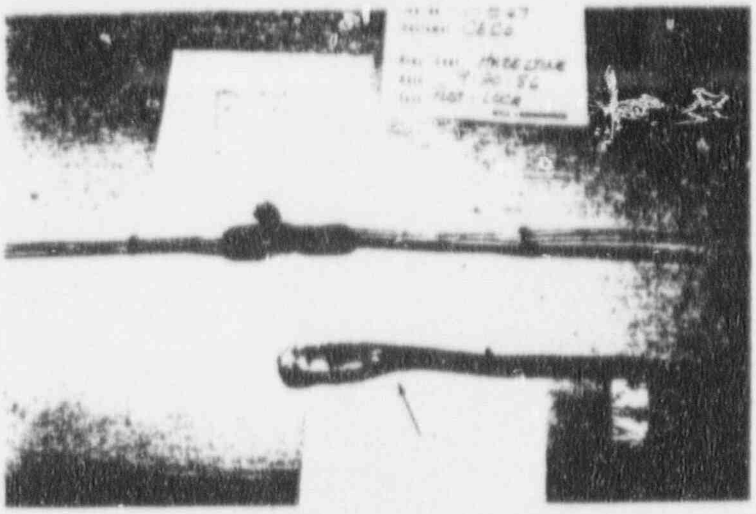
PHOTOGRAPH NO. IX-15

POST-TEST CLOSE-UP VIEW OF SPECIMENS B1 AND B2.
NOTE THE SPLIT RAYCHEM SLEEVE ON SPECIMEN B1.
THIS SPECIMEN DID SHORT DURING THE LOCA TEST.



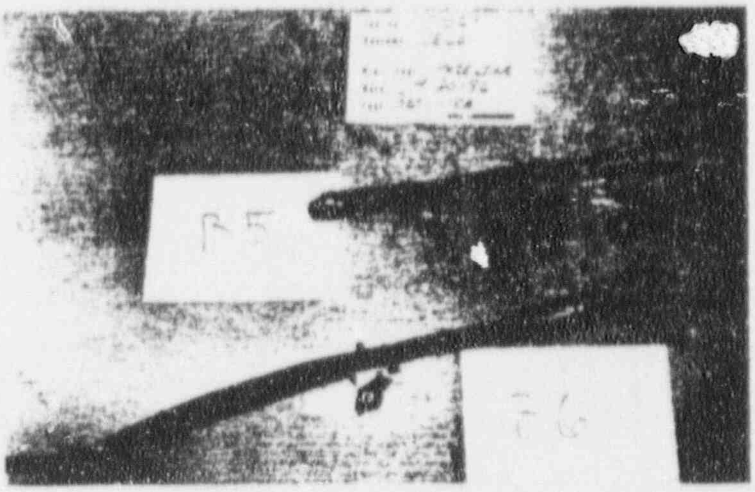
PHOTOGRAPH NO. IX-16

POST-TEST CLOSE-UP VIEW OF SPECIMENS B3 AND B4.
NOTE CRACKS IN BOTH SPECIMENS.
CRACKS WERE IN THE OUTER SLEEVE/TAPE LAYER ONLY.



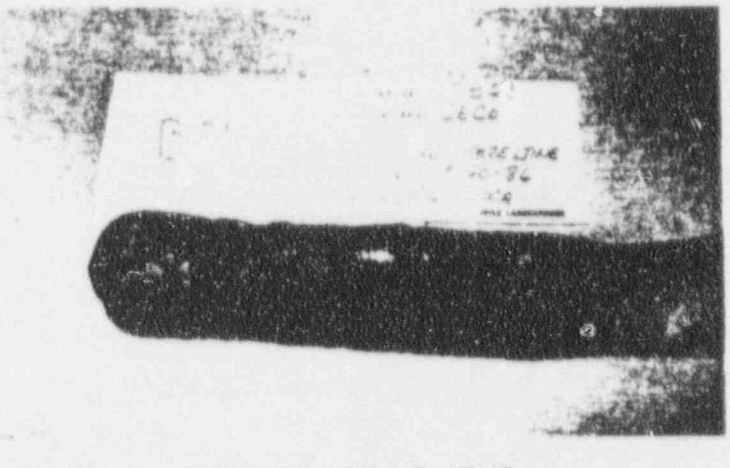
PHOTOGRAPH NO. IX-17

POST-TEST CLOSE-UP VIEW OF SPECIMENS B3 AND B4.
ARROW NOTES THE LOCATION OF THE FAILURE ON SPECIMEN B4.
THE OUTER LAYER ON SPECIMEN B3 WAS REMOVED TO CHECK FOR VISUAL
EVIDENCE OF ARCING. NO SUCH EVIDENCE WAS FOUND.



PHOTOGRAPH NO. IX-18

POST-TEST CLOSE-UP VIEW OF SPECIMENS B5 AND B6



PHOTOGRAPH NO. IX-19

POST-TEST CLOSE-UP VIEW OF SPECIMEN B7.
VERY SMALL RADIAL CRACKS WERE EVIDENT BUT ARE NOT
VISIBLE IN THIS PHOTOGRAPH.

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APPENDIX II

DATA SHEETS

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DATA SHEET

WYLE LABORATORIES

Customer CECo
Specimen Cables and Splices
Part No. Various
Spec. WLQP 17859-01
Para. 3.1.3
S/N N/A
GSI No

Amb. Temp. 76°F
Photo YES
Test Med. Air
Specimen Temp. ~~Ambient~~ 205°F

Job No. 17859
Report No. 17859-02
Start Date 9-20-86

Test Title POST-LOCA FUNCTIONAL TESTS

INSULATION RESISTANCE AT 500 VDC

ACCEPTANCE CRITERIA: DATA COLLECTED FOR INFORMATION ONLY

SPECIMEN NO.	READING
B1	$5.0 \times 10^6 \Omega$
B2	$2.0 \times 10^5 \Omega$ @ 109 VDC
B3	$2.2 \times 10^5 \Omega$ @ 109 VDC
B4	$< 5.0 \times 10^4 \Omega$ @ 10 VDC
B5	$< 5.0 \times 10^4 \Omega$ @ 10 VDC
B6	$1.6 \times 10^5 \Omega$ @ 109 VDC
B7	$1.6 \times 10^7 \Omega$

WHEN TAKEN OUTSIDE TEST CHAMBER WITH Wyle TEST LEADS Cut off. (~~Ambient~~ SPECIMEN Temp ~76°F)

B4	$6.4 \times 10^4 \Omega$ @ 109 VDC
B5	$8.7 \times 10^4 \Omega$ @ 109 VDC
[illegible]	$2.4 \times 10^5 \Omega$ @ 109 VDC

Tested By John H Moor Date: 9/20/'86
Witness [illegible] Date: 9-20-86
Sheet No. _____ of _____
Approved J E Hazell 9/20/86

Notice of Anomaly None

Wyle Form WH 614A, Rev. APR '84

DATA SHEET

WYLE LABORATORIES

Customer CECo
Specimen Cables and Splices
Part No. Various
Spec. WLQP 17859-01
Para. 3.1.3
S/N N/A
GSI No
Amb. Temp. 76°F
Proto YES
Test Med. Air
Specimen Temp. ~~Ambient~~ 205°F
Job No. 17859
Report No. 17859-02
Start Date 9-20-86

Test Title POST-LOCA FUNCTIONAL TESTS

INSULATION RESISTANCE AT 500 VDC

ACCEPTANCE CRITERIA: DATA COLLECTED FOR INFORMATION ONLY

SPECIMEN NO.	READING
Z1	$2.4 \times 10^{10}\,\Omega$
Z2	$4.5 \times 10^{10}\,\Omega$
Z3	$3.0 \times 10^{9}\,\Omega$
Z4	$4.3 \times 10^{9}\,\Omega$
Z5	$8.0 \times 10^{9}\,\Omega$
Z6	$7.0 \times 10^{8}\,\Omega$
Z7	$1.1 \times 10^{9}\,\Omega$
Z8	$1.7 \times 10^{10}\,\Omega$
Z9	$1.9 \times 10^{10}\,\Omega$
Z10	$8.5 \times 10^{9}\,\Omega$
Z11	$3.0 \times 10^{7}\,\Omega$
Z12	$< 5.0 \times 10^{4}\,\Omega$ @ 10 VDC
Z13	$3.2 \times 10^{6}\,\Omega$

Tested By Date: 9/20/86
Witness Date: 9-20-86
Sheet No. of
Approved 9-20-86

Notice of Anomaly None

Wyle Form WH 614A, Rev. APR '84

APPENDIX III

POST-LOCA VISUAL INSPECTION DATA SHEETS

Page No. IX-20
Test Report No. 17859-02P

DATA SHEET

Customer CECo

Specimen Splices and wires

Part No. Various

Spec. WLGP 17859-01

Para 3 3

S/N NO

GSI N/A

Amb. Temp. ~76°F

Photo YES

Test Med. AIR

Specimen Temp. AMBIENT

WYLE LABORATORIES

Job No. 17859

Report No. 17859-02

Start Date 9-20-86

Test Title Post- PWR LOCA TEST VISUAL INSPECTION

Specimen No.	Comments
B1	Outer Raychem sleeve still shiny but is CRACKED ~ 3/4 OF ITS LENGTH. SCREW INSIDE IS VISIBLE THROUGH THE CRACK NO EVIDENCE OF ARCING EXISTS. LEAD WIRES FLEXIBLE
B2	Raychem has DULLED A LITTLE BUT IS INTACT. NO EVIDENCE OF ARCING. LEADS ARE FLEXIBLE.
B3	Raychem sleeve CRACKED ~ 3/4 OF ITS LENGTH AND HAS DULLED SOMEWHAT. METAL CONNECTION POINTS ARE VISIBLE. NO EVIDENCE OF ARCING EXISTS. LEAD WIRES FLEXIBLE.
B4	Outer TAPE Split ~ 3/4 of IT'S LENGTH BUT INNER TAPE IS INTACT. NO EVIDENCE OF ARCING EXISTS LEAD WIRES FLEXIBLE AND INTACT Underneath Splice HAS A WHITE DEPOSIT (From chem spray? ~~or~~), AND AN AREA About 1/4" in diameter where cable MAY HAVE ARCED AND ATE AT INSULATION. Can not see any METAL parts

Tested By N/A Date:

Witness J. Regan (SSL) Date: 9-20-86

Sheet No. of 5

Approved 9-20-80

Notice of Anomaly None

Wyle Form WH 614A, Rev. APR '84

DATA SHEET

WYLE LABORATORIES

Customer CECo
Specimen Splices & wires
Part No. Various
Spec. WLQP 17859-01
Para. 3.3
S/N NO
GSI N/A

Amb. Temp. 76°F
Photo YES
Test Med. AIR
Specimen Temp. AMBIENT

Job No. 17859
Report No. 17859-02
Start Date 9-20-86

Test Title POST-PWR LOCA TEST VISUAL INSPECTION

Specimen No.	Comments
B5	Splice intact but has several small (< 1/2") cracks. Heavy white deposit over bottom of splice. No EVIDENCE OF ARCING is VISIBLE FROM SPLICE. NOMEX COVERING looks to be chemically burned. Other lead wire is intact but BRITTLE.
B6	Splice intact WITH ONE 3/8" CRACK AT END OF "V". NO EVIDENCE OF AN ARC is VISIBLE. Light white DEPOSIT on splice. LEAD WIRES HARD BUT INTACT.
B7	Outer splice tape has 5 cracks About 1" long and 1/16" wide. The inner tape is intact. No metal is visible through the cracks. LEAD WIRES show evidence of chemical burns to jacket. No EVIDENCE OF ARCING is visible.

Tested By N/A Date:
Witness J. KEGAN (SSC) Date: 9-20-86
Sheet No. 2 of 3
Approved 9-20-86

Notice of Anomaly None

Wyle Form WH 614A, Rev. APR '84

Page No. IX-22
Test Report No. 17859-02P

DATA SHEET

WYLE LABORATORIES

Customer CECo
Specimen Splices & Wires
Part No. Various
Spec. WLQP 17859-01
Para. 3.3
S/N NO
GSI N/A
Amb. Temp. 76°F
Photo YES
Test Med AIR
Specimen Temp. AMBIENT
Job No. 17859
Report No. 17859-02
Start Date 9-20-86

Test Title POST-PWR LOCA TEST VISUAL INSPECTION

Specimen No.	Comments
Z1	Raychem boot AND sleeves ARE shiny AND INTACT. NO EVIDENCE OF ARCING IS VISIBLE. High temp lead has braid intact the full length AND NO EVIDENCE OF CRACKS OR ARCING EXIST ON EITHER LEAD
Z2 & Z3	Raychem sleeves are dull with a rough surface. Kapton wire is shiny. Other leads are dull AND brittle. NO EVIDENCE OF ARCING EXISTS. SEAL to Kapton wire is open on both specimens.
Z4	Raychem sleeve is shiny AND intact. High temp wire is flexible with glass braid intact the entire length. NO EVIDENCE OF ARCING OR CRACKING IS VISIBLE
Z5	SAME AS Z4 except Raychem sleeve is dull AND rough in texture. ALSO chem spray bleached the red color in SOME spots on the hig temp wire glass BRAID.

Tested By N/A Date:
Witness J. REGAN (SSC) Date: 9-20-86
Sheet No. 3 of 3
Approved J. Hazlett 9-20-86

Notice of Anomaly None

Wyle Form WH 614A, Rev. APR 84

DATA SHEET

Customer CECo

WYLE LABORATORIES

Specimen Splices & Wires

Part No. Various

Amb. Temp. 76°F

Job No. 17859

Spec. WLTP 17859-01

Photo YES

Report No. 17859-02

Para. 3.3

Test Med. AIR

Start Date 9-20-86

S/N N/A

Specimen Temp. AMBIENT

GSI NO

Test Title Post- PWR LOCA TEST VISUAL INSPECTION

Specimen No.	Comment
Z7	Outer tape split ~ 3/4 of its length. The inner (brown) tape is intact. No metal is visible through the crack. Lead wires somewhat flexible. No visual evidence of arcing.
Z6	Raychem Boot and sleeves have dulled but are intact. Glass braid has deteriorated & fallen off the high temp lead. No visual evidence of arcing or cracking.
Z8 & Z9	Raychem heat sleeves are shiny with no evidence of cracking. Raychem glue seals are intact at both ends. Lead wires are intact and slightly flexible. No visual evidence of arcing.

Tested By N/A Date:

Witness J. Peran (SSL) Date: 9-20-86

Sheet No. 4 of 5

Approved G Hzlt 9-20-86

Notice of Anomaly None

Wyle Form WH 614A, Rev. APR '84

DATA SHEET

WYLE LABORATORIES

Customer CECO
Specimen SPLICES AND WIRES
Part No. VARIOUS
Spec. WLTP 17859-01
Para. 3.3
S/N N/A
GSI NO

Amb. Temp. 76°F
Photo YES
Test Med. AIR
Specimen Temp. AMBIENT

Job No. 17859
Report No. 17859-02
Start Date 9-20-86

Test Title POST-PWR LOCA TEST VISUAL INSPECTION

SPECIMEN NO.	COMMENTS
Z 10	SAME AS Z8 & Z9. SLIGHT DULLING ON SLEEVE WHERE CHEMICAL DEPOSIT WAS ON CABLE.
Z11 & Z12	Splice outer tape split the entire length. The inner tape is intact. No metal is visible through the splice. Point of failure on both cables is on the high temp lead wire. On Z11 the ARCED spot is ~3" FROM the splice. On Z12 it is ~ 5" FROM the splice. Both ARCED spots occurred where the specimen I.D. tags were mounted but this is not felt to have contributed to the problem.
Z13	Splice outer tape split entire length but the inner tape is intact. No EVIDENCE OF ARCING EXISTS. LEAD WIRES ARE INTACT.

Tested By N/A Date:
Witness J. Regan (SSC) Date: 9-20-86
Sheet No. 5 of 5
Approved 9-20-86

Notice of Anomaly None

Wyle Form WH 614A, Rev APR '84

APPENDIX IV

INSTRUMENTATION EQUIPMENT SHEET

INSTRUMENTATION EQUIPMENT SHEET

PAGE 1 OF 1

DATE 09/19/86 JOB NO. 17859-00 LOCATION LOCA
TECHNICIAN J. MORGAN CUSTOMER CECO TYPE TEST I.R. HI POT

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE#	RANGE 1	ACCURACY 1	CALDTE	CALDUE
1	MEG MTE TSTR	ASSOC RESEARCH	4030A	510	100165	4KV	2%DC	05/05/86	11/05/86
2	MEG MTR	GR	1864	657113180	011898	50K-50TOHM	2-5%RANGE	04/23/86	10/23/86

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES, WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION R.E. Archer
9-19-86

CHECKED & RECEIVED BY J Hazott 9/19/86

Q.A. RS Balis 9-19-86 2 Wyle A

WYLE LABORATORIES'
QUALIFICATION PLAN NUMBER
17859-01

1.0 SCOPE

This document has been prepared by Wyle Laboratories for Commonwealth Edison Company (CECo) for nuclear environmental qualification of various configurations of Raychem nuclear sleeves and kits, Scotch Splice Tape, Kerite Splice Tape, Okonite Splice Tape and Amp splice connectors.

1.1 Objectives

The purpose of this qualification plan is to present the approach, methods and general procedures for qualifying Raychem splices installed over various wires and cables. Parallel qualification shall be attempted on Okonite tapes, Scotch tapes and Kerite tapes over various wires and cables.

Nuclear environmental qualification of any safety-related device to meet the intent of IEEE Std. 323-1974 is usually a three-step process; i.e., 1) radiation exposure; 2) aging; and 3) design basis event qualification. The purpose of the first two steps is to put the sample equipment to be used for qualification into a condition that represents the worst state of deterioration that a plant operator will permit prior to taking corrective action, i.e., its end-of-qualified-life condition. The next step demonstrates that it has adequate integrity remaining to withstand the added environmental stresses of specified design basis events and still perform its safety-related functions.

It is incumbent on CECo to assure that the components and materials contained in the equipment actually placed into service are the same as those qualified.

1.2 Applicable Qualification Standards, Specifications, and Documents

- IEEE Std. 323-1974, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations."
- IEEE Std. 383-1974, "IEEE Standard for Type Testing Of Class 1E Cables, Field Splices, and Connections For Nuclear Power Generating Stations." B
- NUREG-0588 "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment," Revision 1, dated July 1981.
- Regulatory Guide 1.89.
- 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants."
- Telecopy, Sargent & Lundy, 11 pages from John Regan.
- Commonwealth Edison Company Purchase Order No. 806121.

1.3 Equipment Description

The test specimens shall be as described in Table I and Appendix 1.

1.4 Qualification Sequence

The test specimen assemblies shall be subjected in order, to the following testing:

- Visual Inspection
- Baseline Functional Tests
- Normal Radiation Exposure
- Functional Tests
- Thermal Aging
- Functional Tests
- Accident Radiation Exposure
- Functional Tests
- Accident (LOCA)/Post-Accident Simulation
- Functional Tests
- Post-Test Inspection

C

2.0 QUALIFICATION REQUIREMENTS

2.1 Definition of Service Conditions

Service conditions as specified by CECo do not include margin. To account for normal variations in commercial production of equipment and variations in service conditions, margins per Paragraph 6.3.1.5 of IEEE 323-1974 shall be added to the applicable conditions.

o	Temperature	+15°F (Accident - peak temperature)
o	Pressure	+10% (not greater than 10 psig)
o	Voltage	+10%
o	Time	+10% (Post-Accident)

2.1.1 Normal Conditions

2.1.1.1 LaSalle, Dresden And Quad Cities

The following normal service conditions are as specified by CECo:

o	Temperature	150°F
o	Relative Humidity	40-90%
o	Radiation (TID air equivalent)	1.6E7 rads gamma
o	Pressure	(-) 0.5 to 2.0 psig

Note: Operating temperature of the specimens is equal to ambient temperature since heat rise is judged to be negligible due to the low currents typical of signal, control and instrumentation circuitry and due to the short operating duration of valve operator motors. C

2.1.1.2 Byron, Braidwood And Zion

The following normal service conditions are as specified by CECo:

o	Temperature	122°F
o	Relative Humidity	20-70%
o	Radiation (TID air equivalent)	3.5E6 rads gamma
o	Pressure	(-) 0.25 to 0.30 psig

Note: Operating temperature of the specimens is equal to ambient temperature since heat rise is judged to be negligible due to the low currents typical of control and instrumentation circuitry and due to the short operating duration of valve operator motors.

2.0 QUALIFICATION REQUIREMENTS (Continued)

2.1.2 Design Basis Event (DBE) Conditions

C

2.1.2.1 LaSalle, Dresden And Quad Cities

2.1.2.1.1 Accident (LOCA) Conditions Inside the Drywell (Zone H2)

Temperature (°F)	340	320	250	200	
Pressure (psig)	-2 to 48.3	-2 to 48.3	0 to 25	0 to 20	B
Relative Humidity	Steam	Steam	100%	100%	
Duration	0-3 hr	3-6 hr	6 hr to 1 day	1 day to 100 days	

Radiation 2×10^3 rads gamma (integrated)

Chemical Spray: Continuously spray vertically downward with demineralized water at a rate of 0.15 gal/min./ft.^{2} of horizontal area of the test specimen holding fixtures. Chemical spray commences at the 6-hour point and continues for 24-hours after initiation. B

2.1.2.1.2 Byron, Braidwood And Zion

Temperature (°F)	330	270	170-155	155
Pressure	50	50	Saturated Steam	Saturated Steam
Relative Humidity	Steam	Steam	100%	100%
Duration	10-180 sec.	5-20 min.	1-120 days	120-365 days

Radiation 2×10^8 rads (integrated) - See Attachment B

Chemical Spray: Continuously spray vertically downward for first 24 hours with a solution of the following composition at a rate of 0.15 gal/min ft^2 of the horizontal area of the test specimen holding fixture. Chemical spray commences after 3 minutes and continues for 24-hours after initiation. B

- 0.28 Molar H3BO3 (3000 ppm)
- 0.064 Molar $Na_2S_2O_3$
- NaOH to make a pH of 10.5 at 77°F

The chemicals shall be mixed according to Wyle Procedure No. 543-100.

2.0 QUALIFICATION REQUIREMENTS (Continued)

2.1.2.2 Seismic

Seismic testing is not required for cable/splice qualification.

2.1.3 Other Service Conditions

o	Voltage	See Table I
o	Current	See Table I

2.2 Safety-Related Functions

The safety classification of this equipment is Class 1E. The subject equipment provides essential services in support of emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or is otherwise essential in providing support to prevent significant release of radioactive material to the environment. The safety-related functions are described in the following paragraph.

2.2.1 Description (See Table I and Appendix IV) C

The subject splices are installed in various Class 1E power (e. g. valve operator motors), control, and instrumentation circuits at the LaSalle County, Dresden, Quad Cities, Zion, Byron and Braidwood Nuclear Power Generating Stations. The specimens were built as descibed in Table I and shown in Figures IV-1 through IV-49 of Appendix IV. C

2.2.2 Acceptance Criteria

The acceptance criteria for the test specimen assemblies is to demonstrate, during accident and post-accident simulation, electrical integrity. Circuit currents of Table 1 will be applied while powered at Table 1 voltages to the appropriate fused circuits.

Insulation resistance shall be measured at each functional test for information only.

Leakage currents to ground on each specimen shall be measured continuously for informational purposes only during the LOCA tests.

3.0 QUALIFICATION PROGRAM

3.1 Baseline Functional Tests

3.1.1 Visual Inspection

A visual inspection of the test specimen components shall be performed by Wyle Laboratories. This inspection will ensure that the equipment has no obvious visible damage and that the components are as described in Paragraph 1.3. Specimen assemblies shall be tagged to facilitate their identification throughout the qualification program.

3.1.2 Specimen Preparation

The test specimens shall be prepared by CECo and forwarded to Wyle Laboratories. All specimens prepared at Wyle shall be accomplished with the CECo technical representative present and to his/her instructions. The test specimens shall be prepared in accordance with the splice preparation procedures in Appendix 1.

3.1.3 Functional Test

The insulation resistance of each specimen shall be measured (for information only) by applying 500 VDC for a minimum of 1 minute between conductor and ground.

A megohmmeter with accuracy of ±5% shall be used for measuring insulation resistance. Record insulation resistance values on the data sheet. If the measured resistance is less than 5.0E5 ohms, reduce the megohmmeter voltage until an insulation resistance value can be measured.

3.2 Aging

3.2.1 Normal Radiation Exposure

The worst-case normal radiation requirement, as specified by Commonwealth Edison Company, is 1.6E7 rads gamma. Therefore, the test specimens (except Q13 through Q20) shall be irradiated to a normal radiation exposure of 1.6E7 rads gamma using a Cobalt 60 source. The dose rate shall be approximately 1E6 rads per hour. C

The Quad Cities inside containment 40-year normal radiation requirement is 1.4E6 rads, gamma. Five-year Specimens Q13 and Q14 shall be irradiated to 1.75E5 rads, and 10-year Specimens Q15 and Q16 shall be irradiated to 3.5E5 rads (5-and 10-year levels respectively) using a Cobalt-60 source at a dose rate of approximately 1E5 rads per hour.

At the direction of CECo, Specimens Q17, Q18, Q19 and Q20 shall be irradiated as follows:

3.0 QUALIFICATION Program (Continued)

3.2.1 Normal Radiation Exposure (Continued)

1. Two specimens (Q17 and Q18) shall be irradiated to 5.25E5 rads (Quad Cities 15-year requirement) at a dose rate of approximately 1E5 rads per hour.
2. The two remaining specimens (Q19 and Q20) shall be irradiated to 7.0E5 rads (Quad Cities 20-year requirement) at a dose rate of approximately 1E5 rads per hour.

The dose rate shall be measured at the geometric centerline of the test specimens. The specimens shall be rotated as necessary during the exposure to ensure a uniform dose distribution.

Dosimetry used shall be traceable to the National Bureau of Standards.

Specimen powering is not required during radiation exposure.

3.2.1.1 Post-Normal Radiation Exposure Functional Tests

The tests of Paragraph 3.1.3 shall be repeated on all specimens.

3.2.2 Time-Temperature Effects

3.2.2.1 Desired Qualified Life

A literature search of Wyle's Aging Library has been utilized to obtain auditable aging data for the component materials used in the various test specimen splices in this qualification program. Aging temperatures of 266°F, 248°F, and 239°F were selected based on past aging programs for similar materials. The aging times shall be as listed in Table II and in Paragraph 3.2.4.

3.2.2.2 Activation Energies

3.2.2.2.1 Specimens Z-1 - Z-6, Z8-Z10, B1-B3, L1-L10, D1, D2, D5-D17 and Q7-Q12

The activation energy of the limiting material in these specimens is 1.29eV for crosslinked polyolefin which is the material used in Raychem WCSF-N heat shrink tubing. This activation energy is contained in Wyle Library Code (WLC) 036080A.

3.2.2.2.2 Specimens Z7, Z11, Z12, and Z13

The insulating material in the splices in these specimens is Kerite tape which is 180°C rated Scotch Number 70 silicone rubber tape. An activation energy of 1.25eV has been selected. This activation energy is for 50 percent loss of elongation for 180°C G.E. silicone rubber wire insulation. It is judged that the thermal properties of the Kerite tape are equivalent to those of the 180°C silicone rubber wire insulation and the 1.25eV activation energy contained in WLC 067382 shall, therefore, be used to develop the program for these specimens.

3.0 QUALIFICATION PROGRAM (Continued)

C

3.2.2.2.3 Specimens D3 and D20

These specimens are pigtail splices used inside the drywell at Dresden. The Dresden and Quad Cities taping procedure provided by CECO states that Scotch 130C and 70 are insulating tapes. Scotch 17 tape is also used in these splices, but its function is jacketing. Therefore, only the 130C and 70 insulating tapes are of concern in developing the thermal aging program for these specimens.

Specific thermal data are not available in the Wyle Aging Library for either Scotch 130C or 70 tapes. Data are available, however, for similar materials.

It is judged that the thermal properties of the 90°C rated ethylene propylene rubber (EPR) Scotch 130C tape are generically equivalent to those of G.E. Class B EPR wire insulation whose activation energy is 1.34 eV for cracking on a 3X mandrel. This data is contained in WLC 018579A.

It is also judged that the thermal properties of the Class H 180°C rated silicone rubber Scotch 70 tape are generically equivalent to those of 180°C rated G.E. silicone rubber wire insulation whose activation energy is 1.25 eV for 50% loss of elongation. This data is contained in WLC 067382.

The lower of the two activation energies (1.25 eV) shall be used for the subject splices.

3.2.2.2.4 Specimens B4-B7 and L11

The activation energy for Okonite T-95 insulation tape (Crosslinked ethylene propylene) is 1.26eV as contained in WLC 051781. This is the primary insulation material used in the above specimens.

3.2.2.2.5 Specimens D4, D21, Q1, Q2, Q3, and Q4

These specimens are pigtail splices used outside the drywell at Dresden and Quad Cities. The Dresden and Quad Cities taping procedure provided by CECo (Appendix II) states that Scotch 33+ tape is used as insulating tape and Scotch 130C is used for jacketing. Quad Cities Procedure QMP 100-60 provided by Bechtel (Appendix III) states that 130C is insulation tape.

Specific thermal data for Scotch 33+ tape are not available in the Wyle Aging Library. Data are available, however, for polyvinyl choloride (PVC), the material comprising 33+ tape. It is judged that the thermal properties of Scotch 33+ vinyl plastic tape are equivalent to those of 105°C rated polyvinyl chloride as contained in WLC 049981. The activation energy for this PVC is 1.15 eV for 50% loss of elongation. The activation energy for 130C is 1.34 eV as discussed in Paragraph 3.2.2.2.3. The activation energy for PVC shall be used to develop the thermal aging program for the subject splices since it is the lower of the two activation energies of concern.

3.0 QUALIFICATION PROGRAM (Continued)

3.2.2.2.6 Specimens D18, D19, Q5, Q6, Q13 through Q20

The insulating material used in the AMP window splices in these test specimens is Nylon (polyamide). The thermal properties of the splice material are judged to be equivalent to those of 125°C Nylon 6/6 (Zytel 101) for 50 percent loss of electrical strength as contained in WLC 003278A. The activation energy of this Nylon is 1.17eV.

3.2.3 Relative Humidity C

Relative humidity is not considered an aging mechanism for the cables. For insulation systems, its effect is usually not the primary failure mechanism, as noted in WAL 0255-80 with respect to motor insulations, "However, in most cases, moisture plays only a secondary role in the failure. It does not produce the damage in the insulation, the insulation wears away or cracks for other reasons. Moisture merely provides a direct elecrical pathway between these matured devices and ground."

Therefore, the ability of the cables to perform their safety-related functions within their relative humidity environment shall be demonstrated during the accident/post-accident test.

3.2.4 Thermal Aging Program Summary C

The specimens shall be aged in accordance with Table II and the following paragraphs. Tolerances on aging temperature are +5, -0 deg. F and on aging time are +2, -0 hours.

3.2.4.1 Specimens Z1-Z6, Z8-Z10, and B1-B3

As specified by CECo, the desired qualified life for these specimens is 40 years. The thermal aging time to simulate 40 years at the Zion and Byron/Braidwood maximum normal ambient temperature of 122°F (50°C) is 149 hours at an aging temperature of 239°F based on an activation energy of 1.29eV.

3.2.4.2 Specimens Z7, Z11, Z12, and Z13

As specified by CECo, the desired qualified life for these specimens is 40 years. The thermal aging time to simulate 40 years at the Zion maximum normal ambient temperature of 122°F (50°C) is 190 hours at an aging temperature of 239°F based on an activation energy of 1.25eV.

3.2.4.3 Specimens B4-B7

As specified by CECo, the desired qualified life for these specimens is 40 years. The thermal aging time to simulate 40 years at the Byron/Braidwood maximum normal ambient temperature is 122°F (50°C) is 179 hours at an aging temperature of 239°F based on an activation energy of 1.26eV.

3.0 QUALIFICATION PROGRAM (Continued)

3.2.4.4 Specimens L1-L10

C

As specified by CECo, the desired qualified life for these specimens is 40 years. The thermal aging time to simulate 40 years at the LaSalle maximum normal ambient temperature of 150°F (66°C) is 298 hours at an aging temperature of 266°F based on an activation energy of 1.29eV.

3.2.4.5 Specimen L11

As specified by CECo, the desired qualified life for this specimen is 40 years. The thermal aging time to simulate 40 years at the LaSalle maximum normal ambient temperature of 150°F (66°C) is 352 hours at an aging temperature of 266°F based on an activation energy of 1.26eV.

3.2.4.6 Specimens D1, D2, D5-D17, Q8, Q10, and Q12

As specified by CECo, the desired qualified life for these specimens is 30 years. The thermal aging time to simulate 30 years at the Dresden and Quad Cities maximum normal ambient temperature of 150°F (66°C) is 224 hours at an aging temperature of 266°F based on an activation energy of 1.29eV.

3.2.4.7 Specimen D3

As specified by CECo, the desired qualified life for this specimen is 30 years. The thermal aging time to simulate 30 years at the Dresden maximum normal ambient temperature of 150°F (66°C) is 279 hours at an aging temperature of 266°F based on an activation energy of 1.25eV.

3.2.4.8 Specimens D4, Q2, and Q4

As specified by CECo, the desired qualified life for these specimens is 30 years The thermal aging time to simulate 30 years at the Dresden and Quad Citie maximum normal ambient temperature of 150°F (66°C) is 482 hours at an aging temperature of 266°F based on an activation energy of 1.15eV.

3.2.4.9 Specimens D18 and D19

As specified by CECo, the desired qualified life for these specimens is 15 years. They have been in service for 10 years and will, therefore, require an additonal 5 years' equivalent aging to bring them up to a total of 15 years. The thermal aging time to simulate 5 years at the Dresden maximum normal ambient temperature of 150°F (66°C) is 170 hours at an aging temperature of 248°F based on an activation energy of 1.17eV.

3.2.4.10 Specimen D20

As specified by CECo, the desired qualified life for this specimen is 15 years. The thermal aging time to simulate 15 years at the Dresden maximum normal ambient temperature of 150°F (66°C) is 140 hours at an aging temperature of 266°F based on an activation energy of 1.25eV.

3.0 QUALIFICATION PROGRAM (Continued

C

3.2.4.11 Specimens D21, Q1 and Q3

As specified by CECo, the desired qualified life for these specimens is 15 years. The thermal aging time to simulate 15 years at the Dresden and Quad Cities maximum normal ambient temperature of 150°F (66°C) is 241 hours at an aging temperature of 266°F based on an activation energy of 1.15eV.

3.2.4.12 Specimens Q5 and Q6

As specified by CECo, the desired qualified life for these specimens is 40 years. The thermal aging time to simulate 40 years at the Quad Cities maximum normal ambient temperature of 150°F (66°C) is 89 hours at an aging temperature of 248°F followed by 538 hours at 266°F based on an activation energy of 1.17eV.

3.2.4.13 Specimens Q7, Q9, and Q11

As specified by CECo, the desired qualified life for these specimens is 15 years. The thermal aging time to simulate 15 years at the Quad Cities maximum normal ambient temperature of 150°F (66°C) is 112 hours at an aging temperature of 266°F based on an activation energy of 1.29eV.

3.2.4.14 Specimens Q13 and Q14

As specified by CECo, the desired qualified life for these specimens is 15 years. They were removed from Quad Cities Unit 2 drywell penetrations after being in service longer than 10 years. An additional 5 year's equivalent thermal aging will bring them up to a total of actual in-service life plus 5 years. The thermal aging time to simulate 5 years at the Quad Cities maximum normal ambient temperature of 150°F is 170 hours at an aging temperature of 248°F based on an activation energy of 1.17 eV.

3.2.4.15 Specimens Q15 and Q16

As specified by CECo, the desired qualified life for these specimens is 20 years. They were removed from Quad Cities Unit 2 drywell (the same as Specimens Q13 and Q14 above). An additional 10 years' equivalent aging will bring them up to a total of actual in service life plus 10 years. The thermal aging time to simulate 10 years at the Quad Cities maximum normal ambient temperature of 150°F is 339 hours at an aging temperature of 248°F based on an activation energy of 1.17eV.

3.2.4.16 Specimens Q17, Q18, Q19 and Q20

The additional desired qualified life for these specimens is one year as specified by CECo. These specimens also were removed from Quad Cities Unit 2 drywell. The thermal aging time to simulate one year at the Quad Cities maximum normal ambient temperature of 150°F is 5[illegible] hours at an aging temperature of 239°F based on an activation energy of 1.17 eV.

3.0 QUALIFICATION PROGRAM (Continued)

3.2.5 Post Thermal Aging Functional Tests C

The tests of Paragraph 3.1.3 shall be repeated on all specimens except Q17 through Q20.

3.2.6 Accident Radiation Exposure C

The worst-case accident radiation requirement is 1.84E8 rads. The test specimens described in Table I (except Specimens Q13 through Q16) shall be exposed to a minimum radiation dose of 1.84E8 rads gamma (air equivalent) using a Cobalt-60 source at a dose rate of approximately 1E6 rads per hour.

The Quad Cities accident radiation requirement is 1.1E8 rads. Specimens Q13, Q14, Q15, and Q16 shall be exposed to a minimum radiation dose of 1.21E8 rads gamma (air equivalent) using a Cobalt 60 source at a close rate of approximately 1E6 rads per hour.

The specimens shall be rotated as necessary during exposure to ensure a uniform dose.

The radiation doses above contains 10% margin on the accident requirement.

Dosimetry utililized during radiation exposure shall be traceable to the National Bureau of Standards (NBS).

3.2.7 Post Accident Radiation Functional Tests C

The tests of Paragraph 3.1.3 shall be repeated on all specimens except Q17 through Q20.

3.3 Accident Simulation C

3.3.1 PWR Specimens (Byron/Braidwood and Zion) LOCA Test

3.3.1.1 Accident Profile

All test specimens described in Table I (pages 23-31) shall be subjected to a simulated accident. The test profile shall envelop the profile specified by CECo which is described in Paragraph 2.1.2.1.2. It is assumed (for purposes of applying margin) that the accident (DBA) portion of the profile is the first 24 hours and the post-DBA portion is from the 24-hour mark through 365 days. Appropriate margins per Paragraph 2.1 have been added. C

The initial transient shall be applied to the test specimens (powered as specified in Table I) as shown in Figure 1 beginning at 122°F and atmospheric pressure.

3.0 QUALIFICATION PROGRAM (Continued)

3.3.1.1 Accident Profile (Continued)

The ramp requirement to 345°F and 55 psig shall be performed on a best-effort basis. Approximately three minutes after equilibrium is achieved at 345°F/55 psig, chemical spray as described in Paragraph 2.1.2.1.2 shall be introduced at a minimum rate of 0.15 gpm/ft^2 of horizontal area of the test specimen enclosure and shall continue for 24 hours. Peak conditions at 345°F/55 psig shall be held for a minimum of five minutes, followed by a decrease in temperature to 270°F saturated conditions. These conditions shall be maintained for a minimum of 5.33 hours at which time the temperature and pressure shall be decreased to 250°F saturated conditions. These conditions shall be maintained for a minimum of 40.5 hours until the 45.83 hour point (end of test).

3.3.1.2 Test Specimen Mounting and Orientation

The test specimens shall be mounted to a solid bottom cable tray, or inside a NEMA 12 and NEMA 3 enclosure as listed below:

Enclosure/ Tray Type	Specimens
Tray	Z2, Z3 and Z11
NEMA 3	Z1 and Z4-Z10
NEMA 12	B1-B7, Z12 and Z13

The specimens mounted to the cable tray shall be tie wrapped in place at each end of the cable. The specimens mounted in either ther NEMA 3 or NEMA 12 enclosure shall be mounted on the bottom ledge of the enclosure except for Specimen B7 which shall be vertical inside the enclosure.

Each of the enclosures shall have a 1/4" weephole drilled in the lower right hand corner of the enclosure. A 1-1/4 inch LB fitting shall be mounted to the top center of the enclosures. All wiring shall enter or exit the enclosure through this penetration. A 18-inch conduit nipple shall be mounted to the end of the LB fitting and shall be oriented in the test chamber away from the chemical spray nozzles.

The test specimen cables shall be connected with Wyle supplied 14 AWG Teflon wire through uninsulated butt splices covered with Raychem WCSF-N sleeves. These Teflon leads shall exit the test chamber and shall be sealed per Wyle Laboratories standard practice.

3.0 QUALIFICATION PROGRAM (Continued)

3.3.1.2 Test Specimen Mounting and Orientation (Continued)

The test specimens shall be powered as described in Table I. The circuitry used to accomplish the electrical setup shall be as shown in Figures 7 and 8. The instrumentation channels utilized shall be as listed below: C

DAYTRONICS DATA ACQUISITION SYSTEM CHANNELS

Channel No.	Specimen No.	Units	Signal Monitored
1	N/A	°F	Chamber control thermocouple
2	N/A	°F	Chamber control thermocouple
3	N/A	°F	Chamber control thermocouple
4	N/A	psig	Chamber pressure control transducer
5	N/A	°F	Average chamber temperature -average of channels 1, 2 and 3
6	N/A	GPM	Chemical Spray Flowrate (3.5-4.0 GPM)
7	N/A	pH	Chemical Spray pH(10.2-10.8)
8	Z2, Z3	psig	Input pressure to Wyle Omega PX114 transmitter used as a load
9	B1	mA	Leakage current to ground
10	B2	mA	Leakage current to ground
11	B3	mA	Leakage current to ground
12	B4	mA	Leakage current to ground
13	B5	mA	Leakage current to ground
14	Z1	mA	Leakage current to ground
15	Z2	mA	Leakage current to ground
16	Z3	mA	Leakage current to ground
17	Z4	mA	Leakage current to ground
18	Z5	mA	Leakage current to ground
19	Z6	mA	Leakage current to ground
20	Z7	mA	Leakage current to ground
21	Z8	mA	Leakage current to ground
22	Z9	mA	Leakage current to ground
23	Z10	mA	Leakage current to ground
24	Z11	mA	Leakage current to ground
25	Z12	mA	Leakage current to ground
26	Z13	mA	Leakage current to ground

3.0 QUALIFICATION PROGRAM (Continued)

3.3.1.2 Test Specimen Mounting and Orientation (Continued)

FLUKE 2240 DATTALOGGER CHANNELS

Channel No.	Specimen No.	Units	Signal Monitored (Range)
1	B1	VAC	Input Voltage (132-136 VAC)
2	B1	Amps	Load Current (6.0-7.4A)
3	B2	VAC	Input Voltage (132-136 VAC)
4	B2	Amps	Load Current (6.0-7.4A)
5	B3	VAC	Input Voltage (132-136 VAC)
6	B3	Amps	Load Current (5.0-7.0A)
7	B4	VAC	Input Voltage (528-544 VAC)
8	B4	Amps	Load Current (6.0-7.4A)
9	B5	VAC	Input Voltage (528-544 VAC)
10	B5	Amps	Load Current (6.0-7.4A)
11	B6	VAC	Input Voltage (528-544 VAC)
12	B6	Amps	Load Current (9.0-11.0A)
13	B7	VAC	Input Voltage (528-544 VAC)
14	B7	Amps	Load Current (13.5-16.5A)
15	Z1	VAC	Input Voltage (132-136 VAC)
16	Z1	Amps	Load Current (6.0-7.4A)
17	Z2	VDC	Input Voltage (34.5-37 VDC)
18	Z2	mA	Load Current (36-44 mA)
19	Z3	VDC	Input Voltage (34.5-37 VDC)
20	Z3	mA	Load Current (36-44 mA)
21	Z4	VAC	Input Voltage (132-136 VAC)
22	Z4	Amps	Load Current (6.0-7.4A)
23	Z5	VAC	Input Voltage (132-136 VAC)
24	Z5	Amps	Load Current (6.0-7.4A)
25	Z6	VAC	Input Voltage (528-544 VAC)
26	Z6	Amps	Load Current (6.0-7.4A)
27	Z7	VAC	Input Voltage (528-544 VAC)
28	Z7	Amps	Load Current (6.0-7.4A)
29	Z8	VAC	Input Voltage (132-136 VAC)
30	Z8	Amps	Load Current (6.0-7.4A)
31	Z9	VAC	Input Voltage (132-136 VAC)
32	Z9	Amps	Load Current (6.0-7.4A)
33	Z10	VAC	Input Voltage (132-136 VAC)
34	Z10	Amps	Load Current (6.0-7.4A)
35	Z11	VAC	Input voltage (528-544 VAC)
36	Z11	Amps	Load Current (6.0-7.4A)
37	Z12	VAC	Input Voltage (528-544 VAC)
38	Z12	Amps	Load Current (6.0-7.4A)
39	Z13	VAC	Input Voltage (528-544 VAC)
40	Z13	Amps	Load Current (6.0-7.4A)

3.3.2 BWR Specimens (LaSalle, Quad Cities and Dresden) LOCA Test

3.3.2.1 Accident Profile

The test specimens described in Table I, pages 23 through 31 shall be subjected to a simulated accident. The test profile shall envelop the profile specified by CECo which is described in Paragraph 2.1.2.1.1 It is assumed (for purposes of applying margin) that the accident (DBA) portion of the profile is the first 24 hours and the post-DBA portion is from the 24-hour mark through 100 days. Appropriate margins per Paragraph 2.1 have been added.

The initial transient shall be applied to the test specimens (powered as specified in Table I) as shown in Figures 2 and 2A beginning at 150°F and atmospheric pressure. The ramp requirement to 355°F and 53.3 psig shall be performed on a best-effort basis. The following description applies to BWR Tests No. 1 and No. 2 only. Approximately 6 hours after equilibrium is achieved at 355°F/53.3 psig, demineralized water spray as described in Paragraph 2.1.2.1 shall be introduced at a minimum rate of 0.15 gpm/ft^2 of horizontal area of the test specimen enclosure and shall continue for 24 hours. Peak conditions at 355°F/53.3 psig shall be held for a minimum of 3 hours, followed by a decrease to 320°F/53.3 psig. These conditions shall be maintained for a minimum of 3 hours at which time the temperature and pressure shall be decreased to 250°F, saturated conditions. These conditions shall be maintained for a minimum of 114 hours or until the 120 hour point (end of test).

3.3.2.2 Test Specimen Mounting and Orientation

The test specimens shall be mounted to a solid bottom cable tray, or inside a NEMA 3 enclosure as listed below:

Enclosure/ Tray Type	Specimens
Tray	D1, D2 D5-D15, L1-L10 and Q7-Q12
NEMA 3	Q1-Q6, Q13-Q20, D3, D4, D16-D21 and L11

The specimens mounted to the cable tray shall be tie wrapped in place at each end of the cable. The specimens mounted in the NEMA 3 enclosure shall be mounted on the bottom ledge of the enclosure or as specified by the CECo Technical Representative.

The enclosure shall have a 1/4" weep hole drilled in the lower right hand corner. A 1-1/4 inch LB fitting shall be mounted to the top center of the enclosure. All wiring shall enter or exit the enclosure through this penetration. An 18-inch conduit nipple shall be mounted to the end of the LB fitting and shall be oriented in the test chamber away from the chemical spray nozzles.

3.0 QUALIFICATION PROGRAM (Continued)

3.3.2.2 Test Specimen Mounting and Orientation (Continued)

The test specimen cables shall be connected with Wyle supplied 14 AWG Teflon wire through uninsulated butt splices covered with Raychem WCSF-N sleeves. These teflon leads shall exit the test chamber and shall be sealed per Wyle Laboratories standard practice.

C

The test specimens shall be powered as described in Table I. The circuitry used to accomplish the electrical setup shall be as shown in Figures 7 and 8. The instrumentation channels utilized shall be as listed below:

***Note:** Due to instrumentation limitations, the BWR specimens shall be tested in three tests. The specimens in each test shall be as listed in the following tables.

BWR TEST #1
DAYTRONICS DATA ACQUISITION SYSTEM CHANNELS

Channel No.	Specimen No.	Units	Signal Monitored
1	N/A	°F	Chamber control thermocouple
2	N/A	°F	Chamber control thermocouple
3	N/A	°F	Chamber control thermocouple
4	N/A	psig	Chamber pressure control transducers
5	N/A	°F	Average chamber temperature -average of channels 1, 2 and 3
6	N/A	GPM	Chemical spray flowrate (3.5-4.0 GPM)
7	Q1	mA	Leakage current to ground
8	Q2	mA	Leakage current to ground
9	Q3	mA	Leakage current to ground
10	Q4	mA	Leakage current to ground
11	Q5	mA	Leakage current to ground
12	Q6	mA	Leakage current to ground
13	D3	mA	Leakage current to ground
14	D4	mA	Leakage current to ground
15	D5, D7	mA	Leakage current to ground
16	D6	mA	Leakage current to ground
17	D8	mA	Leakage current to ground
18	D9	mA	Leakage current to ground
19	D10	mA	Leakage current to ground
20	D11	mA	Leakage current to ground
21	D16	mA	Leakage current to ground
22	D17	mA	Leakage current to ground
23	D18	mA	Leakage current to ground
24	D19	mA	Leakage current to ground
25	D20	mA	Leakage current to ground
26	D21	mA	Leakage current to ground

3.0 QUALIFICATION PROGRAM (Continued)

3.3.2.2 Test Specimen Mounting and Orientation (Continued) C

FLUKE 2240 DATALOGGER CHANNELS

Channel No.	Specimen No.	Units	Signal Monitored (Range)
1	Q3	VAC	Input Voltage (132-136 VAC)
2	Q3	Amps	Load Current (6.0-7.4A)
3	Q4	VAC	Input Voltage (132-136 VAC)
4	Q4	Amps	Load Current (6.0-7.4A)
5	Q5	VAC	Input Voltage (132-136 VAC)
6	Q5	Amps	Load Current (6.0-7.4A)
7	D9	VAC	Input Voltage (132-136 VAC)
8	D9	Amps	Load Current (6.0-7.4A)
9	D19	VAC	Input Voltage (132-136 VAC)
10	D19	Amps	Load Current (6.0-7.4A)
11	Q1	VAC	Input Voltage (528-544 VAC)
12	Q1	Amps	Load Current (6.0-7.4A)
13	Q2	VAC	Input Voltage (528-544 VAC)
14	Q2	Amps	Load Current (6.0-7.4A VAC)
15	Q6	VAC	Input Voltage (528-544 VAC)
16	Q6	Amps	Load Current (6.-7.4A)
17	D3	VAC	Input Voltage (528-544 VAC)
18	D3	Amps	Load Current (6.0-7.4A)
19	D4	VAC	Input Voltage (528-544 VAC)
20	D4	Amps	Load Current (6.0-7.4A)
21	D5, 7	VAC	Input Voltage (528-544 VAC)
22	D5, 7	Amps	Load Current (6.0-7.4A)
23	D6	VAC	Input Voltage (528-544 VAC)
24	D6	Amps	Load Current (6.0-7.4A)
25	D8	VAC	Input Voltage (528-544 VAC)
26	D8	Amps	Load Current (6.0-7.4A)
27	D10	VAC	Input Voltage (528-544 VAC)
28	D10	Amps	Load Current (6.0-7.4A)
29	D11	VAC	Input Voltage (528-544 VAC)
30	D11	Amps	Load Current (6.0-7.4A)
31	D16	VAC	Input Voltage (528-544 VAC)
32	D16	Amps	Load Current (6.0-7.4A)
33	D17	VAC	Input Voltage (528-544 VAC)
34	D17	Amps	Load Current (6.0-7.4A)
35	D18	VAC	Input Voltage (528-544 VAC)
36	D18	Amps	Load Current (6.0-7.4A)
37	D20	VAC	Input Voltage (528-544 VAC)
38	D20	Amps	Load Current (6.0-7.4A)
39	D21	VAC	Input Voltage (528-544 VAC)
40	D21	Amps	Load Current (6.0-7.4A)

3.0 QUALIFICATION PROGRAM (Continued)

3.3.2.2 Test Specimen Mounting and Orientation (Continued)

C

BWR TEST #2

DAYTRONICS DATA ACQUISITION SYSTEM CHANNELS

Channel No.	Specimen No.	Units	Signal Monitored
1	N/A	°F	Chamber control thermocouple
2	N/A	°F	Chamber control thermocouple
3	N/A	°F	Chamber control thermocouple
4	N/A	psig	Chamber pressure control transducer
5	N/A	°F	Average chamber temperature -average of channels 1, 2, & 3
6	NA	GPM	Chemical spray flow rate (3.5-4.0 GPM)
7	N/A	pH	Chemical spray pH (6.0-8.0)
8	Q13	mA	Leakage current to ground
9	Q10	mA	Leakage current to ground
10	Q15	mA	Leakage current to ground
11	Q12	mA	Leakage current to ground
12	Q7,Q9,Q11	mA	Leakage current to ground
13	L1	mA	Leakage current to ground
14	L2,L7,L10	mA	Leakage current to ground
15	L3	mA	Leakage current to ground
16	L5	mA	Leakage current to ground
17	L6, L8	mA	Leakage current to ground
18	L7	mA	Leakage current to ground
19	L9	mA	Leakage current to ground
20	L11	mA	Leakage current to ground
21	Q8	mA	Leakage current to ground
22	D1	mA	Leakage current to ground
23	D2	mA	Leakage current to ground
24	D12	mA	Leakage current to ground
25	D 13, D14, D15	mA	Leakage current to ground
26	Q14	mA	Leakage current to ground
27	Q16	mA	Leakage current to ground

3.0 QUALIFICATION PROGRAM (Continued)

3.3.2.2 Test Specimen Mounting and Orientation (Continued) C

FLUKE 2240 DATALOGGER CHANNELS

Channel No.	Specimen No.	Units	Signal Monitored (Range)
1	Q13	VAC	Input Voltage (132-136 VAC)
2	Q13	Amps	Load Current (6.0-7.4A)
3	Q10	VAC	Input Voltage (132-136 VAC)
4	Q10	Amps	Load Current (6.0-7.4A)
5	Q15	VAC	Input Voltage (132-136 VAC)
6	Q15	Amps	Load Current (6.0-7.4A)
7	Q12	VAC	Input Voltage (132-136 VAC)
8	Q12	Amps	Load Current (6.0-7.4A)
9	Q7,Q9,Q11	VAC	Input Voltage (132-136 VAC)
10	Q7,Q9,Q11	Amps	Load Current (6.0-7.4A)
11	L1	VAC	Input Voltage (528-544 VAC)
12	L1	Amps	Load Current (0.9-1.1A)
13	L2,L4,L10	VAC	Input Voltage (528-544 VAC)
14	L2,L4,L10	Amps	Load Current (0.9-1.1A)
15	L3	VAC	Input Voltage (528-544 VAC)
16	L3	Amps	Load Current (0.9-1.1A)
17	L5	VAC	Input Voltage (528-544 VAC)
18	L5	Amps	Load Current (6.0—7.4A)
19	L6,L8	VAC	Input Voltage (528-544 VAC)
20	L6,L8	Amps	Load Current (6.0-7.4A)
21	L7	VAC	Input Voltage (528-544 VAC)
22	L7	Amps	Load Current (6.0-7.4A)
23	L9	VAC	Input Voltage (528-544 VAC)
24	L9	Amps	Load Current (0.9-1.1A)
25	L11	VAC	Input Voltage (528-544 VAC)
26	L11	Amps	Load Current (0.9-1.1A)
27	Q8	VAC	Input Voltage (528-544 VAC)
28	Q8	Amps	Load Current (6.0-7.4A)
29	D1	VAC	Input Voltage (528-544 VAC)
30	D1	Amps	Load Current (6.0-7.4A)
31	D2	VAC	Input Voltage (528-544 VAC)
32	D2	Amps	Load Current (6.0-7.4A)
33	D12	VAC	Input Voltage (528-544 VAC)
34	D12	Amps	Load Current (6.0-7.4A)
35	D13,D14,D15	VAC	Input Voltage (528-544 VAC)
36	D13,D14,D15	Amps	Load current (6.0-7.4A)
37	Q14	VAC	Input Voltage (528-544 VAC)
38	Q14	Amps	Load Current (6.0-7.4A)
39	Q16	VAC	Input Voltage (528-544 VAC)
40	Q16	Amps	Load Current (6.0-7.4A)

3.0 QUALIFICATION PROGRAM (Continued)

3.3.2.2 Test Specimen Mounting and Orientation (Continued) C

BWR TEST NUMBER 3
DAYTRONICS DATA ACQUISITION CHANNELS

Channel No.	Specimen No.	Units	Signal Monitored
1	N/A	°F	Chamber control thermocouple
2	N/A	°F	Chamber control thermocouple
3	N/A	°F	Chamber control thermocouple
4	N/A	°F	Average chamber temperature average of channels 1, 2, and 3
5	N/A	psig	Chamber pressure control transducer
6	N/A	GPM	Chemical Spray Flowrate (3.5-4.0 GPM)
7	Q17	VAC	Input Voltage (132-136 VAC)
8	Q17	Amps	Load Current (6.0-7.4A)
9	Q17	mA	Leakage current to ground
10	Q18	VAC	Input Voltage (132-136 VAC)
11	Q18	Amps	Load Current (6.0-7.4A)
12	Q18	mA	Leakage current to ground
13	Q19	VAC	Input Voltage (528-544 VAC)
14	Q19	Amps	Load Current (6.0-7.4A)
15	Q19	mA	Leakage current to ground
16	Q20	VAC	Input Voltage (528-544 VAC)
17	Q21	Amps	Load Current (6.0-7.4A)
18	Q21	mA	Leakage current to ground

3.3.3 Post-DBA Functional Tests

The functional tests (insulation resistance) of Paragraph 3.1.3 shall be performed with the specimens inside the chamber. C

3.3.4 Post-Test Inspection

Upon completion of the qualification program, the specimens shall be visually inspected. The specimens shall be disassembled to the extent necessary to perform the inspection. The condition of the specimens shall be recorded. C

3.4 In-Process Inspection

The test items shall be examined for possible damage following all severe tests. All noticeable test effects shall be logged.

Photographs shall be taken of any noticeable physical damage that may occur.

The records shall be checked for quality of performance after each test. CECo and S&L representatives shall be provided access to Wyle facilities and records for QA program evaluation and auditing and inspection/surveillance subject to prior scheduling through Wyle Contracts and QA Departments.

3.0 QUALIFICATION PROGRAM (Continued)

3.5 Instrumentation

All test equipment and instrumentaion to be used in the performance of this program shall be calibrated in accordance with Wyle Laboratories' Quality Assurance Manual, which conforms to the applicable portions of ANSI N 45.2, 10 CFR 50/Appendix B, and Military Specification MIL-STD-45662. Standards used in performing all calibrations shall be traceable to the National Bureau of Standards. C

3.6 Report

The report shall describe the qualification requirements, procedures, and results. The report shall also include rationale and justification required for the qualification and shall certify the qualification of those test items which passed the tests of IEEE Standard 323-1974. The customer shall receive ten bound copies and one reproducible copy of the test report.

3.7 References C

1. DuPont U.L. File No. 41938, Library Code 032-78A
2. "Wires and Cords for Original Equipment Manufacturers," General Electric Company, No. WCC-2, Library Code 185-79A
3. <u>Industrial Motor Users' Handbook of Insulation for Rewinds</u>, L. J. Rejda and Kris Neville, Elsevier, 1977, Library Code 255-80
4. "Raychem Corporation WCSF Thermal Aging Data," EDR-2001, Library Code 360-80A
5. Qualification Report, Westinghouse Electric Corporation, Type AB Circuit Breaker, Rev. 2, dated 11/30/79, Library Code 499-81
6. "Qualification Tests of Flame Guard FR-EP Instrumentation and Control Class 1E Electrical Cables in a Simulated Steam Line Break and Loss-of-Coolant Accident Environment," and Attachment AT-1, Franklin Institute Research Laboratory/The Anaconda Company, F-C4836-2, Library Code 517-81
7. BIW Cable Systems, Inc., Letter dated September 2, 1982 with Thermal Aging Data for GE Silicone Rubber Attached, BIW, Library Code 673-82

TABLE I: TEST SPECIMEN DESCRIPTION

Specimen Number	Splice Material	Configuration	Overlap	Age	Enclosure	Test Voltage	Station	Test Current
B-1	Raychem WCSF-N	Single conductor #14 Rockbestos to two 1/C #14 Rockbestos - WCSF-N splice.	1/2"	40 yrs	NEMA 12 w/weephole	132 VAC	Byron/ Braidwood	6.7A
B-2	Raychem WCSF-N	Single conductor #14 Rockbestos to two 1/C #14 Okonite - WCSF-N splice.	1/2"	40 yrs	NEMA 12 w/weephole	132 VAC	Byron/ Braidwood	6.7A
B-3	Raychem WCSF-N	Two 1/C #16 Rockbestos to three 1/C #16 Rockbestos - WCSF-N splice.	1/2"	40 yrs	NEMA 12 w/weephole	132 VAC	Byron/ Braidwood	5.0A
B-4	Okonite	#14 Okonite to #14 Okonite (lugged back to back) V-type splice with Okonite tape and no insulation tape in crotch.	-	40 yrs	NEMA 12 w/weephole	528 VAC	Byron/ Braidwood	6.7A
B-5	Okonite	#14 Okonite to #14 Nomex (pigtail from Limitorque) (lugged back to back) V-type splice with Okonite tape and no insulation in crotch.	-	40 yrs	NEMA 12 w/weephole	528 VAC	Byron/ Braidwood	6.7A
B-6	Okonite	#10 Okonite to #10 Okonite (lugged back to back) V-type splice with Okonite tape and no insulation in crotch.	-	40 yrs	NEMA 12 w/weephole	528 VAC	Byron/ Braidwood	10.A
B-7	Okonite	500 MCM Okonite to 500 MCM Okonite V-type splice with Okonite tape.	-	40 yrs	NEMA 12 w/weephole	528 VAC	Byron/ Braidwood	15A

TABLE 6: TEST SPECIMEN DESCRIPTION

Specimen Number	Splice Material	Configuration	Overlap	Age	Enclosure	Test Voltage	Station	Test Current
D-1	Raychem WCSF-N	14 ga. Rockbestos to 14 ga. Rockbestos. Oversized Raychem splice (WCSF-200).	2"	30 yrs	-	528 VAC	Dresden	6.7A
D-2	Raychem WCSF-N	12 ga. Rockbestos to 12 ga. Rockbestos. Undersized Raychem splice (WCSF-070).	2"	30 yrs	-	528 VAC	Dresden	6.7A
D-3	Scotch	12 ga. SIS wire to 12 ga. SIS wire. Scotch taped pigtail splice -Bechtel Procedure EP-12 -For in-drywell use: Scotch 130C, 70, 17.	-	30 yrs	NEMA 3 w/weephole	528 VAC	Dresden	6.7A
D-4	Scotch	12 ga. SIS wire to 12 ga. SIS wire. Scotch taped pigtail splice -Bechtel Procedure EP-12 -For outside drywell use: Scotch 130C, 33+.	-	30 yrs	NEMA 3 w/weephole	528 VAC	Dresden	6.7A
D-5	Raychem WCSF-N	14 ga. Rockbestos to solenoid non-impregnated braided jacket coil wire. Inline splice with Raychem WCSF-115.	2" (6" sleeve)	30 yrs	-	528 VAC	Dresden	6.7A
D-6	Raychem WCSF-N	14 ga. Rockbestos to solenoid non-impregnated braided jacket coil wire. Inline splice with Raychem WCSF-115.	1"	30 yrs	-	528 VAC	Dresden	6.7A
D-7	Raychem WCSF-N	14 ga. Rockbestos to impregnated braid coil wire. Inline splice with Raychem WCSF-115.	2"	30 yrs	-	528 VAC	Dresden	6.7A
D-8	Raychem WCSF-N	14 ga. Rockbestos SIS to impregnated braid coil wire. Inline splice with Raychem WCSF-115.	1"	30 yrs	-	528 VAC	Dresden	6.7A
D-9	Raychem WCSF-N	14 ga. Rockbestos SIS to 14 ga. Rockbestos SIS. Inline splice with Raychem WCSF-115 with min. bend violation (tie wrapped bend).	2"	30 yrs	-	132 VAC	Dresden	6.7A
D-10	Raychem WCSF-N	14 ga. Rockbestos SIS to 14 ga. Rockbestos SIS. Raychem WCSF-115 over insulated butt splice (in range).	2"	30 yrs	-	528 VAC	Dresden	6.7A

TABLE I: TEST SPECIMEN DESCRIPTION

Specimen Number	Splice Material	Configuration	Overlap	Age	Enclosure	Test Voltage	Station	Test Current
D-11	Raychem WCSF-N	14 ga. Rockbestos SIS to 14 ga Rockbestos SIS. Raychem WCSF-115 over insulated butt splice (outside range).	2"	30 yrs	-	528 VAC	Dresden	6.7A
D-12	Raychem WCSF-N	14 ga. Rockbestos SIS to 14 ga. Rockbestos SIS. Inline splice with Raychem WCSF-115.	1/4"	30 yrs	-	528 VAC	Dresden	6.7A
D-13	Raychem WCSF-N	14 ga. Rockbestos SIS to 14 ga. Rockbestos SIS. Inline splice with Raychem WCSF-115.	1/2"	30 yrs	-	528 VAC	Dresden	6.7A
D-14	Raychem WCSF-N	14 ga. Rockbestos SIS to 14 ga. Rockbestos SIS inline WCSF-115.	3/4"	30 yrs	-	528 VAC	Dresden	6.7A
D-15	Raychem WCSF-N	14 ga. Rockbestos SIS to 14 ga. Rockbestos SIS. Inline splice with Raychem WCSF-115.	1"	30 yrs	-	528 VAC	Dresden	6.7A
D-16	Raychem NMCK	14 ga. Rockbestos SIS to 14 ga. Rockbestos SIS. Raychem NMCK kit with butt tab trimmed by 1/2".	-	30 yrs	NEMA 3 w/weephole	528 VAC	Dresden	6.7A
D-17	Raychem NMCK	12 ga. braided motor lead to 12 ga. braided motor lead (silicon wire). Inside drywell - Raychem NMCK kit.	-	30 yrs	NEMA 3 w/weephole	528 VAC	Dresden	6.7A
D-18	AMP	G.E. Vulkene SIS 14, (#204M), Unit 3 drywell sample with Amp window splice.	-	15 yrs (10 yrs natural aging)	NEMA 3 w/weephole	528 VAC	Dresden	6.7A
D-19	AMP	G.E. Vulkene SIS #14, (#204M) Unit 3 drywell sample with Amp window splice.	-	15 yrs (10 yrs natural aging)	NEMA 3 w/weephole	132 VAC	Dresden	6.7A
D-20	Scotch	12 ga. SIS wire to 12 ga. SIS wire Scotch taped pigtail splice -Bechtel Procedure EP-12 -For in-drywell use: Scotch 130C, 70, 17.	-	15 yrs	NEMA 3 w/weephole	528 VAC	Dresden	6.7A
D-21	Scotch	12 ga. SIS wire to 12 ga. SIS wire Scotch taped pigtail splice -Bechtel Procedure EP-12 -For outside drywell use: Scotch 130, 30+.	-	15 yrs	NEMA 3 w/weephole	528 VAC	Dresden	6.7A

TABLE 5: TEST SPECIMEN DESCRIPTION

Specimen Number	Splice Material	Configuration	Overlap	Age	Enclosure	Op. Voltage	Station	Test Current
L-1	Raychem WCSF-N	Kapton insulated #16 AWG wire connected to Eaton Corp. (Samuel Moore Dekoron) #16 AWG wire. Overlap of Raychem sleeve on each wire insulation is 1/8".	1/8"	40 yrs	-	528 VAC	LaSalle	1.0A
L-2	Raychem WCSF-N	Kapton insulated #16 AWG wire connected to Eaton Corp. (Samuel Moore Dekoron) #16 AWG wire. Overlap of Raychem sleeve on each wire insulation is 1/4".	1/4"	40 yrs	-	528 VAC	LaSalle	1.0A
L-3	Raychem WCSF-N	Eaton Corp. (Samuel Moore Dekoron) #16 AWG, XLPE insulated wire, 2 lengths. Overlap of Raychem sleeve on each wire insulation is 1/8".	1/8"	40 yrs	-	528 VAC	LaSalle	1.0A
L-4	Raychem WCSF-N	Eaton Corp. (Samuel Moore Dekoron) #16 AWG, XLPE insulated wire, 2 lengths. Overlap of Raychem sleeve on each wire insulation is 1/4".	1/4"	40 yrs	-	528 VAC	LaSalle	1.0A
L-5	Raychem WCSF-N	Okonite #14 AWG EPR insulated wire, 2 lengths. Overlap of Raychem sleeve on each wire insulation is 1/8".	1/8"	40 yrs	-	528 VAC	LaSalle	6.7A
L-6	Raychem WCSF-N	Okonite #14 AWG EPR insulated wire, 2 lengths. Overlap of Raychem sleeve on each wire insulation is 1/4".	1/4"	40 yrs	-	528 VAC	LaSalle	6.7A
L-7	Raychem WCSF-N	Kapton insulated #14 AWG wire connected to Okonite #14 wire EPR insulated wire. Overlap of Raychem sleeve on each wire insulation is 1/8".	1/8"	40 yrs	-	528 VAC	LaSalle	6.7A
L-8	Raychem WCSF-N	Kapton insulated #14 wire AWG wire connected to Okonite #14 wire EPR insulated wire. Overlap of Raychem sleeve on each wire insulation is 1/4".	1/4"	40 yrs	-	528 VAC	LaSalle	6.7A
L-9	Raychem WCSF-N	Raychem Flamtrol #16 AWG XLPO insulated wire connected to Eaton Corp. (Samuel Moore Dekoron) #16 AWG XLKPE insulated wire. Overlap of Raychem sleeve on each wire insulation is 1/8".	1/8"	40 yrs	-	528 VAC	LaSalle	1.0A

TABLE I: TEST SPECIMEN DESCRIPTION

Specimen Number	Splice Material	Configuration	Overlap	Age	Enclosure	Test Voltage	Station	Test Current
L-10	Raychem WCSF-N	Raychem Flamtrol #16 AWG XLPE insulated wire connected to Eaton Corp. (Samuel Moore Dekoron) #16 AWG XLPE insulation wire, overlap of Raychem on each wire is 1/4".	1/4"	40 yrs	-	528 VAC	LaSalle	1.0A
L-11	Okonite	Eaton Corp. (Samuel Moore Dekoron) #16 AWG XLPE, 2 lengths. Okonite #T-95 insulating tape and No. 35 jacketing tape. Spliced in accordance with procedure HPFCO-WI-500.	-	40 yrs	NEMA 3 w/weephole	528 VAC	LaSalle	1.0A

TABLE I: TEST SPECIMEN DESCRIPTION

Specimen Number	Splice Material	Configuration	Overlap	Age	Enclosure	Test Voltage	Station	Test Current
Q-1	Scotch	#14 Rockbestos SIS to #14 Eaton Dekoron (Samuel Moore). Scotch taped splice 130C, 33+.	-	15	NEMA 3 w/weephole	528 VAC	Quad Cities	6.7A
Q-2	Scotch	#14 Rockbestos SIS #14 Eaton Dekoron (Samuel Moore). Scotch taped splice 130C, 33+.	-	30	NEMA 3 w/weephole	528 VAC	Quad Cities	6.7A
Q-3	Scotch	#14 Rockbestos SIS to #14 Eaton Dekoron (Samuel Moore). Scotch taped splice 130C, 33+.	-	15	NEMA 3 w/weephole	528 VAC	Quad Cities	6.7A
Q-4	Scotch	#14 Rockbestos SIS to #14 Eaton Dekoron (Samuel Moore). Scotch taped splice 130C, 33+.	-	30	NEMA 3 w/weephole	132 VAC	Quad Cities	6.7A
Q-5	AMP	#14 Rockbestos SIS to #14 Eaton Dekoron (Samuel Moore). Amp Commercial grade window splices (PIDG splice, Model 320570).	-	40	NEMA 3 w/weephole	132 VAC	Quad Cities	6.7A
Q-6	AMP	#14 Rockbestos SIS to #14 Eaton Dekoron (Samuel Moore). Amp Commercial grade window splices (PIDG splice, Model 320570).	-	40	NEMA 3 w/weephole	528 VAC	Quad Cities	6.7A
Q-7	Raychem WCSF-N	#14 Rockbestos SIS to #14 Eaton Dekoron (Samuel Moore). Raychem sleeve WCSF-70 over Amp window splices (PIDG splice Model 379570).	2"	15	-	132 VAC	Quad Cities	6.7A
Q-8	Raychem WCSF-N	#14 Rockbestos SIS to #14 Eaton Dekoron (Samuel Moore). Raychem sleeve WCSF-70 over AMP window splices (PIDG splice, Model 320570).	2"	30	-	132 VAC	Quad Cities	6.7A
Q-9	Raychem WCSF-N	#14 Rockbestos SIS to #14 Eaton Dekoren. Raychem sleeve WCSF-115 over 1/2" bolted connection (Ref. QC #2).	1-1/2"	15	-	132 VAC	Quad Cities	6.7A
Q-10	Raychem WCSF-N	#14 Rockbestos SIS to #14 Eaton Dekoron Raychem sleeve WCSF-115 over 1/2" bolted connection.	1-1/2"	30	-	132 VAC	Quad Cities	6.7A

TABLE I: TEST SPECIMEN DESCRIPTION

Specimen Number	Splice Material	Configuration	Overlap	Age	Enclosure	Test Voltage	Station	Test Current
Q-11	Raychem WCSF-N	#14 Rockbestos SIS to #14 Eaton Dekoron. Raychem sleeve WCSF-200 over 1/2" bolted connection.	1-1/2"	15	-	132 VAC	Quad Cities	6.7A
Q-12	Raychem WCSF-N	#14 Rockbestos SIS to #14 Eaton Dekoron. Raychem sleeve WCSF-200 over 1/2" bolted connection.	1-1/2"	30	-	132 VAC	Quad Cities	6.7A
Q-13	AMP	G.E. Vulkene SIS #14 one end only. Specimen removed from Unit 2 drywell penetration after in service a minimum of 10 years. AMP window splice.	-	15	NEMA 3 w/weephole	132 VAC	Quad Cities	6.7A
Q-14	AMP	G.E. Vulkene SIS #14 one end only. Specimen removed from Unit 2 drywell penetration after in service a minimum of 10 years. AMP window splice.	-	15	NEMA 3 w/weephole	528 VAC	Quad Cities	6.7A
Q-15	AMP	G.E. Vulkene SIS #14 one end only. Specimen removed from Unit 2 drywell penetration after in service a minimum of 10 years. AMP window splice.	-	20	NEMA 3 w/weephole	132 VAC	Quad Cities	6.7A
Q-16	AMP	G.E. Vulkene SIS #14 one end only. Specimen removed from Unit 2 drywell penetration after in service a minimum of 10 years. AMP window splice.	-	20	NEMA 3 w/weephole	528 VAC	Quad Cities	6.7A
Q-17	AMP	G.E. Vulkene SIS #14 one end only. Specimen removed from Unit 2 drywell penetration after in service a minimum of 10 years. AMP window splice.	-	1	NEMA 3 w/weephole	132 VAC	Quad Cities	6.7A
Q-18	AMP	G.E. Vulkene SIS #14 one end only. Specimen removed from Unit 2 drywell penetration after in service a minimum of 10 years. AMP window splice.	-	1	NEMA 3 w/weephole	132 VAC	Quad Cities	6.7A
Q-19	AMP	G.E. Vulkene SIS #14 one end only. Specimen removed from Unit 2 drywell penetration after in service a minimum of 10 years. AMP window splice.	-	1	NEMA 3 w/weephole	528 VAC	Quad Cities	6.7A
Q-20	AMP	G.E. Vulkene SIS #14 one end only. Specimen removed from Unit 2 drywell penetration after in service a minimum of 10 years. AMP window splice.	-	1	NEMA 3 w/weephole	528 VAC	Quad Cities	6.7A

TABLE I: TEST SPECIMEN DESCRIPTION

Specimen Number	Splice Material	Configuration	Overlap	Age	Enclosure	Test Voltage	Station	Test Current
Z1	Raychem NPKV	#14 BIW(Boston Insulated Wire) single conductor to ASCO solenoid valve lead wire w/non-impregnated braid -Raychem stub type connector NPKV-2-10A.	-	40 yrs	NEMA 3 w/weephole	132 VAC	Zion	6.7A
Z2	Raychem NPKS	#14 BIW to #16 Kapton insulated wire -Raychem NPKS-1-11A.	1/2"	40 yrs	-	36 VDC	Zion	20mA*
Z3	Raychem NPKS	#14 BIW to #16 Kapton insulated wire -Raychem NPKS-1-11A.	3/4"	40 yrs	-	36 VDC	Zion	20 mA*
Z4	Raychem NPKS	#14 BIW single conductor to Static-O-Ring switch lead wire w/impregnated braid -Raychem NPKS-1-11A.	1/2"	40 yrs	NEMA 3 w/weephole	132 VAC	Zion	6.7A
Z5	Raychem NPKS	#14 BIW single conductor to Static-O-Ring switch lead wire w/impregnated braid -Raychem NPKS-1-11A.	3/4"	40 yrs	NEMA 3 w/weephole	132 VAC	Zion	6.7A
Z6	Raychem NPKV	#14 field conductor BIW to silicone hi-temp braid motor lead -Raychem NPKV-2-10A.	-	40 yrs	NEMA 3 w/weephole	528 VAC	Zion	6.7A
Z7	Kerite	#14 BIW to #14 BIW - V-type splice with Kerite tape with putty in crotch.	-	40 yrs	NEMA 3 w/weephole	528 VAC	Zion	6.7A
Z8	Raychem NPKS	#14 BIW to #14 BIW -Raychem NPKS-1-11A with 180 degree bend.	1/2"	40 yrs	NEMA 3 w/weephole	132 VAC	Zion	6.7A
Z9	Raychem NPKS	#14 BIW to #14 BIW -Raychem NPKS 1-11A with 180 degree bend.	1"	40 yrs	NEMA 3 w/weephole	132 VAC	Zion	6.7A
Z10	Raychem NPKS	#14 BIW to #14 BIW -Raychem NPKS 1-11A with 180 degree bend.	2"	40 yrs	NEMA 3 w/weephole	132 VAC	Zion	6.7A
Z11	Kerite	#14 BIW to silicone hi-temp non-impregnated braid motor lead -Kerite tape over bolted V connector with putty in crotch.	-	40 yrs		528 VAC	Zion	6.7A

*Full scale output of a Omega differential pressure transmitter.

TABLE I: TEST SPECIMEN DESCRIPTION

Specimen Number	Splice Material	Configuration	Overlap	Age	Enclosure	Test Voltage	Station	Test Current
Z12	Kerite	#14 BIW to silicone hi-temp non-impregnated braid motor lead -Kerite tape over bolted V connector with putty in crotch.	-	40 yrs	NEMA 12 w/weephole	528 VAC	Zion	6.7A
Z13	Kerite	#14 BIW to #14 BIW - V type splice with Kerite tape with putty in crotch.	-	40 yrs	NEMA 12 w/weephole	528 VAC	Zion	6.7A

TABLE II: CECO 17859 AGING MATRIX

Specimen	Splice Material	E_a,(eV)	QL Goal(yrs)	Baseline Temp.(°C)	Aging Temp.(°C)	Aging Time, (hrs)	Comments
Z-1 - Z-6	Raychem WCSF-N	1.29	40	50	115	149	
Z7, Z11, Z12, Z13	Kerite Tape	1.25	40	50	115	190	Kerite tape is Scotch silicone rubber
Z8 - Z10	Raychem WCSF-N	1.29	40	50	115	149	
B1 - B3	Raychem WCSF-N	1.29	40	50	115	149	
B4 - B7	Okonite Tapes	1.26	40	50	115	179	Okonite T-95 is insul. tape
L1 -L10	Raychem WCSF-N	1.29	40	65.56	130	298	
L 11	Okonite Tapes	1.26	40	65.56	130	352	Okonite T-95 is insul. tape
D1, D2, D5-D17	Raychem WCSF-N	1.29	30	65.56	130	224	
D3	Scotch 130C, 70, 17	1.25	30	65.56	130	279	Assume Scotch 70 is limiting
D4	Scotch 130C, 33+	1.15	30	65.56	130	482	33+ is insulation per CECo plus additional
D18, D19	AMP window splice	1.17	15	65.56	120	170	*10 years in service (natural aging) Nylon - 1.17 eV is 50% of elect. strength
D20	Scotch 130C, 70, 17	1.25	15	65.56	130	170	Same as D3
D21	Scotch 130C, 33+	1.15	15	65.56	130	241	Same as D4
Q1, Q3	Scotch 130C, 33+	1.15	15	65.56	130	241	Same as D4
Q2, Q4	Scotch 130C, 33+	1.15	30	65.56	130	482	Same as D4
Q5	AMP PIDG splice	1.17	40	65.56	120/130	89/538	Nylon
Q6	AMP PIDG splice	1.17	40	65.56	120/130	89/538	Same as Q5
Q7, Q9, Q11	Raychem WCSF-N	1.29	15	65.56	130	112	
Q8, Q10, Q12	Raychem WCSF-N	1.29	30	65.56	130	224	
Q13, Q14	AMP window splice	1.17	15	65.56	120	170	Same as D18 & D19 (10 yrs. nat. aging)
Q15, Q16	AMP window splice	1.17	20	65.56	120	339	Same as D18 & D19 (10 yrs. nat. aging)
Q17 - Q20	AMP window splice	1.17	11	65.56	115	53	Same as D18 & D19 (10 yrs. nat. aging)

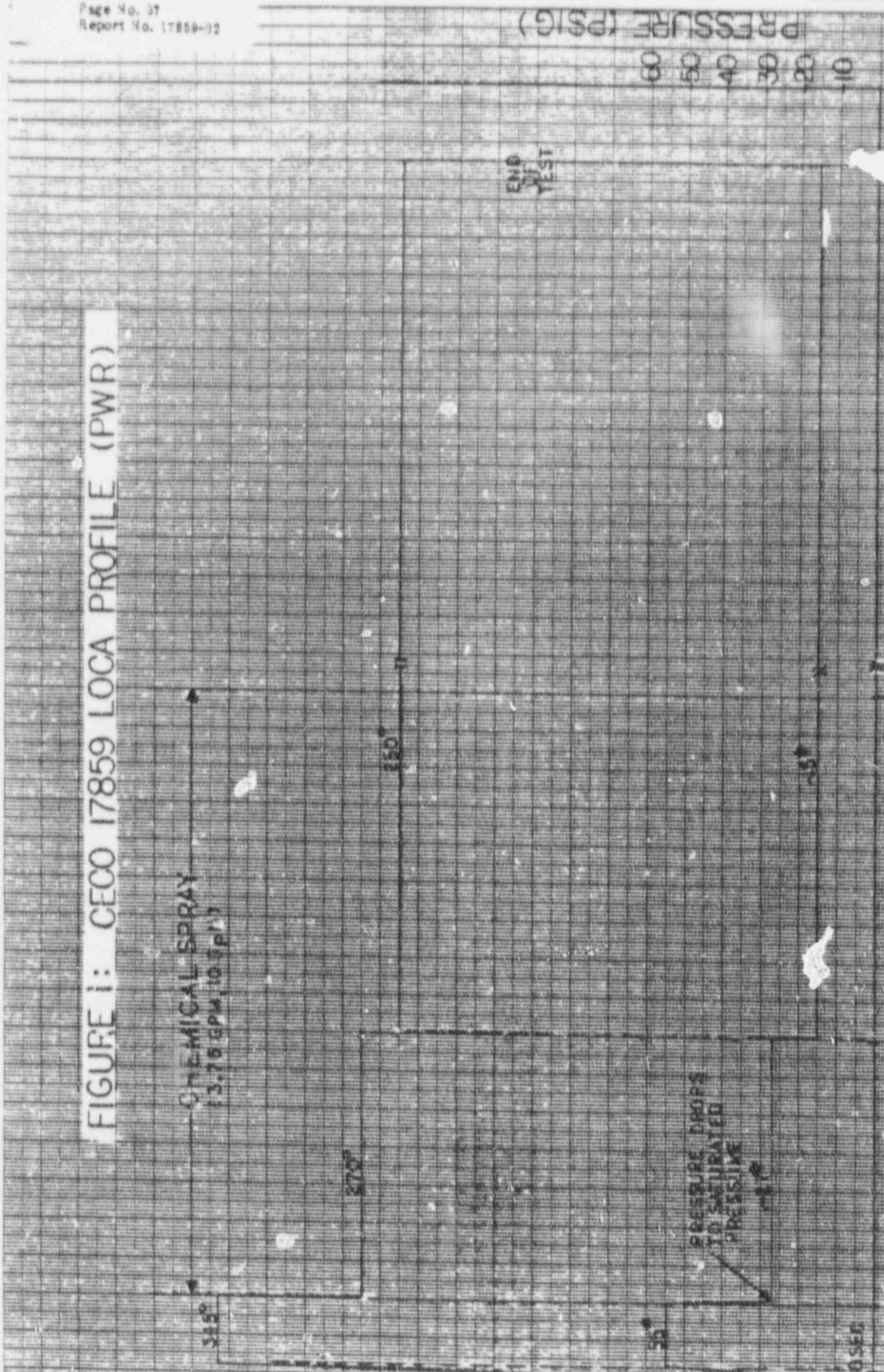

FIGURE 1: CECO 17859 LOCA PROFILE (PWR)

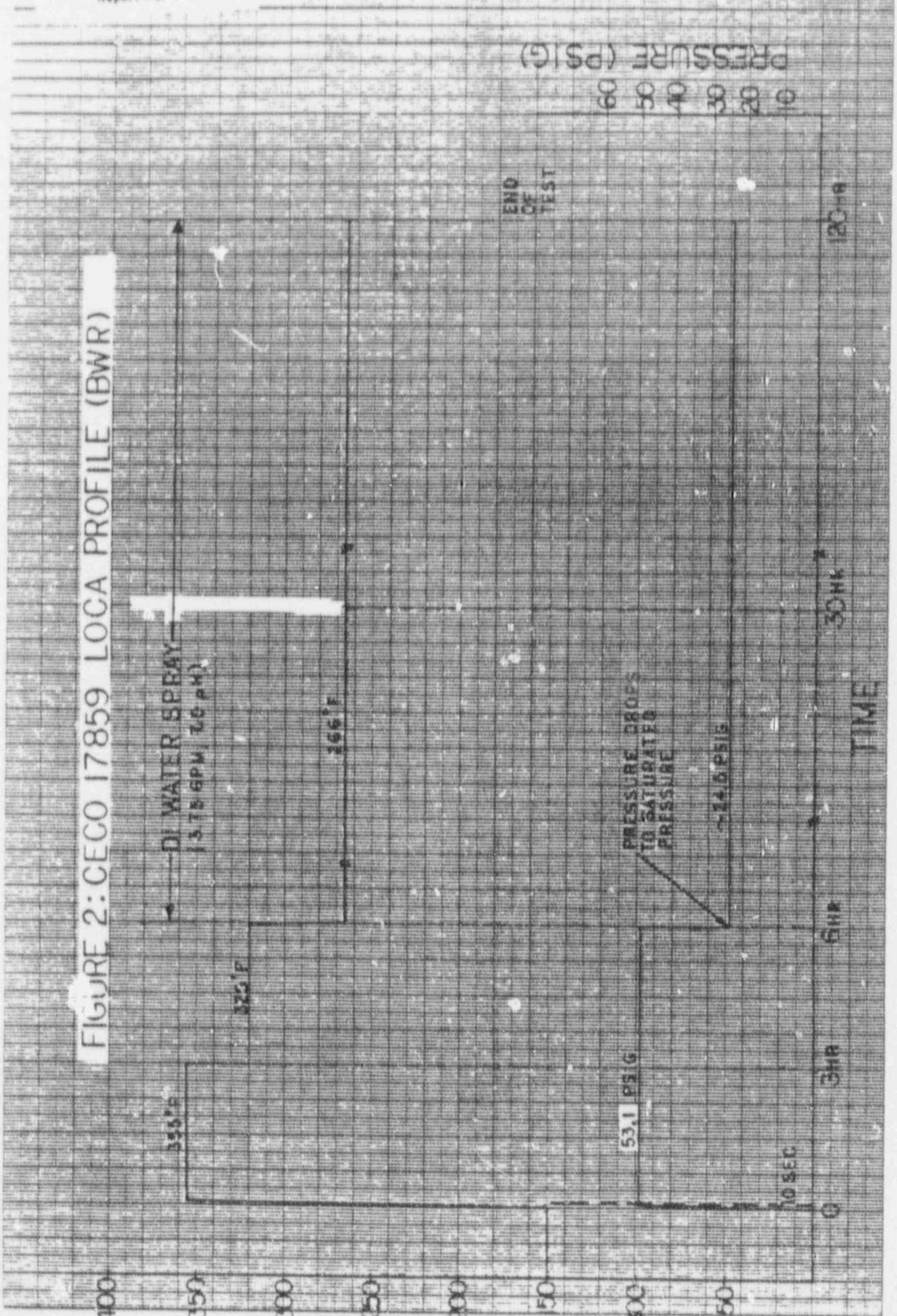

FIGURE 2: CECO 17859 LOCA PROFILE (BWR)

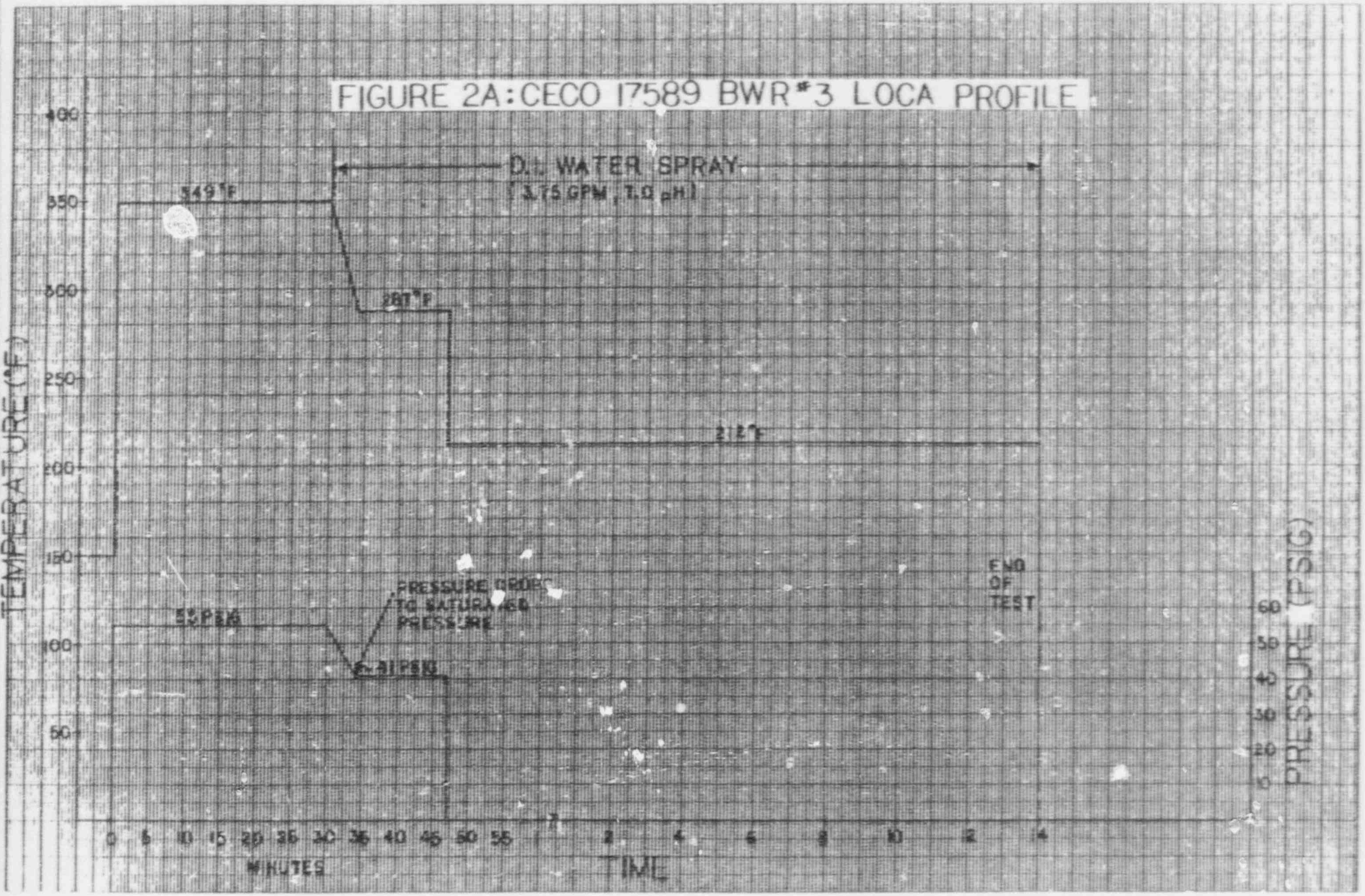

FIGURE 2A: CECO 17589 BWR#3 LOCA PROFILE

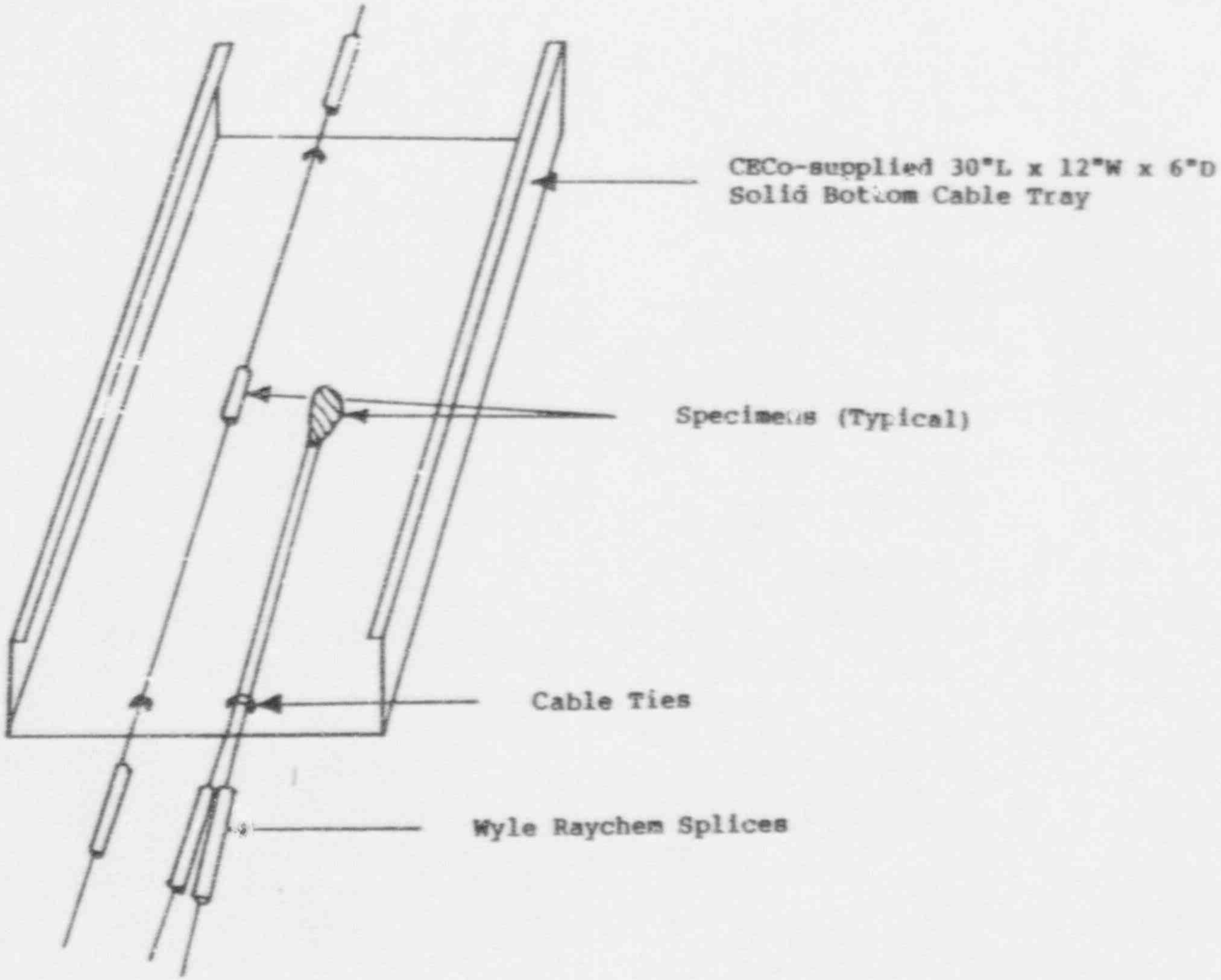

FIGURE 3. TYPICAL CABLE TRAY SETUP

WYLE LABORATORIES
SCIENTIFIC SERVICES & SYSTEMS GROUP
P. O. BOX 1008 • HUNTSVILLE, ALABAMA 35807
TWX (810) 726-2225 • TELEPHONE (205) 837-4411

QUALIFICATION PLAN

QUAL. PLAN 17859-01

DATE: August 11, 1986

TOTAL PAGES 20

REVISION A - 8/28/86
REVISION B - 9/18/86
REVISION C - 12/3/86 and
1/16/87
2/26/87
3/9/87

ENVIRONMENTAL QUALIFICATION OF RAYCHEM WCSF-N NUCLEAR CABLE SPLICES OKONITE TAPES, SCOTCH TAPES, KERITE TAPES AND AMP SPLICES B

AS INSTALLED ON VARIOUS WIRE INSULATIONS AT COMMONWEALTH EDISON COMPANY'S LASALLE COUNTY , ZION, DRESDEN, QUAD CITIES BYRON, AND BRAIDWOOD NUCLEAR GENERATING STATIONS B

APPROVED BY: A. Horsman 8/11/86
PROJECT MANAGER: A. Horsman

APPROVED BY: F. Johnson 8/11/86
FOR: ENVIRONMENTAL QUALIFICATION
F. Johnson

APPROVED BY: G. W. Hight 8/11/86
QUALITY ASSURANCE: G. W. Hight

PREPARED BY: J. Hazeltine 8-11-86
PROJECT ENGINEER: J. Hazeltine

REVISIONS

(DN411) FORM 1109-1/8-81

REV. NO.	DATE	PAGE OR PARAGRAPH AFFECTED	BY	APP'L	DESCRIPTION OF CHANGES
A	8/28/86	All	JTH		Revised to incorporate Interim
			8/28/86	8/28/86	Procedure Revisions 1 and 2
				8/28/86	
				8/28/86	
B	9/17/86	All	JTH		Revised to incorporate Interim
			9/17/86	9/18/86	Procedure 1 to Rev. A, correct
				9/18/86	typographical errors, and add
				9/19/86	details on PWR LOCA test.

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REVISIONS

REVISION C
REPORT NO. 17859-01
DATE: December 5, 1986

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

REV NO	DATE	PAGE OR PARAGRAPH AFFECTED	BY	APP'L	DESCRIPTION OF CHANGES
C	12/5/86	All	ARH	12/9/86 3-11-87	Incorporate IPRs B-1 and B-2. IPR B1 added instrumentation requirement for PWR LOCA test of Para. 3.3.1., provided details of BWR LOCA test per Para. 3.3.2 and added various electrical schematic and setup figures. IPR B-2 added Specimens Q13 through Q20, provided basis for activation energies and thermal aging program summary.
C	1/16/87	Para. 3.5	ARH		Added "Bureau" in last sentence
C	2/26/87	Para. 1.4, Table I	JH	3-16-87	Incorporate CECo comments
C	3/9/87	iii. 5 and Appendix IV all pages	JH	3-16-87	Add splice construction details

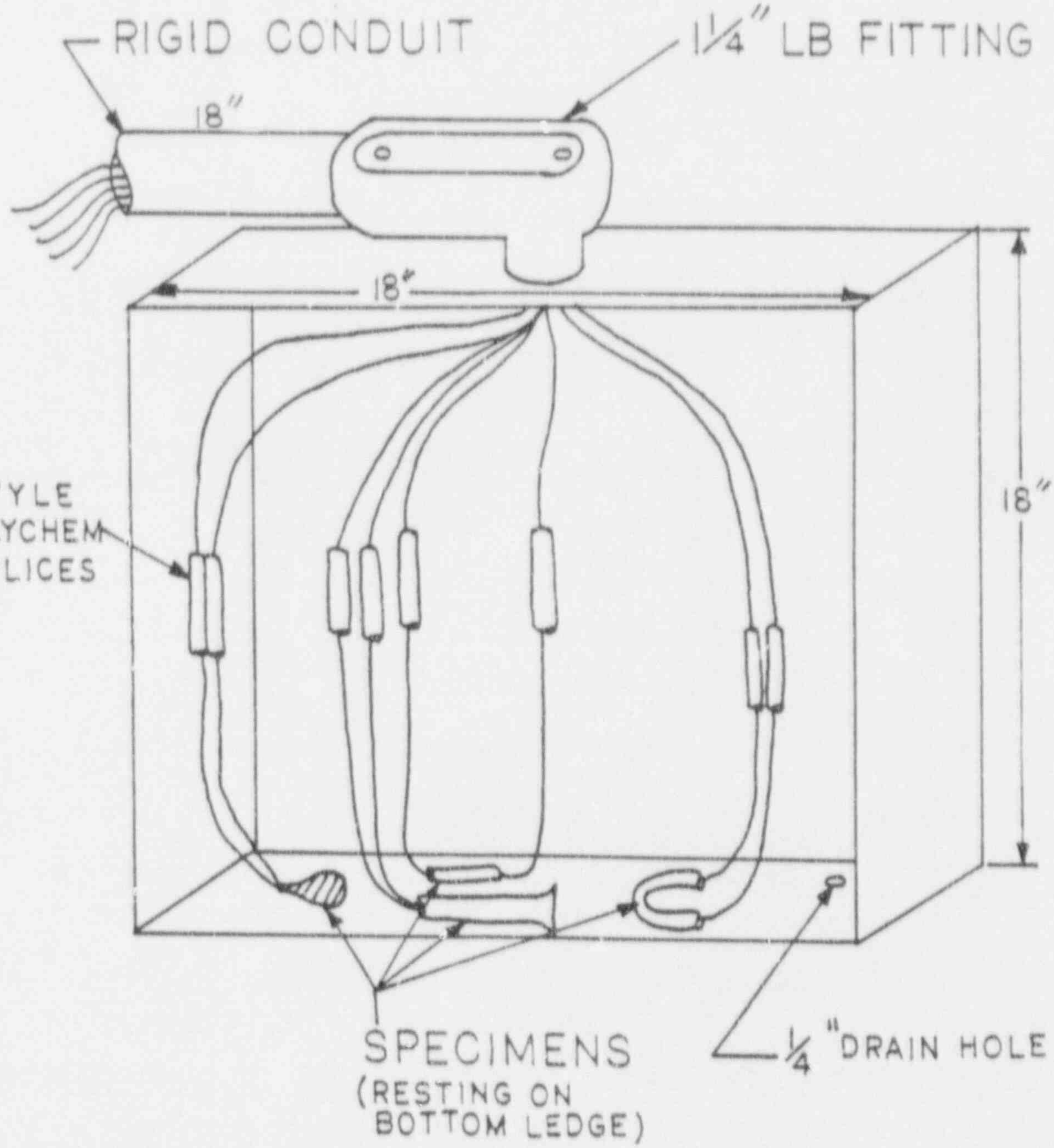


FIGURE 4. TYPICAL NEMA 3 ENCLOSURE TEST SETUP

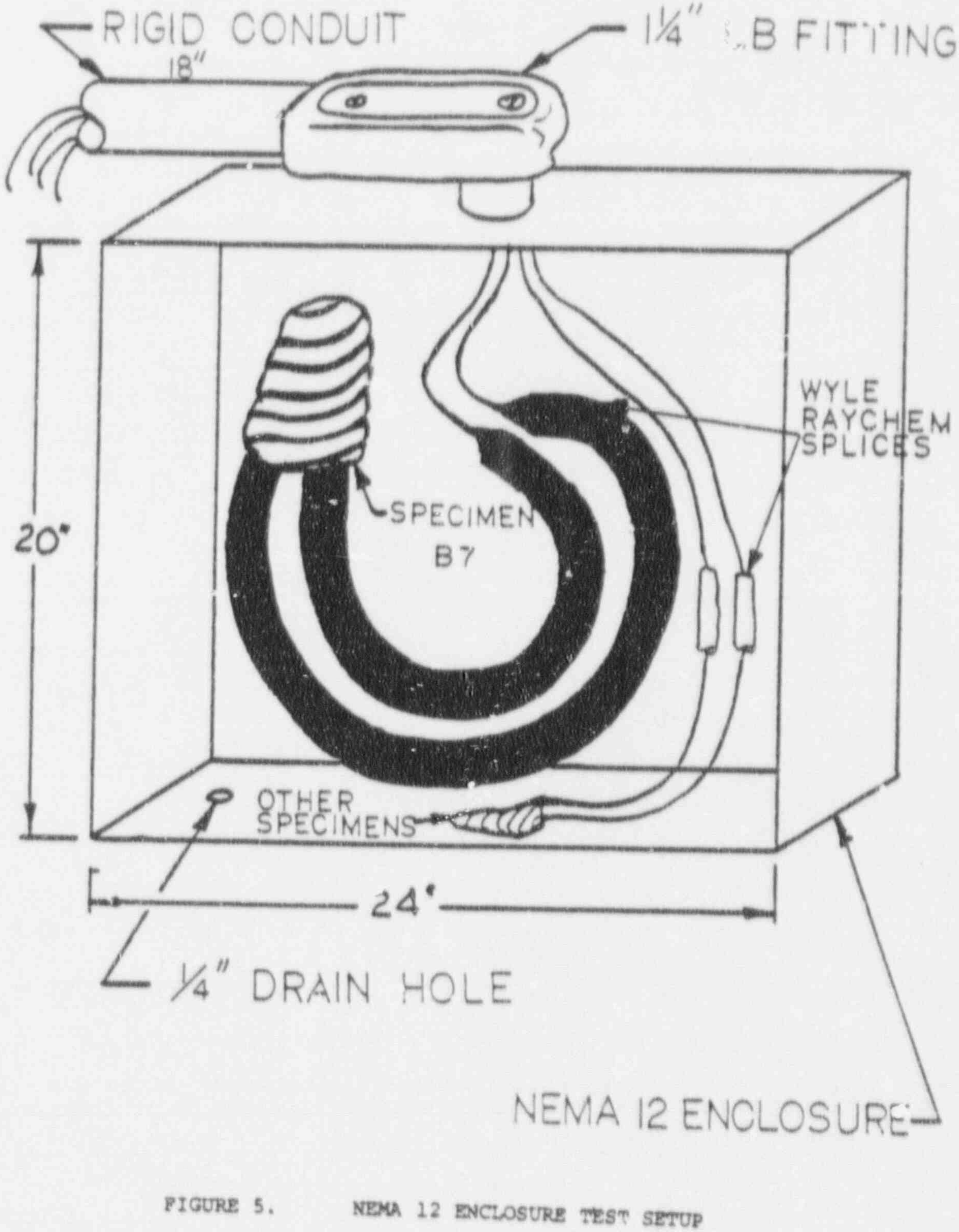
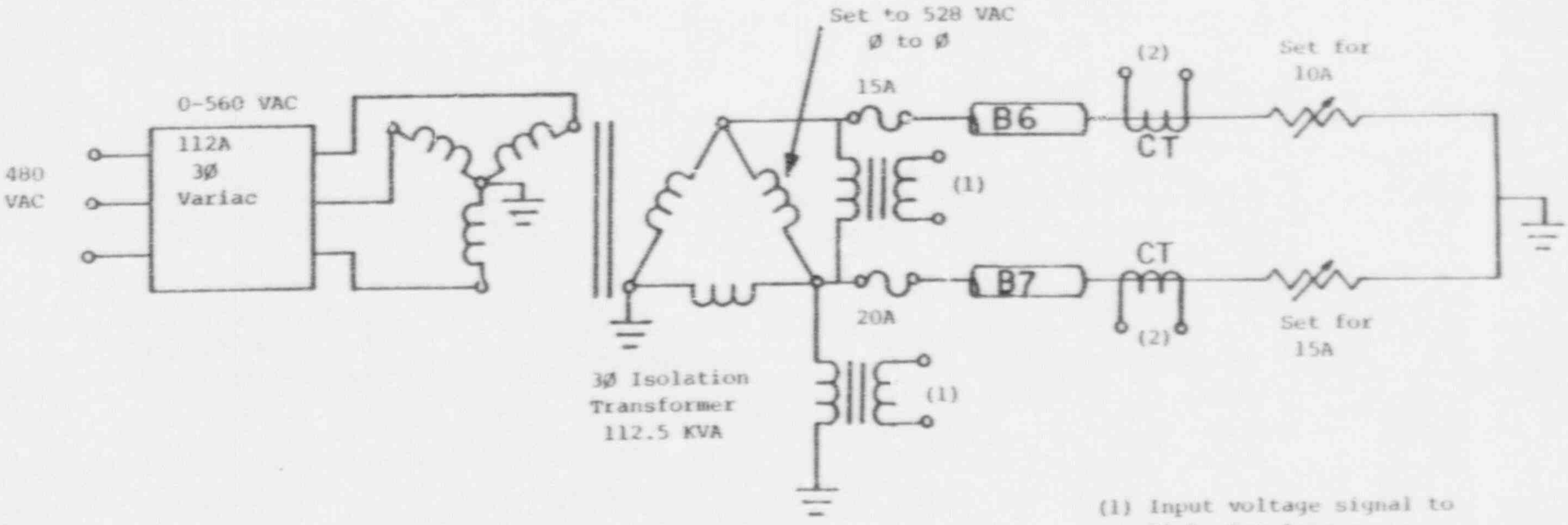


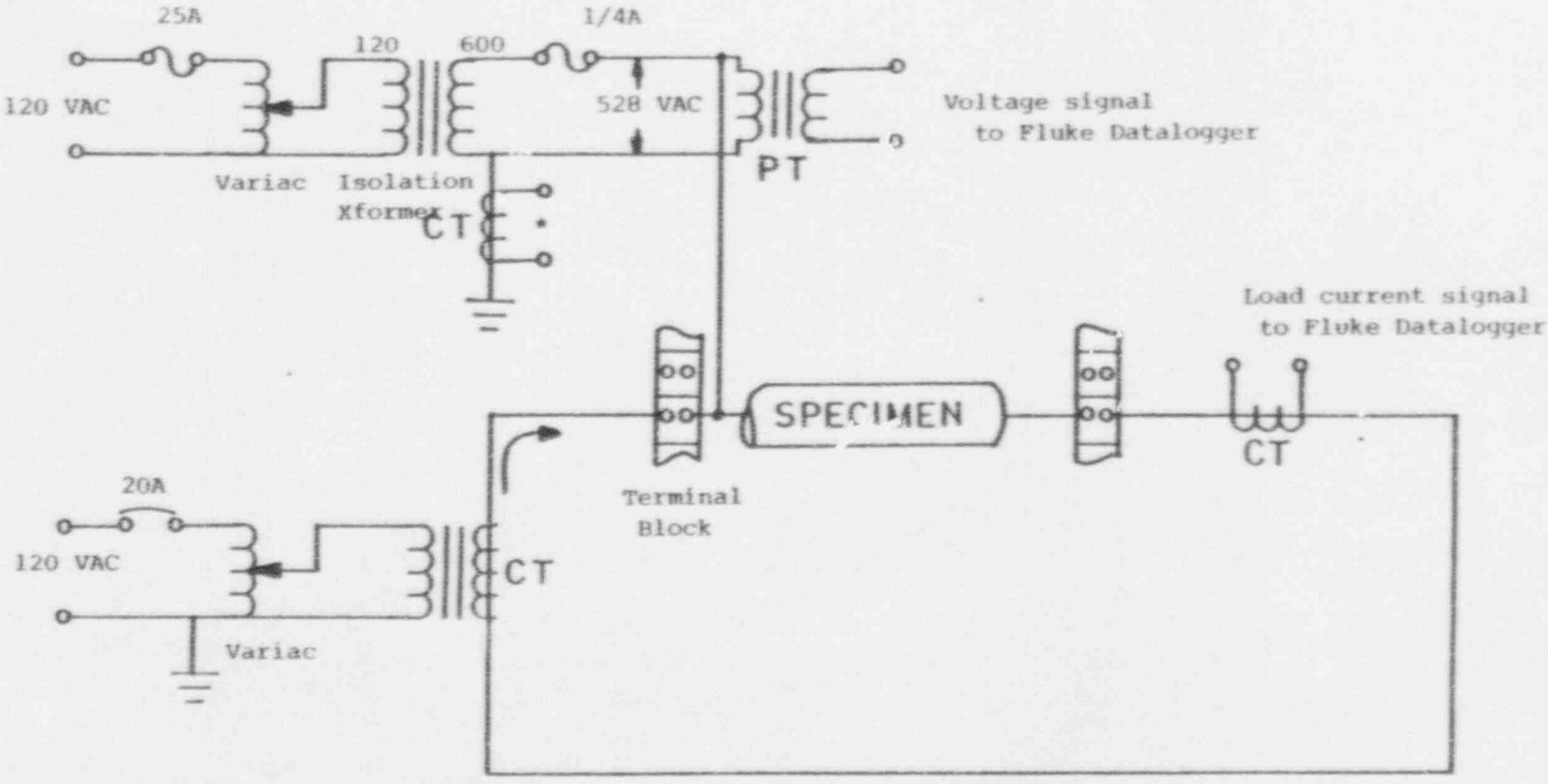
FIGURE 5. NEMA 12 ENCLOSURE TEST SETUP



(1) Input voltage signal to Fluke Datalogger

(2) Applied current signal to Fluke Datalogger

FIGURE 6. ELECTRICAL SETUP FOR SPECIMENS B6 AND B7



*Leakage current to ground signal to Daytronics Data Acquisition System.

FIGURE 7. TYPICAL ELECTRICAL SETUP FOR 528 VAC AND 6.7A OR 5A CIRCUITS

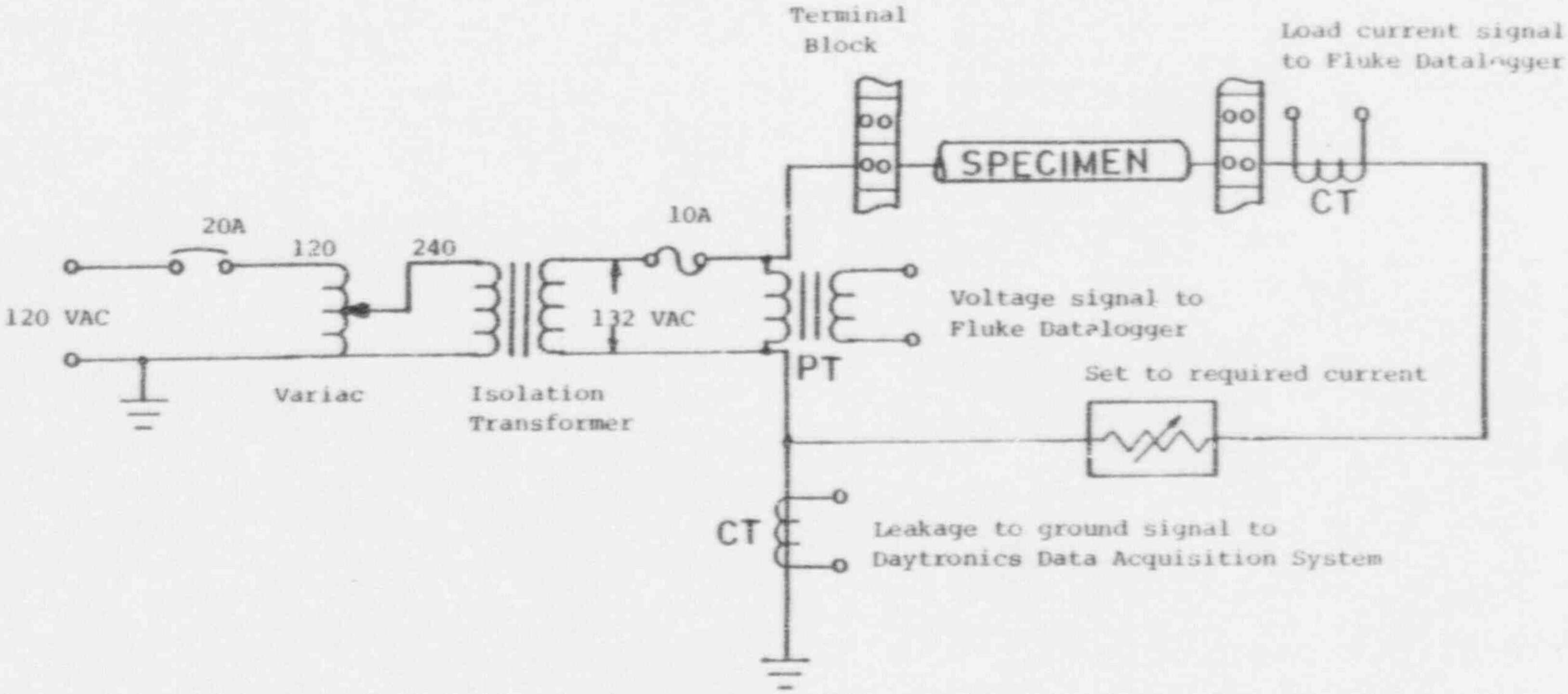


FIGURE 8. TYPICAL ELECTRICAL SETUP FOR 132 VAC CIRCUITS

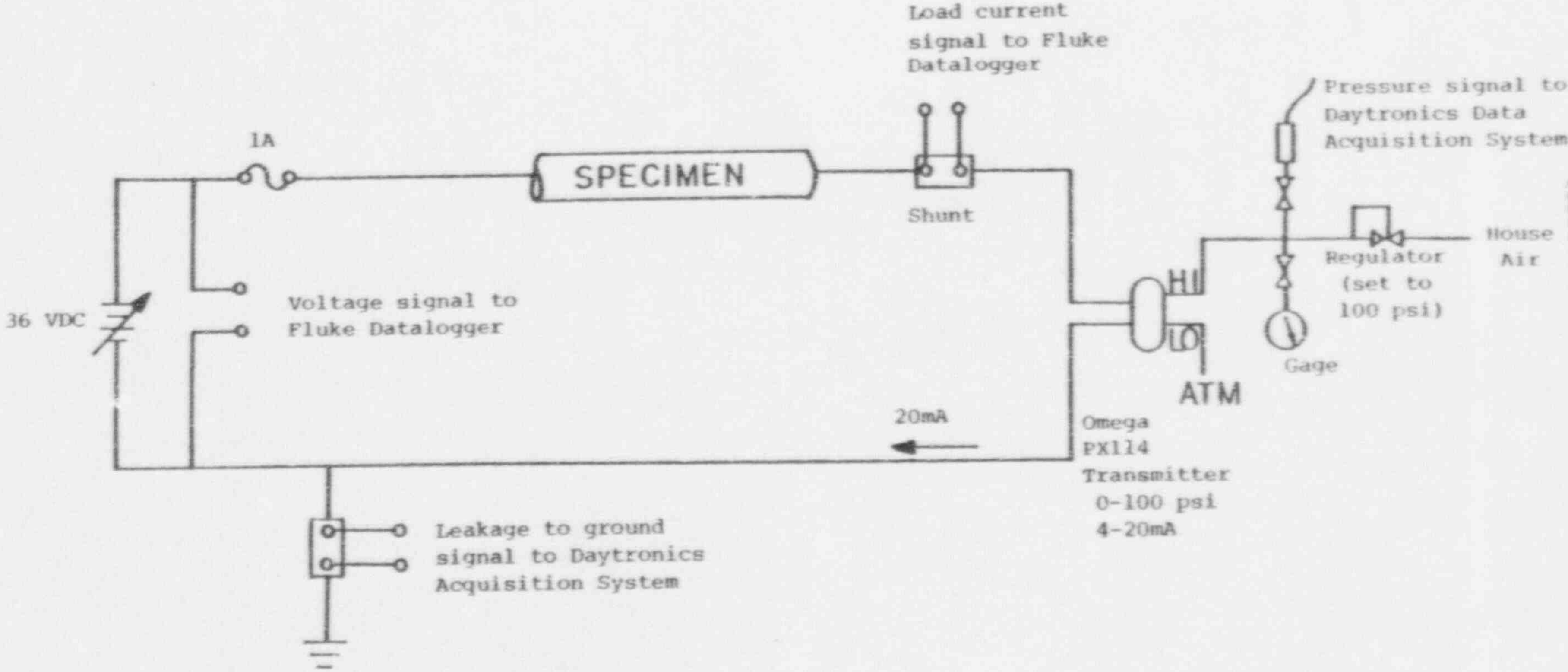


FIGURE 9. TYPICAL ELECTRICAL SETUP FOR SPECIMENS Z2 AND Z3

APPENDIX I

Splice Preparation Procedures

R-1

WI-500 Addendum #3
Rev. 1

Procedure No: WI-500

Revision No: N/A

TITLE: ADDENDUM ON FIELD TEST OF T-95 & #35 OKONITE TAPE

Prepared by: Ronald W Ramsey Date 2-11-83

Reviewed by: Dan L. Heider Date 2-11-83
Manager, Quality

Approved by: R.O. Liles Date 2-14-83
Project Manager

Approved by: B. Hirst Date 2.16.83
Director, Quality Assurance

CECo Acceptance: Per CECo letter dated 4/4/83

Foley
THE
HOWARD P. FOLEY
COMPANY

ADDENDUM - WI-500

ADDENDUM ON FIELD TEST OF T-95 & #35 OKONITE TAPE

The shelf life for T-95 Okonite tape is 12 months from date of manufacture. The shelf life for #35 Okonite tape is 24 months from date of manufacture. Okonite tapes remain usuable beyond shelf life expiration date, provided the following two (2) in-field tests can be passed.

1. When stretching the tape to 3/4 of its original width, the tape should not rupture or tear.
2. Wrap several half-lapped layers around a dowel or any other object to simulate a cable. The layers should be applied under a tension described above. After lightly squeezing the half-lapped layers, slice open the taped mass along the axis of the dowel. If the taped layers are inseparable, (fused together), the tape is acceptable for use.

The Craft shall notify Quality Control prior to performing the test. Quality Control shall monitor the tests through in-process inspections.

References:

Mark Teras memo dated 1/14/83.

WI-500 Addendum #4
Rev. 1

R-1

PROCEDURE CLARIFICATION

Terminations made at motors 480V and below are to be performed in the following manner:

1. Lugs are to be bolted together with the appropriate bolt type and associated hardware. Bolting material for bolt diameter of 3/8" and larger are to be stainless steel in accordance with CECo Standard C-849.
2. Any voids that exist between the attached lugs are to be filled by the use of Okonite rubber cement and sufficient layers of Okonite T-95 tape as applicable to prevent moisture creepage.
3. Apply Okonite rubber cement over both lugs and exposed conductor area. Let dry until cement becomes tacky.
4. Using Okonite T-95 tape, wrap both lugs a minimum of two half-laps, paying attention to completely softening the bolt attachment.
5. Apply a minimum of two half-laps of Okonite O-35 tape. The layers of O-35 should extend approximately one inch past the boundary of the lugs on to the cable jacket.

Richard Ouzts
Manager, Quality (HPFCo)

Ken W Steele 10/24/79
K. Steele
CECo Project Engineer

References:

HPFCo WI-500, Rev. 7
S&L Std. EA-209
S&L Dwg. 1E-0-3089
CECo Std. C-849

[illegible]
312 [illegible]

WI-500 Addendum #3
Rev. 1

R-1

January 11, 1983

Mr. Jim Phelan
Principal Engineer
Commonwealth Edison Company
Post Office Box 767
Chicago, Illinois 60690

RE: T-95, #35 Okonite Tapes

Dear Mr. Phelan:

The shelf life for the subject tapes remains as stated below and as in my previous December 21, 1982 letter:

T-95 -- 12 months from date of manufacture

#35 -- 24 Months from date of manufacture

However, the term shelf life must be further defined so that unnecessary restrictions are not invoked regarding the use of Okonite tapes. Okonite tapes remain useable provided that the following two (2) in-field tests can be passed:

1. When stretching the tape to 3/4 of its original width, the tape should not rupture or tear.
2. Wrap several half-lapped layers around a dowel or any other object to simulate a cable. The layers should be applied under the tension described above. After lightly squeezing the half-lapped layers, slice open the taped mass along the axis of the dowel. If the taped layers are inseparable, (fused together), the tape is acceptable for use.

Due to the many varying conditions under which tapes are stored in the field, the "shelf life" parameter is used to assist the the customer in keeping fresh, useable tape on the jobsite. Expiration of the recommended shelf life does not mandate that the tape is not suitable for use.

Please advise this office if you have further questions in this matter.

Very truly yours,

THE OKONITE COMPANY

Donald N. Martin
District Manager

DNM:rc

3.0 ACTIVITIES INVOLVED (con't.)

R-10 21. All wiring shall be complete, supported, neat in appearance and shall comply with the latest revision of the A/E's wiring diagrams. Any unique termination problems will be referred to the Owner and A/E for disposition.

R-10 22. The bending radii of cables trained in place shall not exceed values given in Table A.

3.3 Cable Terminations Revisions

1. When a termination is changed per drawing revision a new termination card is filled out noting the reason for the termination change in the comment section of the termination cards. All revisions to cables terminated must be coordinated under the direction of Commonwealth Edision's Operational Analysis Department.

3.4 Power Terminations

1. Manufacturers terminatio. kits are required for 6900 and 4160 V cables per S&L drawings 1E-0-3088, 3089, and 3089A.

2. Terminations of 600v and below made with uninsulated lugs are to be taped with the "Okonite Method", (see section 3.4.3 for lug to lug connections and uninsulated butt splices). The cable, insulation and jacket shall be cleaned with a suitable solvent and allowed to dry. The entire surface to be taped shall be coated with Okonite cement. The lug barrel and conductor shall be wrapped or softened by two half-lapped layers of Okonite T-95 tape, followed by sufficient but not less than 2 half-lapped layers of Okonite O-35 insulation tape. The total insulation thickness should be approximately 1½ times the thickness of the factory applied cable jacket insulation. (See Addendum #3) R-10

3. Lug to lug terminations (both insulated and uninsulated) of 600V and below need not be individually insulated prior to connection. Only the total bolted connection requires insulation by the Okonite method. If lugs are connected in such a manner as to leave a void area between the lugs, this area is filled in with Okonite T-95 taping material to prevent moisture creepage. Uninsulated butt splices are to be taped to the Okonite method or covered by WCSF Racham shrink tubing.
R-10 (See Addendum #4)

APPENDIX II

Dresden/Quad Cities Procedures
For
Scotch Tapes

THIS TELECOPY HAS
BEEN
SENT AND VERIFIED
Time______Date________

FACSIMILE TRANSMITTAL SHEET

Commonwealth Edison

Station Nuclear Engineering Department

Date: 8/21/86
Time: ~~[illegible]~~ 3:56

Transmittal Sheet P. 4 Pages
Sent from Xerox Automatic Telecopier

TO: Al Horsman

LOCATION: Wyle Laboratories

STATION/DEPARTMENT: --

CITY/STATE: Huntsville, Alabama

TELECOPIER TELEPHONE NUMBER: 205 - 837 - 4411

VERIFICATION TELEPHONE NUMBER: (same)

FROM: Gerald De Young

DEPARTMENT: ~~[illegible]~~ SNED

CHICAGO, ILLINOIS 60690

TELEPHONE NUMBER: (312) 294-8819

IF YOU HAVE ANY PROBLEMS RECEIVING YOUR TELECOPY PLEASE CALL (312) 294-8484

NOTES

8/21/86

Al,

As we discussed this morning, enclosed please find the Dresden & Quad procedures for Scotch Tape inside and outside [illegible] use.

[illegible] also discussed, the Kerite tape used at Zion is a Bishop W962 tape per conversation with William Blythe of Kerite. In summary, this tape is an EPR tape.

Please call me if you have any questions

Jerry De Young
Commonwealth Edison

H. Do not insulate the connection until quality control has inspected the termination.

6. PREPARATION OF CABLE (EXISTING SPLICES)

A. Remove any tape from the existing splice.

B. Inspect the existing splice. Splice should be in good condition and properly crimped with no broken and/or frayed conductors. Improperly crimped splices or splices having broken and/or frayed conductors shall be replaced. Refer to Section 4, Preparation of Cable (New Splices), for further details.

7. APPLICATION OF RAYCHEM INSULATION

A. Do not insulate the connection until quality control has inspected the termination. Inspect the connection using the Raychem Inspection Guide furnished with the insulating kit.

B. For application of Raychem tubing, refer to installation instructions furnished with the Raychem tubing installation kit.

Heat shall be applied to the heat shrink tubing using an electric heat gun. Do not use anything other than an electric heat gun (e.g., propane or acetylene torch) to apply heat to shrink tubing.

When applying heat, keep heat gun moving to prevent overheating the tubing or the cable jacket. Overheated shrink tubing shall be completely removed and replaced (shrink tubing will char when it is overheated).

8. INSULATION OF CONNECTION USING TAPE (OUTSIDE DRYWELL) FOR USE WITH FIGURE 1

A. Clean the surface of the connector, the insulation, and the jacket with a cloth moistened in chlorothene or similar solvent. When dry, all connectors having irregular surfaces shall be padded with Scotchfill putty or Scotch 33 tape prior to insulating with Scotch 33+ or Scotch 88 electrical tape.

B. Fill connector slots and indents with insulating tape.

C. For pigtail splices, apply one layer of insulating tape (Scotch 33+ or Scotch 88) half-lapped. Start half-lapped taping between the two conductors taping toward the lugs. Complete two layers of tape over the top of the lugs then return to the starting area and pass the tape between the conductors to complete the total encapsulation of the lugs. Stretch tape to reduce width to at least 75%.

3 layers total

D. ~~Apply three layers of insulating tape (Scotch 33+ or Scotch 88) half-lapped to the connectors, pencils, and the scored area. Stretch tape to reduce width to at least 75%.~~

E. Apply two layers of jacketing tape (Scotch 130C) over the insulating tape and approximately 1 inch over factory insulation at each end. Apply tape with minimum tension.

F. Apply another layer of Scotch 33+ over the Scotch 130C. This is to cover the somewhat tacky 130C tape to help reduce dust buildup.

~~F. As an alternative to taping, apply WCSF Raychem heat shrink extending approximately 2 inches onto the factory insulation at each end of the splice. For detailed application instructions, see the instruction sheet provided with the Raychem tubing and/or splice kit.~~

~~Heat shall be applied to the heat shrink tubing using an electric heat gun. **Do not use** anything other than an electric heat gun (such as propane or acetylene torch) to apply heat to shrink tubing.~~

~~When applying heat, keep heat gun moving to prevent overheating the tubing or the cable jacket. Overheated shrink tubing shall be completely removed and replaced (shrink tubing will char when it is overheated).~~

9. <u>INSULATION OF CONNECTION USING TAPE (INSIDE DRYWELL) FOR USE WITH FIGURE 2</u>

A. **Do not** insulate the connection until quality control has inspected the termination.

B. Clean the surface of the connector, the insulation, and the jacket with a cloth moistened in chlorothene or similar solvent. Ensure that connector, insulation, and jacket are dry and free from external materials before proceeding.

C. For pigtail splices, apply one layer of insulating tape (Scotch 130C) half-lapped. Start half-lapped taping between the two conductors taping toward the lugs. Complete two layers of tape over the top of the lugs then return to the starting area and pass the tape between the conductors to complete the total encapsulation of the lugs.

D. Apply five layers of insulating tape (Scotch 130C) half-lapped over the connector, pencils, and scored. Taper the last 1/2 inch at each end. Stretch tape to reduce width to at least 75% when applying.

E. Apply two layers of insulating tape (Scotch 70) half-lapped over all the insulating tape (Scotch 130C

EPR) and 1/4 inch of factory insulation at each end. Taper the last 1/4 inch at each end. Stretch tape to reduce width to at least 75% when applying.

F. Apply two additional layers of insulating tape (Scotch 70) half-lapped over the insulating tape and 1/4 inch of factory insulation at each end. Taper the last 1/4 inch at each end. Stretch tape to reduce width to at least 75% when applying.

G. Apply two layers of jacketing tape (Scotch 17) half-lapped over the insulating tape and 1/4 inch of factory insulation at each end. Taper the last 1/4 inch at each end. Apply tape with only enough pressure to ensure good adhesion.

H. Apply two additional layers of jacketing tape (Scotch 17) over the jacketing tape and 1/4 inch of factory insulation at each end. Apply tape with only enough pressure to ensure good adhesion.

I. ~~As an alternative to taping, apply WCSF-N Raychem heat shrink extending approximately 2 inches onto the factory insulation at each end of the splice. For detailed application instructions, see the instruction sheet provided with the Raychem tubing and/or splice kit.~~

~~Heat shall be applied to the heat shrink tubing using an electric heat gun. Do not use anything other than an electric heat gun (such as propane or acetylene torch) to apply heat to shrink tubing.~~

~~When applying heat, keep heat gun moving to prevent overheating the tubing or the cable jacket. Overheated shrink tubing shall be completely removed and replaced (shrink tubing will char when it is overheated).~~

10. <u>INSULATION of 4.16 KV MOTOR CONNECTORS USING TAPE (RADIATION HARSH ENVIRONMENT ONLY)</u>

A. Clean the surface of the connector, the insulation, and the jacket with a cloth moistened in chlorothene or similar solvent. When dry, all connectors having irregular surfaces shall be padded with Scotch 13 semi-conducting tape.

B. Fill connector slots and indents with Scotch 13 semi-conducting tape.

C. Apply one layer (minimum) of Scotch 13 semi-conducting tape tightly half-lapped. Tape across connector area overlapping approximately 1/16 inch onto each edge of the penciled insulation. Form a smooth concentric buildup as shown in Figure 3. Scotch 13 tape may be stretched as necessary during application without adverse effect.

TABLE OF CONTENTS

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(CONTINUED)

APPENDIX III
Quad Cities Procedure For Scotch Brand 33+ and 130C Tapes

QMP 100-60
Revision 1
November 1986

SCOTCH BRAND TAPES
E.Q. INSTALLATION INSTRUCTIONS

A. PURPOSE

The purpose of this procedure is to provide the instructions necessary to perform an Environmentally Qualified splice using Scotch Brand tapes 130c and 33+.

B. REFERENCES

1. CQO-029164.

C. PREREQUISITES

1. Cables to be spliced should be de-energized and out-of-service.

D. PRECAUTIONS

1. Observe standard safety precautions while working on electrical equipment.

2. The instructions of this procedure must be followed implicitly so that the equipments' environmental qualification status is not jeopardized. (Only Scotch Brand tapes 130c and 33+ may be used.)

E. LIMITATIONS AND ACTIONS

1. To ensure continued compliance with 10CFR 50.49, any revisions to this procedure must be reviewed by the E.Q. Coordinator.

2. This procedure may be performed over electrical connections on all equipment in the E.Q. program and will provide proper insulation up to 10,000 volts.

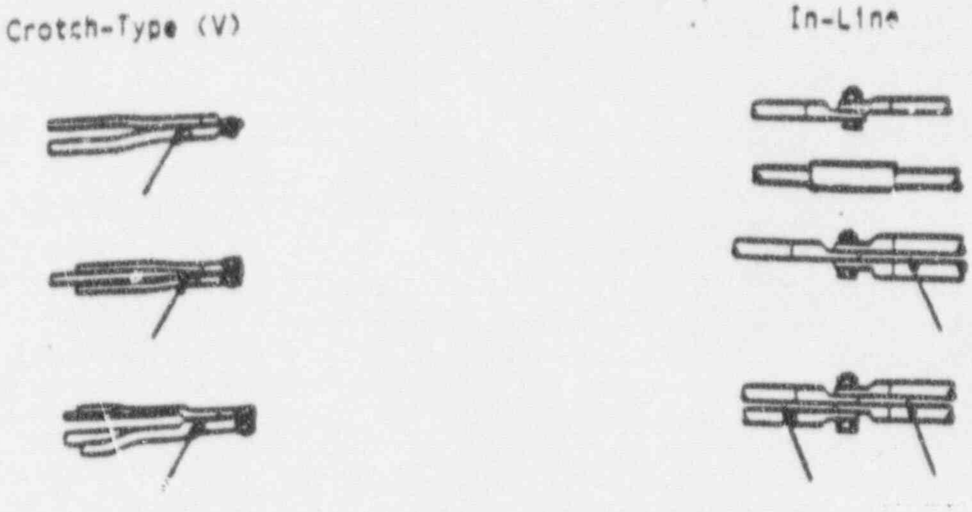
3. Environmentally qualified tape splices must be housed in an enclosure if the splices may possibly be exposed to direct spray or steam. The enclosure acts as a direct impingement barrier against these moisture sources. The enclosure must have weephole(s) at the lowest point to allow any accumulated moisture to escape. Consult the E.Q. Coordinator if splices are not going to be housed in an enclosure.

4. In-line splices, as well as crotch-type (V) splices, are covered by this procedure.

APPROVED
NOV 4 1986
Q.C.O.S.R.

F. PROCEDURE

FIGURE 1
Splice Examples (typical)



→ Arrows designate voided areas

1. Make the electrical connection. For bolted connections with conductors in the crotch-type (V) or multi-conductor (more than 2) in-line configurations, make the connections with the conductors as close together as possible. This will minimize the voided area between the conductors that must be filled in with tape in a later step.

2. Ensure there are no sharp edges on the connecting hardware. File or replace hardware as necessary.

3. Ensure that the splice area is free of oil, moisture, dirt, dust, or other contamination. Clean as needed.

4. For crotch-type (V) and in-line multiconductor (more than 2) connections only. Fill in the voided area with Scotch Brand tape 130c. (See figure 1 above for examples of splices.) The tape should be applied, sticky side out, with tension (stretch the tape until its width is reduced to approximately 50% of its original width) to each of the individual conductors. Tape is to be applied to the lug in the crotch area and continue to a minumum of 1" past the butt of the lug, onto the conductor. Enough tape must be added to the conductors so that the voided area becomes filled with tape.

APPROVED
NOV 4 1986
Q.C.O.S.R.

5. Apply 5 half-lapped layers of Scotch Brand tape 130c, sticky side out, with tension (stretch the tape until its width is reduced to approximately 50% of its original width) to the connection. The tape must cover the entire connection area and extend a minimum of 1" onto the conductors. (If it was necessary to fill the voided areas with tape, the application of the 130c insulating tape must extend past the "filler" tape and onto the conductors.) Five half-laps is the minimum amount of insulating tape to be used. Additional layers may be added, as desired, to smooth out irregular contours.

6. Apply 2 half-lapped layers of Scotch 33+, sticky side in, at minimum tension (stretch tape just enough so that it adheres smoothly) over the insulating tape. Ensure all of the insulating tape is covered and that the 33+ extends past the 130c tape and onto the conductors. This tape serves as abrasion protection for the 130c insulating tape. Additional layers of the 33+ jacketing tape may be applied as desired.

NOTE

When the finished splices are returned to their enclosure, ensure that the minimum bending radius of the conductors involved is not violated (i.e., no sharp bends, twists, or kinks).

G. CHECKLISTS

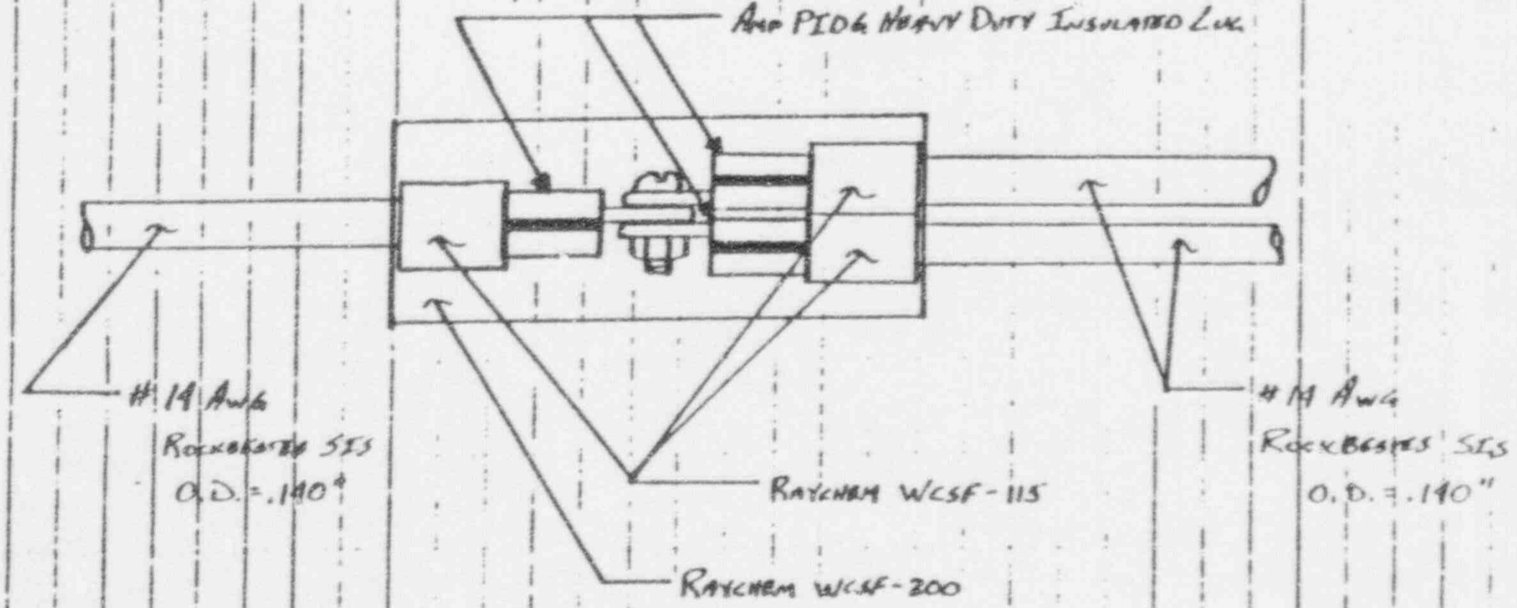
1. None.

H. TECHNICAL SPECIFICATIONS

1. Sections 6.7.A and B.

APPROVED
NOV 4 1986
O.C.O.S.R

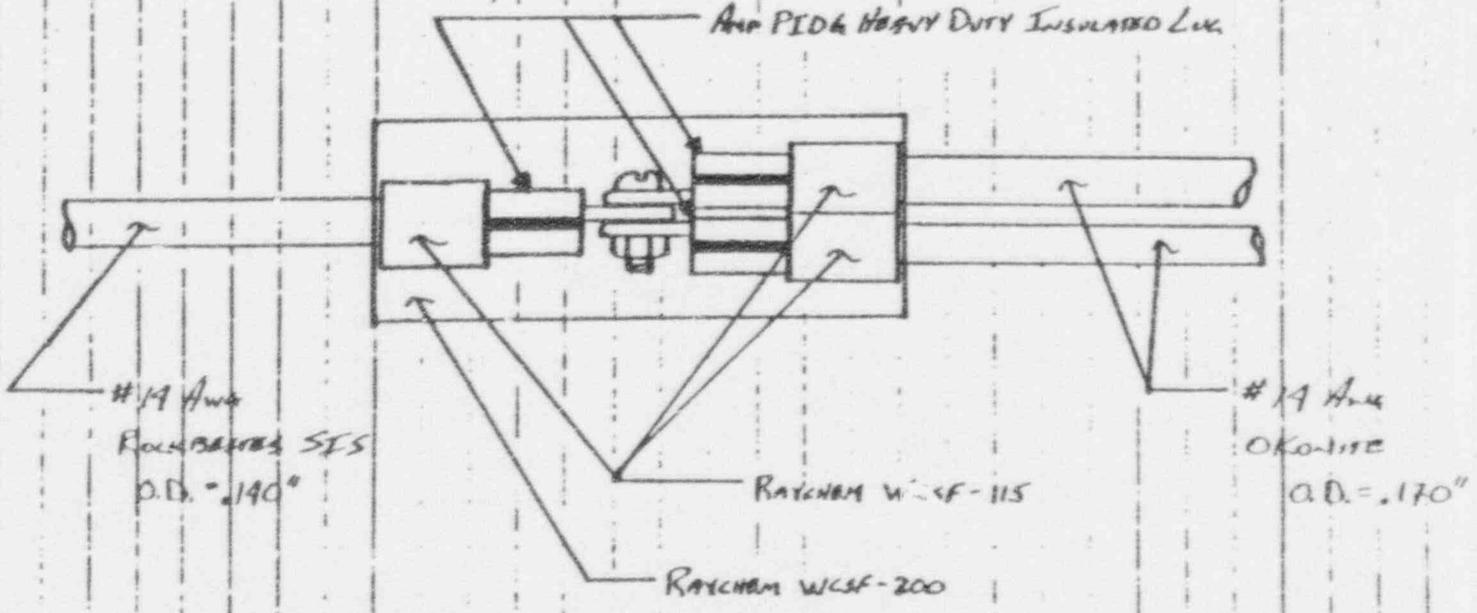
APPENDIX IV
SPLICE CONSTRUCTION DETAILED SKETCHES



NOTES: 1) RAYCHEM TUBING IS NUCLEAR GRADE
2) WCSF-200 FLATTENED OVER SPLICE WHILE HEATED
3) WCSF-200 IS APPROX. 2 3/4" LONG
4) WCSF-115 ARE APPROX. 1/2"
5) PIDG LUGS ARE FOR #16-14 AWG

FIGURE IV-1

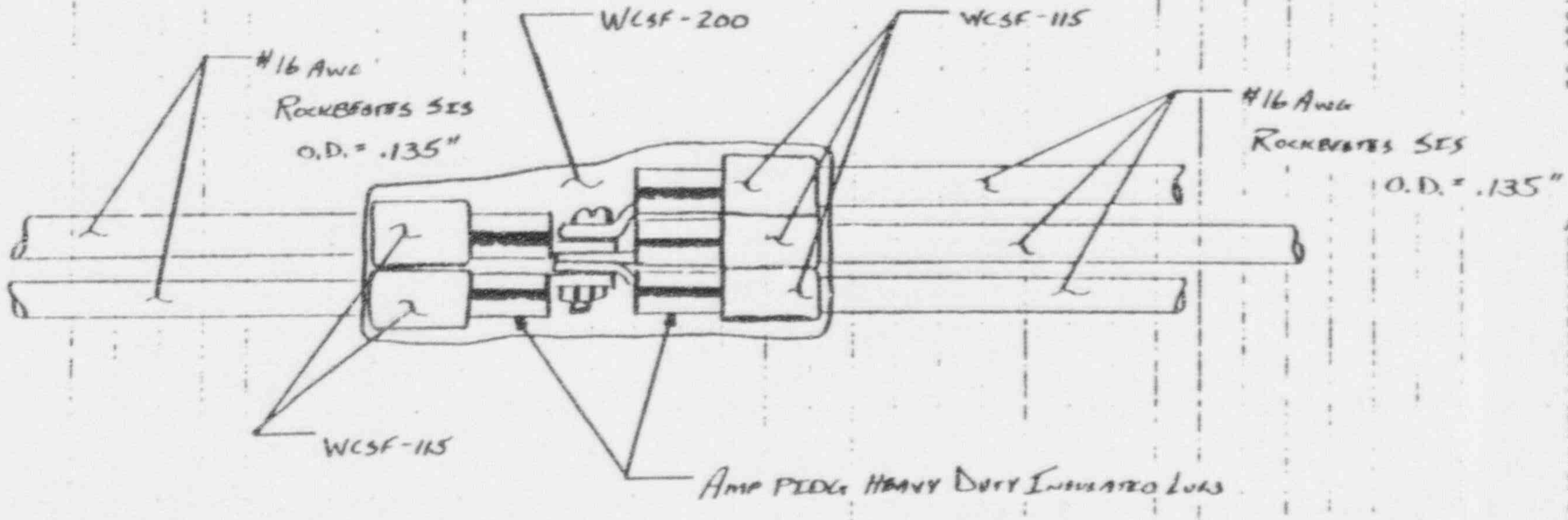
SPECIMEN B1



NOTES: 1) RAYCHEM TUBING IS NUCLEAR GRADE
2) WCSF-200 FLATTENED OVER SPLICE WHILE HEATED
3) WCSF-200 IS APPROX. 2 3/4" LONG
4) WCSF-115 ARE 1/2" LONG
5) PIDG LUGS ARE FOR #16-14 AWG

FIGURE IV-2

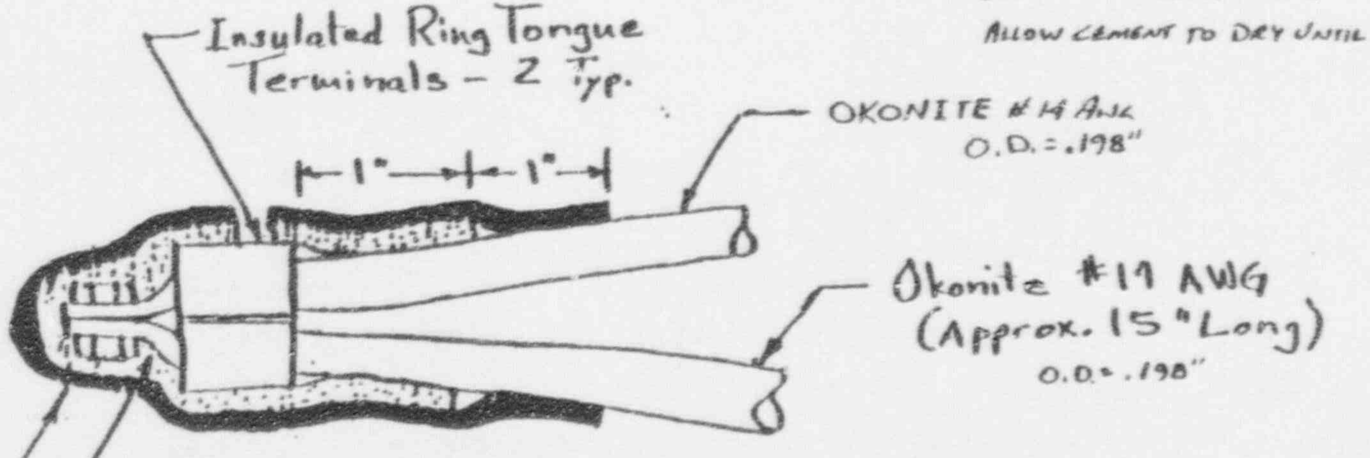
SPECIMEN B2



Notes: 1) RAYCHEM TUBING IS NUCLEAR GRADE
2) WCSF-200 IS FLATTENED OVER SPLICE WHILE HEATED
3) WCSF-200 IS APPROX. 2 5/8" LONG
4) WCSF-115 ARE APPROX. 1/2" LONG
5) PIDG LUGS ARE FOR #16-14 AWG

FIGURE IV-3
SPECIMEN B3

NOTE:
PRIOR TO TAPING APPLY OKONITE NUCLEAR SPLICING CEMENT OVER CABLE AND LUGS. ALLOW CEMENT TO DRY UNTIL TACKY



Okonite T-95 Insulation Tape - Apply to a Thickness of Approximately 1½ Times the Insulation Thickness of the Okonite and Thermofit Wires. Overlap the Wire Insulation Approximately 1".

Okonite No. 35 Jacketing Tape - Two Half-Lapped Layers. Tape Shall Extend Approximately 1" Past The T-95 Tape.

FIGURE IV-4

SPECIMEN B4

Note:

Prior to taping apply Okonite Nuclear splicing cement to cable and lugs. Allow cement to dry until tacky

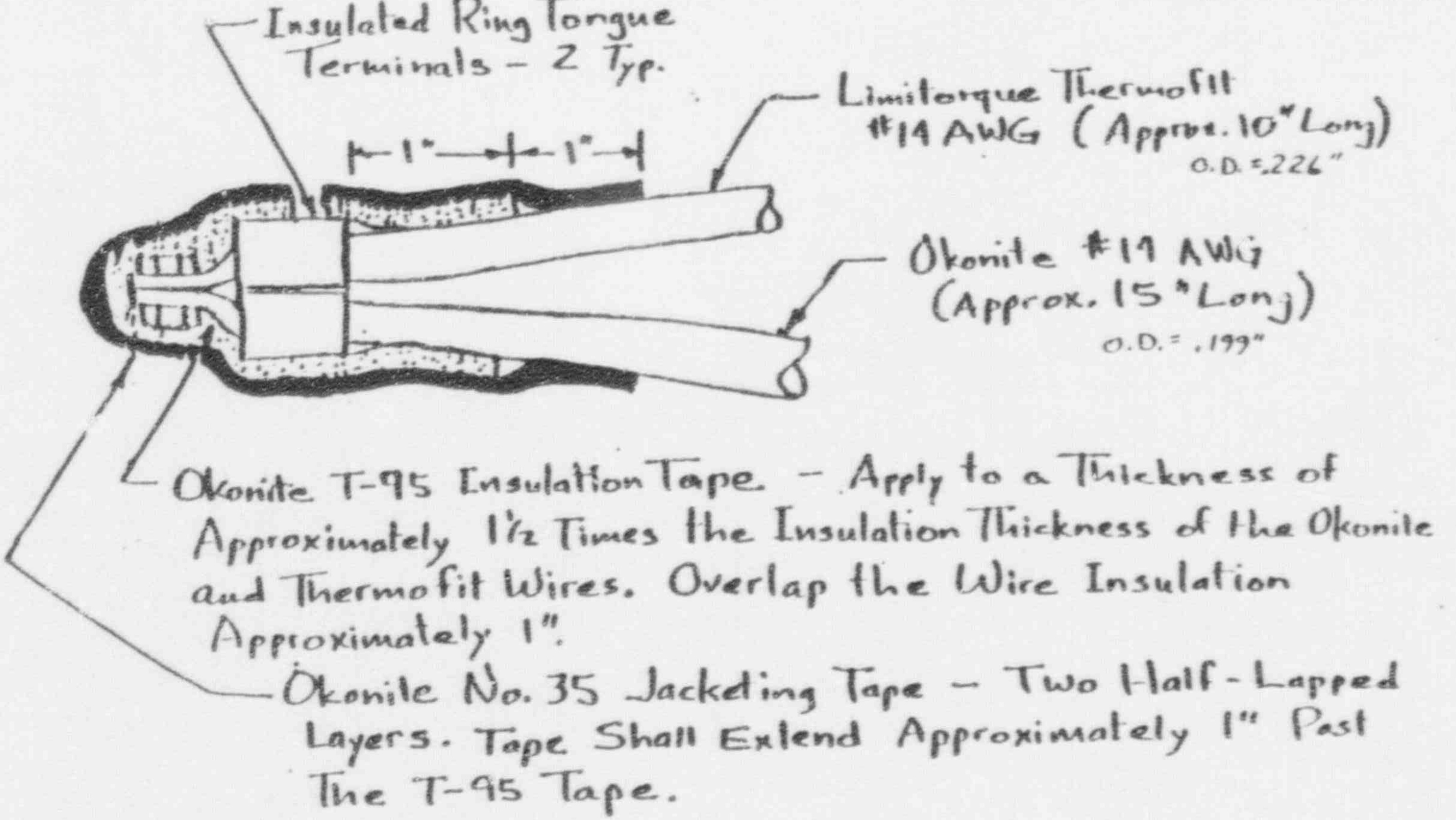
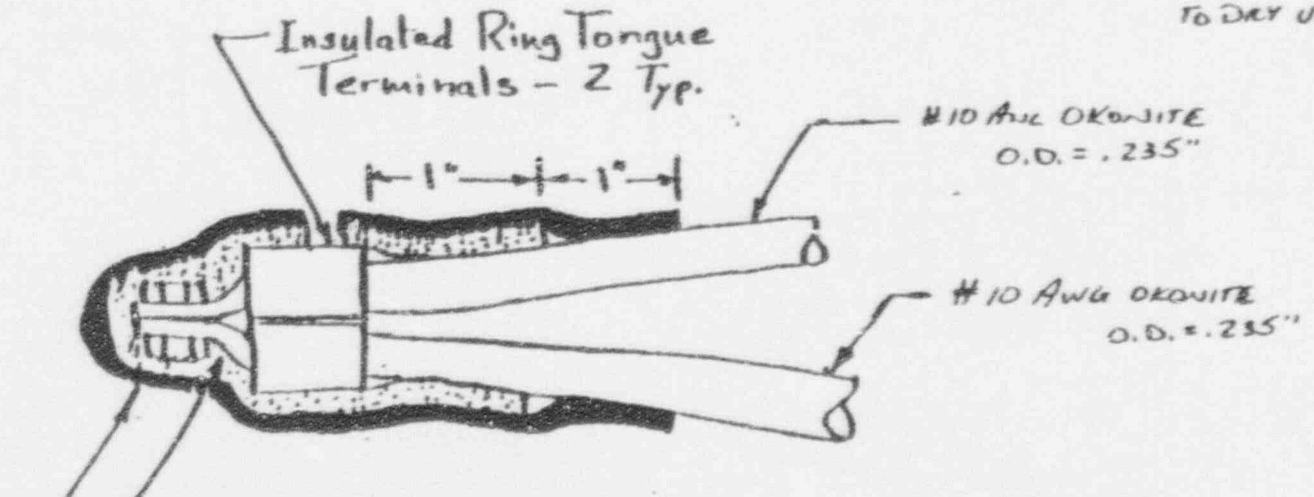


FIGURE IV-5

Specimen B5

NOTE: PRIOR TO APPLYING TAPE APPLY OKONITE NUCLEAR SPLICING CEMENT TO CABLE AND LUGS, ALLOW CEMENT TO DRY UNTIL TACKY.

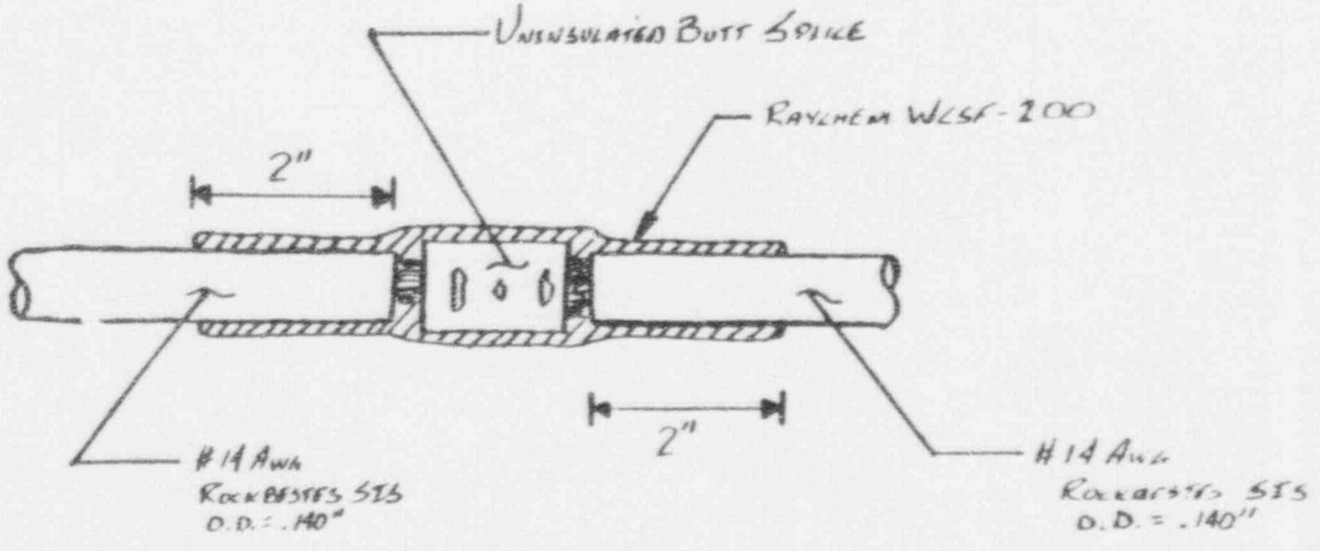


Okonite T-95 Insulation Tape - Apply to a Thickness of Approximately 1½ Times the Insulation Thickness of the Okonite and Thermofit Wires. Overlap the Wire Insulation Approximately 1".

Okonite No. 35 Jacketing Tape - Two Half-Lapped Layers. Tape Shall Extend Approximately 1" Past The T-95 Tape.

FIGURE IV-6

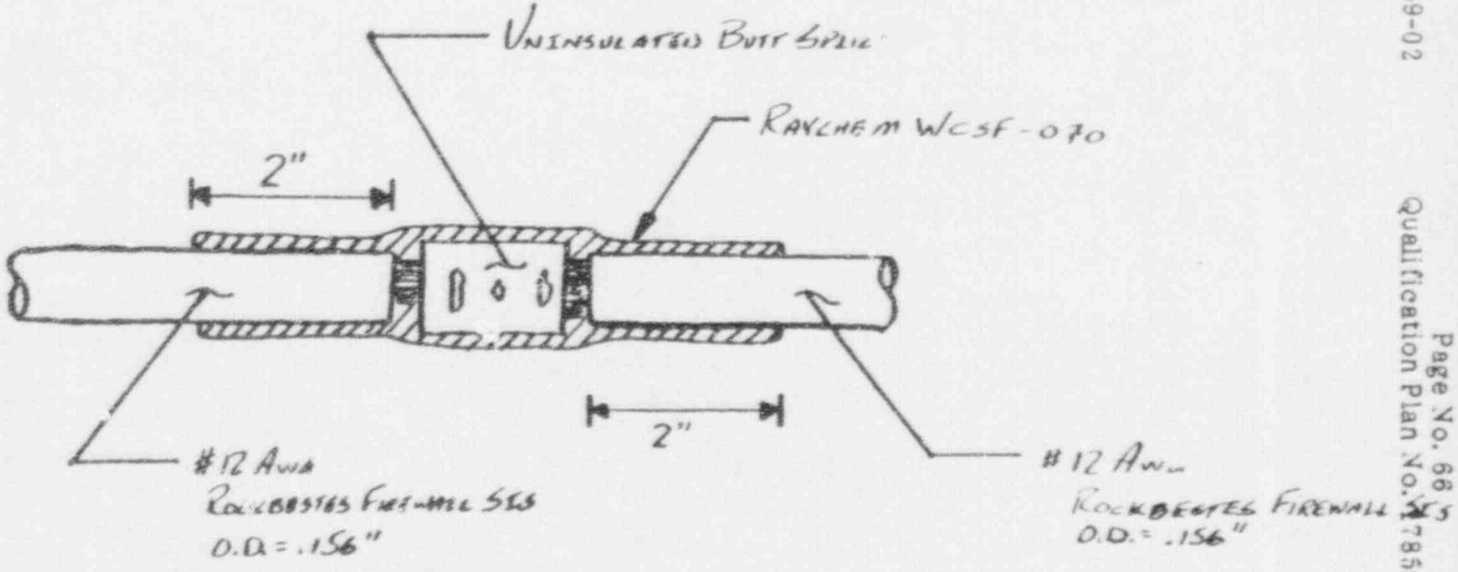
SPECIMEN B6



NOTE: 1) RAYCHEM WCSF IS NUCLEAR GRADE

FIGURE IV-7

SPECIMEN D1

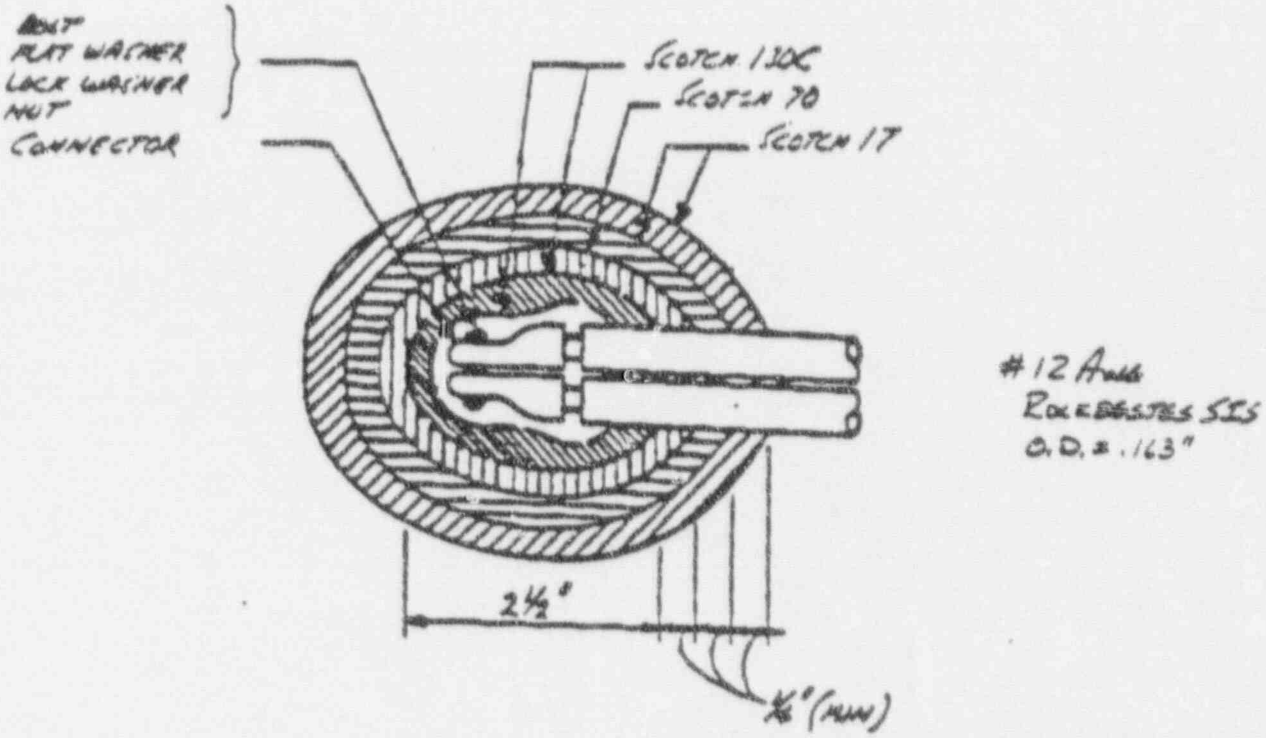


NOTE: 1) RAYCHEM WCSF IS NUCLEAR GRADE

FIGURE IV-8

SPECIMEN D2

SPECIMENS D3, D20



APPLY TAPE IN ACCORDANCE WITH PROCEDURE ON PAGE 2 OF 2

FIGURE IV-9

SCOTCH 130C, 70, 17 TAPING PROCEDURE

A Clean the surface of the connector, the insulation, and the jacket with a cloth moistened in chlorothene or similar solvent. Ensure that connector, insulation, and jacket are dry and free from external materials before proceeding.

B For pigtail splices, apply one layer of insulating tape (Scotch 130C) half-lapped. Start half-lapped taping between the two conductors taping toward the lugs. Complete two layers of tape over the top of the lugs then return to the starting area and pass the tape between the conductors to complete the total encapsulation of the lugs.

C Apply five layers of insulating tape (Scotch 130C) half-lapped over the connector, pencils, and scoured. Taper the last 1/2 inch at each end. Stretch tape to reduce width to at least 75% when applying.

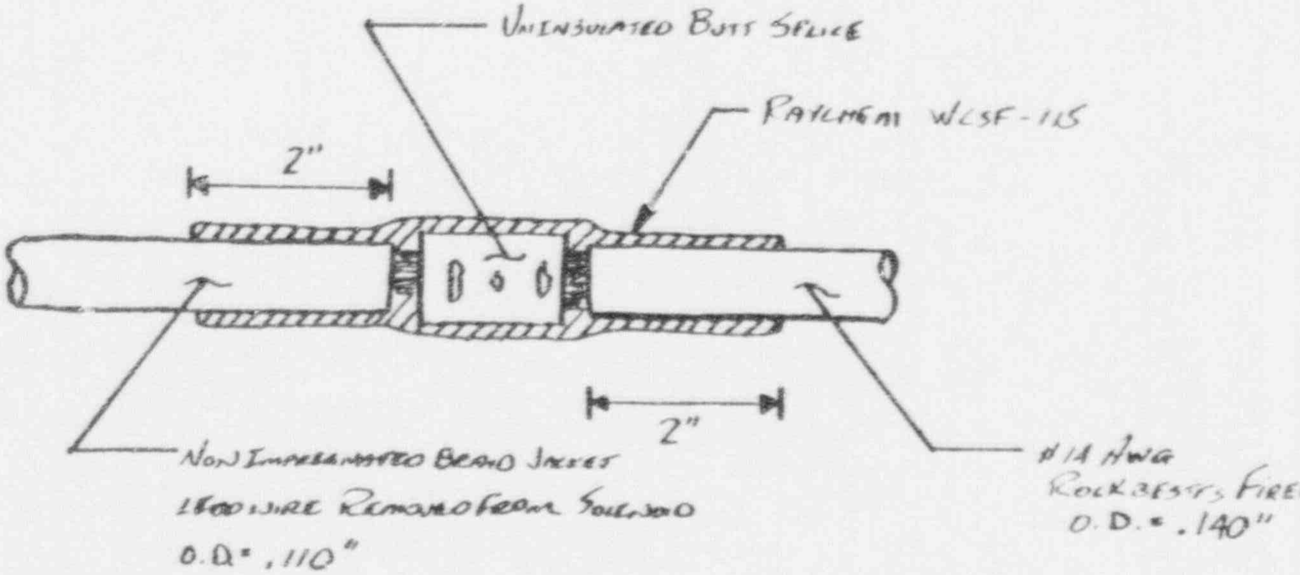
D Apply two layers of insulating tape (Scotch 70) half-lapped over all the insulating tape (Scotch 130C EPR) and 1/4 inch of factory insulation at each end. Taper the last 1/4 inch at each end. Stretch tape to reduce width to at least 75% when applying.

E Apply two additional layers of insulating tape (Scotch 70) half-lapped over the insulating tape and 1/4 inch of factory insulation at each end. Taper the last 1/4 inch at each end. Stretch tape to reduce width to at least 75% when applying.

F Apply two layers of jacketing tape (Scotch 17) half-lapped over the insulating tape and 1/4 inch of factory insulation at each end. Taper the last 1/4 inch at each end. Apply tape with only enough pressure to ensure good adhesion.

G Apply two additional layers of jacketing tape (Scotch 17) over the jacketing tape and 1/4 inch of factory insulation at each end. Apply tape with only enough pressure to ensure good adhesion.

FIGURE IV-9



NOTE: 1) RAYCHEM WCSF IS NUCLEAR GRADE

FIGURE IV-10

SPECIMEN D5

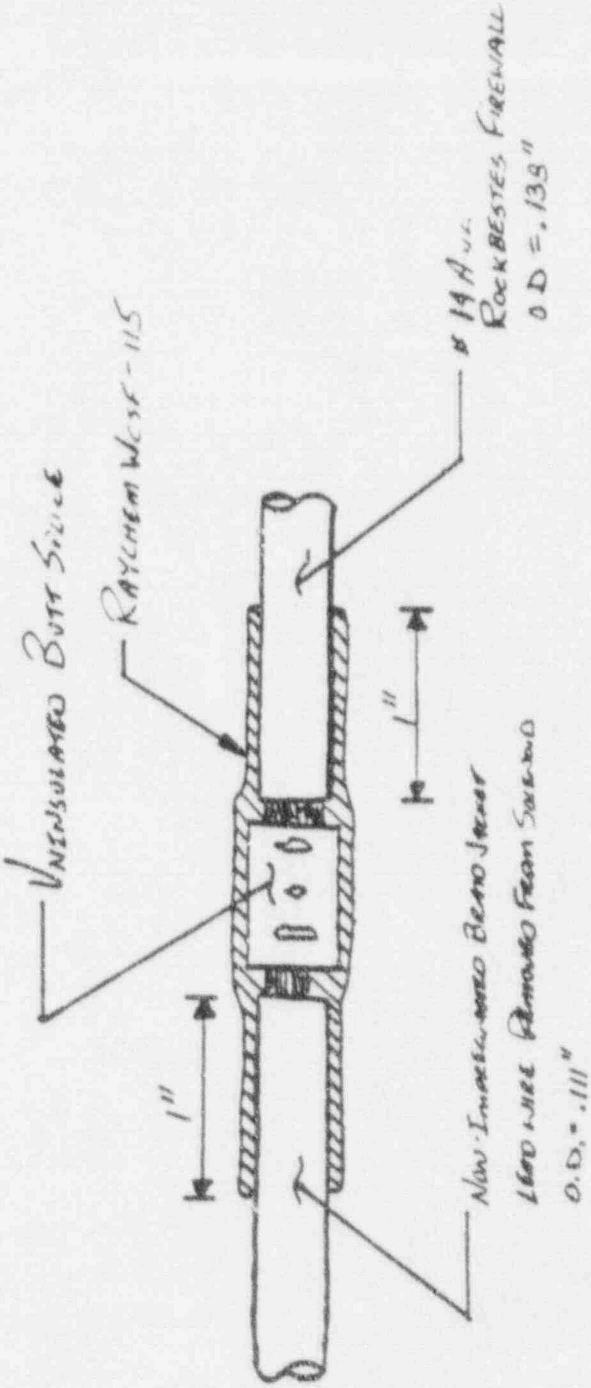
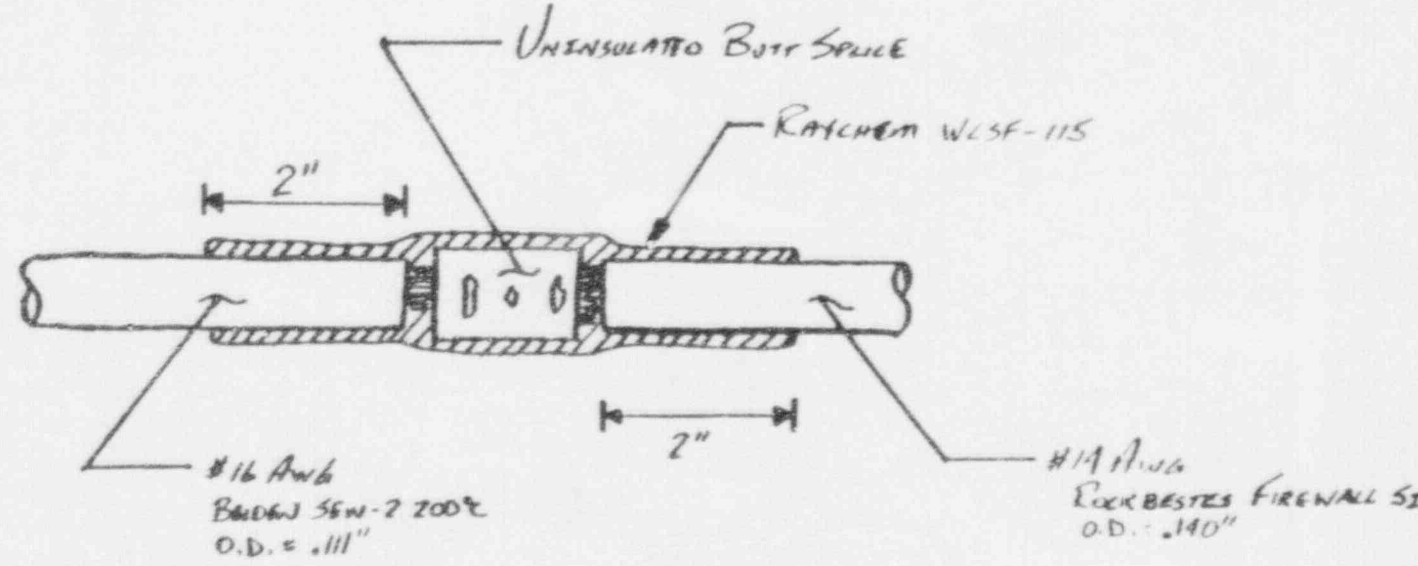


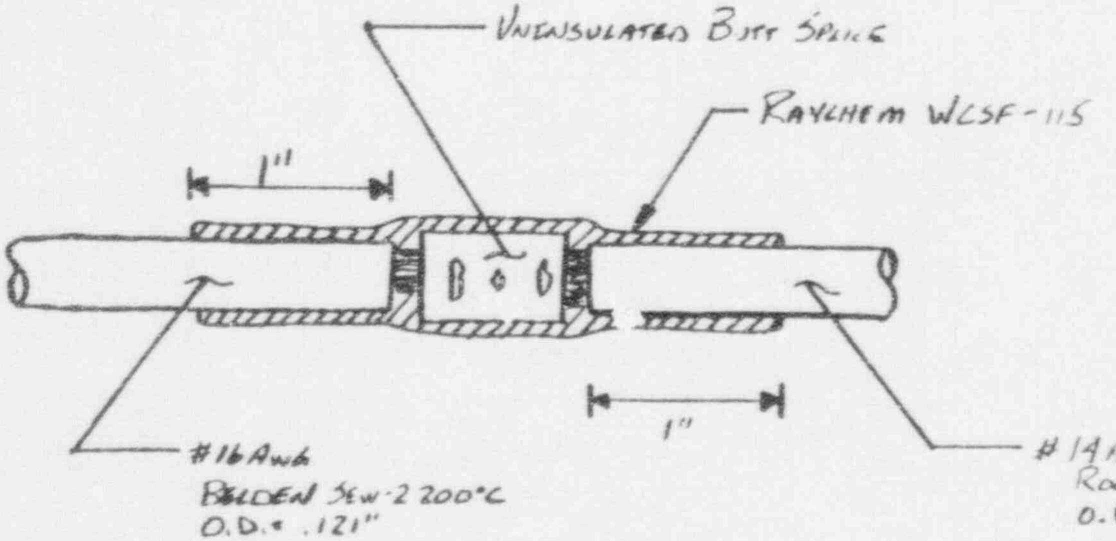
FIGURE IV-11
SPECIMEN D6

NOTE: 1) RAYCHEM WCSF IS NUCLEAR GRADE



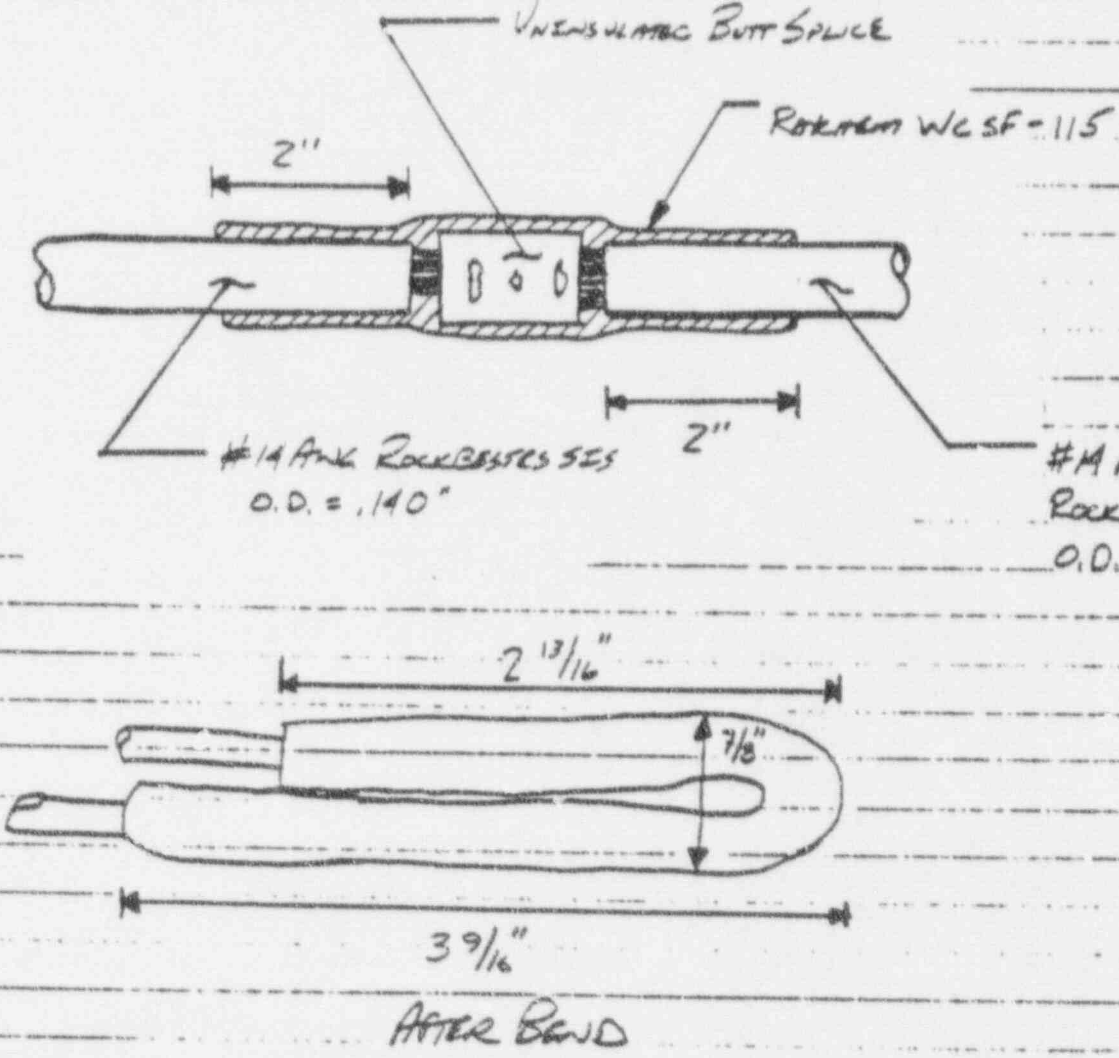
NOTE: 1) RAYCHEM WCSF IS NUCLEAR GRADE
2) BELDEN WIRE IS AN IMPREGNATED GLASS BRAID OVER SILICONE INSULATION

FIGURE IV-12
SPECIMEN D7



NOTES: 1) RAYCHEM WCSF IS NUCLEAR GRADE
2) BELDEN .AEE IS AN IMPREGNATED GLASS
BRAID OVER SILICONE INSULATION

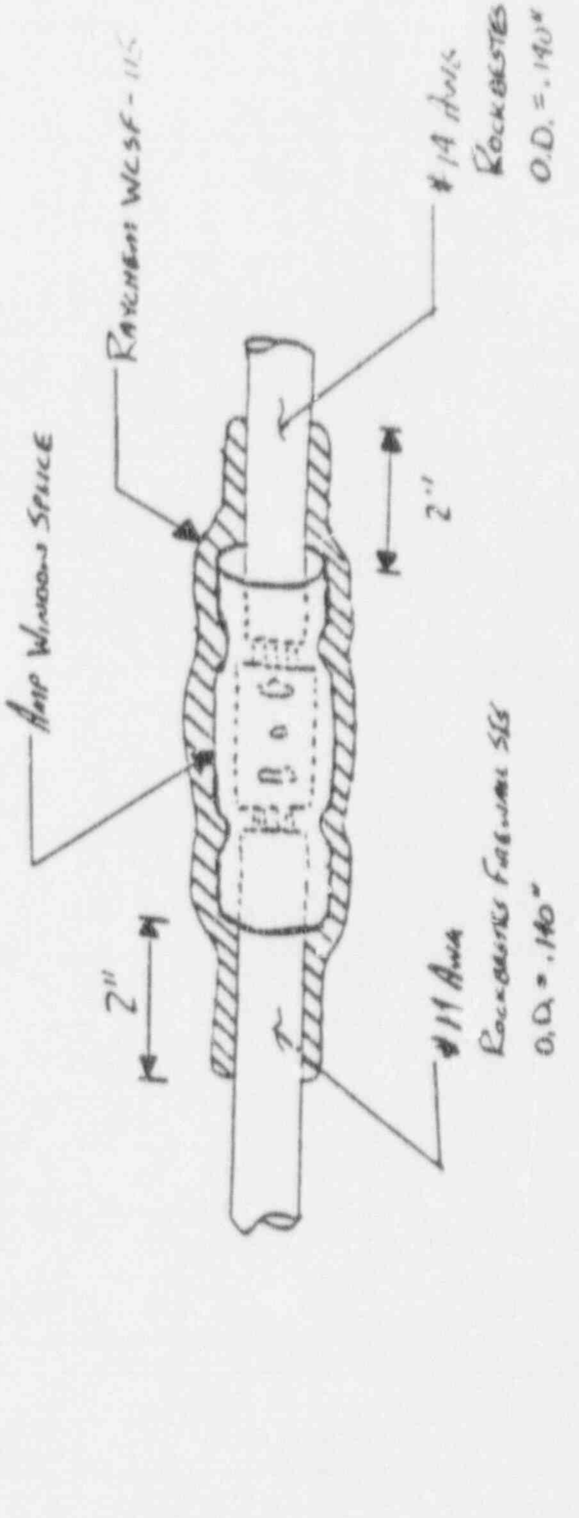
FIGURE IV-13
SPECIMEN D8



NOTE: 1) RAYCHEM TUBING IS WCW
2) SPECIMEN BENT AFTER COOLING
TIE-WRAPPED IN BENT CONDITION
DURING ENTIRE TEST

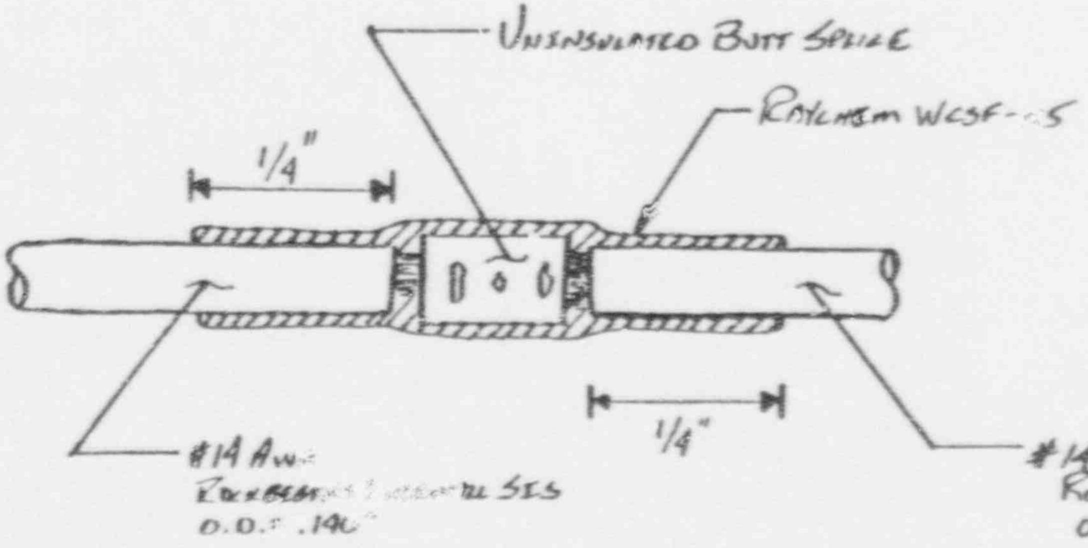
FIGURE IV-14

SPECIMEN D9



Note: Raychem Tubing is WCSF-N

FIGURE IV-15
Specimen D10 + D11



NOTE: HEATSHRINK TUBING IS WCSF-N

FIGURE IV-16

SPECIMEN D12

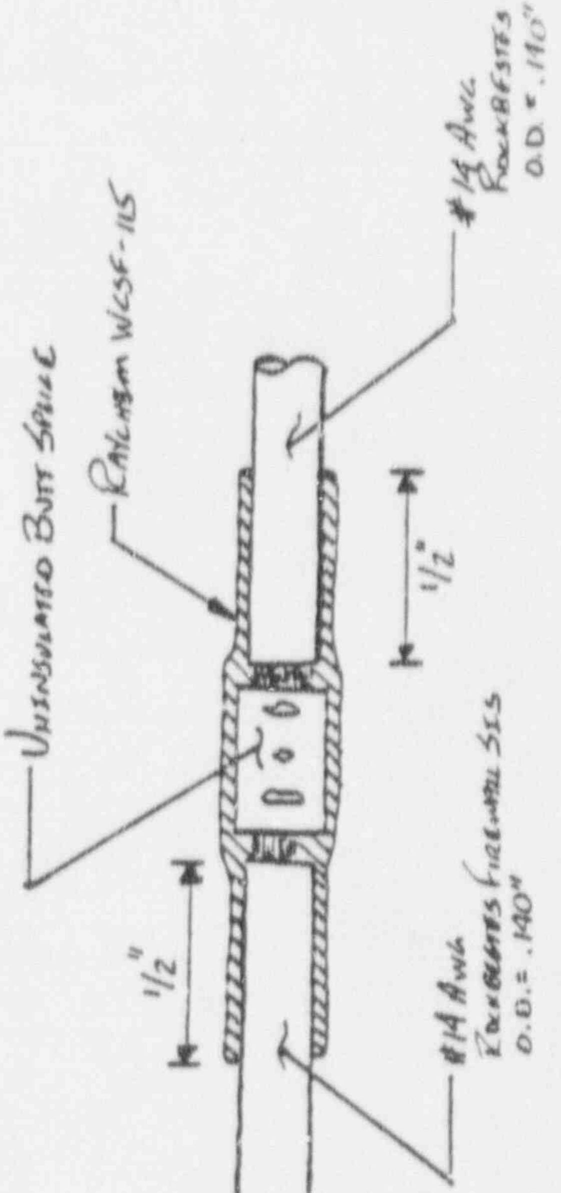
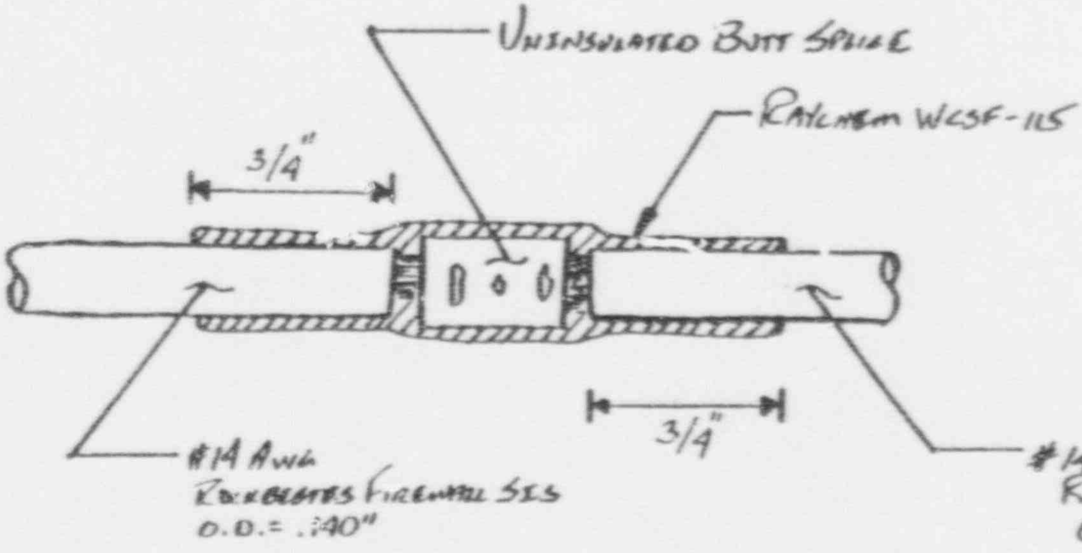


FIGURE IV-17

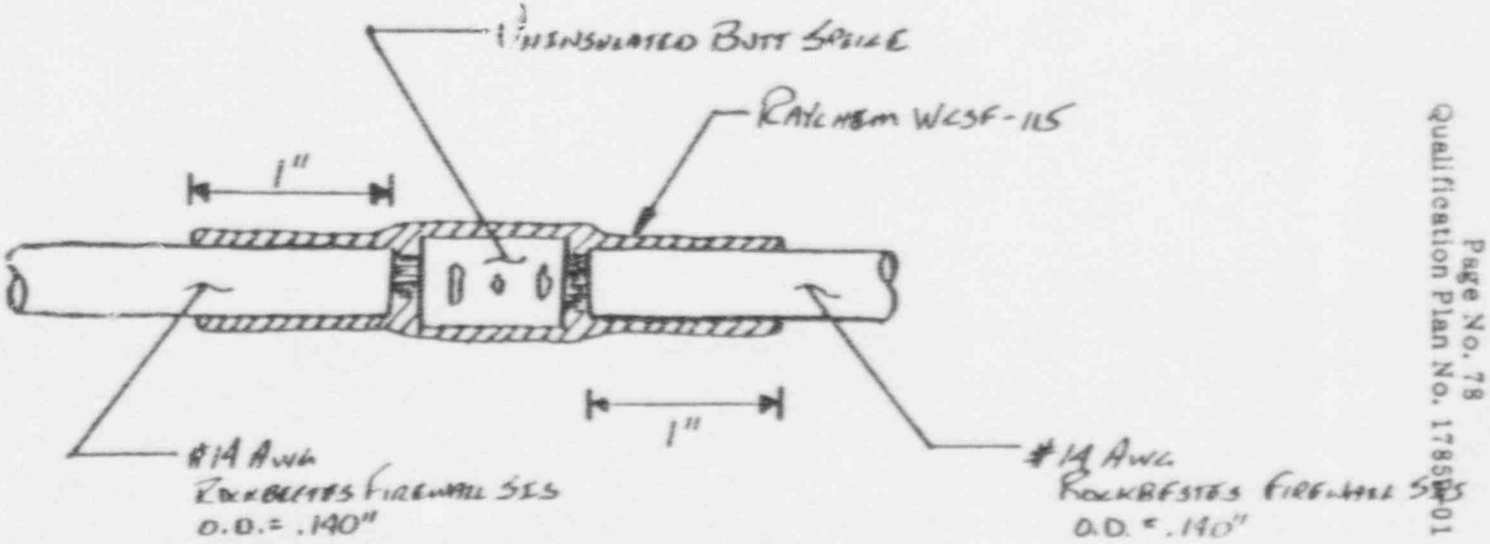
SPECIMEN E

NOTE: HEAT SHRINK TUBING IS WCSF-N



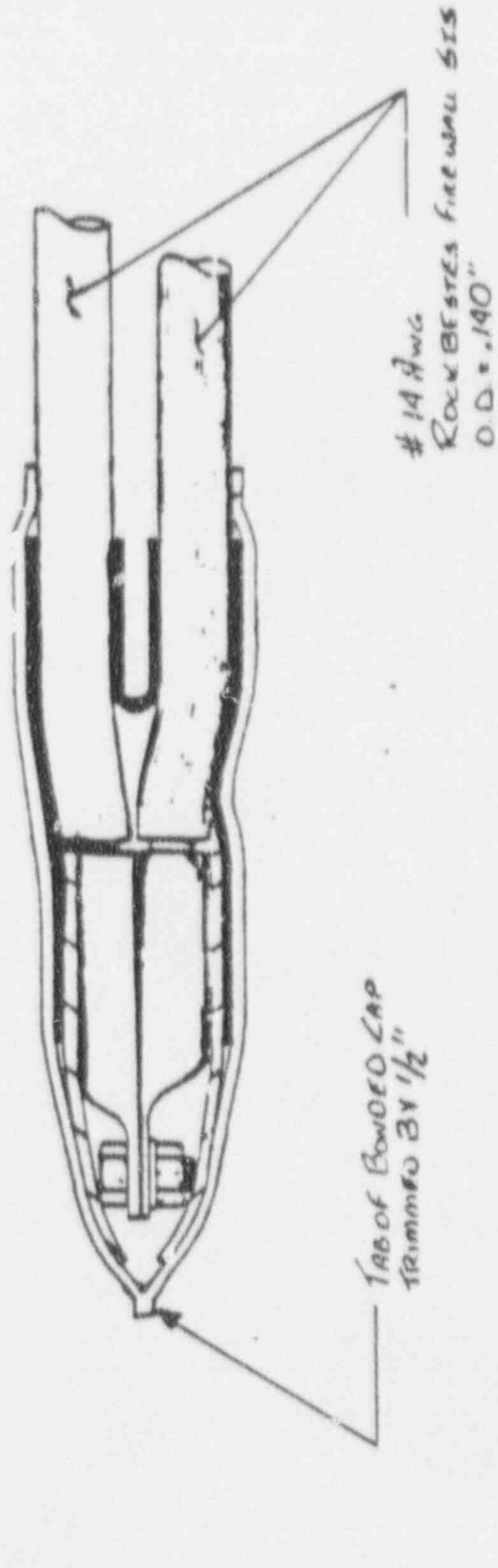
Note: Heat shrink tubing is WCSF-N

FIGURE IV-18
Specimen D 14



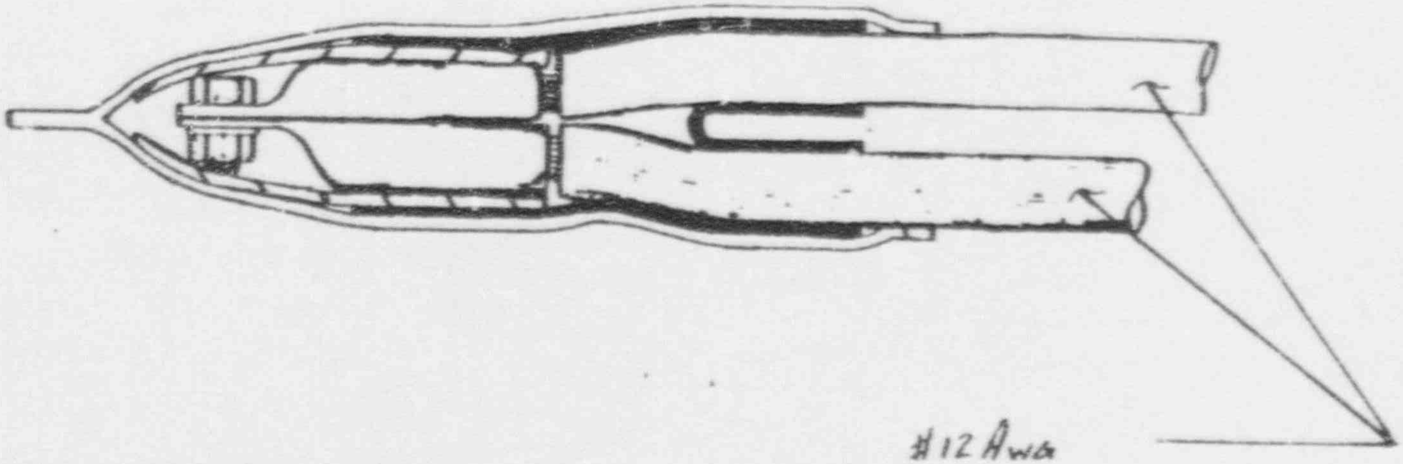
NOTE: HEAT SHRINK TUBING IS WCSF-N

FIGURE IV-19
SPECIMEN D15



NOTE: RAYCHEM NMCK-1V-35-00 INSTALLED
IN ACCORDANCE WITH RAYCHEM INSTR.

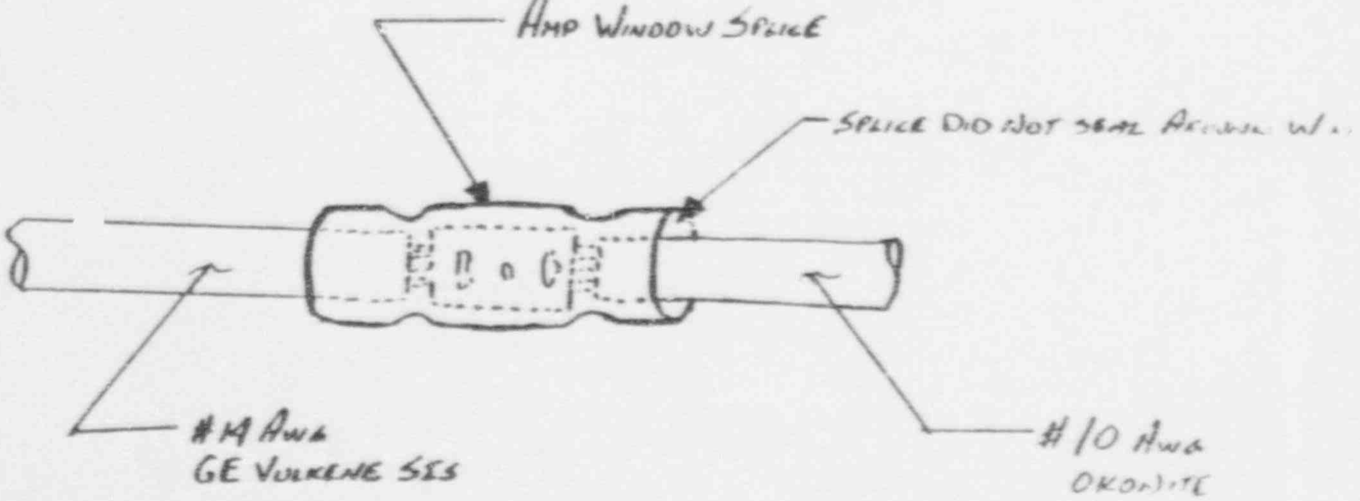
FIGURE IV-20
SPECIMEN D16



#12 AWG
GLASS BRAID SILICONE
HIGH TEMP WIRE
O.D. = .170"

NOTE: RAYCHEM NMCK-IV-35-00
INSTALLED IN ACCORDANCE WITH
RAYCHEM INSTRUCTIONS

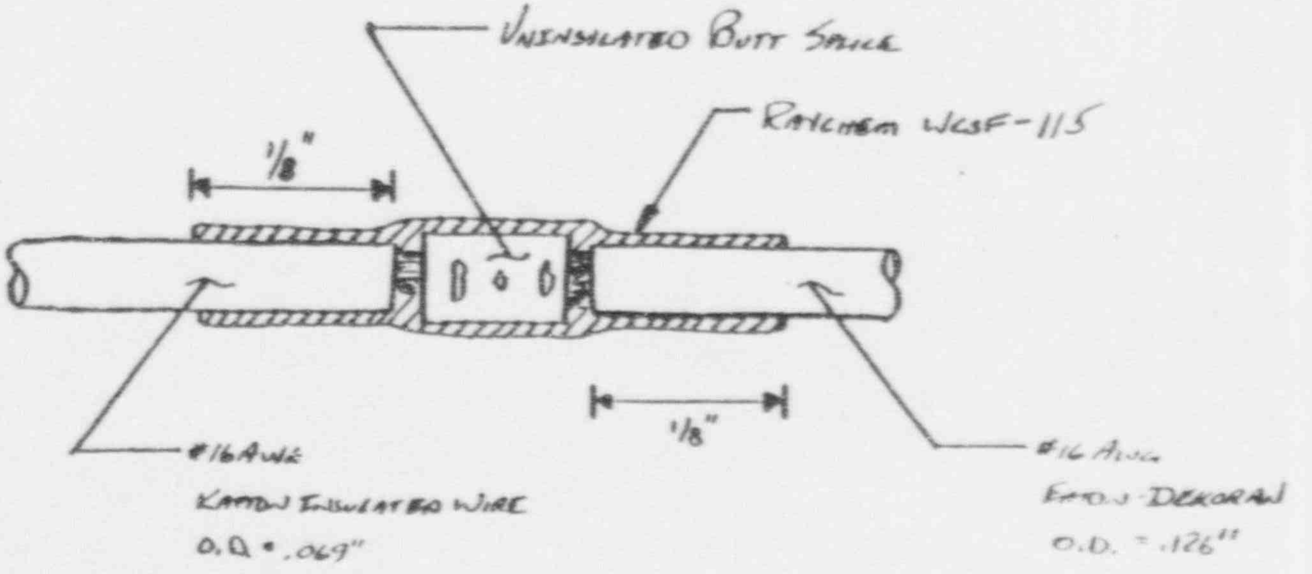
FIGURE IV-21
SPECIMEN D17



NOTE: AMP SPLICE REMOVED FROM PIGTAIL
OF GENERAL ELECTRIC F-100 SERIES
PENETRATION INSTALLED IN DRYWELL
OF DRESDEN UNIT 3

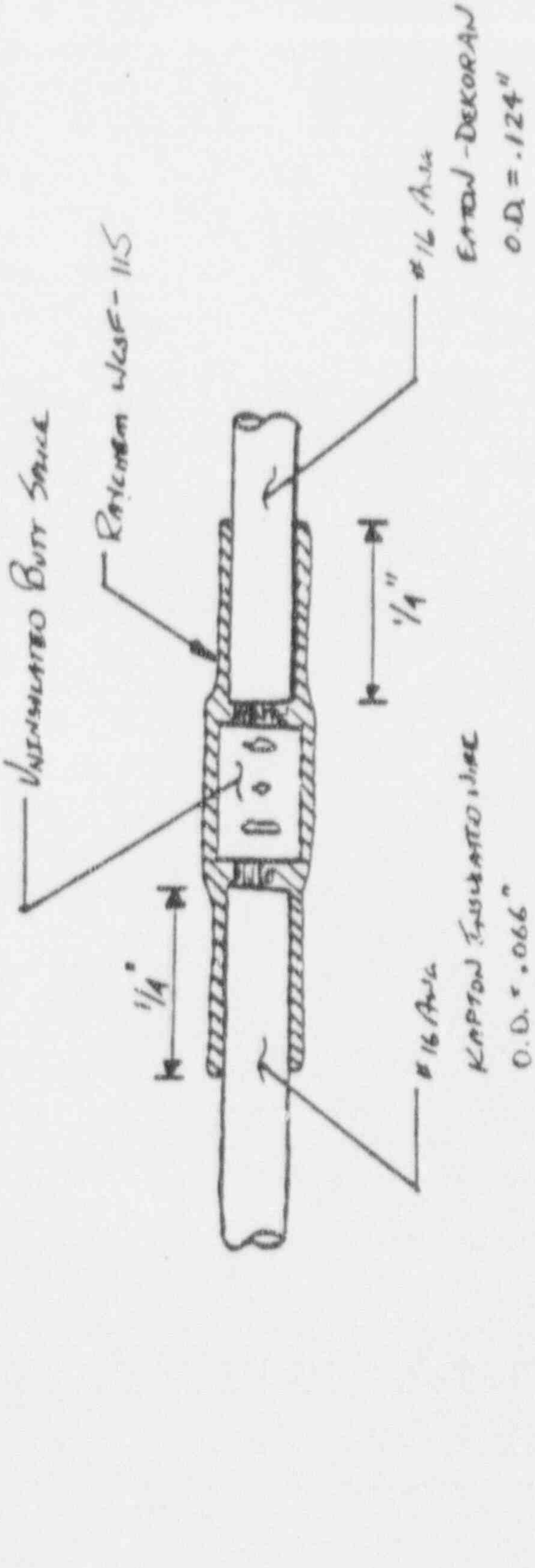
FIGURE IV-22

SPECIMENS D18 AND D19



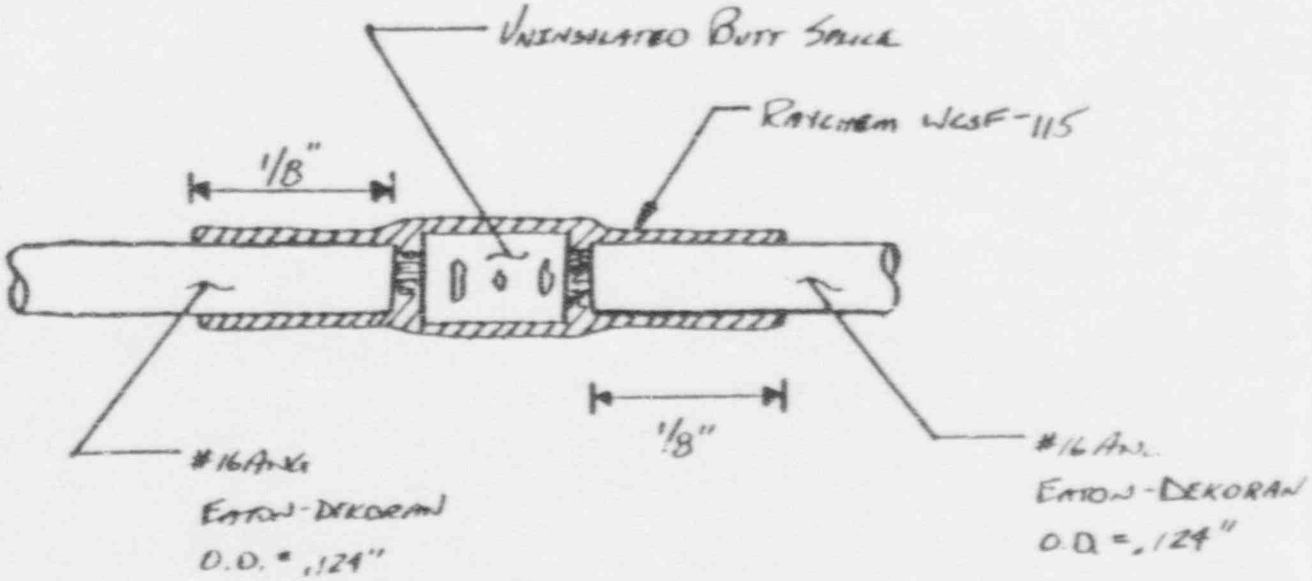
NOTE: RAYCHEM TUBING IS WCSF-N

FIGURE IV-23
SPECIMEN L1



NOTE: RAYCHEM TUBING IS WCSF-N

FIGURE IV-24
SPECIMEN L2



NOTE: RAYCHEM TUBING IS WCSF-N

FIGURE IV-25
SPECIMEN L3

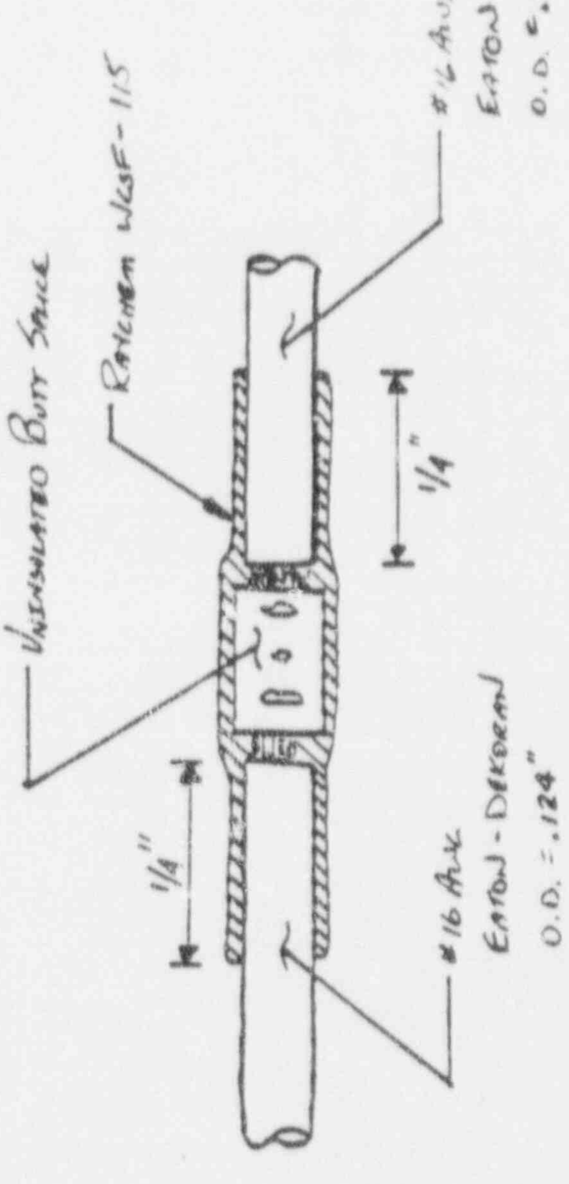
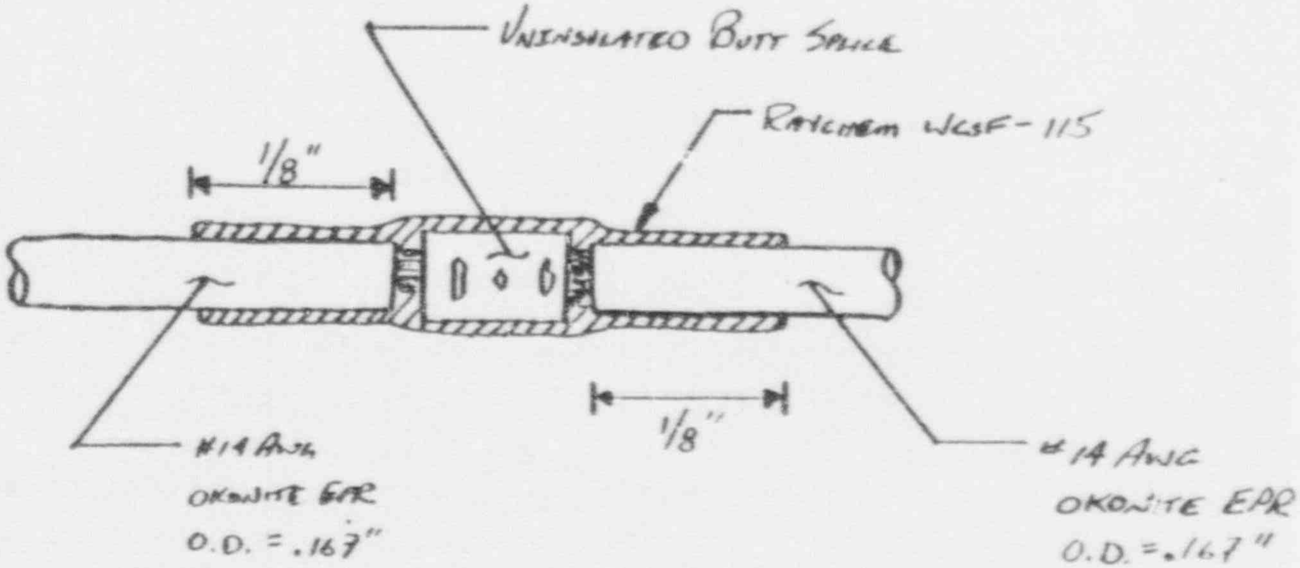


FIGURE IV-26
SPECIMEN L4

NOTE: RAYCHEM TUBING IS WCSF-N



No : RAICHEM TUBING IS WCSF-N

FIGURE IV-27
SPECIMEN L5

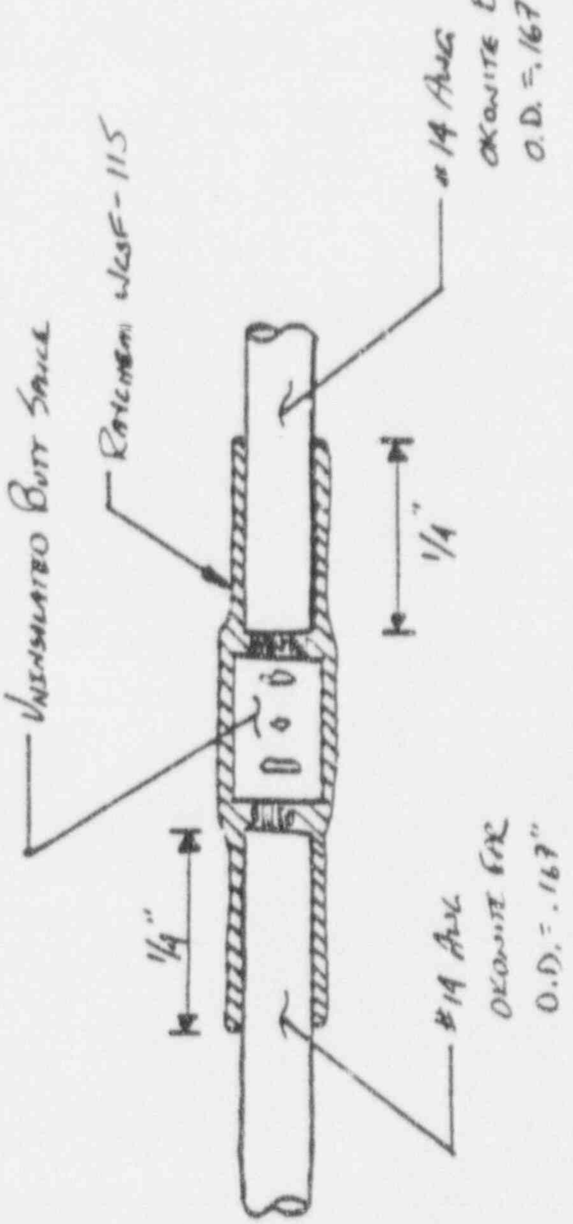
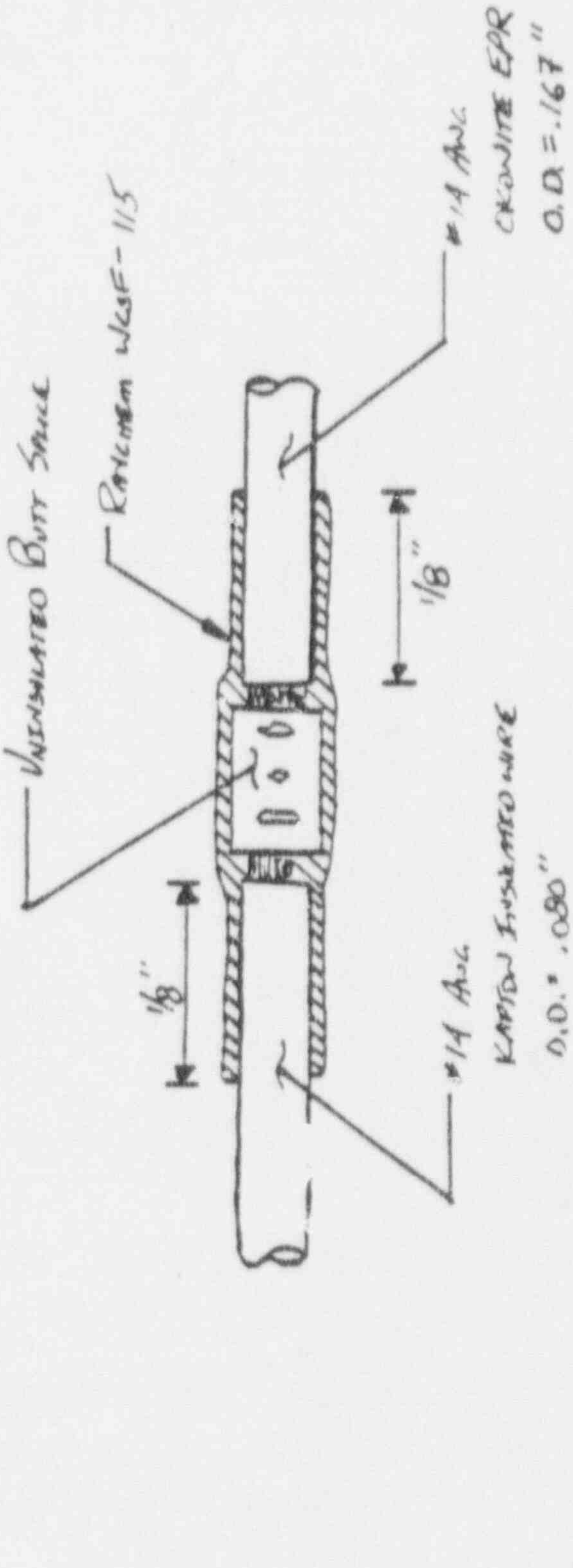


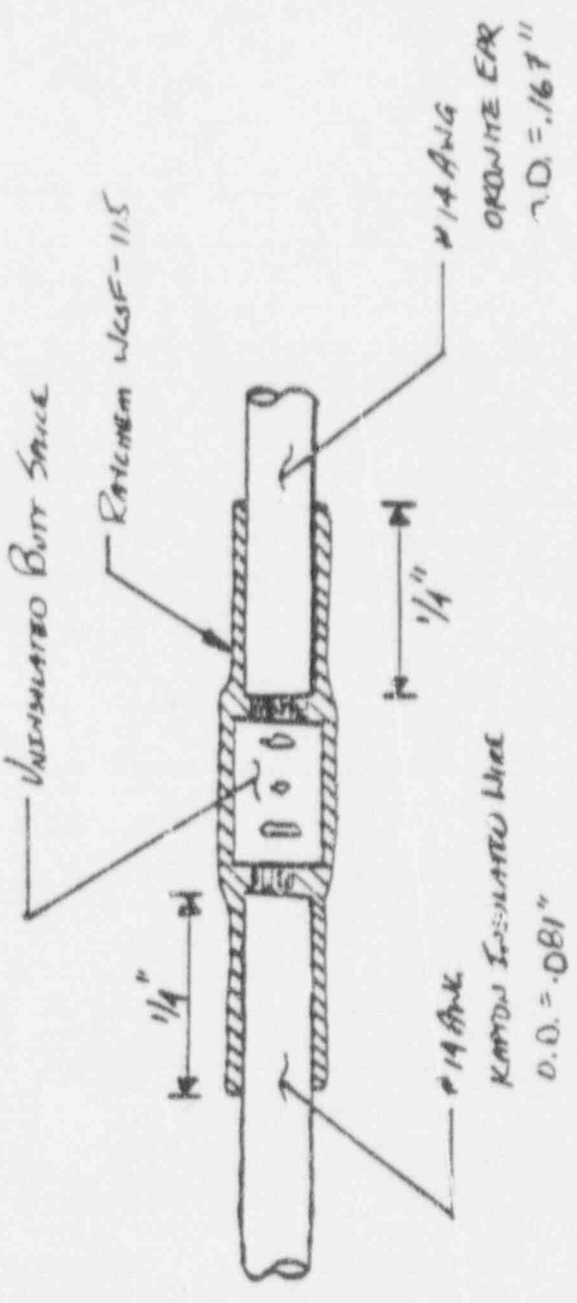
FIGURE IV-28
Specimen L6

Note: Raychem Tubing is WCSF-N



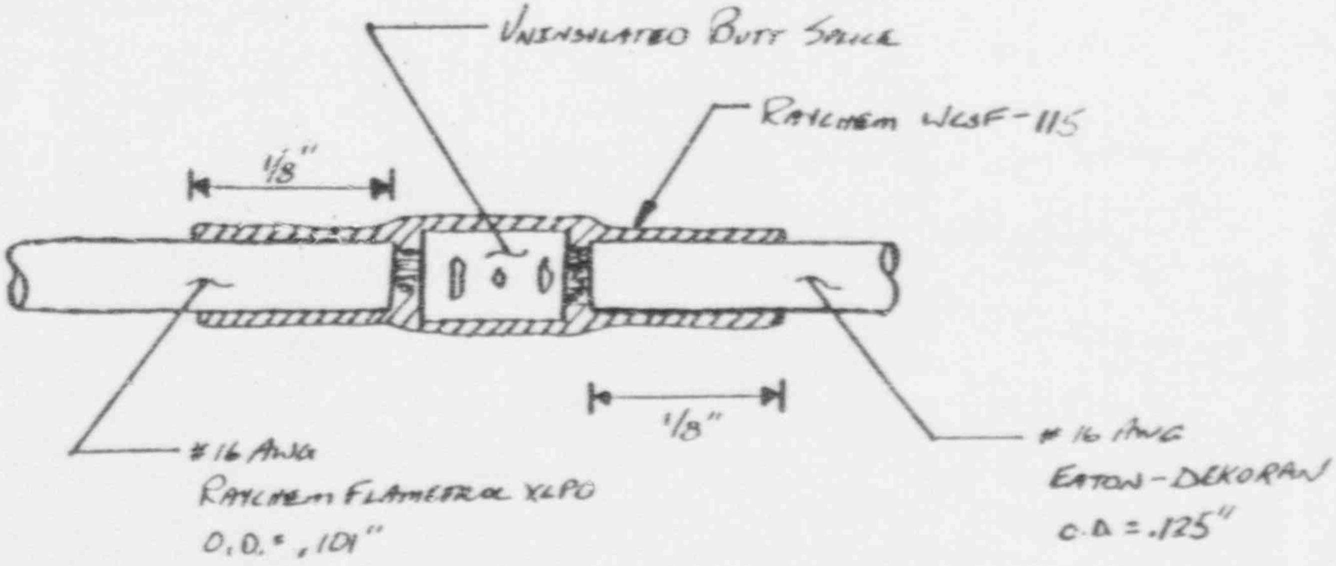
NOTE: RAYCHEM TUBING IS WCSF-N

FIGURE IV-29
SPECIMEN L7



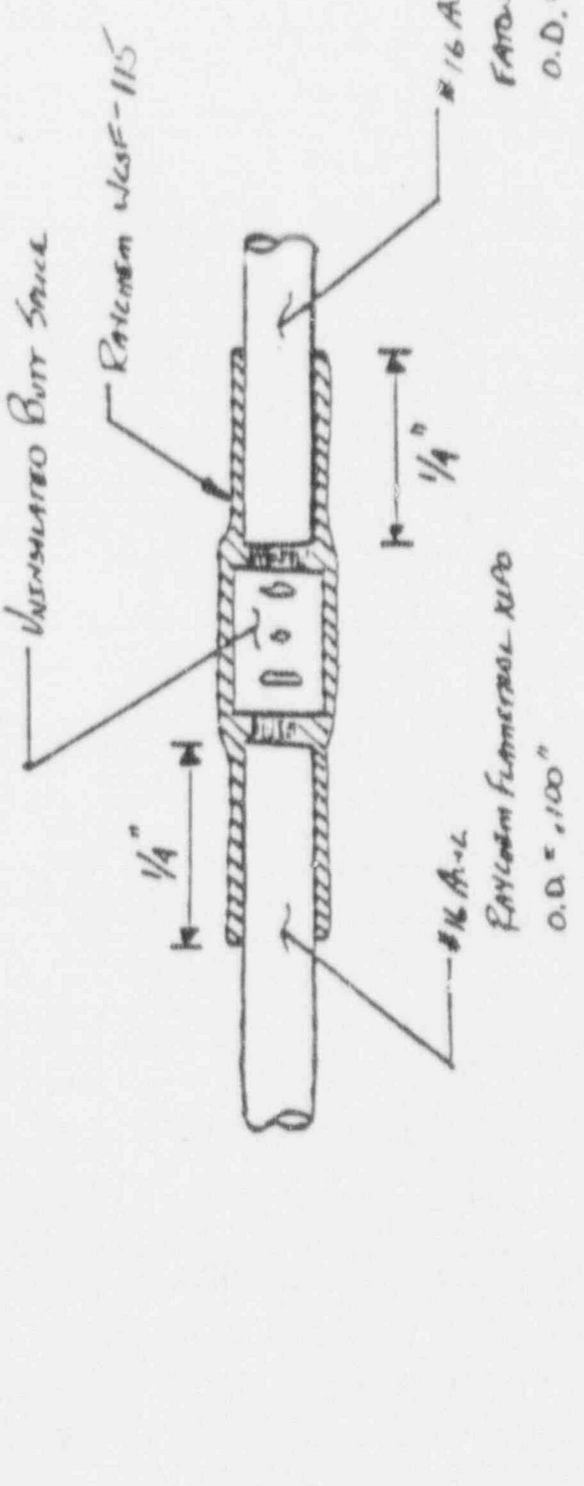
NOTE: RAYCHEM TUBING IS WCSF-N

FIGURE IV-30
SPECIMEN L8



NOTE: RAYCHEM TUBING IS WCSF-N

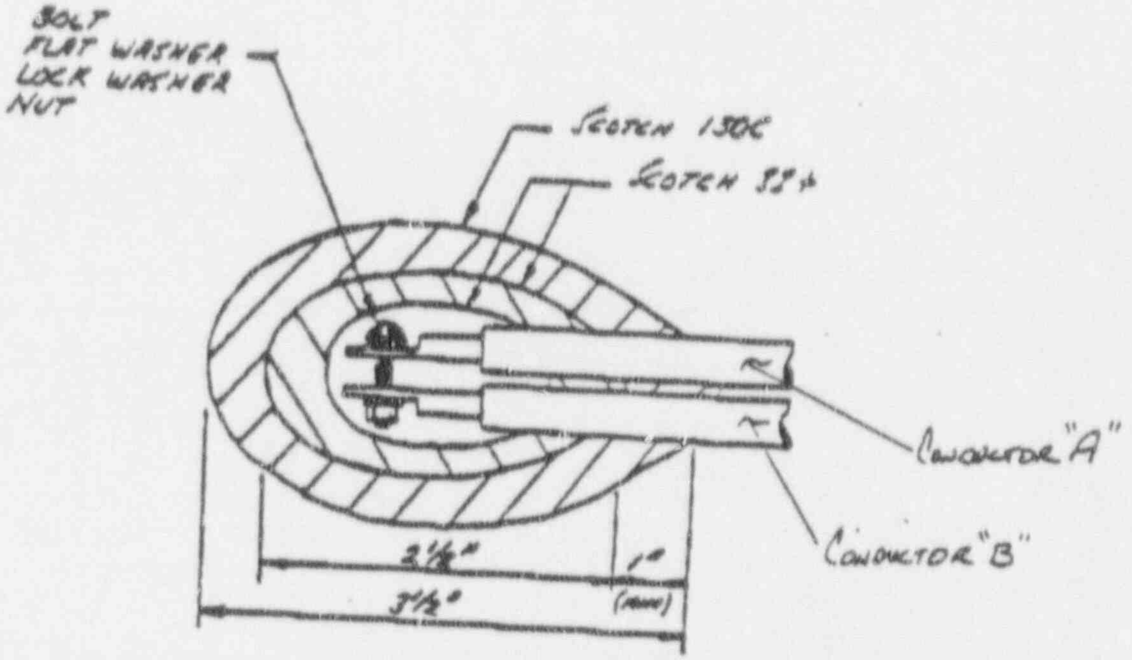
FIGURE IV-31
SPECIMEN 19



NOTE: RAYCHEM TUBING IS WCSF-N

FIGURE IV-32
SPECIMEN L10

SPECIMENS D4, D21, Q1, Q2, Q3, Q4



SPECIMEN	CONDUCTOR "A"	CONDUCTOR "B"
D4, D21	#12 AWG ROCKBESTOS SIS O.D. = .138"	#12 AWG ROCKBESTOS SIS O.D. = .138"
Q1 thru Q4	#14 AWG ROCKBESTOS SIS O.D. = .137"	#14 AWG EATON-DEKORON O.D. = .170

APPLY TAPE IN ACCORDANCE WITH PROCEDURE ON PAGE 2 OF 2

FIGURE IV-33

Scotch 130C, 33+ Tape Procedure

A. Clean the surface of the connector, the insulation, and the jacket with a cloth moistened in chlorothene or similar solvent. When dry, all connectors having irregular surfaces shall be padded with Scotchfill putty or Scotch 23 tape prior to insulating with Scotch 33+ or Scotch 88 electrical tape.

B. Fill connector slots and indents with insulating tape.

C. For pigtail splices, apply one layer of insulating tape (Scotch 33+ or Scotch 88) half-lapped. Start half-lapped taping between the two conductors taping toward the lugs. Complete two layers of tape over the top of the lugs then return to the starting area and pass the tape between the conductors to complete the total encapsulation of the lugs. Stretch tape to reduce width to at least 75%.

D. Apply two layers of jacketing tape (Scotch 130C) over the insulating tape and approximately 1 inch over factory insulation at each end. Apply tape with minimum tension.

E. Apply another layer of Scotch 33+ over the Scotch 130C. This is to cover the somewhat tacky surface of the Scotch 130C tape to reduce dust buildup.

FIGURE IV-33

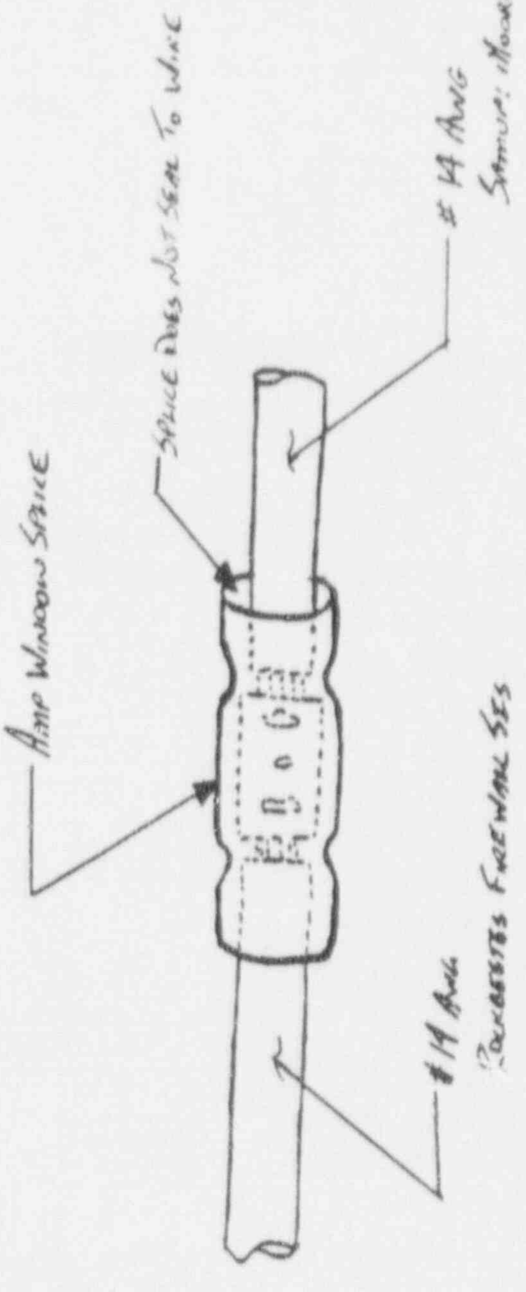
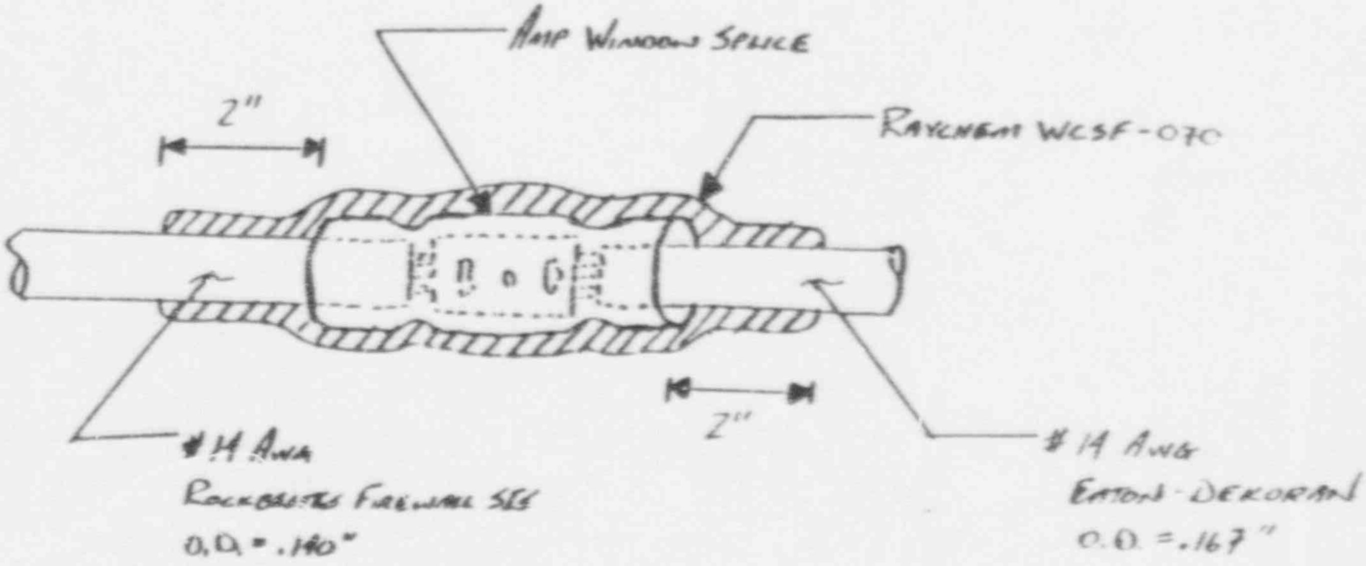


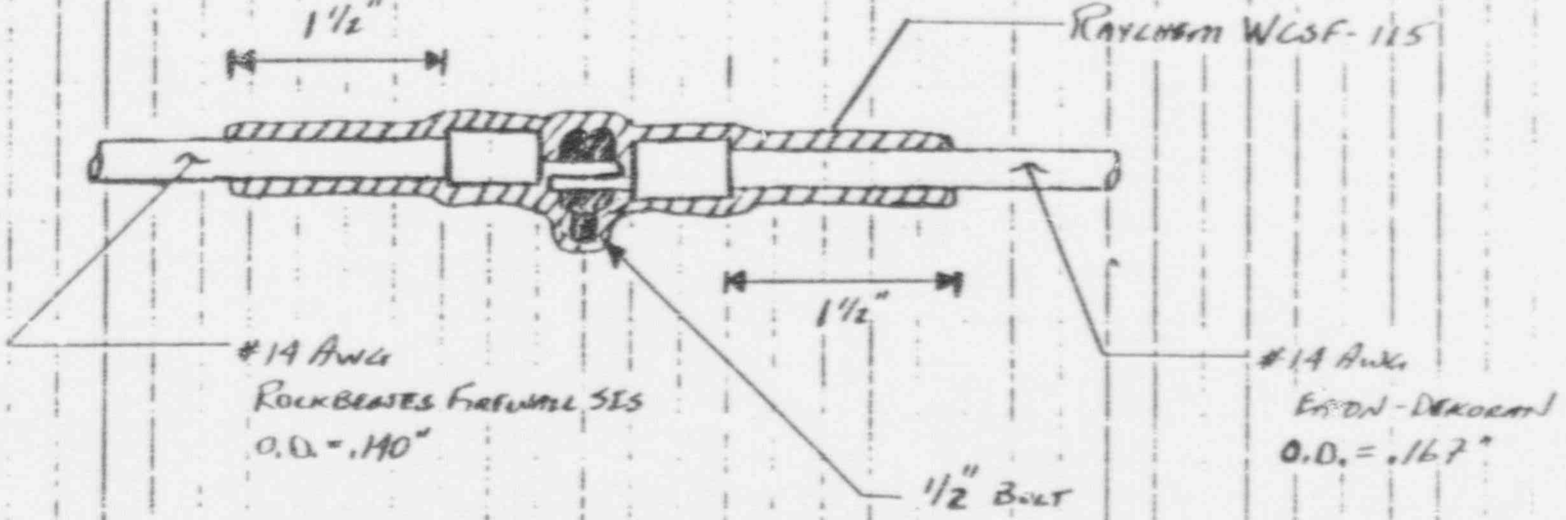
FIGURE IV-34
Specimen Q5+Q6

Note: Amp Commercial Grade
PIDG Splice Model 320570



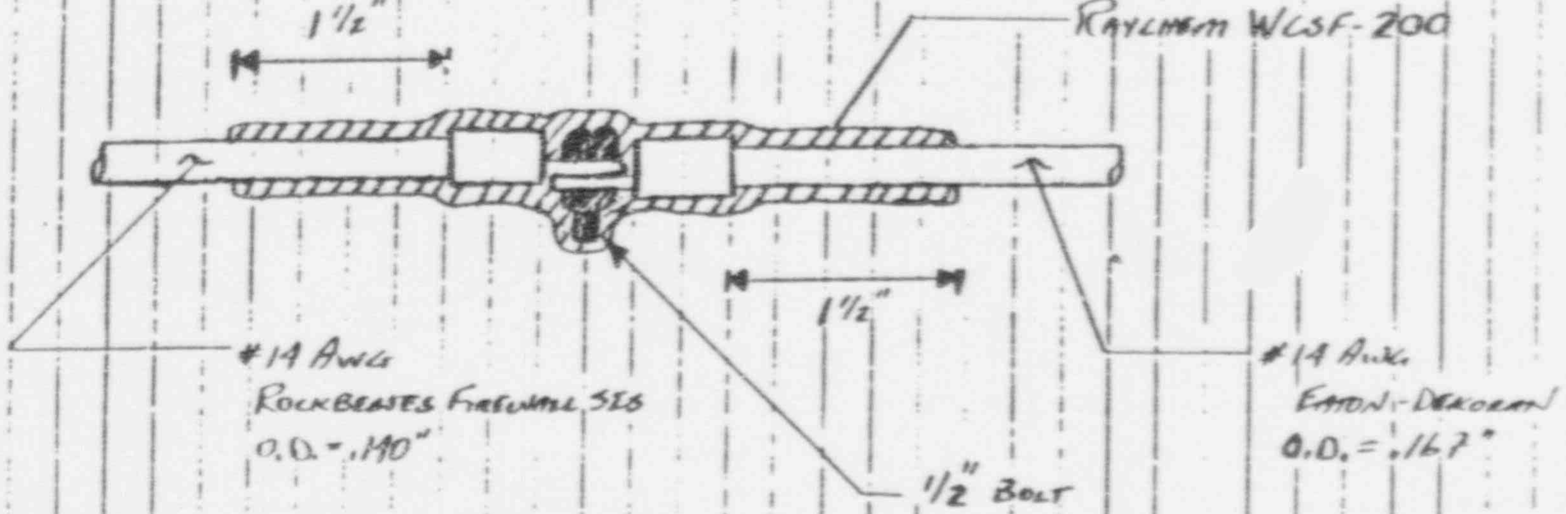
NOTES: 1) HEAT SHRINK TUBING IS WCSF-N
2) AMP SPLICE IS COMMERCIAL GRADE PIDG
MODEL 320570

FIGURE IV-35
SPECIMEN Q7 + Q8



NOTE: 1) RAYCHEM TUBING IS WCSF-N

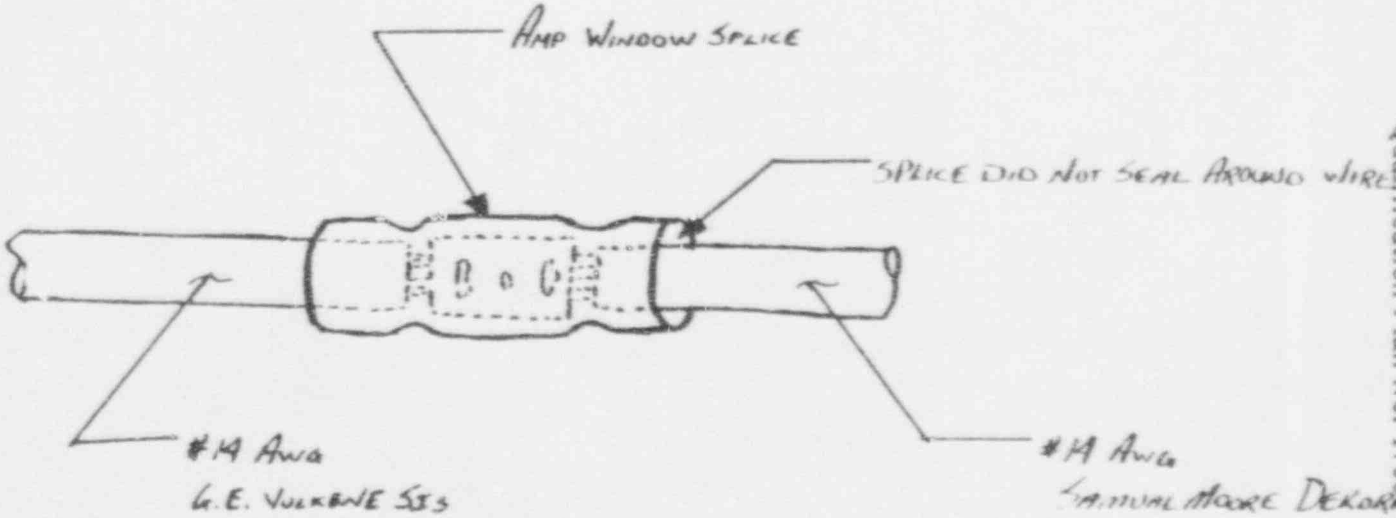
FIGURE IV-36
SPECIMEN Q9 + Q10



NOTE: RAYCHEM TUBING IS WCSF-N

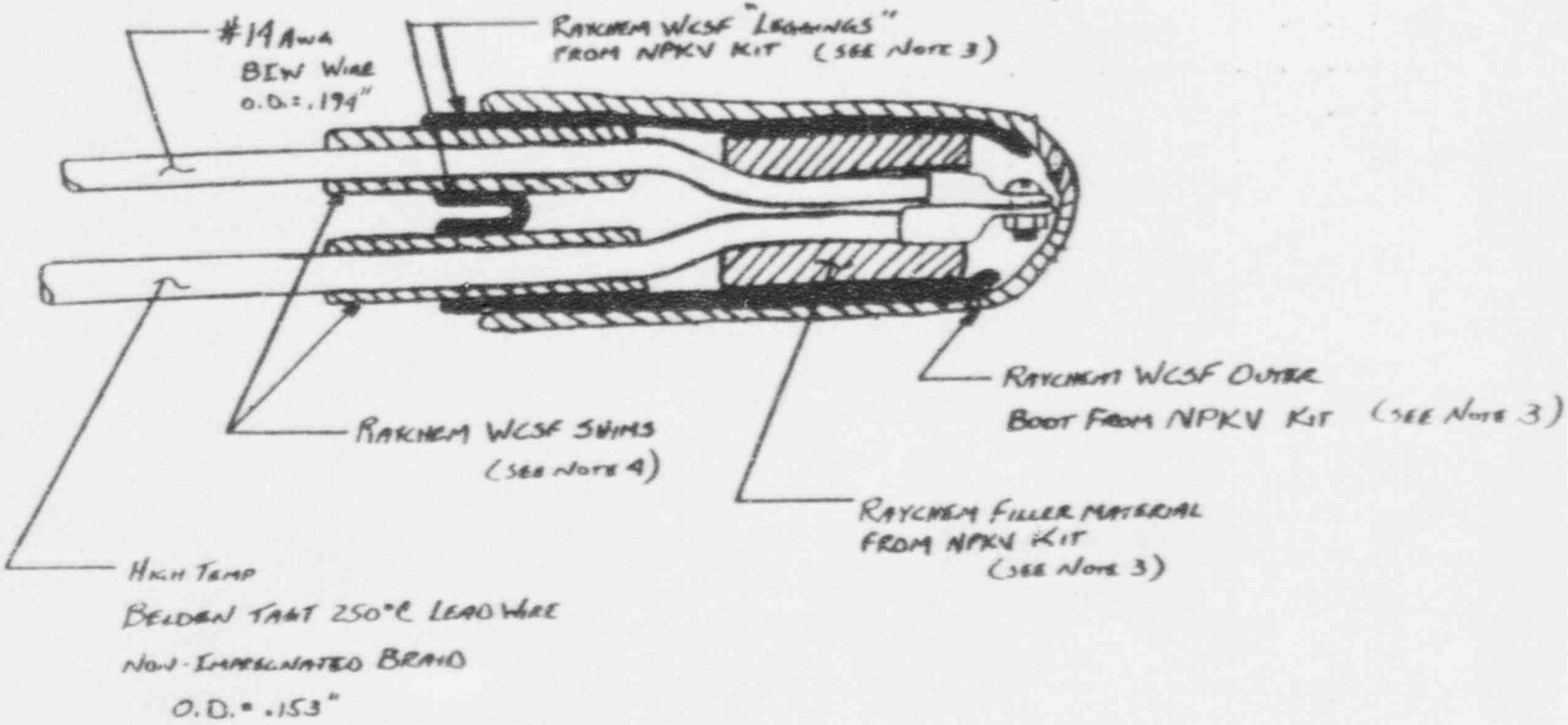
FIGURE IV-37

SPECIMEN Q11 + Q12



NOTE: AMP SPLICE WAS REMOVED
FROM PIGTAIL OF GENERAL ELECTRIC
F-100 SERIES PENETRATION INSTALLED
IN DRYWELL AT QUAD CITIES UNIT 2

FIGURE IV-38
SPECIMENS Q13-Q20



Notes: 1) WCSF Material is Nuclear Grade
2) Belden Wire Removed From Asco Solenoid
3) Raychem NPKV-2-10A Kit
4) Shims Supplied With Kit and Sized For Wire

FIGURE IV-39

Specimen Z1

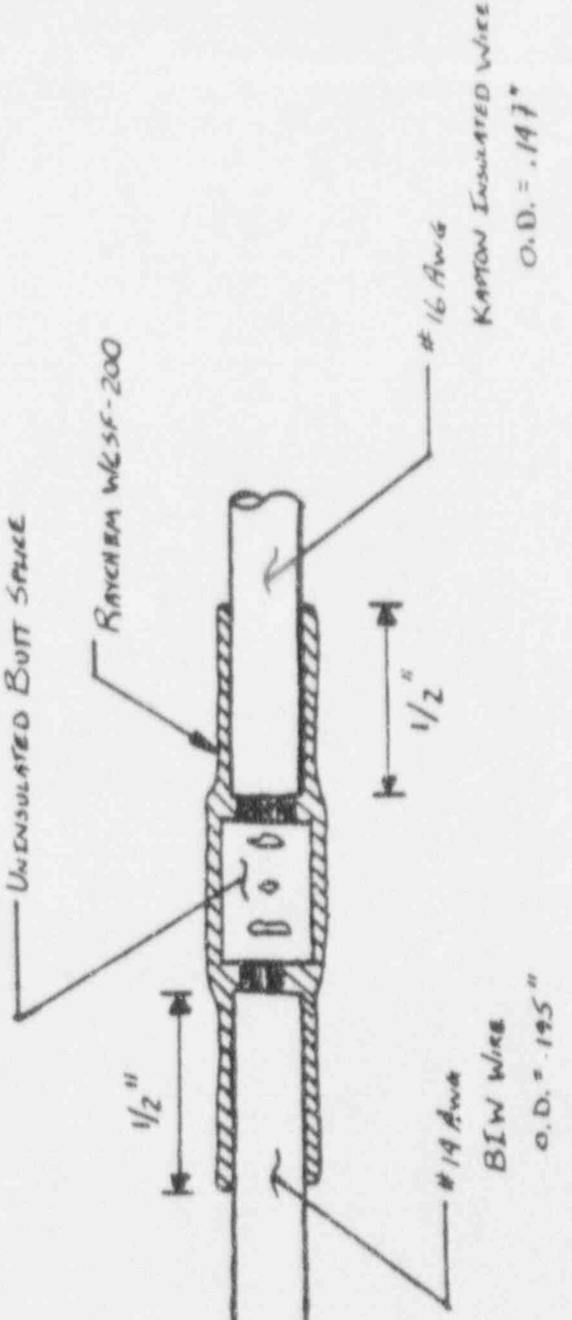
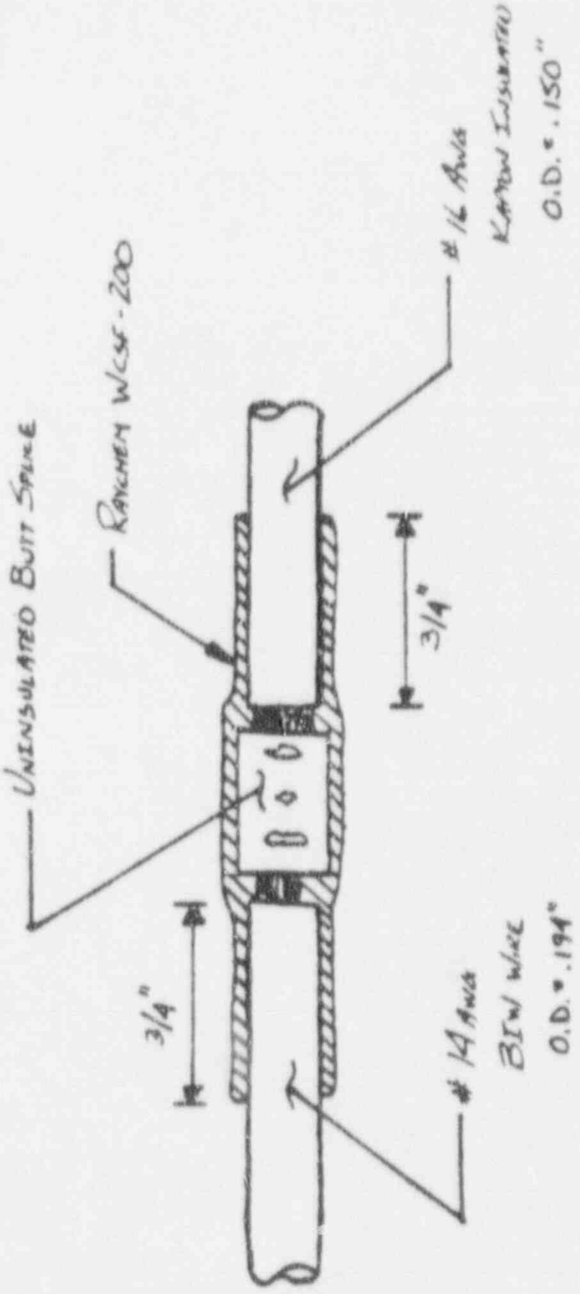


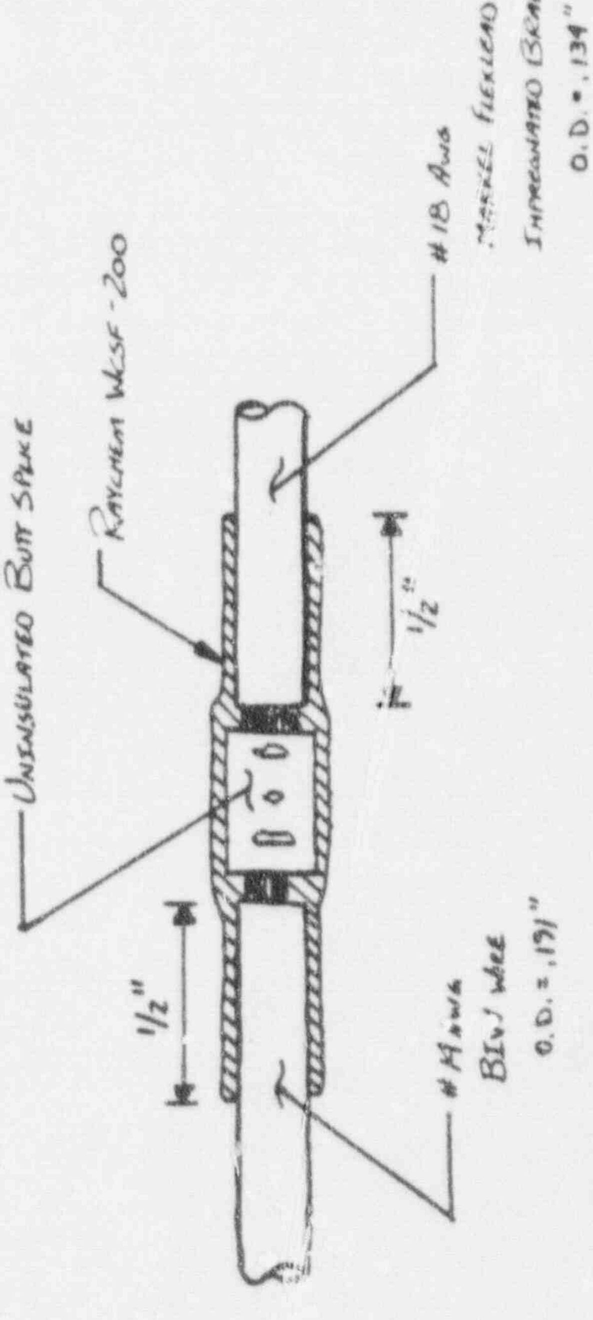
FIGURE IV-40
Specimen Z2

Notes: 1) Raychem tubing is Nuclear Grade



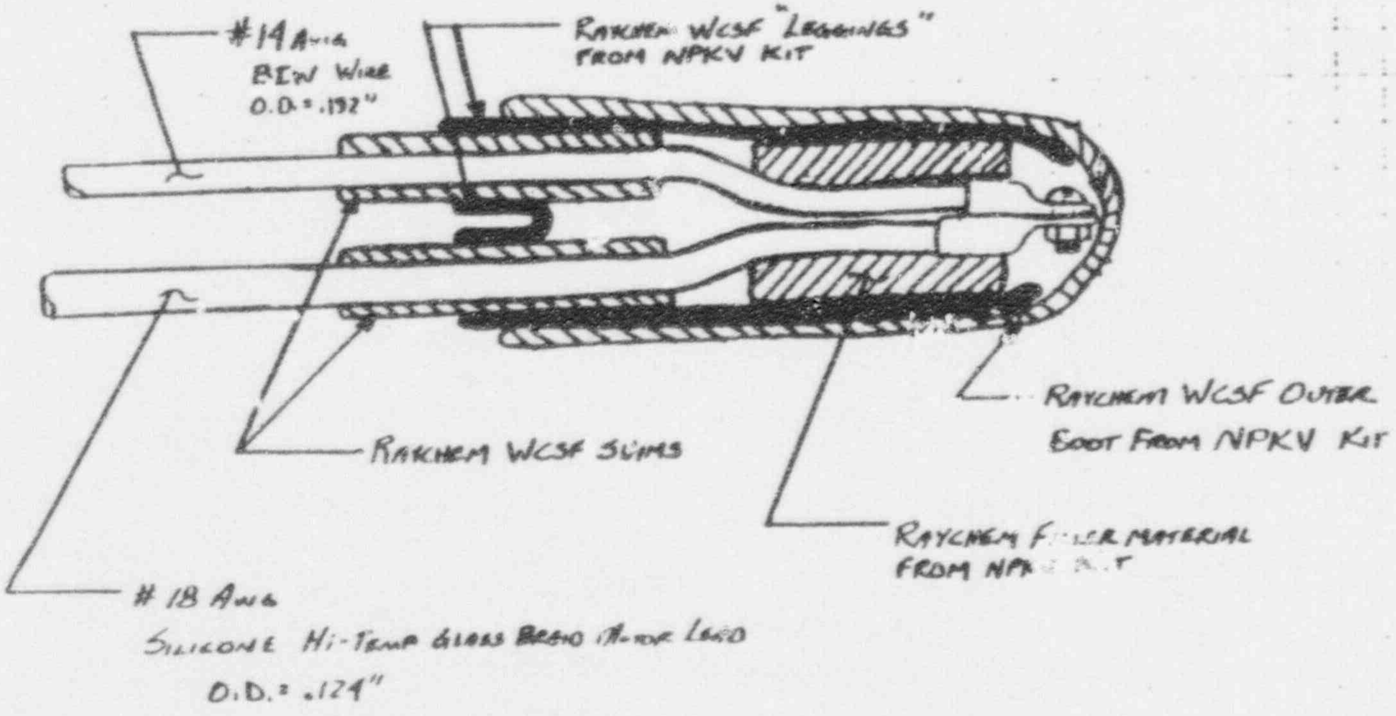
Notes: 1) Raychem Tubing is Nuclear Grade

FIGURE IV-41
Specimen Z3



Note: 1) Raychem Tubing is Nuclear Grade
2) Markel Braid's lead wire was
removed from Static-O-Ring Switch

FIGURE IV-42
Specimen 24



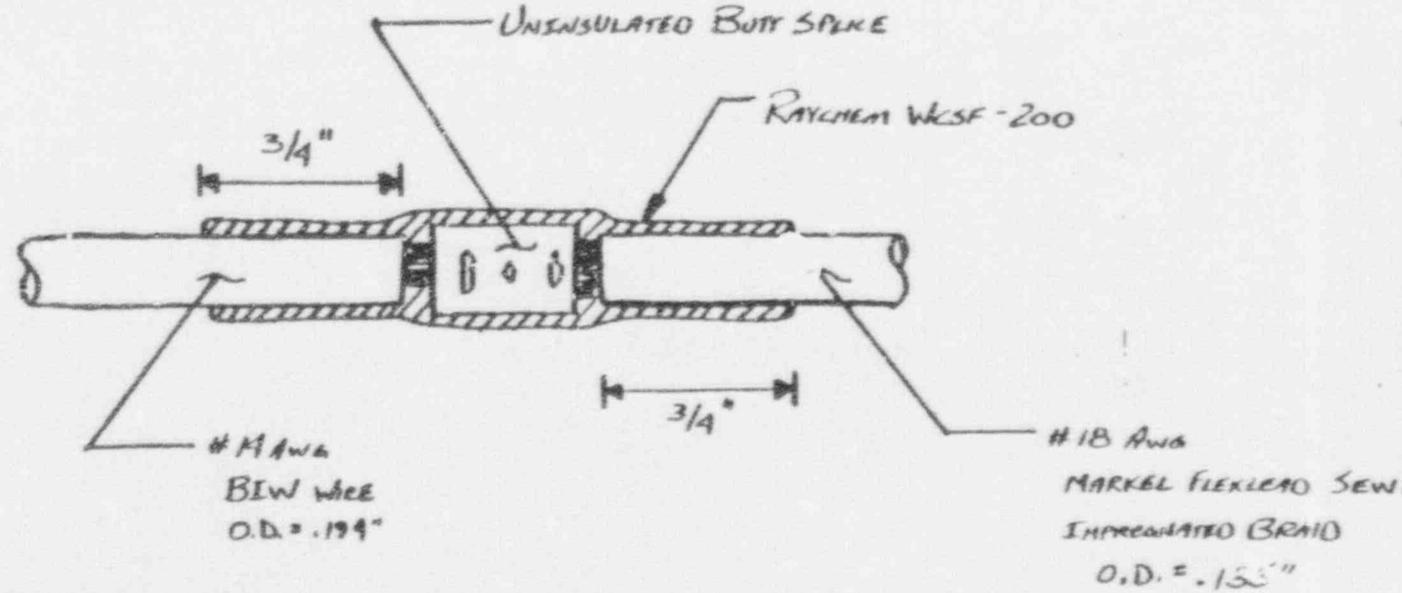
NOTES: 1) WCSF MATERIAL IS NUCLEAR GRADE

2) RAYCHEM KIT # NPKV-2-10A

3) SHIMS SUPPLIED WITH NPKV KIT AND SIZED FOR WIRE

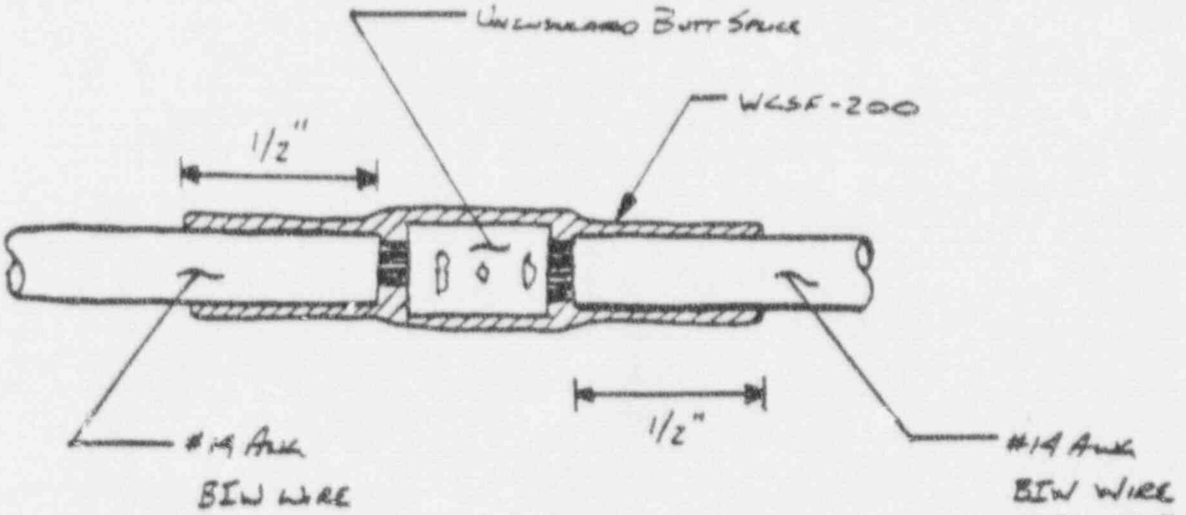
FIGURE IV-43

SPECIMEN 26

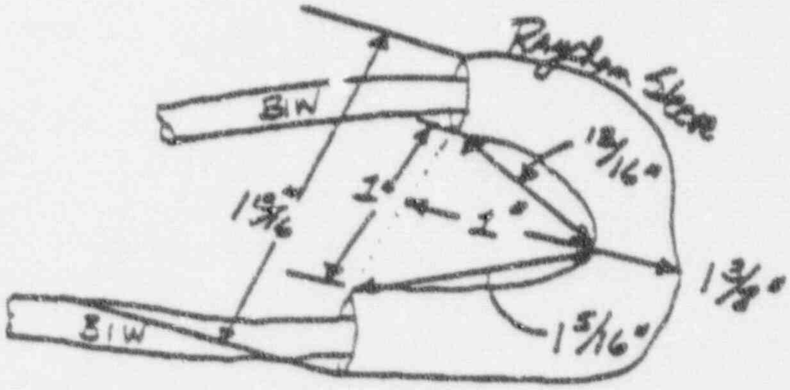


NOTE: 1) RAYCHEM TUBING IS NUCLEAR GRADE
2) MARKEL BRAIDED LEAD WIRE WAS REMOVED FROM STATIC-O-RING SWITCH

FIGURE IV-44
SPECIMEN Z5



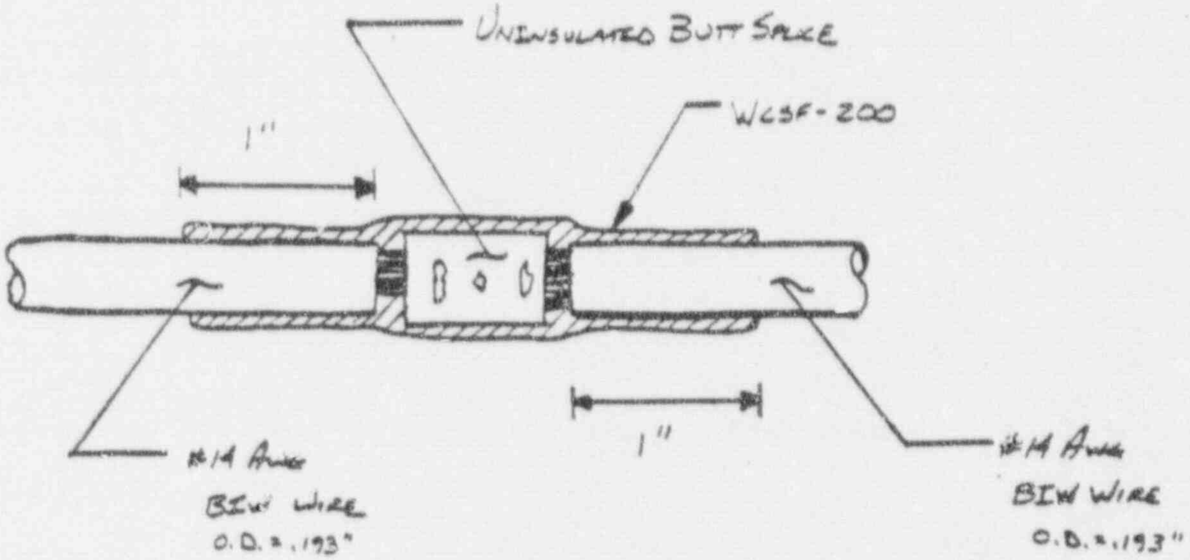
PRIOR TO BENDING



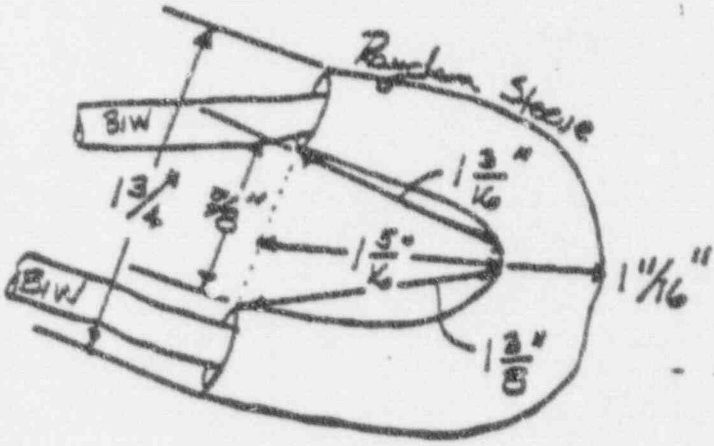
AFTER BENDING

NOTES: 1) RAYCHEM TUBING IS NUCLEAR GRADE
2) TUBING BENT WHILE HEATED
3) BENDS MADE ABOVE AND BELOW BUTT SPLICE

FIGURE IV-45
SPECIMEN 28



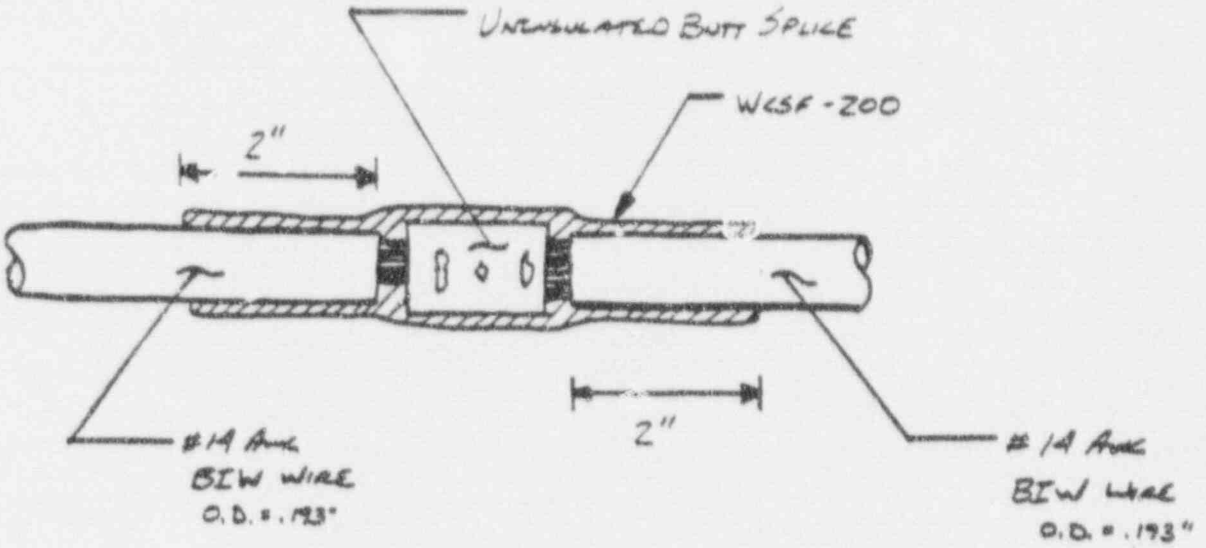
PRIOR TO BENDING



AFTER BENDING

NOTES: 1) RAYCHEM TUBING IS NUCLEAR GRADE
2) TUBING BENT WHILE HEATED
3) BENDS MADE ABOVE AND BELOW BUTT SPLICE

FIGURE IV-46
SPECIMEN Z9



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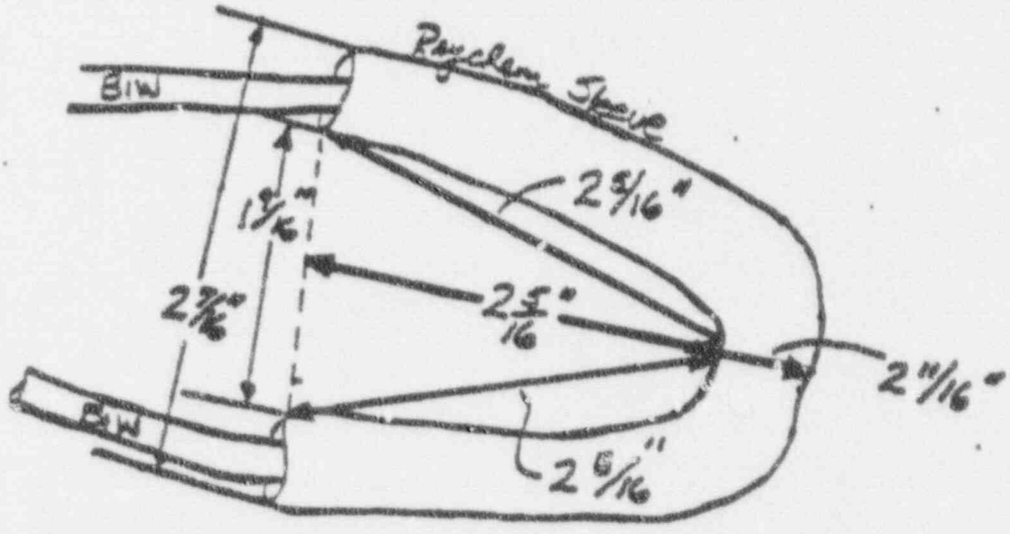
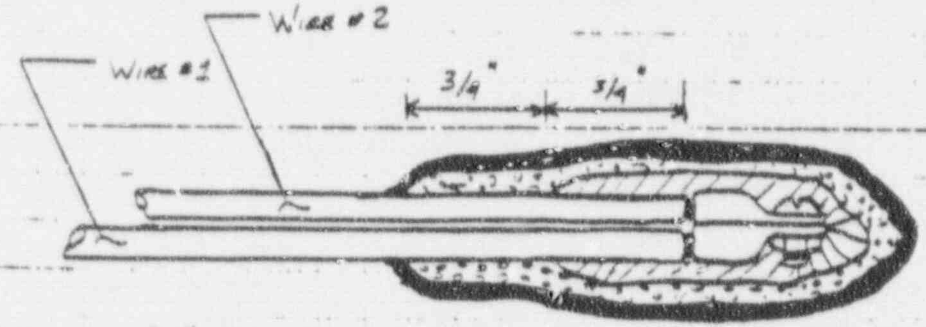


AFTER BENDING

NOTES: 1) RAYCHEM TUBING IS NUCLEAR GRADE
2) TUBING BENT WHILE HEATED
3) BENDS MADE ABOVE AND BELOW BUTT SPLICE

FIGURE IV-47
SPECIMEN 210

KERITE SPLICE TAPE PROCEDURE



▬ : KERITE "A" TAPE (GRAY)

▨ : KERITE CONDUCTING FABRIC TAPE

▨ : KERITE INSULATING TAPE (BLACK)

SPECIMEN #	WIRE #1	WIRE #2
Z 7	# 14 AWG BIW O.D. = .194"	# 14 AWG BIW O.D. = .194"
Z 11	# 14 AWG BIW O.D. = .193"	# 14 AWG BELDEN TEXT 250°C HI-TEMP SILICONE BRAID O.D. = .151"
Z 12	# 14 AWG BIW O.D. = .194"	# 14 AWG BELDEN TEXT 250°C HI-TEMP SILICONE BRAID O.D.=.151
Z 13	# 14 AWG BIW O.D. = .194"	# 14 AWG BIW O.D. = .194"

APPLY TAPE IN ACCORDANCE WITH THE FOLLOWING PROCEDURE:

1) APPLY KERITE "A" TAPE ON CABLE INSULATION STARTING APPROXIMATELY 3/4" PAST THE END OF INSULATION ON THE CABLE LUG. WRAP "A" TAPE USING HALF LAPPED LAYERS AROUND THE CABLE AND LUG PAST THE BOLTED END OF THE LUG. CONTINUE WRAPPING TAPE, BRINGING TAPE BACK OVER THE LUG AND CABLE TO STARTING POINT OF "A" TAPE. REPEAT TAPING PROCEDURE BRINGING "A" BACK OVER FIRST TWO LAYERS OF TAPE, EXTENDING PAST END OF LUG, AND RETURNING TO ORIGINAL STARTING POINT.

FIGURE IV-48
PAGE 1 OF 2

2) APPLY KERITE CONDUCTING FABRIC TAPE ON CABLE INSULATION STARTING APPROXIMATELY 3/4" PAST END OF THE KERITE "A" TAPE. WRAP THE FABRIC TAPE USING HALF LAPPED LAYERS AROUND THE CABLE AND TAPED LUGS UP TO THE END OF THE PREVIOUSLY TAPED SPLICE. CONTINUE WRAPPING TAPE, BRINGING THE TAPE BACK OVER THE TAPED SPLICE TO THE STARTING POINT OF THE FABRIC TAPE. REPEAT THE TAPE PROCEDURE WRAPPING THE FABRIC TAPE BACK OVER THE PREVIOUSLY TAPED LUGS, EXTENDING THE FABRIC TAPE PAST THE END OF THE TAPED SPLICE, THEN RETURNING TO THE STARTING POINT.

3) APPLY THE KERITE INSULATING TAPE STARTING AT THE BOLTED LUG END OF THE SPLICE. WRAP THE INSULATING TAPE USING HALF LAPPED LAYERS DOWN TO THE END OF THE FABRIC TAPE. CONTINUE WRAPPING THE INSULATING TAPE IN HALF LAPPED LAYERS TO BUILD UP A TOTAL OF FIVE LAYERS OF INSULATING TAPE.

FIGURE IV-49

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