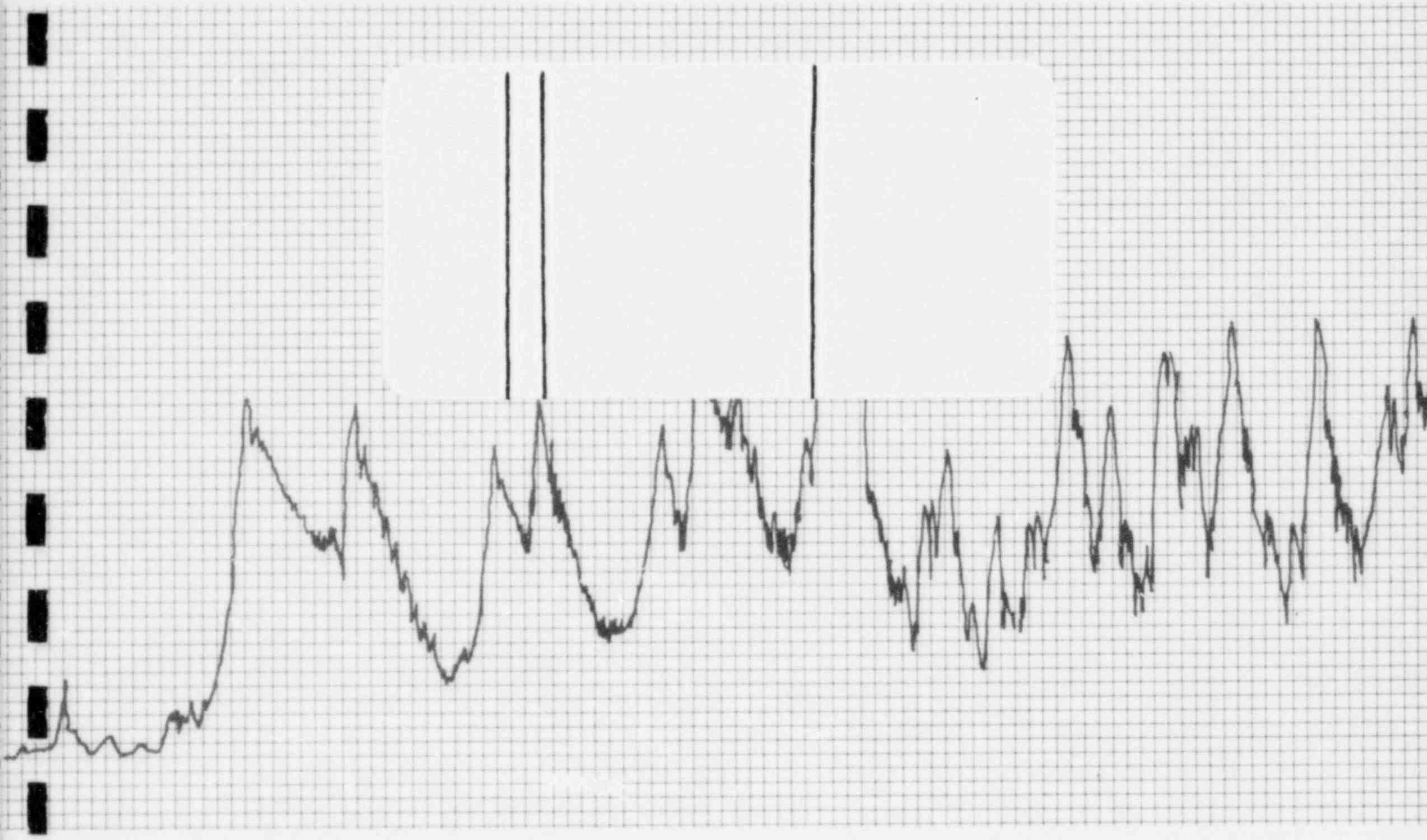
WYLE
LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP



NEQ
NUCLEAR ENVIRONMENTAL QUALIFICATION

test REPORT

ANALYSIS OF CABLES AND CONNECTORS FOLLOWING

ACCIDENT TEST CONCLUDED ON MARCH 31, 1982

AND

EXTENDED ACCIDENT TEST CONDUCTED

FROM MAY 10 THROUGH 18, 1982

ON

ELECTRICAL PENETRATION ASSEMBLY, TYPE B-M

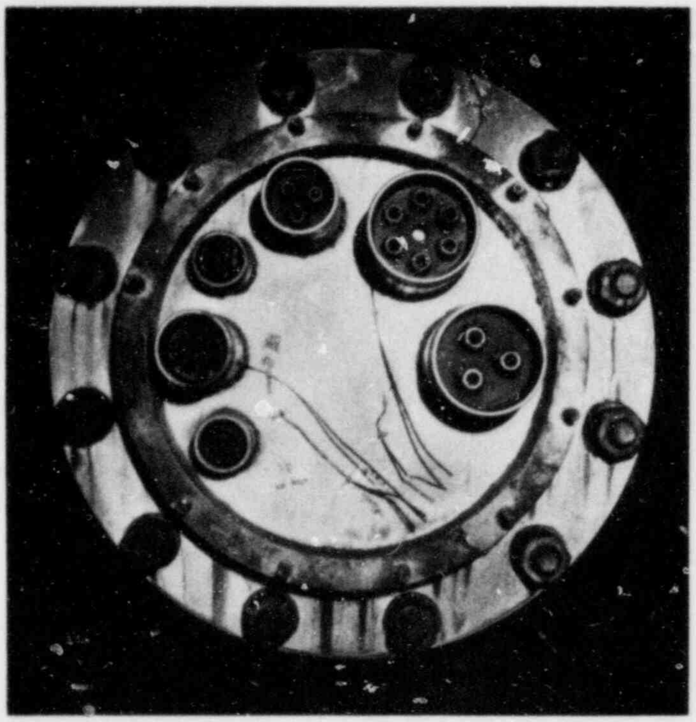
FOR

DUKE POWER COMPANY

VOLUME II

422 Church Street
Charlotte, NC 28242

VOLUME II



NEQ

Nuclear Environmental Qualification

Test Report

REPORT NO. 45869-1

WYLE JOB NO. 45869

CUSTOMER P. O. NO. 8828.05-3PM

PAGE i OF 89 PAGE REPORT

DATE September 10, 1982

SPECIFICATION (S) See References, Paragraph 5.0.

1.0 **CUSTOMER** Duke Power Company

ADDRESS 422 Church Street, Charlotte, NC 28242

2.0 **TEST SPECIMEN** Electrical Penetration Assembly, Type B-M, Twelve Electrical Plug Kits

3.0 **MANUFACTURER** D. G. O'Brien

4.0 **SUMMARY**

This portion of the report, Volume II, provides the procedures and results of an analysis task designed to (1) isolate the cause of erratic behavior (leakage current intermittently blowing 0.5 amp fuses) of Modules C, E, and L experienced during the Accident Test completed on March 21, 1982, and (2) a second seven-day Accident Test using the same penetration assembly.

The analysis task conducted after the first Accident Test failed to isolate the cause of erratic behavior of Modules C, E and L.

STATE OF ALABAMA } ss. AL PE No. 8256
COUNTY OF MADISON

F. R. Johnson, 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 [signature]

SUBSCRIBED and sworn to before me this 23rd day of Sept., 1982

[signature]
Notary Public in and for the State of Alabama at large

My Commission expires Jan. 30, 1985

PREPARED BY [signature] H. Smith Al PE No. 5683

APPROVED BY [signature] F.R. Johnson, AL P.E. # 8256

WYLE Q. A. [signature] T. Stinson

WYLE LABORATORIES
SCIENTIFIC SERVICES AND SYSTEMS GROUP
HUNTSVILLE, ALABAMA

4.0 SUMMARY (CONTINUED)

The second Accident Test was conducted exactly like the first Accident Test, with the exception of (1) eliminating the long cables in the chamber to minimize any cable insulation steam leakage affecting the test, (2) extending the initial steam ramp to eight hours, and (3) eliminating the superheat portion of the test. All other conditions were the same as in the first Accident Test.

There were no problems with Modules C, D, F, K, and L during the second Accident Test, but Module E experienced erratic behavior (low insulation resistance) and it was necessary to reduce the voltage from 600 volts AC to 120 volts AC to avoid blowing the 0.5 amp fuse. After the Accident Test, an inspection of the disassembled E connector revealed a blackened area of the insulator near Pins 9 and 12. There was also a severe cut in the insulation of Conductor No. 12 under the backshell clamp. This cut could have allowed moisture to enter the connector and cause erratic behavior of Module E. There were no anomalous conditions detected during the final inspection of Modules C, D, F, K, and L.

This volume contains the following sections:

Section I - Introduction

Section II - Analysis of Module C, E, And L Cables and K Module Connector after the First Accident Test

Section III - Extended Accident Test

Section IV - Final Inspection

5.0 REFERENCES

5.1 Wyle Laboratories' Test Procedure No. 543/6124-2/DK, Revision B, dated 3/17/82 and Revision C, dated 4/28/82.

5.2 Duke Power Company Specification No. MCS-1393.01-00-0003, July 23, 1981, Revisions 1, 2, 3, 4, and 5.

5.3 IEEE 323-1971, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations."

5.4 IEEE 317-1972, "IEEE Standard for Electric Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations."

5.5 ANSI N45-2.2-1972, "Packaging, Shipping, Receiving, Storage, and Handling of Items for Nuclear Power Plants."

5.6 Duke Power Company MCM 1361-00-0016, "Low Voltage Penetration Instruction Manual."

5.0 REFERENCES (CONTINUED)

5.7 Duke Power Company MCM 1361-00-0017, "Instrumentation Penetration Instruction Manual."

5.8 Duke Power Company CNM 1361-00-0010, "Low Voltage Penetration Instruction Manual."

5.9 Duke Power Company CNM 1361-00-0011, "Instrument Penetration Instruction Manual."

5.10 Duke Power Company IP-MCP-001, "Test Assembly Installation Sequence."

SECTION I

INTRODUCTION

Modules K, D, and F performed satisfactorily during the Accident Test conducted from March 24, 1982, thru March 31, 1982, but erratic behavior (fuse blowing) was observed with Modules C, E, And L. For details, see Volume I, Section VII. Erratic behavior of Modules C, E, and L ceased at the end of the test when checked at room temperature and electrical measurements could not demonstrate any problems with any of the six modules. Subsequently, Duke Power Company directed Wyle to extend the test program with the same penetration assembly to determine if the erratic behavior could be isolated with a detailed analysis program or if the erratic behavior would repeat during a second seven-day Accident Test. The extended program consisted of three tasks as follows:

1) Conduct an analysis program on some of the cabling and connectors that had been subjected to the tests ending March 31, 1982, as reported in Volume I.

2) Conduct a second seven-day Accident Test with the penetration assembly but with the conductors, in the chamber, spliced at the connectors such that no long cables were used in the chamber. (The intent was to minimize the possibility of any cable steam leaks transmitting steam into the connectors of the penetration assembly.)

3) Conduct a final inspection of all plug modules after completion of the second Accident Test.

SECTION II

ANALYSIS OF MODULE C, E, AND L CABLES AND K MODULE CONNECTOR AFTER THE FIRST ACCIDENT TEST

1.0 INTRODUCTION, CABLE ANALYSIS

During the first Accident Test, several conductors of Modules E, C and L exhibited erratic behavior (low insulation resistance at times) during the test, but returned to normal at the end of the test. Power to the penetration assembly was supplied with long lengths of cables located inside the accident chamber. The procedure shown below was designed to determine whether problems were integral to the plug connectors or to the long lengths of cable in the accident chamber.

During the first Accident Test, water was observed seeping out at the conductor splice (outside the chamber) of Conductor No. 3 of Module C and Conductor No. 6 of Module E. The above observation indicates that the problem could be external to the electrical penetration assembly.

1.1 Cable Analysis Procedure

The following procedure was used in an attempt to isolate the precise locations causing low insulation resistance.

1.1.1 Visually examine suspect cables where they enter the test chamber, especially where they enter the epoxy pipe connection of the test chamber. Also, visually examine cables on the outside (annulus side) of the test chamber. Inspect cables where they enter the junction box and feed into the coupling ring on the back of the penetration plugs. Record all anomalous conditions.

1.1.2 Sever the cables of Modules C, E and L at the connectors outside the penetration assembly (annulus side) and take insulation resistance of the section from the severed cable through the penetration assembly.

1.1.3 Disconnect the connectors of Modules C, E and L and take insulation resistance readings of the short section of the severed cable and the disconnected connector.

1.1.4 Prepare to open test chamber by removing epoxy pipe fitting and by cutting the cables. Check for moisture in all leads. Record lead numbers when moisture is detected. Take insulation resistance reading of Modules C, E and L cables.

1.1.5 Remove the test chamber dome and slide the complete penetration assembly out of the test chamber. Be sure not to drag or cut the cables in the tank. Insure that the cables are supported off the floor and off the bottom of the test chamber. Take a complete set of insulation resistance readings of cables inside the chamber.

1.0 INTRODUCTION, CABLE ANALYSIS (CONTINUED)

1.1 Cable Analysis Procedure (Continued)

1.1.6 Make a visual observation of the cables, cable entry into junction box, and inspect plug coupling rings. Record findings and take appropriate photographs.

1.1.7 Take high potential readings at 650 VAC of the following:

- o Module E - Conductor Nos. 1 and 6
- o Module C - Conductor No. 3
- o Module L - Conductor Nos. 8 and 9
- o Module K - Conductor Nos. 3 and 6

Take an insulation resistance reading at 500 volts of Module L, Conductors 8 and 9, with a wet rag on the connector.

1.1.8 Cut the cables inside the junction box of all the modules and record insulation resistance of all connectors.

1.1.9 Measure the insulation resistance of the cut cables from 1.1.8 of Modules C, E and L.

1.1.10 Submerse the cables from Modules C, E and L in water and measure insulation resistance and take high potential readings.

1.2 Water Analysis

The following procedure was used in an attempt to determine if water could have entered the conductors through the cable insulation or splices of the modules that had exhibited erratic behavior.

1.2.1 One end of the conductors was sealed and the other end was left open (wires exposed). The open end of the conductors was placed in a pressure vessel filled with water and the cables routed through penetrations. The vessel was pressurized to 5 psig, and the cables observed for water seepage.

1.2.2 Any water observed was collected and analyzed for the presence of boron since boron was used in the chemical spray solution during the Accident Test. Its presence would indicate that moisture had entered the cables during the Accident Test.

2.0 MODULE K CONNECTOR ANALYSIS

The Module K connector was sectioned longitudinally and inspected for any evidence of distortion of the electrical conductors resulting from thermal expansion of the grommet RTV material.

3.0 RESULTS

3.1 Cable Analysis

3.1.1 There was no anomalous conditions detected during the visual inspection of the cables.

3.1.2 It could not be determined by the insulation resistance measurements taken as described in Paragraph 1.1.2 through 1.1.10, if the low resistance readings recorded during the Accident Test were caused by steam/water leaks in the cables or leaks in the connectors. See Appendix II-1 for test data sheets.

3.1.3 The test, as conducted in paragraph 1.2, showed that water could seep along the cables between the conductors and insulation if the cable insulation contained an opening such as a crack. Leakage was observed on Conductors L-8 and L-10. At this time, water samples were collected from Modules C, E and L by removing the sealed ends, and this water was analyzed for the presence of boron by the University of Alabama at Huntsville. Results of the analysis indicated essentially no presence of boron. See Appendix II-2 for analysis data.

3.2 Module K Connector Analysis

3.2.1 The thickness of the grommet was measured and found to be 0.230 inch versus a new grommet thickness of 0.250 inch, and the grommet displayed some surface indentations indicating it had expanded some during the Accident Testing.

The examination of the K module plug did not show problems with extrusion of the grommet material or problems with stripping of the conductor insulation. The attached photograph shows each half of the accident tested K plug on the left and right. A section of a K plug that had been thermally aged but not subjected to accident testing was placed in the photograph between the accident tested K plug sections for comparison purposes. See Appendix II-3 for photographs of the K plug.

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APPENDIX II-1

ELECTRICAL DATA TAKEN AFTER FIRST ACCIDENT TEST

DURING POST TEST ANALYSIS TASK

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DATA SHEET

WYLE LABORATORIES

Customer DUKE
Specimen CABLES
Part No. L, C & E MODS
Spec. —
Para. —
S/N —
GSI NO

Amb. Temp. 70°F
Photo NO
Test Med.
Specimen Temp.
PER PARA 1.1.2 & 1.1.3

Job No. 45869-10
Report No.
Start Date 4-1-82

Test Title FUNCTIONAL POST TEST CIRCUIT INVESTIGATION

L MOD	1435 HRS		E MOD	1454 HRS	
WIRE #	IN IR	OUT IR	WIRE #	IN IR	OUT IR
1	2.5×10^10 Ω	6.6×10^11 Ω	1	8.0×10^8 Ω	3.5×10^11 Ω
2	1.3×10^10 Ω	1.1×10^12 Ω	2	1.3×10^8 Ω	
3	5.1×10^10 Ω	8.6×10^11 Ω	3	1.3×10^8 Ω	
4	1.4×10^11 Ω	8.4×10^11 Ω	4	5.8×10^7 Ω	
5	2.2×10^10 Ω		5	2.8×10^7 Ω	
6	2.0×10^10 Ω		6	8.8×10^7 Ω	2.4×10^11 Ω
7	1.6×10^10 Ω		7	3.5×10^7 Ω	
8	6.4×10^5 Ω	1.1×10^12 Ω	8	6.8×10^8 Ω	
9	7.7×10^5 Ω	1.1×10^12 Ω	9	1.1×10^8 Ω	
10	4.0×10^10 Ω		10	1.3×10^8 Ω	
11	1.0×10^10 Ω		11	1.7×10^8 Ω	
12	6.2×10^10 Ω		12	2.2×10^8 Ω	

C MOD	1447 HRS	
WIRE #	IN IR	OUT IR
1	8.5×10^7 Ω	1.6×10^12 Ω
2	5.0×10^7 Ω	3.5×10^11 Ω
3	1.2×10^8 Ω	2.2×10^11 Ω

NOTE: IN IR DENOTES IR READINGS TAKEN PRIOR TO DISCONNECTING THE CONNECTORS, AND OUT IR AFTER DISCONNECTING

Specimen Failed
Specimen Passed
NOA Written

Tested By [signature] Date: 4-1-82
Witness Date:
Sheet No. 1 of
Approved [signature]

WH-614A

DATA SHEET

WYLE LABORATORIES

Customer: DUKE
Specimen: CABLES
Part No.: –
Spec.: –
Para.: –
S/N: –
GSI: NO
Amb. Temp.: 70°F
Photo: NO
Test Med.:
Specimen Temp.:
PER PARA. 1.1.4
Job No.: 45869-10
Report No.:
Start Date: 4-1-82
TIME 1400HRS
Test Title: POST TEST CIRCUIT INVESTIGATION

1.) RESISTANCE READING OF L MOD WIRE #8 (H) - 178K
WIRE #9 (E) - 219K
2.) REMOVED OUTSIDE COVER PLATE FROM PENETRATION
3.) DISCONNECTED L, C & E MOD FROM PENETRATION
4.) IR'S (STEP 5) E MOD

		GRND	COUPLING
	WIRE #6	4.5×10^{11} Ω	4.8×10^{11} Ω
	WIRE #1	4.0×10^{11} Ω	5.2×10^{11} Ω
L MOD	WIRE #8	1.4×10^{11} Ω	5.0×10^{6} Ω
	WIRE #9	7.4×10^{11} Ω	3.5×10^{10} Ω
C MOD	WIRE #3	5.0×10^{11} Ω	2.5×10^{11} Ω

5.) REMOVED SPECIMEN'S FROM CHAMBER
6.) REMOVED INSIDE COVER PLATE FROM PENETRATION
7.) IR'S (STEP 6) INSIDE CONTAINMENT

Specimen Failed:
Specimen Passed:
NOA Written:
Tested By: R McC[illegible] Date: 4-1-82
Witness: Date:
Sheet No.: of
Approved: H [illegible]

WH-614A

6

DATA SHEET

WYLE LABORATORIES

Customer: OKONITE
Specimen: CABLES
Part No.: L MOD
Spec.: —
Para.: —
S/N: —
GSI: NO

Amb. Temp.: 70°F
Photo: YES
Test Med.:
Specimen Temp.:
PER PARA. 1.1.5

Job No.: 45869-10
Report No.:
Start Date: 4-1-82
TIME 1605 HRS

Test Title: FUNCTIONAL - POST TEST CIRCUIT INVESTIGATION

L MOD

WIRE #	IR	
1	6.2 x 10^9 Ω	
2	1.6 x 10^10 Ω	
3	1.0 x 10^10 Ω	
4	8.2 x 10^10 Ω	
5	3.0 x 10^10 Ω	
6	2.4 x 10^5 Ω	AT 100VDC
7	2.0 x 10^5 Ω	AT 100VDC
8	1.4 x 10^10 Ω	
9	1.5 x 10^10 Ω	
10	6.4 x 10^10 Ω	
11	6.6 x 10^9 Ω	
12	3.0 x 10^10 Ω	

Specimen Failed
Specimen Passed
NOA Written

Tested By: R. McClellan Date: 4-1-82
Witness: Date:
Sheet No.: of
Approved: H. Smith

WH-614A

DATA SHEET

WYLE LABORATORIES

Customer: DUKE
Specimen: CABLE
Part No.: C MOD
Spec.: –
Para.: –
S/N: –
GSI: NO

Amb. Temp.: 70°F
Photo: 4155
Test Med.:
Specimen Temp.:
PER PARA 1.1.5

Job No.: 45867-10
Report No.:
Start Date: 4-1-82
TIME: 1610 HRS

Test Title: FUNCTIONAL - POST TEST CIRCUIT INVESTIGATION (STKA 6)

C MOD

WIRE #	ER
1	4.0×10^{7} Ω
2	6.8×10^{7} Ω
3	1.1×10^{8} Ω

Specimen Failed:
Specimen Passed:
NOA Written:

Tested By: R. Mc [signature] Date: 4-1-82
Witness: Date:
Sheet No. of
Approved: H Small

DATA SHEET

WYLE LABORATORIES

Customer: DUKE
Specimen: CABLE
Part No.: E MOO
Spec.: -
Para.: -
S/N: -
GSI: NO

Amb. Temp.: 70°F
Photo: YES
Test Med.:
Specimen Temp.:
PER PARA 1.1.5

Job No.: 45869-10
Report No.:
Start Date: 4-1-82
TIME: 1615 HRS

Test Title: FUNCTIONAL - POST TEST CIRCUIT INVESTIGATION

E MOO

WIRE #	IR
1	$1.3 \times 10^8 \Omega$
2	$4.0 \times 10^8 \Omega$
3	$8.0 \times 10^7 \Omega$
4	$6.4 \times 10^7 \Omega$
5	$1.3 \times 10^8 \Omega$
6	$1.0 \times 10^8 \Omega$
7	$5.6 \times 10^8 \Omega$
8	$3.0 \times 10^7 \Omega$
9	$9.8 \times 10^7 \Omega$
10	$1.7 \times 10^8 \Omega$
11	$1.6 \times 10^8 \Omega$
12	$1.1 \times 10^8 \Omega$

Specimen Failed
Specimen Passed
NOA Written

Tested By: R. McClellan Date: 4-1-82
Witness: Date:
Sheet No. of
Approved: H Smith

WH-614A

DATA SHEET

Customer DUKE

Specimen CABLE

WYLE LABORATORIES

Part No. D MOD | Amb. Temp. 70°F | Job No. 45869-10

Spec. – | Photo YES | Report No.

Para. – | Test Med. | Start Date 4-1-82

S/N – | Specimen Temp. | TIME 1620 HRS

GSI NO

PER PARA. 1.1.5

Test Title FUNCTIONAL - POST TEST CIRCUIT INVESTIGATION

D MOD

WIRE #	IR
1	$5.6 \times 10^7 \Omega$
2	$9.6 \times 10^{11} \Omega$
3	$5.8 \times 10^7 \Omega$
4	$6.2 \times 10^7 \Omega$
5	$1.0 \times 10^8 \Omega$
6	$2.2 \times 10^7 \Omega$

Specimen Failed

Specimen Passed

NOA Written

Tested By R McClellan Date: 4-1-82

Witness Date:

Sheet No. of

Approved H Smith

WH-614A

DATA SHEET

WYLE LABORATORIES

Customer DUKE
Specimen CABLE
Part No. E MOD
Spec. —
Para. —
S/N
GSI NO

Amb. Temp. 70°F
Photo YES
Test Med.
Specimen Temp.

Job No. 45869-10
Report No. —
Start Date 4-1-82
TIME 1625 HRS

PER PARA 1.1.5

Test Title FUNCTIONAL - POST TEST CIRCUIT INVESTIGATION

FMOD

WIRE #	IR
1	6.4×10^6
2	1.3×10^7
3	5.2×10^6

Specimen Failed
Specimen Passed
NOA Written

Tested By R McC[illegible] Date: 4-1-82
Witness Date:
Sheet No. of
Approved H Smith

WH-614A

DATA SHEET

WYLE LABORATORIES

Customer: DUKE
Specimen: CABLE
Part No.: K MOD
Spec.: –
Para.: –
S/N: –
GSI: NO
Amb. Temp.: 70°F
Photo: YES
Test Med.:
Specimen Temp.:
Job No.: 45869-10
Report No.:
Start Date: 4-1-82
TIME: 1630 HRS

PER PARA 1.1.5

Test Title: FUNCTIONAL - POST TEST CIRCUIT INVESTIGATION

K MOD

WIRE #	IR	
1	$8.6 \times 10^6 \Omega$	TOP PENETRATION
2	$1.1 \times 10^7 \Omega$	TOP PENETRATION
3	$2.6 \times 10^6 \Omega$	TOP PENETRATION
4	$1.6 \times 10^7 \Omega$	TOP PENETRATION
5	$8.5 \times 10^7 \Omega$	TOP PENETRATION
6	$2.8 \times 10^7 \Omega$	TOP PENETRATION
7	$1.1 \times 10^7 \Omega$	TOP PENETRATION
8	$2.8 \times 10^6 \Omega$	BOTTOM PENETRATION
9	$5.8 \times 10^7 \Omega$	BOTTOM PENETRATION
10	$5.4 \times 10^7 \Omega$	BOTTOM PENETRATION
11	$8.8 \times 10^6 \Omega$	BOTTOM PENETRATION
12	$4.0 \times 10^6 \Omega$	BOTTOM PENETRATION
13	$1.4 \times 10^7 \Omega$	BOTTOM PENETRATION
14	$2.5 \times 10^6 \Omega$	BOTTOM PENETRATION

Specimen Failed
Specimen Passed
NOA Written

Tested By: R. McC[illegible] Date: 4-1-82
Witness: Date:
Sheet No. of
Approved: H[illegible]

WH-614A

DATA SHEET

Customer: DUKE
Specimen: CABLES
Part No.: –
Spec.: –
Para.: –
S/N: –
GSI: NO

Amb. Temp.: 71°F
Photo: YES
Test Med.:
Specimen Temp.:

WYLE LABORATORIES
Job No.: 45869-10
Report No.:
Start Date: 4-2-82
TIME 0845 HRS

PER PARA. 1.1.7

Test Title: FUNCTIONAL - POST TEST CIRCUIT INVESTIGATION (STEP 8)

	WIRE #	HYPOT 650VAC	IR
E MOD	#1	90 μAMPS	
	#6	90 μAMPS	
C MOD	#3	115 μAMPS	
			WITH WET RAG ON PLUG
L MOD	#8	200 μAMPS	1.7x10⁸Ω
	#9	210 μAMPS	1.4x10⁸Ω
K MOD (TOP)	#3	310 μAMPS	
	#6	230 μAMPS	
K MOD (BOTTOM)	#3	220 μAMPS	
	#6	235 μAMPS	

CUT CABLES IN JUNCTION BOX (STEP 9)

F MOD		C MOD	
#1	$7.6\times10^{6}\Omega$	#1	$6.8\times10^{7}\Omega$
#2	$1.1\times10^{7}\Omega$	#2	$1.1\times10^{8}\Omega$
#3	$5.0\times10^{6}\Omega$	#3	$8.8\times10^{7}\Omega$

Specimen Failed:
Specimen Passed:
NOA Written:

Tested By: R. McClellan Date: 4-2-82
Witness: Date:
Sheet No. of
Approved: H Smith

WH-614A

DATA SHEET

WYLE LABORATORIES

Customer DUKE
Specimen CARLISS
Part No. –
Spec. –
Para. –
S/N –
GSI 10
Amb. Temp. 71°F
Photo YES
Test Med.
Specimen Temp.
Job No. 45869-10
Report No.
Start Date 4-2-82

PER PARA 1.1.8

Test Title FUNCTIONAL - POST TEST CIRCUIT INVESTIGATION - (STRIP 9)

E MOD	IR	C MOD	IR	
#1	1.2x10^8 Ω	1	1.9x10^10 Ω	MOISTURE UNDER SHRINK TUBING
#2	2.4x10^8 Ω	#2	1.5x10^10 Ω	
#3	1.8x10^8 Ω	#3	2.6x10^10 Ω	
#4	1.4x10^8 Ω	#4	6.6x10^10 Ω	
#5	1.5x10^8 Ω	#5	4.5x10^10 Ω	
#6	1.3x10^8 Ω	#6	3.0x10^10 Ω	
#7	1.5x10^8 Ω	#7	6.4x10^10 Ω	
#8	3.5x10^7 Ω	#8	2.8x10^10 Ω	
#9	1.5x10^8 Ω	#9	1.9x10^10 Ω	
#10	8.7x10^7 Ω	#10	2.6x10^10 Ω	
#11	1.8x10^8 Ω	#11	1.6x10^10 Ω	
#12	1.0x10^8 Ω	#12	4.5x10^10 Ω	
K MOD (TOP)	IR	K MOD (BOTTOM)	IR	
#1	1.4x10^7 Ω	#1	9.2x10^6 Ω	
#2	1.7x10^7 Ω	#2	9.6x10^7 Ω	
#3	1.1x10^7 Ω	#3	3.0x10^7 Ω	
#4	2.2x10^7 Ω	#4	1.2x10^7 Ω	
#5	4.5x10^7 Ω	#5	5.4x10^7 Ω	
#6	4.0x10^7 Ω	#6	1.8x10^7 Ω	
#7	1.3x10^7 Ω	#7	1.2x10^7 Ω	

Specimen Failed
Specimen Passed
NOA Written
Tested By R. Moller Date: 4-2-82
Witness Date:
Sheet No. of
Approved H Smith

WH-614A

DATA SHEET

WYLE LABORATORIES

Customer: DUKE
Specimen: CABLE
Part No.: —
Spec.: —
Para.: —
S/N: —
GSI: NO

Amb. Temp.: 71°F
Photo: YES
Test Med.:
Specimen Temp.:

Job No.: 45869-10
Report No.:
Start Date: 4-2-82

PER PARA. 1.1.9

Test Title: FUNCTIONAL – POST TEST CIRCUIT INVESTIGATION (STEP 9)

DMOD IR
#1 7.8x10^7 Ω
#2 2.4x10^9 Ω
#3 1.0x10^8 Ω
#4 1.2x10^8 Ω
#5 8.6x10^7 Ω
#6 5.0x10^7 Ω

(STEP 9A) IR ON CABLE CUT FROM JUNCTION BOX

EMOD IR
#1 3.5x10^10 Ω
#6 2.6x10^10 Ω

LMOD IR
#8 3.5x10^9 Ω
#9 5.0x10^10 Ω

CMOD IR
#3 4.5x10^10 Ω

Specimen Failed:
Specimen Passed:
NOA Written:

Tested By: [signature] Date: 4-2-82
Witness: Date:
Sheet No. of
Approved: H Smith

WH-614A

DATA SHEET

Customer: DUKE
Specimen: CABLES
Part No.: —
Spec.: —
Para.: —
S/N: —
GSI: NO

Amb. Temp.: 71°F
Photo: YES
Test Med.: WATER
Specimen Temp.: AMB
PER PARA 1.1.10

WYLE LABORATORIES
Job No.: 45869-10
Report No.:
Start Date: 4-2-82
TIME 1130 HRS.

Test Title: FUNCTIONAL - POST TEST CIRCUIT INVESTIGATION - (STEP 98)

L MOD, E MOD & C MOD IMMERSED IN WATER.
THE PORTION OF CABLE CUT FROM INSIDE OF
JUNCTION BOX THAT WAS LOCATED IN TEST CHAMBER

L MOD	IR	HYPOT 650VAC	E MOD	IR	HYPOT 650VAC
#8	3.0x10¹¹ Ω	180 µAMPS	#1	9.4x10¹¹ Ω	105 µAMPS
#9	2.6x10¹¹ Ω	190 µAMPS	#6	3.5x10¹⁰ Ω	110 µAMPS

C MOD	IR	HYPOT 650VAC
#3	7.6x10¹¹ Ω	165 µAMPS

Specimen Failed
Specimen Passed
NOA Written

Tested By: R. McClellan Date: 4-2-82
Witness: Date:
Sheet No. of
Approved: H. Grant

WH-614A

APPENDIX II-2

BORON ANALYSIS BY THE UNIVERSITY OF ALABAMA AT HUNTSVILLE

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June 25, 1982

Mr. Hampton Smith
Wyle Laboratories
7800 Governors Drive, West
Huntsville, AL 35806

Dear Mr. Smith:

The attached data sheet contains the results of the analyses performed for boron in the water samples and on the inner surfaces of the cables which you requested.

The analyses were performed by graphite furnace atomic absorption spectroscopy. The water samples were run directly after acidification with nitric acid. The cable samples were wiped down with cotton swabs that were first dipped in 2% nitric acid. The liquid residues on the swabs were then analyzed.

As is indicated in the data sheet the boron concentrations were all in the low parts-per-billion range. These concentration levels were very near the instrumental detection limits of the method.

At the concentrations found it is not highly probable that the boron is from the test. It is more likely that the boron represents the background concentrations in the distilled water and/or boron contamination from sources other than the test.

Please contact me concerning any questions about the analyses.

Sincerely,

Michael William Mullen

Michael W. Mullen
Research Associate
Johnson Environmental and Energy Center
University of Alabama at Huntsville

MWM:cms

Encl.: a/s

SAMPLE	CONCENTRATION (MG/L)
E1L	0.027
C3L	0.036
L9LP	0.022
C3LP	0.020
L8LP	0.030
E6LP	0.021
E1LP	0.021

APPENDIX II-3

PHOTOGRAPHS OF K PLUG

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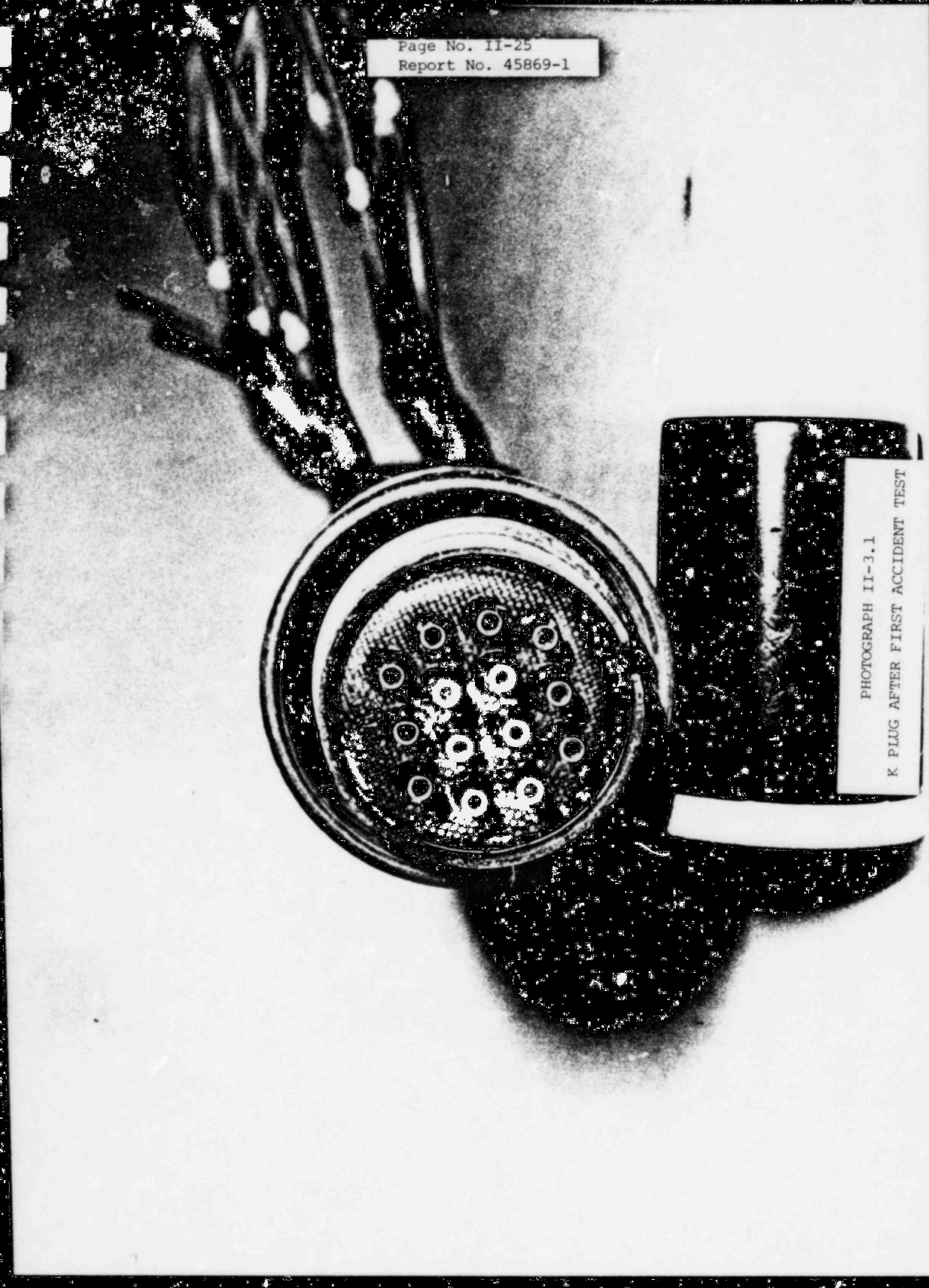
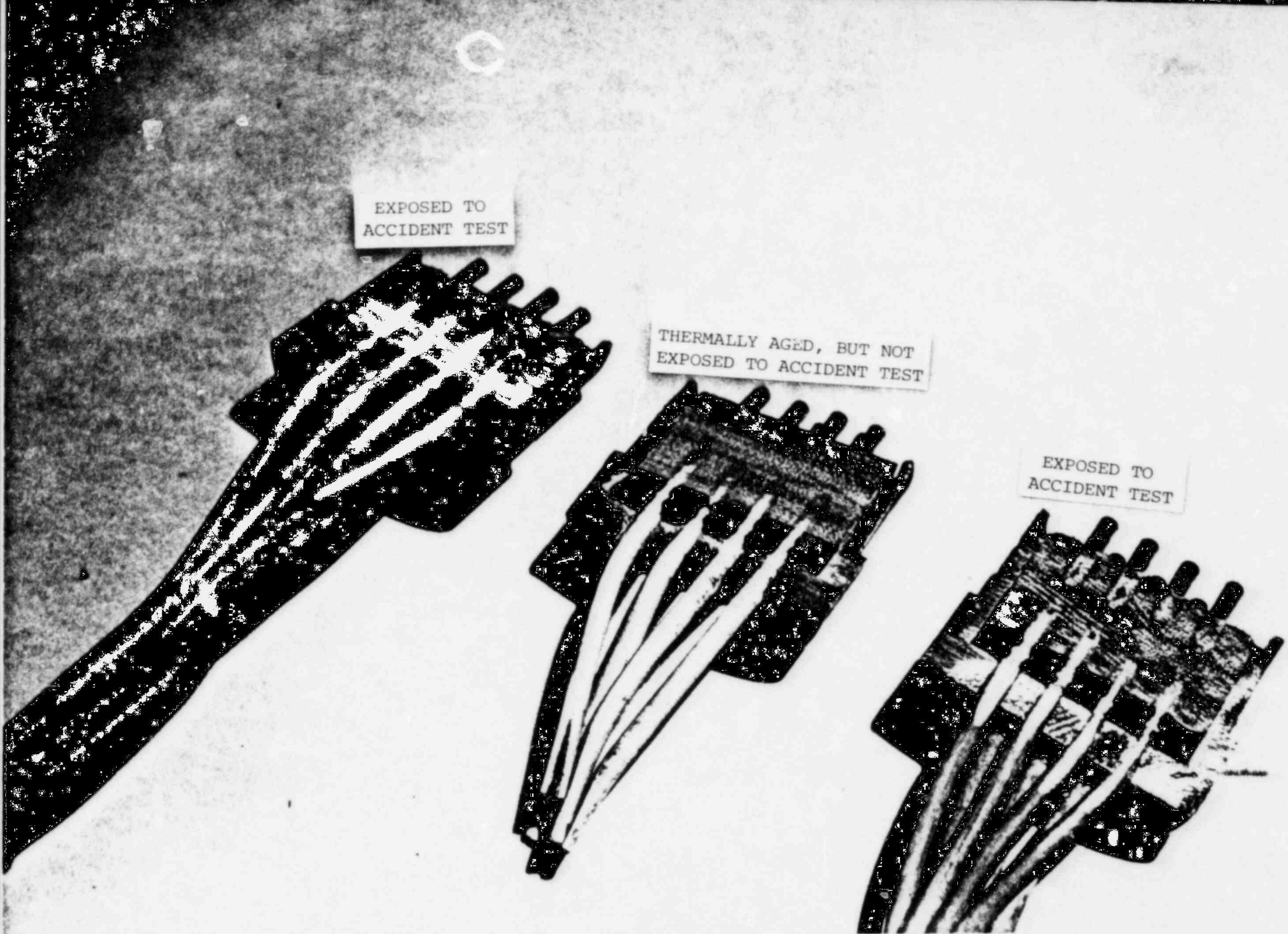


PHOTOGRAPH II-3.1
K PLUG AFTER FIRST ACCIDENT TEST



PHOTOGRAPH II-3.2

CROSS-SECTION K PLUG AFTER FIRST ACCIDENT TEST

SECTION III

EXTENDED ACCIDENT TEST

1.0 PROCEDURE

1.1 Test Arrangement

Steam Chamber

The steam chamber and annulus mockup arrangement was identical to the first arrangement as used in the first Accident Test and as reported in Volume I, Section VII. Unlike the arrangement used in the first Accident Test, cables were not used inside the chamber for suppling power to the penetration assembly, as all the conductors were spliced on the back of the plugs by Duke Power personnel. See Figure III-1.1, Appendix III-1, for the wiring diagram. All penetration connectors were undisturbed (not disconnected, loosened or tightened) from their condition at the end of the first Accident Test with the exception of the K module connector. The K module connector on the annulus side of the penetration assembly was moved to the inside of the chamber and the outside connector was replaced with a K connector that had been thermally aged and irradiated. The K connector removed from the chamber side was sectioned and inspected as reported in Section II.

Steam test conditions were the same as during the first Accident Test with the following exceptions.

1) The initial steam ramp was extended to eight hours.

2) There was no superheated steam used during the test.

Instrumentation

General

Temperatures, voltages, currents, and chamber pressure were recorded on a Data Logger. Chemical flow rate and pH were recorded daily from digital readout devices.

Temperature Measurements

All temperatures, as shown in Table III-1.I of Appendix III-1, were recorded at a minimum sample rate of one (1) sample per 15 minutes during the eight (8) hour transients and a minimum of one (1) sample per hour during the remainder of the accident test.

Chamber Pressure Measurements

The chamber pressure was recorded at the same sampling rates as the temperature measurements.

1.0 PROCEDURE (CONTINUED)

1.1 Test Arrangement (Continued)

Voltage and Current Measurements

Voltage on all modules, current on Modules C, D, E, F, and L, and leakage current on all Module K pins and Conductor No. 2 of Modules C and F were recorded at one (1) sample per 15 minutes during the eight (8) hour transients, and at one (1) sample per 30 minutes during the remainder of the Accident Test.

Chemical Spray Requirements

The initial chemical spray solution contained, as a minimum, 1922 ppm boron and the pH was between six (6) and ten (10). The initial chemical spray solution also contained five (5) to eight (8) ppm of fluorescent dye for a post test investigation.

The chemical spray was active during the period, as shown in Figure III-2.1 of Appendix III-2. New batches of the chemical spray solution were made at least every four (4) days to replace the old chemical spray solution.

Test Specimen Electrical Power

The conductors of Modules C, D, E, F, and L were wired in series to form six (6) current loops. Each loop was independently energized to the voltage and current specified in Table III-2.I of Appendix III-2 using the polarization voltage method. The conductors of Module K were energized at 120 volts and zero amps.

1.2 Accident Test Sequence and Procedure

The Accident Test was conducted in the following sequence and manner:

1) A Baseline Electrical Test was conducted just prior to admitting steam to the chamber.

   A. Visual Inspection - The electrical circuits were inspected for damage and proper labeling, and the general appearance recorded.

   B. Insulation Resistance (IR) - The IR of each conductor pair was measured at 500 VDC. If the IR was less than the minimum scale of the meter, the IR was measured at 100 VDC. All IR's were recorded.

   C. High Potential - A high potential test was conducted on Modules C and F, by applying 1000 VAC across each pin and ground. The leakage current was recorded.

1.0 PROCEDURE (CONTINUED)

1.2 Accident Test Sequence and Procedure (Continued)

2) Electrical power was applied to Modules C, D, E, F, L, and K, as shown in Table III-2.I of Appendix III-2. The electrical power was applied throughout the seven-day Accident Test, except during the brief periods when insulation resistance readings were taken.

3) Steam was introduced into the chamber to maintain the temperature - pressure - time profile as shown in Figure III-2.1 of Appendix III-2. The annulus mockup temperature was maintained, as shown in Figure III-2.2 of Appendix III-2.

4) At eight hours after initiation of the steam ramp, chemical spray solution flow was initiated and the flow maintained throughout the Accident Test. The flow was directed vertically downward at a flow rate of 0.15 gallon/minute/$ft.^2$ of specimen area or, specifically, 0.75 gallon/minute.

5) IR measurements per paragraph 1.2, 1-a, b, c were taken every eight hours during the first 24 hours of the Accident Test. After the first 24 hours, IR measurements were taken daily and following any prescribed temperature transient. High potential measurements were taken per paragraph 1.2, 1-a, b, c each time IR measurements were taken.

6) The electrical measurements of paragraph 1.2, 1-a, b, c (baseline functional) were repeated after the modules had cooled to room temperature, but prior to their removal from the chamber.

1.3 Results

1.3.1 Electrical Results

The erratic behavior (low insulation resistance) observed during the first Accident Test was not observed during the second Accident Test, except with Module E. There were difficulties in constantly maintaining 600 volts, AC on some of the conductors of Module E. These difficulties can be seen in detail by studying Table III-3.I of Appendix III-3. There were no problems with Modules C, D, F, K, and L. Insulation resistance and high potential readings taken during the Accident Test are shown in Appendix III-3, Tables III-3.II thru III-3.VII.

1.3.2 Environmental Results

Chemical Spray

Chemical spray solution flow rate and pH were monitored daily. The flow rate was maintained at 0.75 gallon/minute and the pH maintained between 6 and 10.

1.0 PROCEDURE (CONTINUED)

1.3 Results (Continued)

1.3.2 Environmental Results (Continued)

Steam

The required Accident Test steam pressure-temperature profile, Figure III-2.1 of Appendix III-2, was maintained within tolerance throughout the seven-day Accident Test. Significant parameters (steam chamber pressure and temperature, annulus temperature, and Module K backshell temperature) are presented in plotted format in Appendix III-3.

APPENDIX III-1

ACCIDENT TEST ARRANGEMENT

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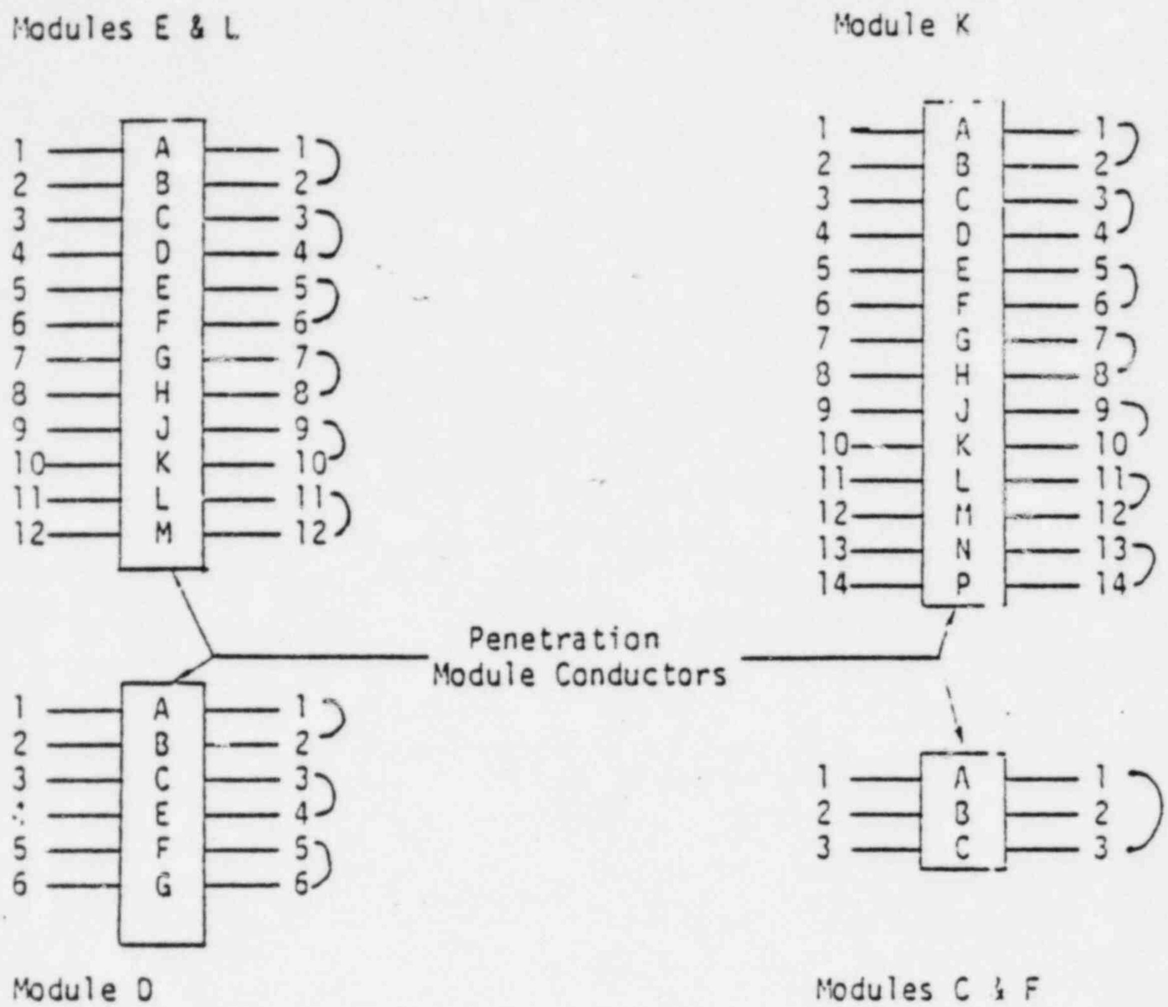

NOTE: 1- On module D Pins C & E are 4 AWG and Pins A,B,F & G are 8 AWG

2. Insulation resistance (IR) shall be measured between each conductor and all other conductors tied to ground.

3. Insulation Resistance shall be greater than 100 megohms for modules C, D, E, and F and 10 megohms for modules K and L prior to start of testing. Readings below these values after the start of testing shall be acceptable. Functional capability of the circuits is determined by the ability of the circuits to maintain the prescribed voltage.

FIGURE III-1.1

WIRE DIAGRAM AND INSULATION RESISTANCE

TABLE III-1.I

THERMOCOUPLE LOCATIONS

INSIDE STEAM CHAMBER

1. On exterior face of junction box cover
2. Air temperature inside junction box
3. In backshell of Module C
4. In backshell of Module D
5. In backshell of Module E
6. In backshell of Module F
7. In backshell of Module K
8. In backshell of Module L
9. On outside of junction box mtg ring (360°)
10. On face of flange near Module C
11. On face of flange near Module K or L
12. On 3/4 inch chamber flange plate at 360°
13. On 3/4 inch chamber flange plate at 90°
14. On 3/4 inch chamber flange plate at 180°
15. On 3/4 inch chamber flange plate at 270°
16. Chamber air temperature
17. Chamber air temperature
18. Chamber air temperature
19. On receptacle of Module E
20. On receptacle of Module D

OUTSIDE STEAM CHAMBER

24. On exterior face of junction box cover
25. Air temperature inside junction box
26. On backshell of Module C
27. Inside nozzle air temperature
28. On face of flange near Module C
29. On face of flange near Module K or L
30. On 3/4 inch chamber flange plate at 360°
31. On 3/4 inch chamber flange plate at 90°
32. On 3/4 inch chamber flange plate at 180°
33. On 3/4 inch chamber flange plate at 270°
34. Annulus air temperature (high)
35. Annulus air temperature (center)
36. Annulus air temperature (low)

APPENDIX III-2

REQUIRED TEST CONDITIONS

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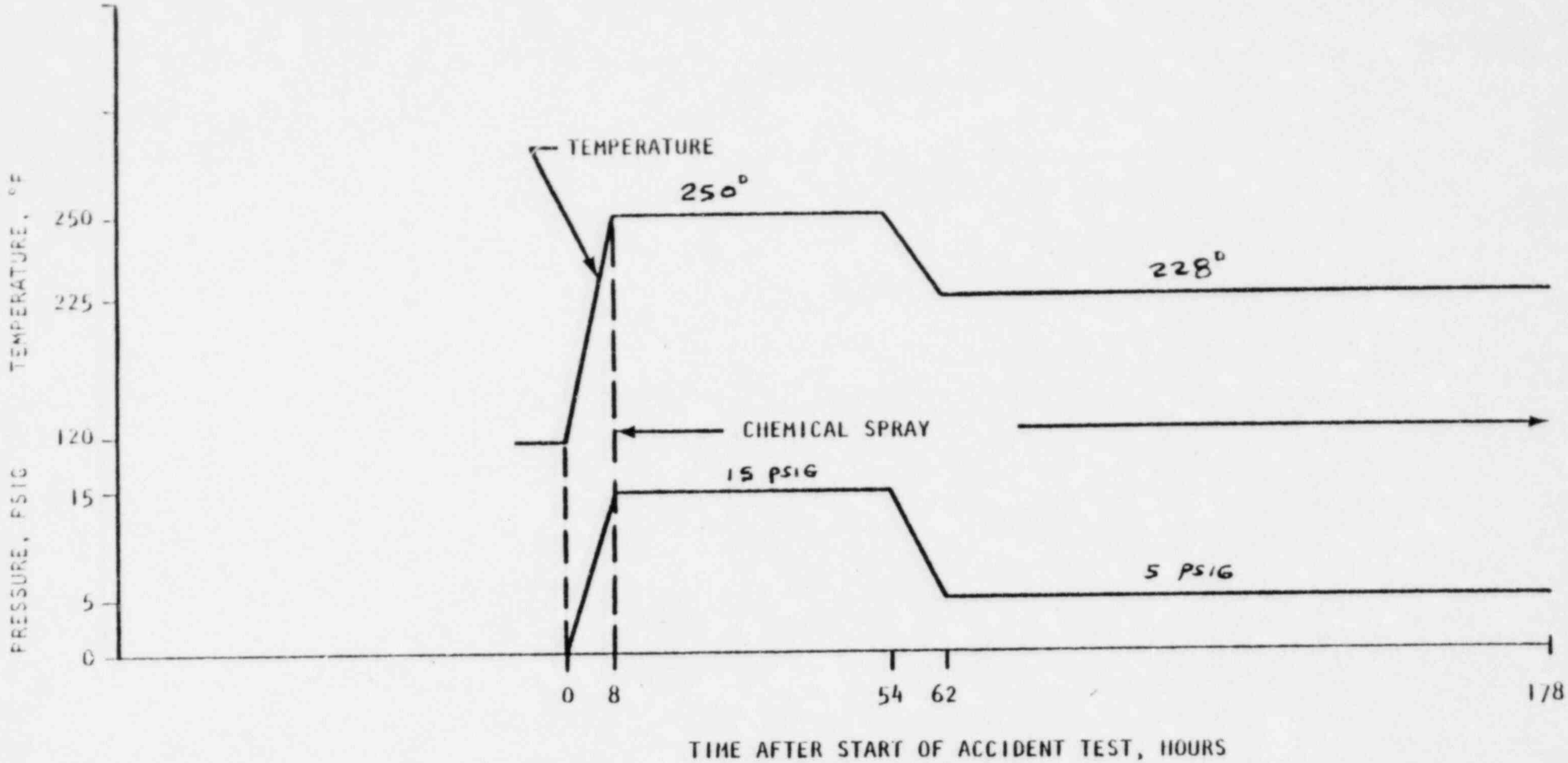
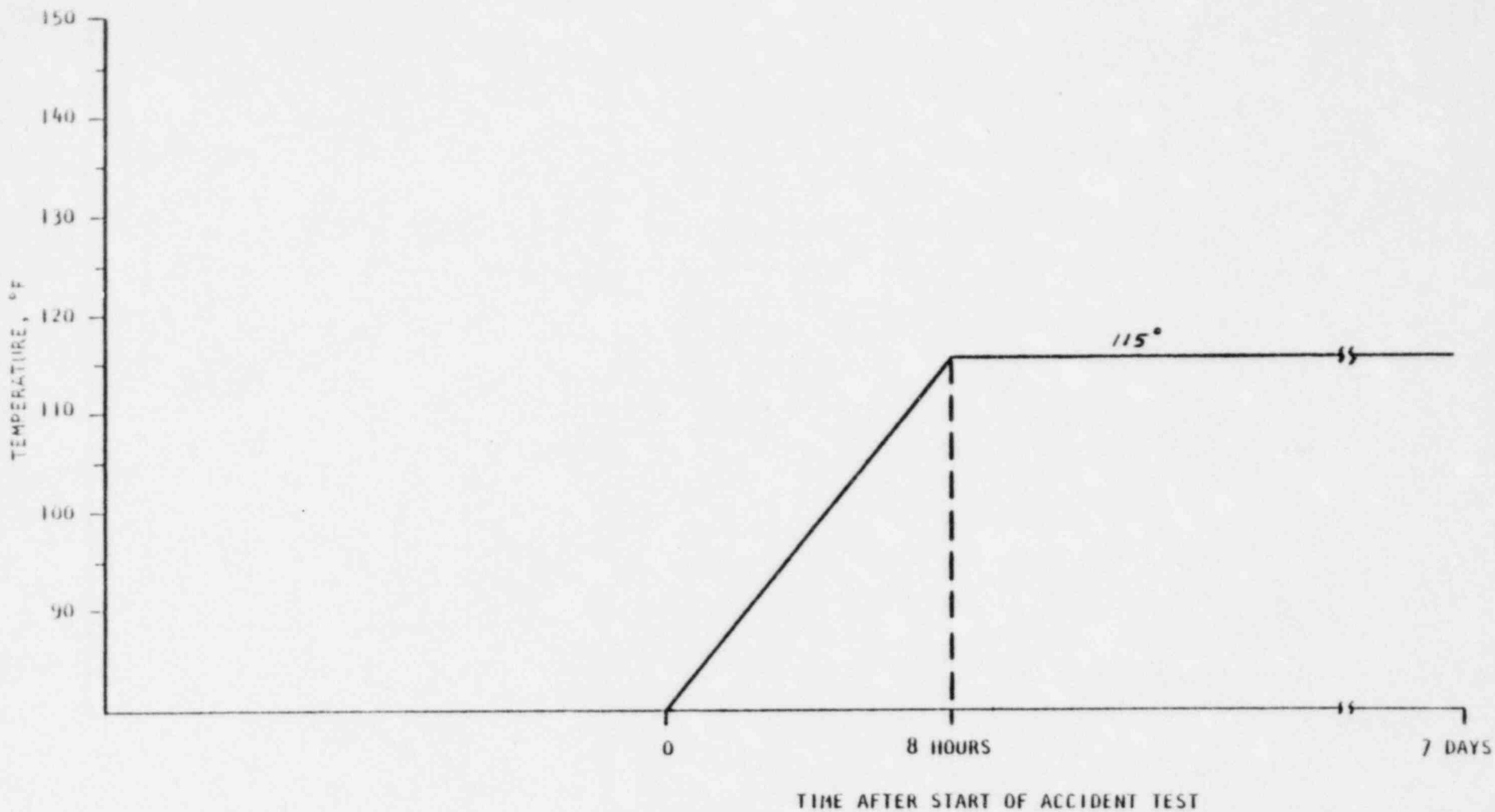


NOTES: (1) All steady state temperatures shall be as shown, +10°F, -0°F.

(2) Peak pressure shall not exceed 25 psig.

FIGURE III-2.1

ENVIRONMENTAL TEST PROFILE INSIDE CONTAINMENT



NOTES: (1) The test temperature profile shall be as close to the above profile as practical during the transient.

(2) After 2400 seconds, the test temperature shall be within +15°F, -0°F.

FIGURE III-2.2

ANNULUS TEMPERATURE PROFILE COMBINED MSLB/LOCA

TABLE III-2.I

MODULE ELECTRICAL REQUIREMENTS

MODULE	CONDUCTOR	VOLTAGE	CURRENT
C	1	600 VAC	150 Amps (± 10 amps)
	2	600 VAC	0 Amps
	3	600 VAC	150 Amps
D	1	600 VAC	25 Amps (± 2 amps)
	2	600 VAC	25 Amps
	3	600 VAC	50 Amps (± 3 amps)
	4	600 VAC	50 Amps
	5	600 VAC	25 Amps
	6	600 VAC	25 Amps
E	1	600 VAC	15 Amps (± 2 amps)
	2	600 VAC	15 Amps
	3	600 VAC	15 Amps
	4	600 VAC	15 Amps
	5	600 VAC	15 Amps
	6	600 VAC	15 Amps
	7	600 VAC	15 Amps
	8	600 VAC	15 Amps
	9	600 VAC	15 Amps
	10	600 VAC	15 Amps
	11	600 VAC	15 Amps
	12	600 VAC	15 Amps
F	1	600 VAC	30 Amps (± 3 amps)
	2	600 VAC	0 Amps
	3	600 VAC	30 Amps
K	1	120 VAC	0
	2	120 VAC	0
	3	120 VAC	0

TABLE III-2.I (CONTINUED)

MODULE	CONDUCTOR	VOLTAGE	CURRENT
K	4	120 VAC	0
	5	120 VAC	0
	6	120 VAC	0
	7	120 VAC	0
	8	120 VAC	0
	9	120 VAC	0
	10	120 VAC	0
	11	120 VAC	0
	12	120 VAC	0
	13	120 VAC	0
	14	120 VAC	0
L	1	600 VAC	5 Amps (± 1 amp)
	2	600 VAC	5 Amps
	3	600 VAC	5 Amps
	4	600 VAC	5 Amps
	5	600 VAC	5 Amps
	6	600 VAC	5 Amps
	7	600 VAC	5 Amps
	8	600 VAC	5 Amps
	9	600 VAC	5 Amps
	10	600 VAC	5 Amps
	11	600 VAC	5 Amps
	12	600 VAC	5 Amps

NOTE: Tolerance on 600 VAC is ± 10V, and on 120 VAC + 5 VAC
Tolerances on currents are noted above and applied to each conductor requiring that ampacity.

APPENDIX III-3

ACCIDENT TEST DATA

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TABLE III-3.I

MODULE E BEHAVIOR DURING ACCIDENT TEST

TIME, DAY-HOURS (1982)	EVENT
May 10 - 1403	Started steam ramp.
May 10 - 2100	Blew 0.5 amp fuse. Attempted to re-establish power with one amp fuse; blew immediately. Found conductors 9-10 with low resistance (157K Ω). Removed conductors 9-10 from circuit and re-established power at 600 volts, AC.
May 11 - 0815	Re-established power at 120 volts on conductors 9-10 (0.5 amp fuse). IR 9-10 - 1.5 X $10^6 \Omega$.
May 11 - 0835	Applied 600 volts on conductors 9-10. Blew 0.5 amp fuse.
May 11 - 0940	Applied 120 volts on conductors 9-10, 0.5 amp fuse holding.
May 12 - 1000	Re-established 600 volts on conductors 9-10, 0.5 amp fuse holding.
May 12 - 2300	Blew fuse.
May 13 - 0800	Re-established 120 volts on conductors 9-10, 0.5 amp fuse.
May 13 - 1415	Re-established 600 volts on conductors 9-10, 0.5 amp fuse.
May 13 - 1417	Blew fuse, re-established power at 120 volts on conductors 9-10, 0.5 amp fuse.
May 14 - 0748	Re-established 600 volts on conductors 9-10, 0.5 amp fuse.
May 15 - 1500	Blew fuse. Low resistance conductors 7-8, and 9-10. Applied 120 volts these two circuits.
May 16 - 0835	Blew fuse. Low resistance found on conductors 1-2, placed these on 120 volts.
May 16 - 0850	Blew fuse. Low resistance found on conductors 9-10, placed these on 120 volts.
May 16 - 1820	Blew fuse. Could not establish power on conductors 1-2.
May 16 - 1825	Blew fuse. Could not establish power on conductors 11-12.
May 17 - 0740	Re-established 600 volts on all circuits.
May 17 - 1300	Blew fuse. Could not establish power on conductors 1-2, and 11-12. Power to all other circuits at 120 volts.
May 18 - 1152	Blew fuse. Conductors 3 thru 8 holding at 600 volts; all other circuits blowing fuse at 120 volts.

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TABULATED ELECTRICAL DATA OF ALL MODULES

TAKEN DURING ACCIDENT TEST

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TABLE III-3.II

MODULE C ELECTRICAL DATA DURING ACCIDENT TEST

INSULATION RESISTANCE, OHMS

CONDUCTOR	TIME, FROM START OF RAMP											
	ZERO 5-7	8 HOURS 250^oF 5-10	16 HOURS 250^oF 5-11	24 HOURS 250^oF 5-11	42 HOURS 250^oF 5-12	66 HOURS 228^oF 5-13	90 HOURS 228^oF 5-14	114 HOURS 228^oF 5-15	138 HOURS 228^oF 5-16	162 HOURS 228^oF 5-17	178 HOURS 228^oF 5-17	202 HOURS 95^oF 5-18
C1-C3	$8.6X10^7$	$1.2X10^8$	$1.2X10^7$	$3.5X10^6$	$5.2X10^6$	$3.5X10^6$	$2.5X10^6$	$2.5X10^6$	$3.5X10^6$	$3.5X10^6$	$4.0X10^6$	$5.8X10^6$
C2	$6.2X10^9$	$1.4X10^7$	$5.6X10^6$	$2.5X10^6$	$7.2X10^6$	$3.0X10^6$	$7.8X10^6$	$5.2X10^6$	$2.5X10^6$	$4.0X10^6$	$2.0X10^6$	$1.7X10^6$
	HIGH POTENTIAL TEST, MICROAMPS											
C1-C3	700	625	750	900	800	1600	1200	950	1100	1000	1200	750
C2	390	410	600	800	1200	1100	700	900	900	700	800	800

TABLE III-3.III

MODULE D ELECTRICAL DATA DURING ACCIDENT TEST

INSULATION RESISTANCE, OHMS

CONDUCTOR	TIME, FROM START OF RAMP										
	ZERO 5-7	8 HOURS 250°F 5-10	16 HOURS 250°F 5-11	24 HOURS 250°F 5-11	42 HOURS 250°F 5-12	66 HOURS 228°F 5-13	90 HOURS 228°F 5-14	114 HOURS 228°F 5-15	138 HOURS 228°F 5-16	162 HOURS 228°F 5-17	178 HOURS 228°F 5-17	202 HOURS 95°F 5-18
D1-D2	1.2×10^{8}	1.6×10^{6}	0.8×10^{6}	7.4×10^{6} (1)	0.68×10^{6} (1)	1.0×10^{7} (1)	0.88×10^{6}	0.72×10^{6}	1.2×10^{6} (1)	1.0×10^{7} (1)	1.0×10^{7} (1)	5.0×10^{6}
D3-D4	1.1×10^{8}	4.5×10^{6} (1)	3.5×10^{6} (1)	3.0×10^{6} (1)	0.5×10^{6} (1)	4.5×10^{6} (1)	5.2×10^{6} (1)	4.5×10^{6} (1)	3.5×10^{6} (1)	2.5×10^{6}	2.5×10^{6} (1)	5.6×10^{6}
D5-D6	1.6×10^{8}	4.0×10^{6}	2.5×10^{6}	1.3×10^{6}	1.1×10^{6}	1.2×10^{6}	1.5×10^{6}	0.94×10^{6} (1)	0.9×10^{6} (1)	6.6×10^{6} (1)	5.6×10^{6} (1)	3.0×10^{6}
				HIGH POTENTIAL TEST, MICROAMPS								
											>5000 (2)	900
											>5000 (3)	1050
											3500	900

(1) At 100 Volts, DC

(2) At 850 Volts, AC

(3) At 750 Volts, AC

TABLE III-3.IV

MODULE E ELECTRICAL DATA DURING ACCIDENT TEST

INSULATION RESISTANCE, OHMS

CONDUCTOR	TIME, FROM START OF RAMP										
	ZERO 5-7	8 HOURS 250°F 5-10	16 HOURS 250°F 5-11	24 HOURS 250°F 5-11	42 HOURS 250°F 5-12	66 HOURS 228°F 5-13	90 HOURS 228°F 5-14	114 HOURS 228°F 5-15	138 HOURS 228°F 5-16	162 HOURS 228°F 5-17	178 HOURS 228°F 5-17	202 HOURS 95°F 5-18
E1-E2	1.3×10^{8}	7.2×10^{6}	2.5×10^{6}	1.1×10^{6}	1.5×10^{6}	1.9×10^{6}	1.5×10^{6}	1.4×10^{6}	7.6×10^{6} (1)	0.54×10^{6} (1)	0.58×10^{6} (1)	0.58×10^{6} (1)
E3-E4	8.4×10^{7}	3.0×10^{6}	1.8×10^{6}	1.7×10^{6}	2.2×10^{6}	3.0×10^{6}	1.9×10^{6}	1.5×10^{6}	1.0×10^{6} (1)	4.0×10^{6} (1)	0.58×10^{6} (1)	2.0×10^{6} (1)
E5-E6	9.2×10^{7}	7.4×10^{6}	1.0×10^{6}	6.9×10^{6} (1)	0.96×10^{6} (1)	3.5×10^{6} (1)	1.6×10^{6}	1.5×10^{6}	1.1×10^{6} (1)	0.64×10^{6} (1)	0.68×10^{6} (1)	0.62×10^{6} (1)
E7-E8	4.5×10^{7}	1.3×10^{7}	2.5×10^{6}	6.8×10^{6}	5.0×10^{6}	4.5×10^{6}	4.5×10^{6}	8.2×10^{6}	5.8×10^{6} (1)	0.58×10^{6} (1)	0.86×10^{6} (1)	0.92×10^{6} (1)
E9-E10	5.0×10^{7}	7.8×10^{5} (1)	0.7×10^{6} (1)	0.8×10^{6} (1)	1.2×10^{6} (1)	7.4×10^{6} (1)	1.5×10^{7} (1)	1.1×10^{6}	0.58×10^{6} (1)	0.58×10^{6} (1)	0.62×10^{6} (1)	0.6×10^{6} (1)
E11-E12	1.2×10^{8}	3.5×10^{6}	1.8×10^{6}	2.5×10^{6}	2.2×10^{5}	1.5×10^{6}	2.0×10^{6}	2.0×10^{6}	1.2×10^{6} (1)	0.58×10^{6} (1)	0.56×10^{6} (1)	0.56×10^{6} (1)
	HIGH POTENTIAL TEST, MICROAMPS											
E1-E2											>5000 (2)	5000 (2)
E3-E4											5000 (3)	2200
E5-E6											5000 (4)	5000 (6)
E7-E8											5000 (5)	5000 (7)
E9-E10											>5000 (2)	5000 (2)
E11-E12											>5000 (2)	5000 (2)

(1) At 100 Volts, DC
(2) At 50 Volts, AC
(3) At 600 Volts, AC
(4) At 100 Volts, AC
(5) At 250 Volts, AC
(6) At 150 Volts, AC
(7) At 850 Volts, AC

TABLE III-3.V

MODULE F ELECTRICAL DATA DURING ACCIDENT TEST

INSULATION RESISTANCE, OHMS

CONDUCTOR	TIME, FROM START OF RAMP											
	ZERO 5-7	8 HOURS 250°F 5-10	16 HOURS 250°F 5-11	24 HOURS 250°F 5-11	42 HOURS 250°F 5-12	66 HOURS 228°F 5-13	90 HOURS 228°F 5-14	114 HOURS 228°F 5-15	138 HOURS 228°F 5-16	162 HOURS 228°F 5-17	178 HOURS 228°F 5-17	202 HOURS 95°F 5-18
F1-F3	$5.0X10^7$	$6.2X10^6$	$2.0X10^6$	$1.1X10^6$	$0.8X10^6$	$5.6X10^6$(1)	$6.2X10^6$(1)	$3.5X10^6$(1)	$2.5X10^6$(1)	$4.5X10^6$(1)	$4.5X10^6$(1)	$9.2X10^6$
F2	$2.5X10^7$	$7.8X10^6$	$3.0X10^6$	$1.5X10^6$	$2.2X10^6$	$1.4X10^6$	$2.0X10^6$	$1.1X10^6$	$1.2X10^6$	$1.5X10^6$	$1.4X10^6$	$1.7X10^7$
	HIGH POTENTIAL TEST, MICROAMPS											
F1-F3	310	600	1300	2000	3800	4100	3800	1600	5000	4700	5000	850
F2	230	360	700	1100	1500	2050	1300	>5000	2000	1400	1500	258

(1) At 100 Volts, DC

TABLE III-3.VI

MODULE K ELECTRICAL DATA DURING ACCIDENT TEST

INSULATION RESISTANCE, OHMS

CONDUCTOR	TIME, FROM START OF RAMP											
	ZERO 5-7	8 HOURS 250^oF 5-10	16 HOURS 250^oF 5-11	24 HOURS 250^oF 5-11	42 HOURS 250^oF 5-12	66 HOURS 228^oF 5-13	90 HOURS 228^oF 5-14	114 HOURS 228^oF 5-15	138 HOURS 228^oF 5-16	162 HOURS 228^oF 5-17	178 HOURS 228^oF 5-17	202 HOURS 95^oF 5-18
K1-K2	$1.0X10^8$	$1.8X10^8$	$4.5X10^6$	$3.5X10^6$	$0.9X10^6$(1)	$6.4X10^6$(1)	$0.92X10^6$(1)	$1.1X10^6$(1)	$1.0X10^6$(1)	$0.82X10^6$(1)	$0.86X10^6$(1)	$6.2X10^6$
K3-K4	$1.9X10^8$	$2.5X10^8$	$2.0X10^6$	$1.8X10^6$	$<.5X10^6$(1)	$3.0X10^6$(1)	$1.3X10^6$(1)	$1.2X10^6$(1)	$1.0X10^6$(1)	$0.82X10^6$(1)	$0.88X10^6$(1)	$3.5X10^6$
K5-K6	$3.0X10^8$	$2.5X10^8$	$1.9X10^6$	$1.2X10^6$	$<.5X10^6$(1)	$2.0X10^6$(1)	$1.3X10^6$(1)	$1.3X10^6$(1)	$0.98X10^6$(1)	$0.74X10^6$(1)	$0.76X10^6$(1)	$3.0X10^6$
K7-K8	$3.0X10^7$	$1.5X10^8$	$2.5X10^6$	$1.9X10^6$	$0.82X10^6$(1)	$3.0X10^6$(1)	$1.6X10^6$(1)	$1.5X10^6$(1)	$1.6X10^6$(1)	$0.82X10^6$(1)	$0.86X10^6$(1)	$3.0X10^6$
K9-K10	$2.5X10^8$	$4.0X10^8$	$3.0X10^6$	$1.6X10^6$	$<.5X10^6$(1)	$2.5X10^6$(1)	$1.8X10^6$(1)	$1.4X10^6$(1)	$1.0X10^6$(1)	$0.76X10^6$(1)	$0.76X10^6$(1)	$2.5X10^6$
K11-K12	$7.0X10^7$	$3.0X10^8$	$1.8X10^6$	$1.2X10^6$	$<.5X10^6$(1)	$3.0X10^6$(1)	$1.1X10^6$(1)	$1.2X10^6$(1)	$0.86X10^6$(1)	$0.74X10^6$(1)	$0.78X10^6$(1)	$4.0X10^6$
K13-K14	$2.5X10^8$	$2.0X10^8$	$3.5X10^6$	$1.2X10^6$	$<.5X10^6$(1)	$2.5X10^6$(1)	$1.0X10^6$(1)	$1.0X10^6$ (1)	$0.86X10^6$(1)	$0.74X10^6$(1)	$0.74X10^6$(1)	$5.0X10^6$
	HIGH POTENTIAL TEST, MICROAMPS											
K1-K2											> 5000 (2)	1300
K3-K4											> 5000 (3)	1050
K5-K6											> 5000 (3)	1550
K7-K8											> 5000 (3)	1250
K9-K10											> 5000 (4)	1400
K11-K12											> 5000 (4)	> 5000 (5)
K13-K14											> 5000 (4)	1200

(1) At 100 Volts, DC
(2) At 250 Volts, AC
(3) At 200 Volts, AC
(4) At 150 Volts, AC
(5) At 450 Volts, AC

TABLE III-3.VI

MODULE L ELECTRICAL DATA DURING ACCIDENT TEST

INSULATION RESISTANCE, OHMS

CONDUCTOR	TIME, FROM START OF RAMP											
	ZERO 5-7	8 HOURS 250°F 5-10	16 HOURS 250°F 5-11	24 HOURS 250°F 5-11	42 HOURS 250°F 5-12	66 HOURS 228°F 5-13	90 HOURS 228°F 5-14	114 HOURS 228°F 5-15	138 HOURS 228°F 5-16	162 HOURS 228°F 5-17	178 HOURS 228°F 5-17	202 HOURS 95°F 5-18
L1-L2	$7.4X10^{8}$	$6.6X10^{8}$	$1.6X10^{6}$	$1.6X10^{6}$	$1.7X10^{6}$	$1.2X10^{6}$	$0.58X10^{6}$(1)	$1.4X10^{6}$	$1.1X10^{6}$	$0.98X10^{6}$	$1.4X10^{6}$	$1.5X10^{9}$
L3-L4	$6.4X10^{8}$	$7.8X10^{7}$	$1.2X10^{6}$	$1.7X10^{6}$	$1.8X10^{6}$	$1.1X10^{6}$	$2.0X10^{6}$	$1.7X10^{6}$	$1.3X10^{6}$	$1.3X10^{6}$	$1.8X10^{6}$	$1.1X10^{9}$
L5-L6	$1.7X10^{8}$	$4.5X10^{7}$	$1.0X10^{6}$	$1.0X10^{6}$	$1.0X10^{6}$	$1.3X10^{6}$	$1.6X10^{6}$	$1.1X10^{6}$	$1.0X10^{6}$	$1.2X10^{6}$	$1.3X10^{6}$	$1.9X10^{9}$
L7-L8	$4.0X10^{8}$	$1.0X10^{8}$	$1.0X10^{6}$	$1.3X10^{6}$	$1.4X10^{6}$	$2.0X10^{6}$	$2.5X10^{6}$	$2.0X10^{6}$	$1.7X10^{6}$	$1.4X10^{6}$	$2.0X10^{6}$	$1.1X10^{9}$
L9-L10	$4.0X10^{9}$	$4.5X10^{7}$	$1.1X10^{6}$	$1.0X10^{6}$	$0.99X10^{6}$	$1.1X10^{6}$	$1.4X10^{6}$	$1.0X10^{6}$	$0.92X10^{6}$	$1.0X10^{6}$	$1.2X10^{6}$	$4.0X10^{8}$
L11-L12	$1.0X10^{9}$	$5.0X10^{7}$	$0.96X10^{6}$	$9.2X10^{6}$(1)	$0.9X10^{6}$(1)	$0.9X10^{6}$	$1.2X10^{6}$	$0.9X10^{6}$	$0.78X10^{6}$	$0.68X10^{6}$	$0.78X10^{6}$	$1.6X10^{8}$
	HIGH POTENTIAL TEST, MICROAMPS											
L1-L2											2000	390
L3-L4											2700	410
L5-L6											3300	425
L7-L8											2200	390
L9-L10											3100	400
L11-L12											3200	415

(1) At 100 Volts, DC

PLOTS OF SIGNIFICANT PARAMETERS DURING THE ACCIDENT TEST

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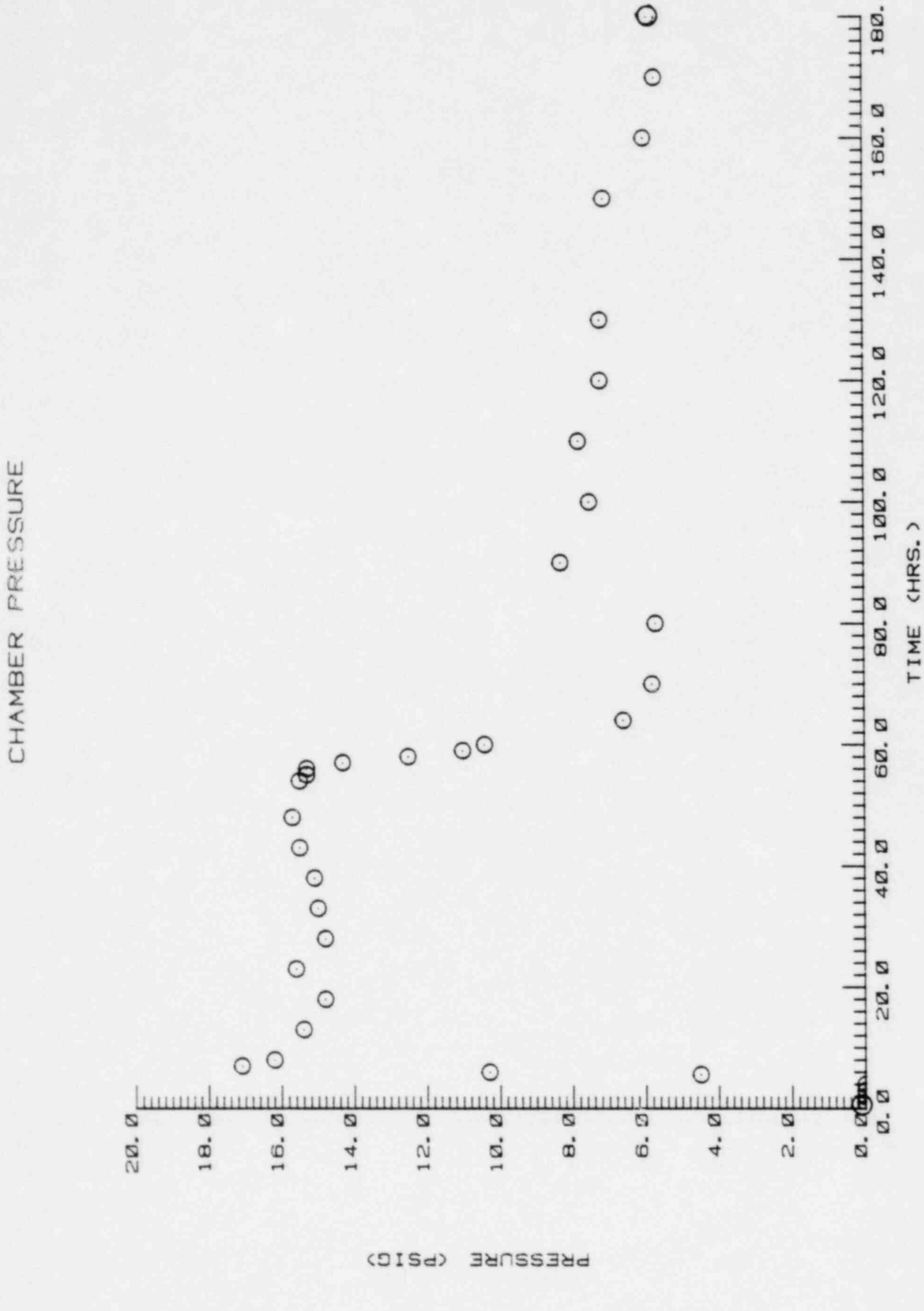
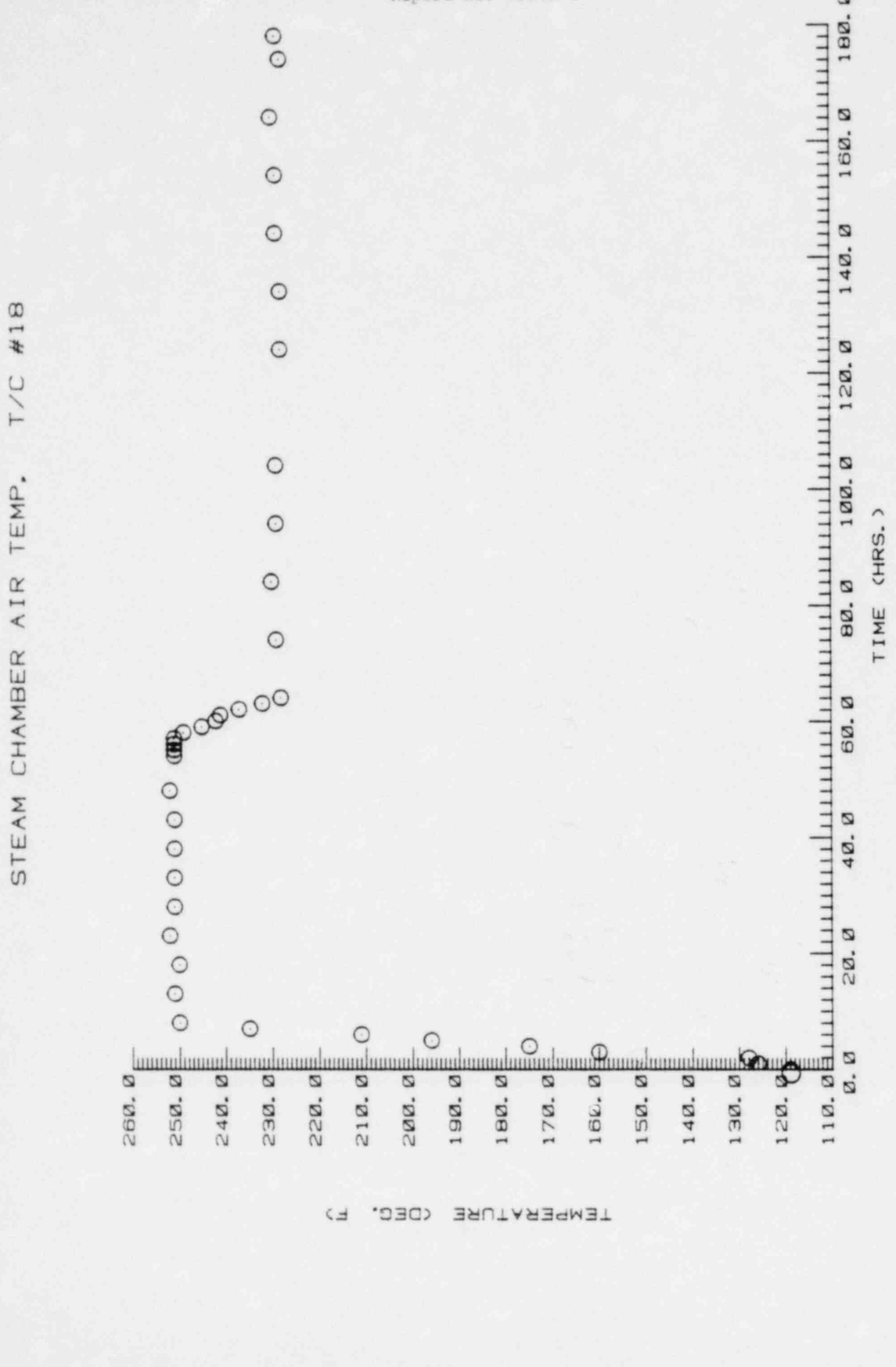
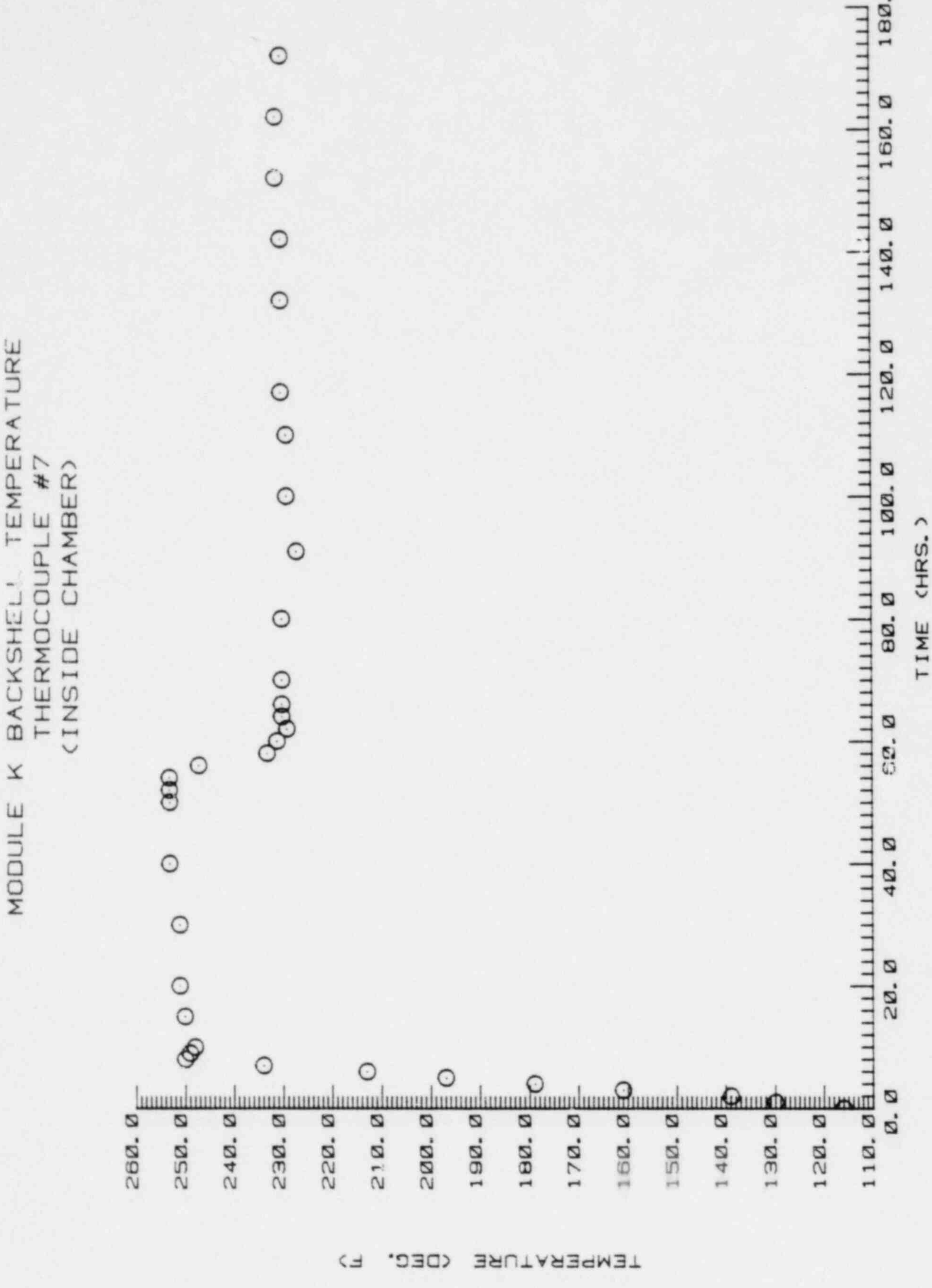
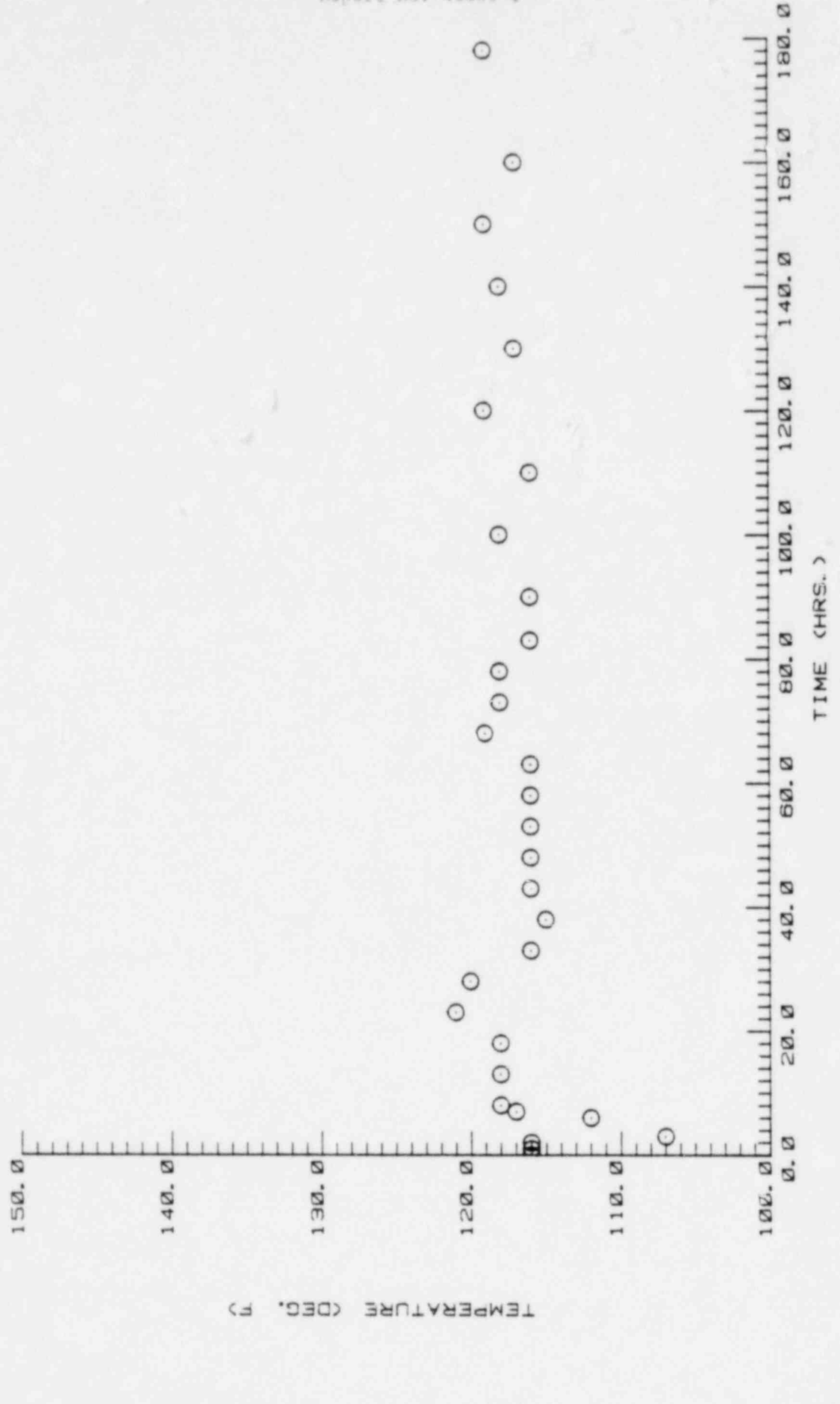

CHAMBER PRESSURE
PRESSURE (PSIG)
TIME (HRS.)
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0


STEAM CHAMBER AIR TEMP. T/C #18
TEMPERATURE (DEG. F)
260.0
250.0
240.0
230.0
220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
TIME (HRS.)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0


MODULE K BACKSHELL TEMPERATURE
THERMOCOUPLE #7
(INSIDE CHAMBER)
TIME (HRS.)
TEMPERATURE (DEG. F)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
260.0
250.0
240.0
230.0
220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0

ANNULUS TEMPERATURE. T/C #35



SECTION IV

FINAL INSPECTION

1.0 PROCEDURE

At the completion of the extended Accident Test, all plug modules were disassembled for evidence of distortion, extrusion, or moisture. The electrical penetration assembly was returned to D. G. O'Brien, Inc. for a leak test.

1.1 Results

1.1.1 Visual Examination

All modules were found to be in excellent condition with the exception of the E plug module. Examination of the E plug revealed a blackened area on the insulator near Pins 9 and 12 (see Photograph in Appendix IV-1). There was also a severe cut in the insulation of Conductor No. 12 under the backshell clamp. This cut could have allowed moisture to enter the connector and caused the erratic behavior of Module E. See Appendix IV-1 for photographs of all the connectors.

1.1.2 Boron Analysis

In another attempt to determine the presence of boron, which would indicate steam leakage, various samples were sent to Micron, Inc. for analysis. After the first Accident Test, samples of insulation jackets were sent to Micron, Inc. for boron analysis. These insulation samples were from the conductors which had leakage current in excess of 0.5 amps during the first Accident Test: Conductors 1 and 6 from Module E, Conductors 8 and 9 from Module L, and Conductor 3 from Module C. After the second Accident Test, grommets and insulators from Connectors E, C, and L were sent to Micron, Inc. for boron analysis. All samples were examined with an electron micro probe to determine the presence of boron.

No boron was detected in any of the samples. See Micron, Inc. Report, Appendix IV-2.

1.1.3 Penetration Assembly Leak Test

The leak test of the penetration assembly, conducted by D.G. O'Brien, Inc. indicated a leakage rate well below the maximum allowable of 10^{-2} STD cc/sec. See Appendix IV-3 for the D.G. O'Brien Report.

1.0 PROCEDURE (CONTINUED)

1.1.4 Fluorescent Dye Investigation

A black light used to determine the presence of fluorescent dye, which was mixed in the chemical spray, failed to establish any dye inside the cable insulation or inside the module connectors.

APPENDIX IV-1

CONNECTOR PHOTOGRAPHS AFTER SECOND ACCIDENT TEST

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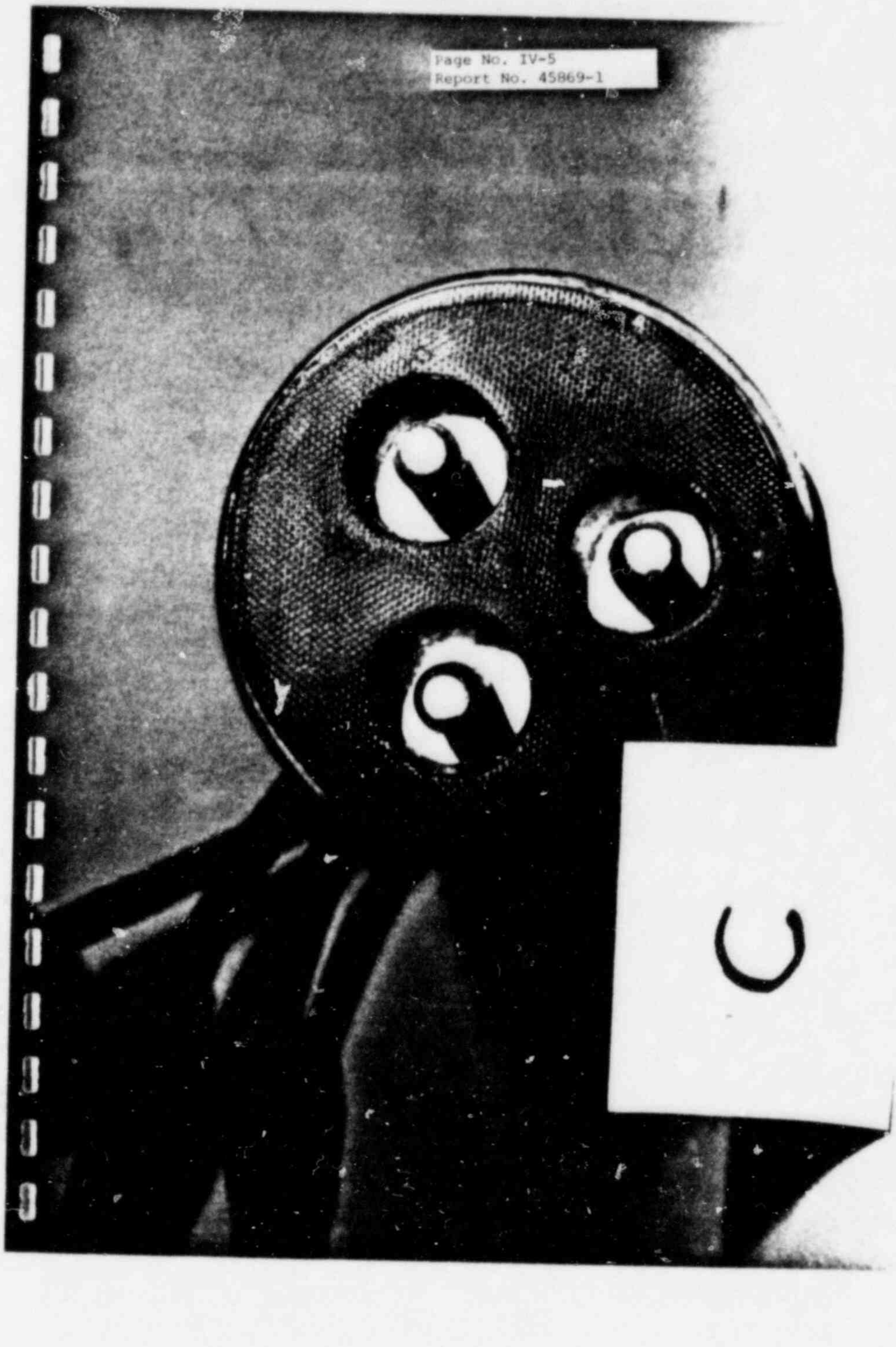
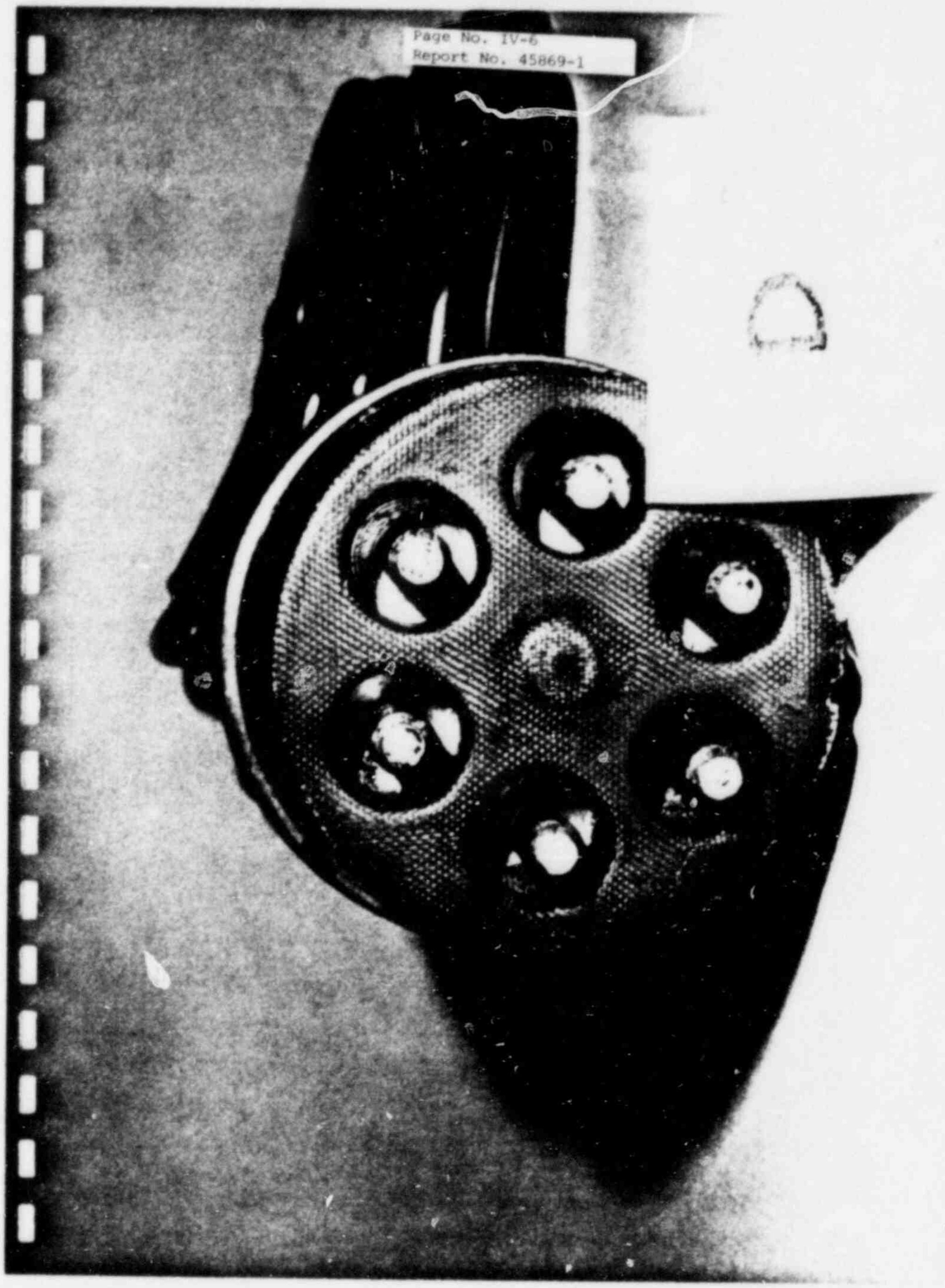
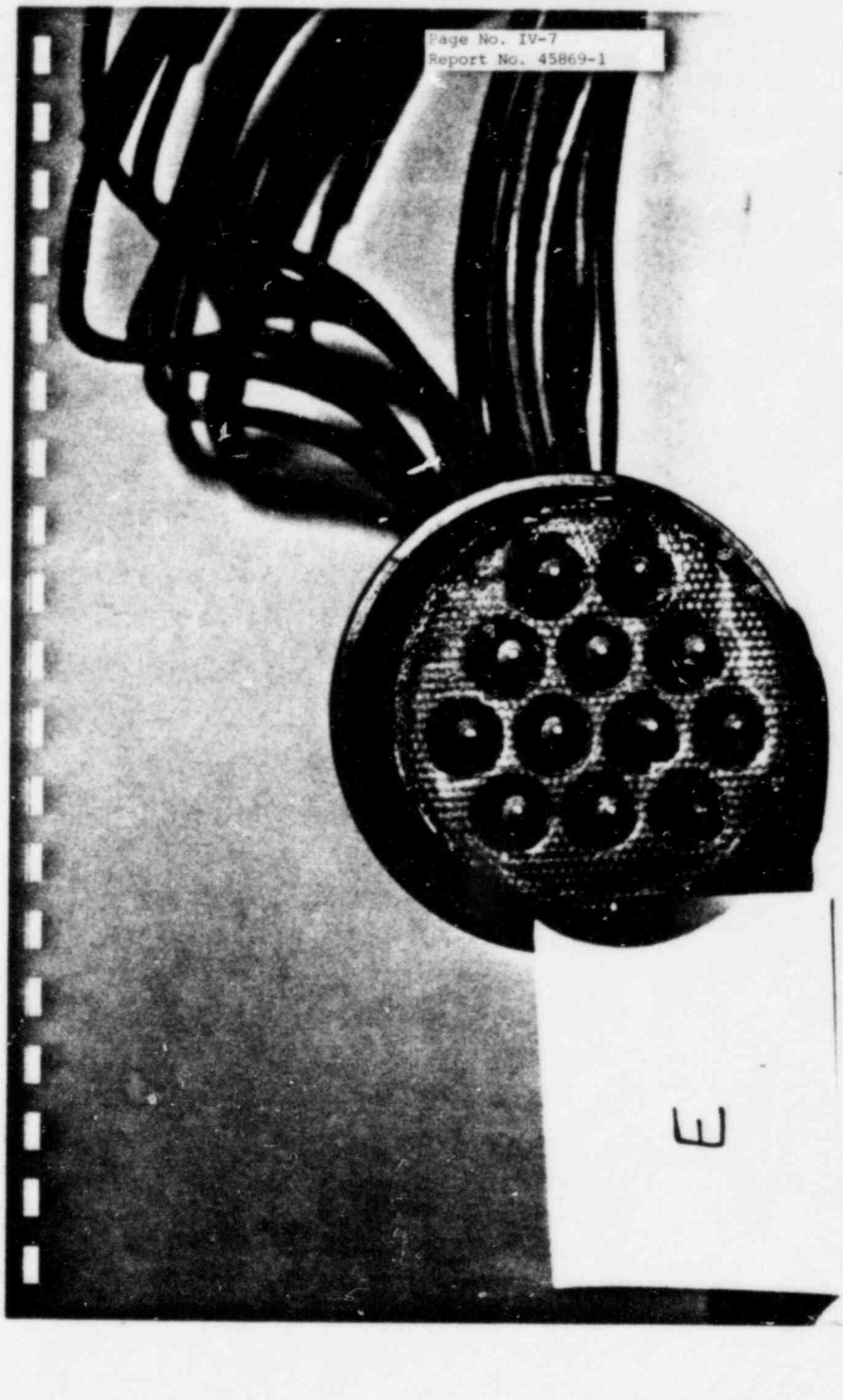
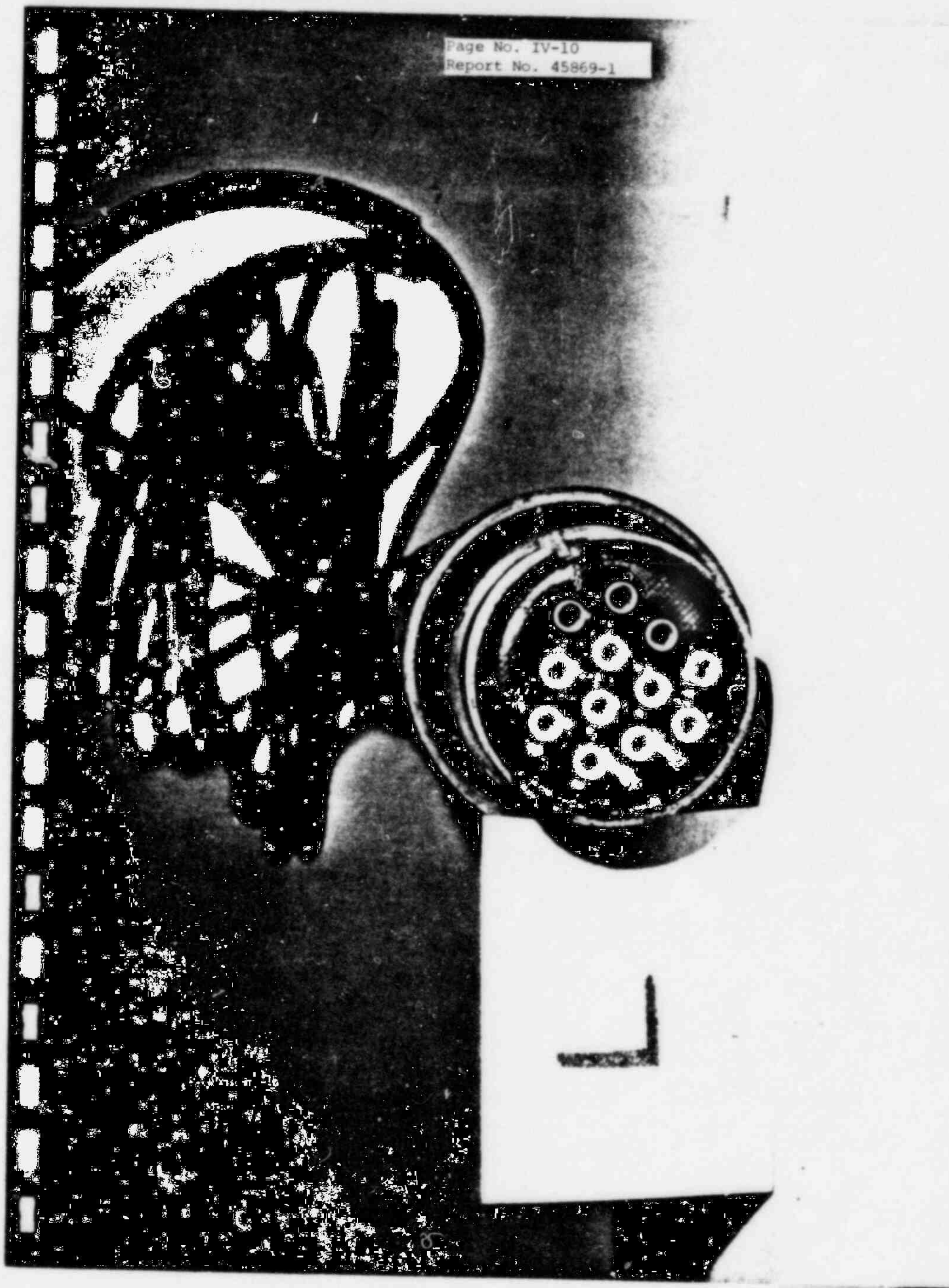

C







APPENDIX IV-2

MICRON, INC. BORON ANALYSIS REPORT

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Report #R-5606
Rubber Cable Jackets

Mr. Hamp Smith
WYLE LABORATORIES
7800 Governors Drive West
Huntsville, AL

Date: July 7, 1982

Approved:

Dr. Norman E. Weston
Vice President

4153-P

NEW/kf

micron inc.
Analytical Service Laboratory

Report #R-5606 July 7, 1982

Mr. Hamp Smith
WYLE LABORATORIES
7800 Gobernors Drive West
Huntsville, AL

Rubber Cable Jackets

Samples: Five rubber cable jackets, identified as E-1-L, E-6-L, C-3-L, L-8-L, L-9-L plus other samples.

Request: Perform electron probe analysis of the inner surface of each jacket to seek evidence of boric acid residue as per telephone conversation between W. E. Gresham (Micron) and H. Smith (Wyle Laboratories) or A. Husseini (Duke Power).

Results: The inner surface of each jacket was examined optically, at 30X magnification, to select an appropriate area for analysis, i.e. an area showing an apparent surface residue. Figure 1 shows scanning electron micrographs of the areas which were examined. Figures 2-3 show EDXA spectra typical of the materials studied; the method is sensitive to elements with atomic number above 8. Note that jacket L-8-L had high chlorine, while E-1-L had little.

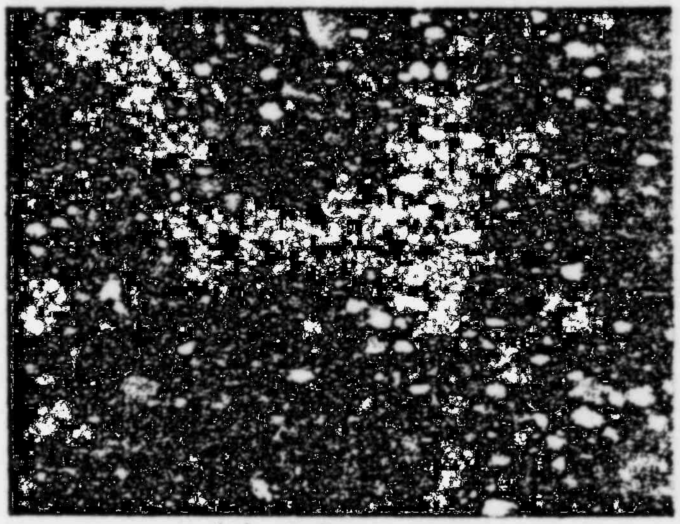
Limited spectral scans for boron are shown in Figs. 4-5. Boron was not detected in any sampled area. The low intensity line observed for

(Report #R-5606 RESULTS cont'd)

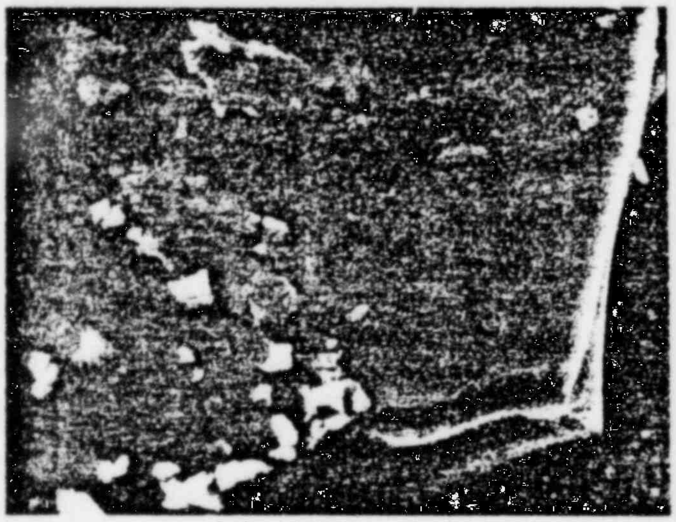
L-8-L and for L-9-L was attributed to chlorine which was high in these samples. The sensitivity for boron is shown by the B $K\alpha$ peak in Figure 6 which was obtained from sodium tetraborate with 21.49 wt.% boron.

Scanning Electron Micrographs (800X) of Areas
For Boron Analysis

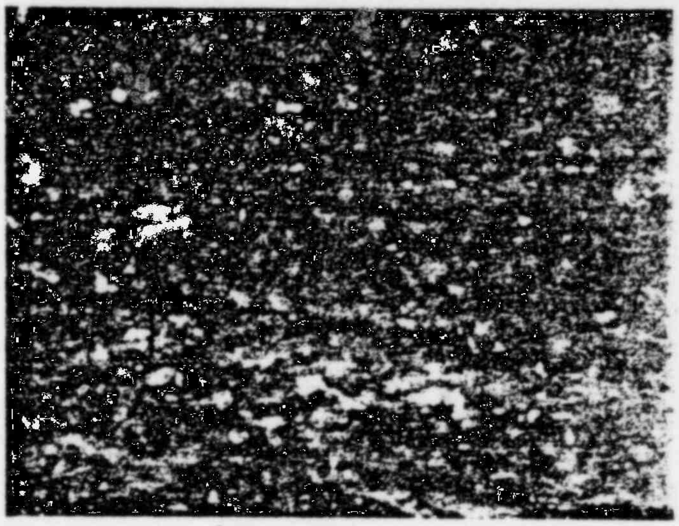
(a) E-1-L



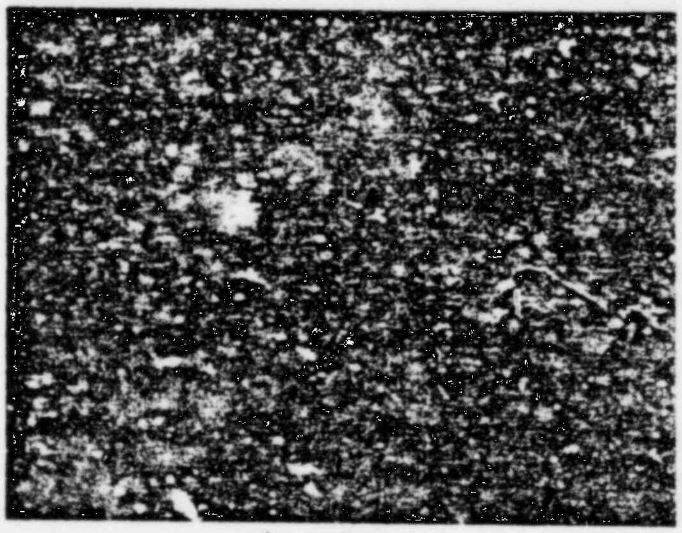
(b) E-6-L



(c) C-3-L



(d) L-8-L



(e) L-9-L

Figure 1

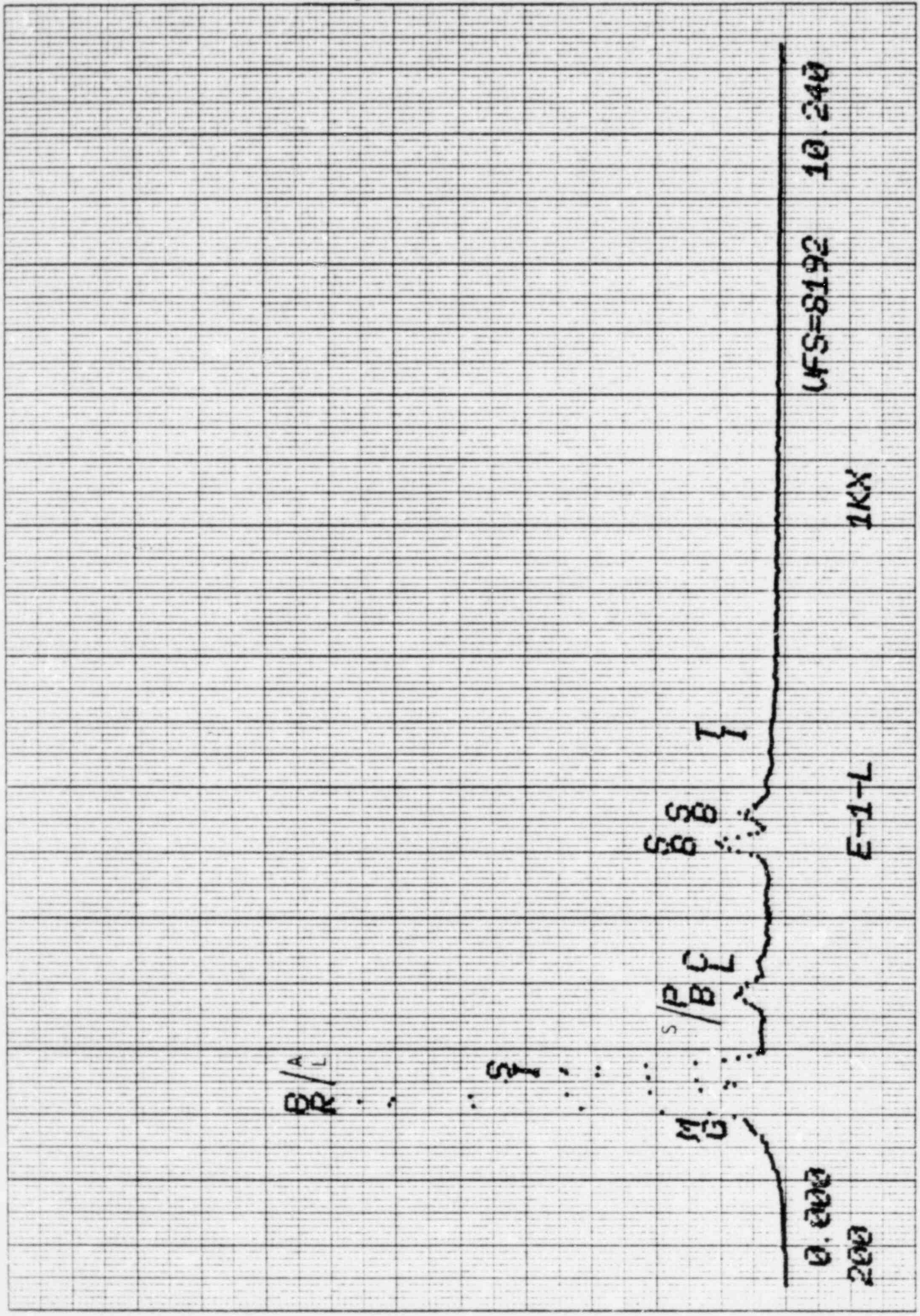


Figure 2

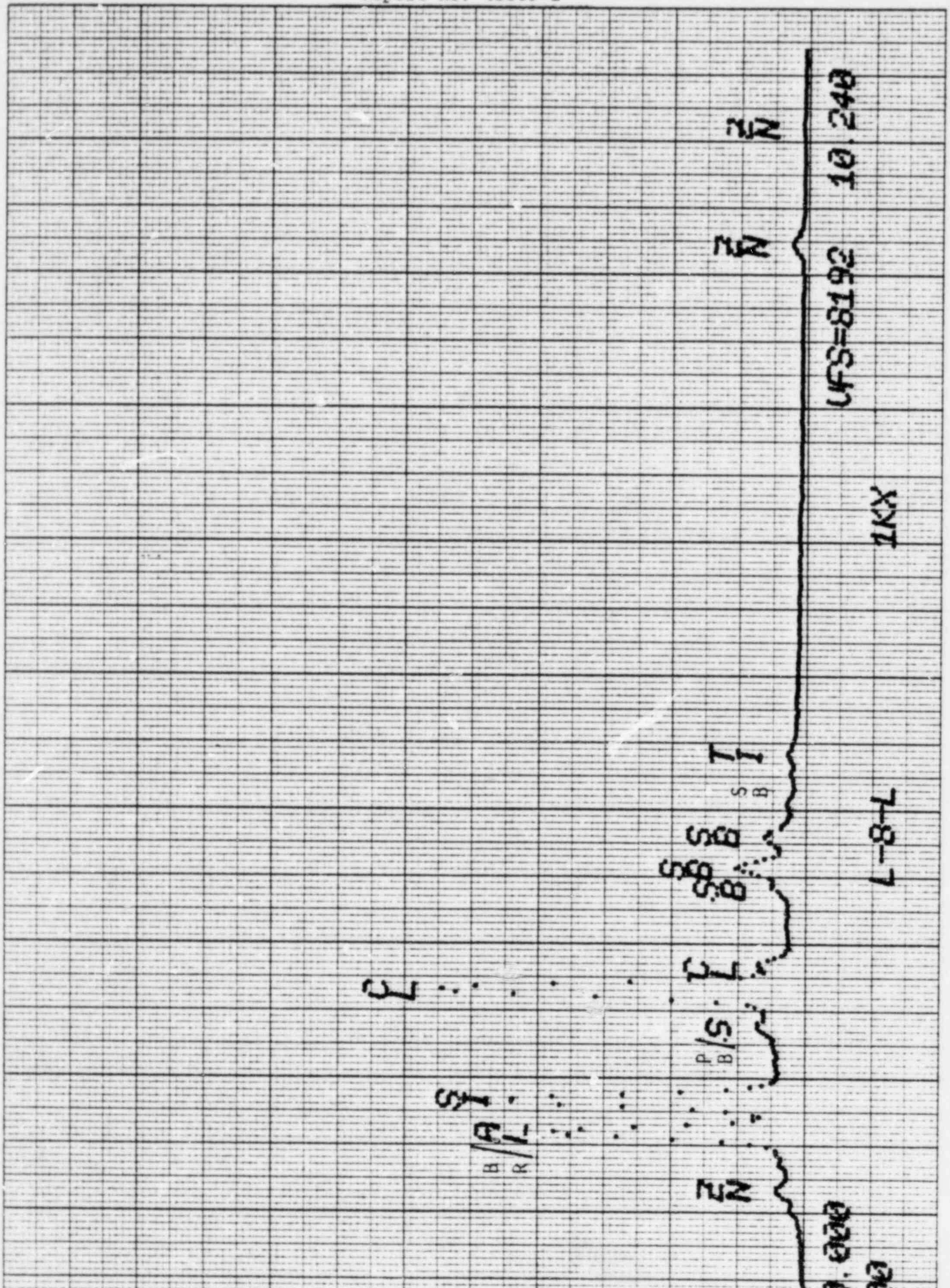


Figure 3

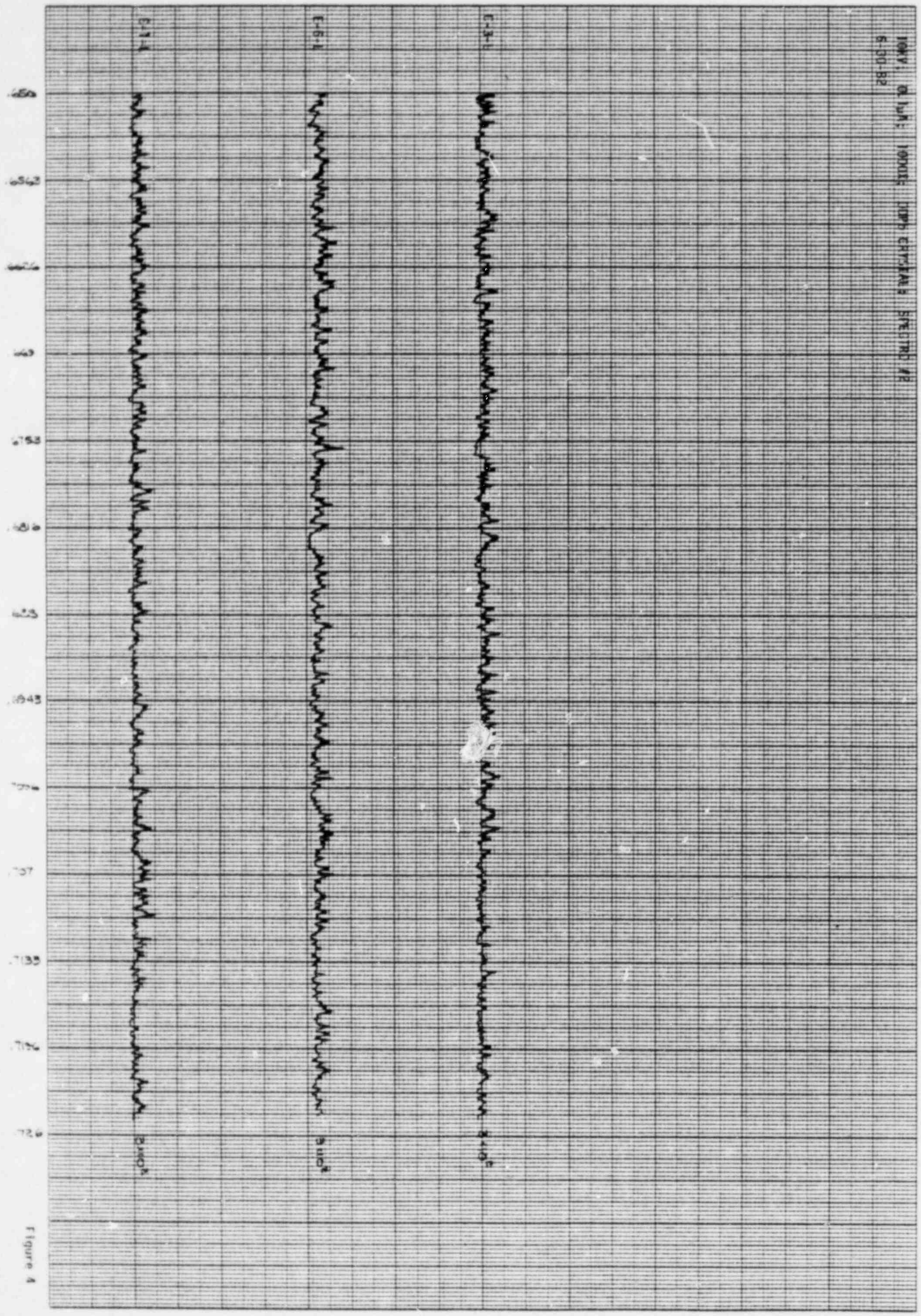


Figure 4

K+E 20 X 20 TO THE INCH • 10 X 15 INCHES KEUFFEL & ESSER CO. 4/1240

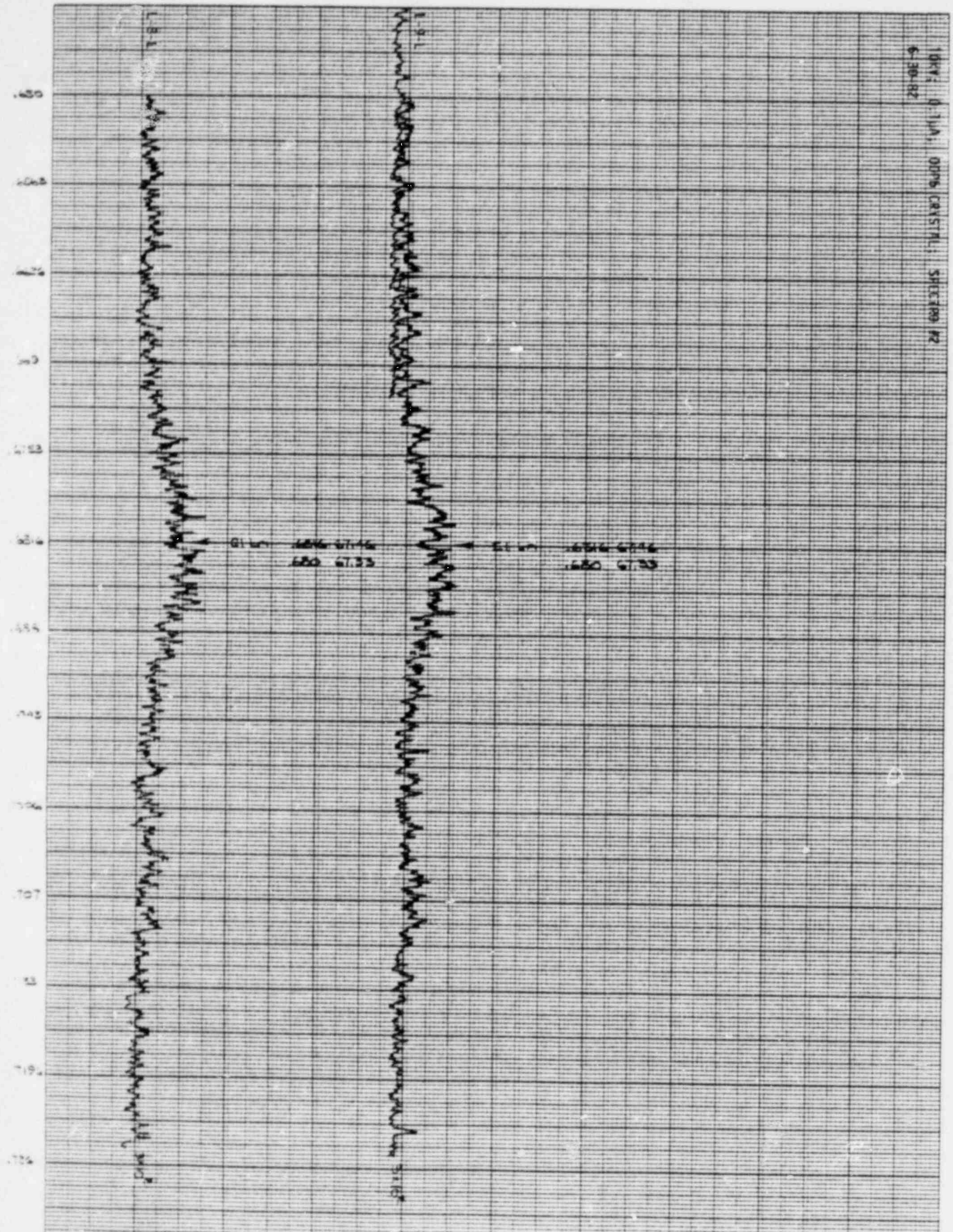


Figure 5

K+E 10 X 10 TO THE INCH KEUFFEL & ESSER CO. 1240

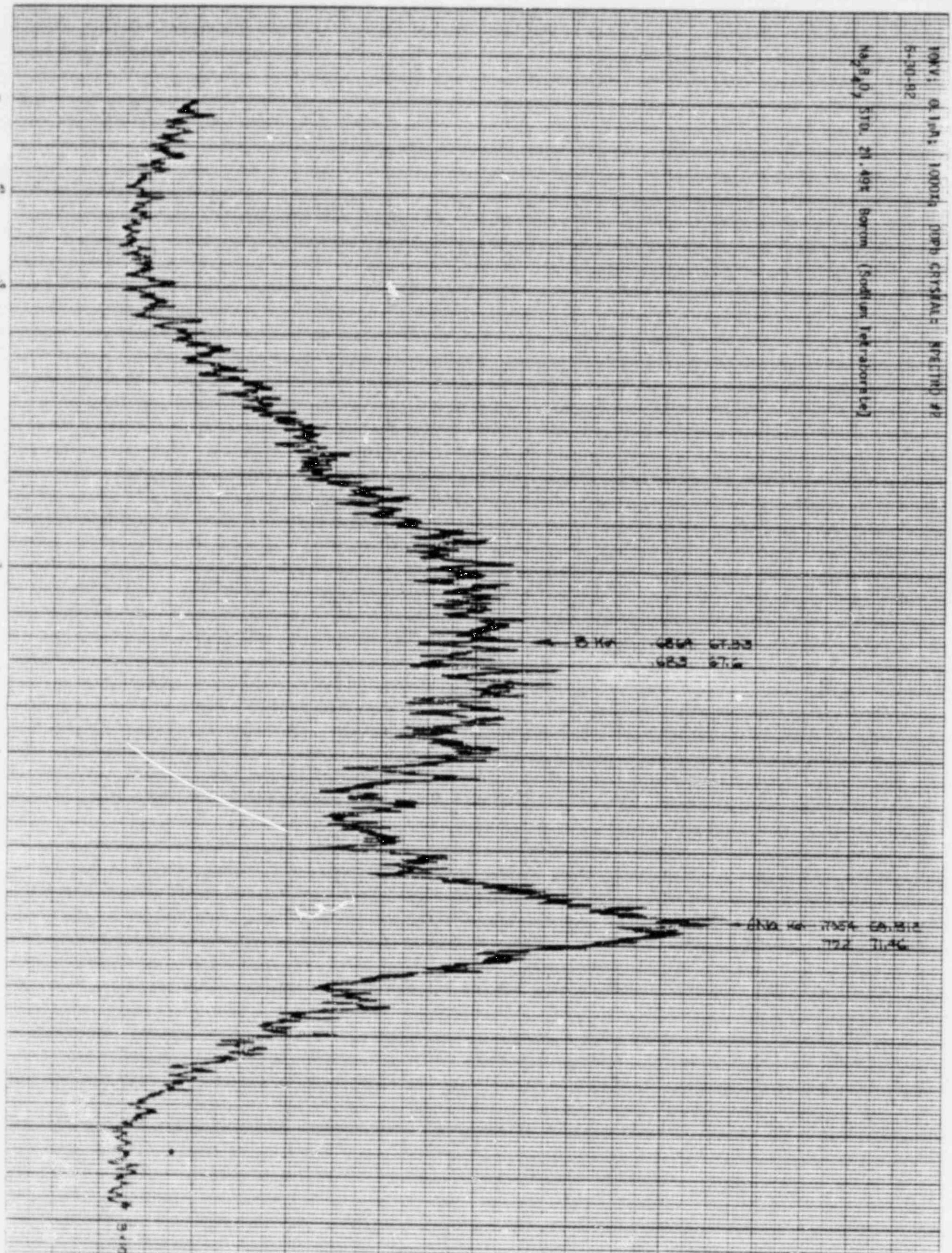


Figure 6

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APPENDIX IV-3

PENETRATION ASSEMBLY LEAK TEST REPORT

BY

D, G, O'BRIEN, INC.

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N-3538-63024
June 21, 1982

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

Attn: Mr. John S. Tannery
Design Engineer I

Subject: Helium Leak Test - McGuire/Wyle Labs Specimen

Gentlemen:

Enclosed are two copies of the helium leak test report on the subject specimen after the two steam exposures at Wyle Labs. As you can see, the leak rate is well below the 10^{-2} std cc/sec rate allowable after such exposure.

We have set the unit aside for the moment until such time as we may collectively consider further testing requirements.

Very truly yours,

D. G. O'BRIEN, INC.

H. P. Hilberg
Manager
Energy Components

P. C. Doringer
Sales Manager

HPH/PCD/ldb
cc: T. R. Black, Mill Power Supply Co.
Hampton Smith, Wyle Laboratories
S. Perkinson, The Perkinson Co.

D. G. O'Brien, Inc.

NPP

HELIUM LEAK TEST

JOB. NO. 63024-01 TESTER Mark Franceschini DATE 6/18/82

PART NO. ______ REV ______ PROC. NO. TP-LK-107 REV. E PROC. PARA. NO. 3.0

TEMPERATURE 70 °F HUMIDITY 50 % QA-TM- 194-1 REV. J

REQUIREMENT $\leq 1 \times 10^{-6}$ ATM CC/SEC. SENSITIVITY 9.43×10^{-10} ATM CC/SEC/DIV

HELIUM PRESSURE 17.5 PSIG. HELIUM 100 %

VACUUM LEVEL .01 MICRONS. TIME AT PRESSURE BEFORE READING 15 MIN.

HEL. STD. LEAK S/N T- 83 DATE NEXT CALIBRATION 5/29/84

SERIAL NO.	BACKGROUND	READING	LEAK RATE CC/SEC
(Leak	Rate of Both Sides	done Sim	ultaneously)
7740L-	0	50X35	1.65×10^{-6}

SERIAL NO.	ACTUAL LEAK RATE ATM (STD.) CC/SEC.
7740L	Corrected leak rate 7.524×10^{-7} Atm. cc/sec.

REMARKS: cf = 0.456

Approved [signature] Date 6/21/82
Test Supervisor

D. G. O'Brien, Inc.

PAGE N OF P

QUALITY ASSURANCE TEST RECORD SHEET

REQUIREMENT	QA-TM-194-1 Rev J	DATE	6/16/82
PARA. NUMBER	Step 3.0 & 4.0	JOB NUMBER	63024-01
PROCEDURE	TP-LK-109 REV. E	OPERATOR	Mark Franceschini
DESCRIPTION	Prototype Flange	TEMPERATURE	78°F
SERIAL NUMBER	7740L	HUMIDITY	BP 29.80

1. Evacuate Flange For Helium Leak Test.
2. Fill Flange with 17.5 PSIG of Helium.
3. Helium Leak Flange Per TP-LK-109 Rev E
   Refer to D.G. O'Brien Form #QA 208 Rev B 12/78.
4. Check Helium Pressure in Flange after Helium
   Leak Test = 17.3 PSIG.
5. Evacuate Flange Per MP-EP-110 Rev and
   Fill with SF6 instead of nitrogen

Form # QA-206 Rev. A 12/78

Approved [signature] Date 6/16/82
Test Supervisor