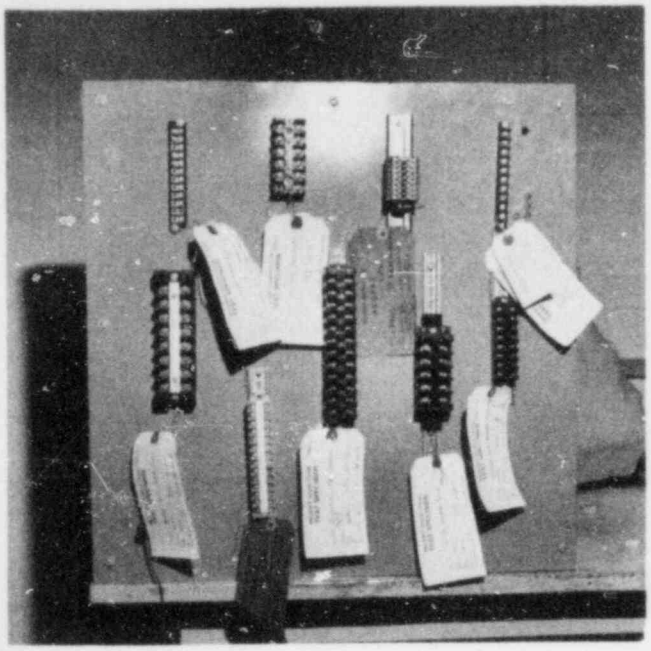
TEST REPORT
ON
ELECTRICAL SEPARATION VERIFICATION TESTING
ON TERMINAL BLOCKS AND PANEL METERS
FOR THE
PHILADELPHIA ELECTRIC COMPANY
LIMERICK GENERATING STATION
UNITS 1 AND 2

FOR

PHILADELPHIA ELECTRIC COMPANY
2301 MARKET STREET
PHILADELPHIA, PA 19101



Test Report

REPORT NO. 46960-4

WYLE JOB NO. 46960

CUSTOMER P. O. NO. EE 356122-N

PAGE 1 OF 60 PAGE REPORT

DATE May 14, 1984

SPECIFICATION (S) See Test Procedure in Section III

1.0 CUSTOMER Philadelphia Electric Company

ADDRESS 2301 Market Street, Philadelphia, PA 19101

2.0 TEST SPECIMEN Terminal Blocks and Panel Meters

3.0 MANUFACTURER As described in Section 5.0

4.0 SUMMARY

Representative terminal blocks and panel meters were subjected to a test program to verify adequacy of separation between redundant Class 1E systems and between Class 1E and non-Class 1E electrical systems in representative configurations as installed in the Limerick Generating Station, Units 1 and 2.

(DN284)

STATE OF ALABAMA
COUNTY OF MADISON } ss.

Alabama Professional Engineer Reg. No. 13475

Gerald R. Carbonneau, 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 Gerald R. Carbonneau

SUBSCRIBED and sworn to before me this 16th day of May, 1984

Virginia R. Dent

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

My Commission expires June 13, 1987

PREPARED BY J. Hazeltine 5/15/84
J. Hazeltine

APPROVED BY Flavous R. Johnson 5/16/84
Flavous R. Johnson

WYLE Q. A. W. B. Roberts 5/16/84 KB 5-15-84
W. B. Roberts

WYLE LABORATORIES
SCIENTIFIC SERVICES AND SYSTEMS GROUP
HUNTSVILLE, ALABAMA

4.0 SUMMARY (Continued)

4.1 This document has been prepared by Wyle Laboratories for the Philadelphia Electric Company as an Addendum to the Design Verification Test Report, "Internal Panel Control Wiring Separation Criteria," Philadelphia Electric Company Report No. 48503, dated September 1, 1982. This Addendum documents insulation resistance and overcurrent test data for terminal block specimens. In addition, accuracy tests and overcurrent/overvoltage tests for panel meter specimens were performed during this program.

4.2 The test program was conducted as specified in Reference 8.1.

4.2.1 The terminal block specimens were subjected to the test in the sequence listed below:

- o Test Specimen Preparation
- o Baseline Functional Test
- o Overcurrent Test
- o Voltage Breakdown Test
- o Post-Overcurrent Test Functional Test

4.2.2 The panel meter specimens were subjected to the test in the sequence listed below:

- o Test Specimen Preparation
- o Baseline Functional Test
- o Overcurrent/Overvoltage Test
- o Post-Overcurrent/Overvoltage Functional Test

4.2.3 The test results and support documentation are presented in the following sections of this report:

- o Section I — Test Programs, Terminal Blocks
- o Section II — Test Program, Panel Meters
- o Section III — Wyle Laboratories' Test Procedure No. 46960-2, Revision A

5.0 TEST SPECIMEN DESCRIPTIONS

The following table contains a listing of the test specimens:

Item No.	Description
1.0	General Electric CR151D70110 Twelve Point Terminal Block
2.0	General Electric CR151B6 Six Point Terminal Block
3.0	General Electric CR151A2 Terminal Block
4.0	Kulka Ten Point Terminal Block (GE PPD #137C6387P010)
5.0	Marathon 1600 8-Point Terminal Block
6.0	Cutler Hammer C381ST Terminal Block
7.1	Buchanan NQB Terminal Block (Heavy Duty)
7.2	Buchanan NQB Terminal Block (Medium Duty)
8.0	Weidmuller SAK 4 Terminal Block
9.0	General Electric Model 180 Edgewise Panel Meter (#1)
10.0	General Electric Model 180 Edgewise Panel Meter (#2)
11.0	General Electric Model 180 Edgewise Panel Meter (#3)

6.0 PURPOSE

Philadelphia Electric Company (PECO) performed a series of tests during 1981 to determine the separation criteria to be applied for internal panel control wiring at its Limerick Generating Station. IEEE Standard 384-1981, Section 6.6.2, allows the use of other than six inches of spatial separation if a lesser distance can be shown to be adequate by analysis or test. This report documents the testing performed on a representative sample of terminal blocks and GE Model 180 Edgewise Panel Meters to justify the separation criteria that are being used in the wiring of the Limerick control panels.

6.1 Assumption of Failure Modes

6.1.1 Terminal Blocks

The majority of the cables terminating on the terminal blocks to be tested are Size 14 AWG. Reference 8.3 showed that for Size 14 AWG conductors, the maximum current which was carried continuously was 90 amperes and that the conductors failed open when energized with 100 amperes.

In order to verify that adjacent terminal points on a terminal block provide adequate electrical separation, it must be demonstrated that on an overcurrent condition the Size 14 AWG conductors fail prior to degradation of the terminal block. To verify this, a terminal point must be capable of carrying 100 amperes continuously without degradation of a circuit, on an adjacent terminal point.

6.0 PURPOSE (Continued)

6.1.2 Panel Meters

The Limerick design includes panel meters mounted side by side with no physical separation. The internal circuitry of the GE Model 180 Edgewise Panel Meter requires performance of both overvoltage and overcurrent tests to demonstrate the adequacy of the Limerick design.

As discussed in Reference 8.3, page 7, it can be postulated that a cable connected to a panel meter could become energized with 480 VAC. Therefore, overvoltage tests applying 480 VAC minimum to the meter in both common mode (voltage applied with meter terminals jumpered together) and differential mode (voltage applied across meter terminals) must be performed.

Reference 8.3 also demonstrated that worst case overcurrent conditions will exist when the magnitude of the current is just below that which will cause the meter circuitry to open. This condition would transmit the most heat to an adjacent panel meter. A range of current levels from 10 times to 250 times maximum meter input were chosen to demonstrate this condition.

7.0 CONCLUSIONS

7.1 Terminal Blocks

It was demonstrated that with 100 amps of alternating current applied through a terminal point for 20 minutes there was neither interference with nor interruption of a 10 amp alternating current signal applied to an adjacent terminal point. In addition, with a difference in potential of 4,000 VAC applied between two adjacent terminal points, there was no evidence of insulation breakdown or flashover.

It is therefore concluded that a single-point terminal barrier provides adequate electrical separation, during electrical fault conditions, between redundant Class 1E electrical systems or between a Class 1E and a non-Class 1E electrical system.

Table I summarizes the results of the testing performed on nine different terminal blocks tested during this program.

7.2 Panel Meters

It was demonstrated by the test that the application of the following signals to a GE Model 180 Edgewise Panel Meter will not in any way affect the indication of another GE Model 180 Edgewise Panel Meter adjacent to and in contact with the first meter:

- 200 mA at 2 VDC (10 times the maximum meter input)
- 2 A at 20 VDC (100 times the maximum meter input)
- 5 amps at 50 VDC (250 times the maximum meter input)
- 125 VDC
- 600 VAC

It is therefore concluded that adequate electrical separation exists when two (2) GE Model 180 Edgewise Panel Meters are in contact with each other during the application of any credible electrical fault at the Limerick Generating Station Units 1 and 2.

TABLE I

Item No.	Part No.	Baseline Functional Insulation Resistance Test Test Points 1 to Gnd	Baseline Functional Insulation Resistance Test Test Points 5 to Gnd	Overcurrent Test 10 Amp Circuit V/I Before	Overcurrent Test 10 Amp Circuit V/I After	Overcurrent Test 10 Amp Circuit Time to Ignition	Post Functional Test Insulation Resistance Test Test Points 1 to Gnd	Post Functional Test Insulation Resistance Test Test Points 5 to Gnd	Voltage Breakdown Test Breakdown Voltage Test Points 1 to Gnd	Voltage Breakdown Test Breakdown Voltage Test Points 5 to Gnd	Voltage Breakdown Test Leakage Current Test Points 1 to Gnd	Voltage Breakdown Test Leakage Current Test Points 5 to Gnd
1.0	GE CR151D70110	$7.6 \times 10^{9}\ \Omega$	$7.2 \times 10^{9}\ \Omega$	382V/ 10.0A	382V/ 9.9A	No ignition in 1200.14 Sec.	$5.5 \times 10^{9}\ \Omega$	$1.2 \times 10^{10}\ \Omega$	N/A	>4000VAC	17μa	140μa
2.0	GE CR151B6	$4.0 \times 10^{10}\ \Omega$	$4.5 \times 10^{10}\ \Omega$	38 V/ 10.03A	390V/ 10.06A	No ignition in 1200.97 Sec	$4.5 \times 10^{9}\ \Omega$	$6.2 \times 10^{9}\ \Omega$	N/A	>4000VAC	15μa	125μa
3.0	GE CR151A2	$4.5 \times 10^{11}\ \Omega$	$4.5 \times 10^{11}\ \Omega$	495V/ 10.02A	495V/ 9.99A	No ignition in 1200.22 Sec	$4.5 \times 10^{11}\ \Omega$	$5.0 \times 10^{11}\ \Omega$	N/A	>4000VAC	22μa	170μa
4.0	GE PPD 137C6387P010	$1.6 \times 10^{11}\ \Omega$	$0.88 \times 10^{11}\ \Omega$	498V/ 10.05A	498V/ 10.03A	No ignition in 1200.01 Sec	$2.0 \times 10^{11}\ \Omega$	$7.0 \times 10^{10}\ \Omega$	N/A	>4000VAC	23μa	160μa
5.0	Marathon 1600	$2.5 \times 10^{9}\ \Omega$	$4.0 \times 10^{9}\ \Omega$	380V/ 10.0A	380V/ 9.9A	No ignition in 1205.26 Sec	$1.3 \times 10^{8}\ \Omega$	$3.0 \times 10^{9}\ \Omega$	N/A	>4000VAC	19μa	135μa
6.0	CH C381ST	$2.5 \times 10^{11}\ \Omega$	$75.0 \times 10^{11}\ \Omega$	393V/ 10.0A	389V/ 10.09A	No ignition in 1208.56 Sec	$>5.0 \times 10^{11}\ \Omega$	$4.5 \times 10^{10}\ \Omega$	N/A	>4000VAC	16μa	115μa
7.1	Buchanan NQB (Heavy Duty)	$3.5 \times 10^{10}\ \Omega$	$6.2 \times 10^{10}\ \Omega$	387V/ 10.0A	392V/ 10.08A	No ignition in 1208.67 Sec	$3.5 \times 10^{10}\ \Omega$	$4.0 \times 10^{10}\ \Omega$	N/A	>4000VAC	18μa	130μa
7.2	Buchanan NQB (Medium Duty)	$1.3 \times 10^{10}\ \Omega$	$3.5 \times 10^{10}\ \Omega$	384V/ 10.05A	386V/ 10.08A	No ignition in 1200.91 Sec	$5.0 \times 10^{10}\ \Omega$	$1.7 \times 10^{10}\ \Omega$	N/A	>4000VAC	19μa	160μa
8.0	Weidmuller SAK-4	$4.0 \times 10^{11}\ \Omega$	$75.0 \times 10^{11}\ \Omega$	389V/ 10.04A	389V/ 10.08A	No ignition in 1200.53 Sec	$>5.0 \times 10^{11}\ \Omega$	$>5.0 \times 10^{11}\ \Omega$	N/A	>4000VAC	19μa	160μa

8.0 REFERENCES

8.1 Wyle Laboratories' Test Procedure No. 46960-2, Revision A, "Electrical Separation Verification Testing on Terminal Blocks and Panel Meters for the Philadelphia Electric Company, Limerick Generating Station Units 1 and 2," dated November 1, 1983.

8.2 IEEE Standard 384-1981, "IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits."

8.3 Philadelphia Electric Company Report Number 48503, "Design Verification Test Report, Internal Panel Control Wiring Separation Criteria," dated September 1, 1982.

9.0 QUALITY ASSURANCE

All work on this test program was performed in accordance with Wyle Laboratories' Quality Assurance Program which complies with the applicable requirements of 10 CFR 50 Appendix B, ANSI N 45.2 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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SECTION I

TEST PROGRAM — TERMINAL BLOCKS

1.0 REQUIREMENTS

1.1 Acceptance Criteria

1.1.1 Insulation Resistance Test

Measured insulation resistance shall be greater than 1.6×10^6 ohms with an applied potential of 500 VDC for 60 seconds.

1.1.2 Terminal Block Overcurrent Test

- Terminal block ignition shall not occur with 100 amperes applied for 20 minutes.
- Adjacent terminal circuit continuity shall be maintained throughout the overcurrent test.
- There shall be no evidence of breakdown or flashover with a potential of 600 VAC applied for 60 seconds from the adjacent target terminal to ground.

2.0 PROCEDURES

2.1 Test Specimen Identification

An inspection was performed upon receipt of the test specimen components at Wyle Laboratories.

The manufacturer, model, and part numbers were found to be:

Item No.	Description
1.0	General Electric CR151D70110 Twelve Point Terminal Block
2.0	General Electric CR151B6 Six Point Terminal Block
3.0	General Electric CR151A2 Terminal Block
4.0	Kulka Ten Point Terminal Block (GE PPD #137C6387P010)
5.0	Marathon 1600 8-Point Terminal Block
6.0	Cutler Hammer C381ST Terminal Block
7.1	Buchanan NQB Terminal Block (Heavy Duty)
7.2	Buchanan NQB Terminal Block (Medium Duty)
8.0	Weidmuller SAK 4 Terminal Block

2.0 PROCEDURES (Continued)

2.2 Test Specimen Preparation

The nine PECO-supplied terminal blocks were prepared using the following procedure:

1. A 24" by 18" steel plate was attached to a 24" by 18" wooden frame.

2. The following terminal blocks were mounted on the steel plate with the terminal points running vertically (with a minimum of four inches of clearance around each terminal block):

Item 1.0	General Electric CR151D70110 12-point terminal block
Item 2.0	General Electric CR151B6 6-point terminal block
Item 3.0	General Electric CR151A2 terminal block (rail mounted)
Item 4.0	Kulka 10-point terminal block (GE PPD #137C6387P010)
Item 5.0	Marathon 1600 8-point terminal block
Item 6.0	Cutler Hammer C381ST Terminal Block (rail mounted)
Item 7.1	Buchanan NQB Terminal Block (rail mounted) Heavy Duty
Item 7.2	Buchanan NQB Terminal Block (rail mounted) Medium Duty
Item 8.0	Weidmuller SAK 4 Terminal Block (rail mounted)

3. The 24" by 18" test fixture was mounted vertically on a wooden test table.

4. The steel plate was grounded.

2.3 Baseline Functional Tests

2.3.1 Insulation Resistance Tests (See Figure 1 of Section III)

1. A jumper was connected from Point 2 of Item 1.0 to the mounting plate.

2. Using a megohmmeter, a potential of 500 VDC was applied. The minimum insulation resistance indicated over a period of 60 seconds between Point 1 and the mounting plate was recorded.

3. The jumper at Point 2 was disconnected and attached to Point 4 of Item 1.0.

4. Using a megohmmeter, a potential of 500 VDC was applied. The minimum insulation resistance indicated over a period of 60 seconds between Point 5 and the mounting plate was recorded.

5. The jumper was disconnected from Point 4.

6. Steps 1 through 5 were repeated for Items 2.0 through 8.0.

For each performance of this test, the measured value was compared to the acceptance criterion, Paragraph 1.1.1, i.e., greater than 1.6×10^6.

2.0 PROCEDURES (Continued)

2.4 Overcurrent Test (See Figure 1 of Section III)

1. 480 VAC/10 amperes/1 phase power was connected to Point 1 of Item 1.0 per Figure 1.
2. A Multi-Amp CB 8130 Test Set was connected to Point 2 of Item 1.0 per Figure 1.
3. The 480 VAC power supply was adjusted such that 10 $\pm$0.1 amperes of current was applied to Point 1 of the terminal block.
4. The Multi-Amp Test Set was adjusted to supply 100 amperes through Point 2.
5. The 100 amperes current was allowed to flow for 20 minutes.
6. The Multi-Amp Test Set output and the 480 VAC power supply were de-energized.
7. The results of the overcurrent test and time to ignition, if applicable, were recorded.
8. Steps 1 through 7 were repeated for Items 2.0 through 8.0.

2.5 Post-Overcurrent Test Functional Tests

2.5.1 **Insulation Resistance Tests** — The insulation resistance tests of Paragraph 2.3.1 were repeated.

2.5.2 Voltage Breakdown Test

1. A jumper was connected from Point 4 of Item 1.0 to the mounting plate.
2. Using an AC Hi-Pot Test Assembly connected to Point 5 of Item 1.0, the voltage was increased at a rate of approximately 100 volts per second until evidence of breakdown occurred or a voltage of 4,000 VAC was reached.
3. The voltage level and leakage current were recorded.
4. Using an AC Hi-Pot Test Assembly connected to Point 1 of Item 1.0, the voltage was increased to 600 VAC at a rate of 100 volts per second.
5. The voltage was maintained at 600 VAC for a period of 60 seconds and the maximum leakage current was recorded.
6. Steps 1 through 3 were repeated for Items 2.0 through 8.0.

2.0 PROCEDURES (Continued)

2.5 Post-Overcurrent Test Functional Tests (Continued)

2.5.2 Voltage Breakdown Test (Continued)

For all performances of this test (Steps 3 and 5), the observed values were compared to the acceptance criterion, Paragraph 1.1.2, i.e., there was no evidence of insulation breakdown or flashover.

3.0 RESULTS

All test specimens demonstrated sufficient integrity to meet or exceed the acceptance criteria specified in Section I, Paragraph 1.1 when subjected to the testing of Paragraph 2.0 above.

There was no apparent physical damage to the terminal blocks after 100 amps was applied through a terminal point for 20 minutes continuously, nor was there any evidence of insulation breakdown or flashover with 4,000 VAC applied between two adjacent terminal points.

Photographs I-1 through I-6 are presented in Appendix I of this section.

Photographs I-1 and I-2 show overcurrent test setup of Items 5.0 and 7.2, respectively.

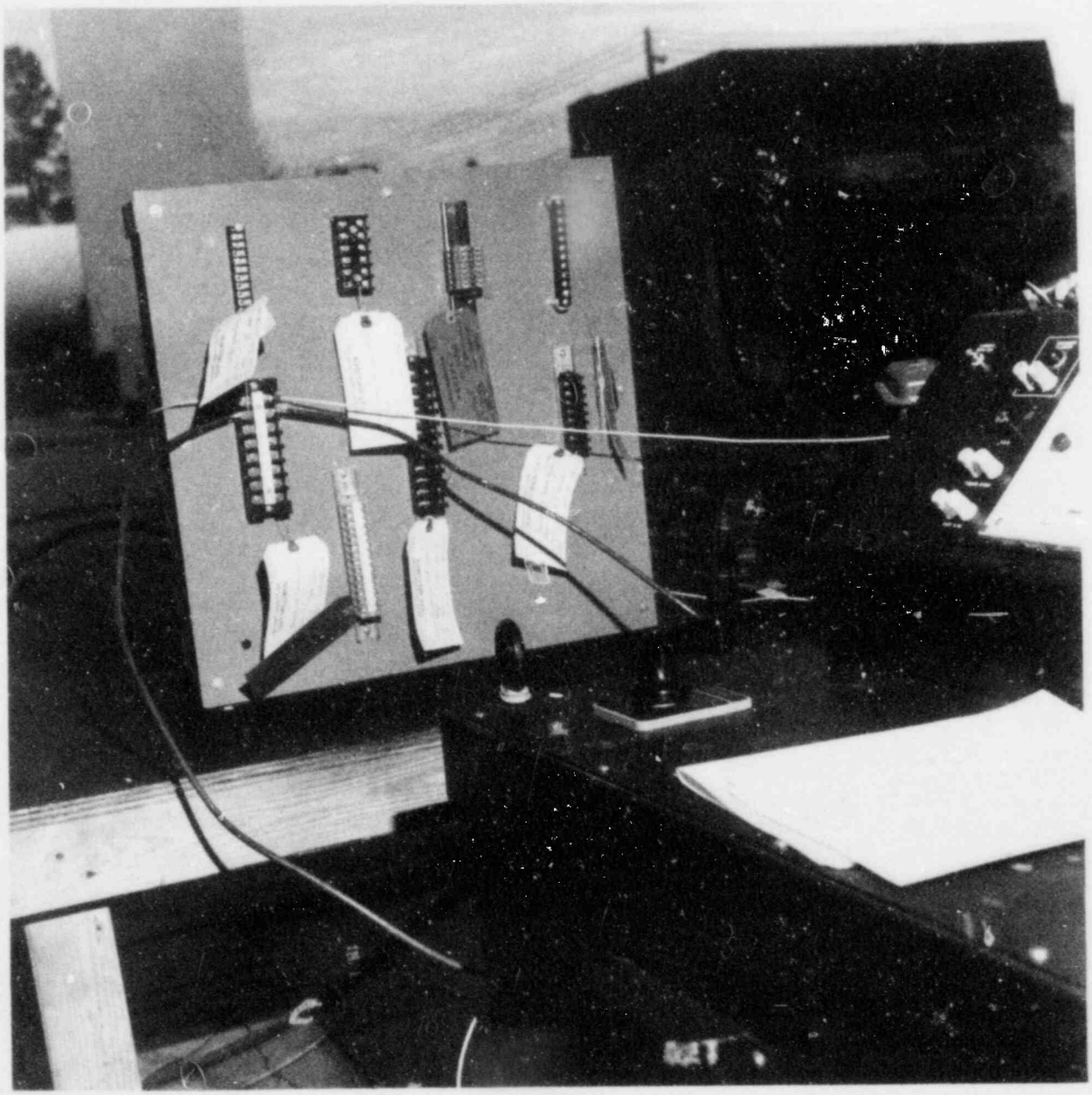
Photographs I-3 and I-4 show details of 12 kilowatt resistive load used during overcurrent test.

Photographs I-5 and I-6 provide a post-test view of terminal block mounting, both front and rear.

The Data Sheets and Instrumentation Equipment Sheet for the terminal block tests are presented in Appendix II of this section.

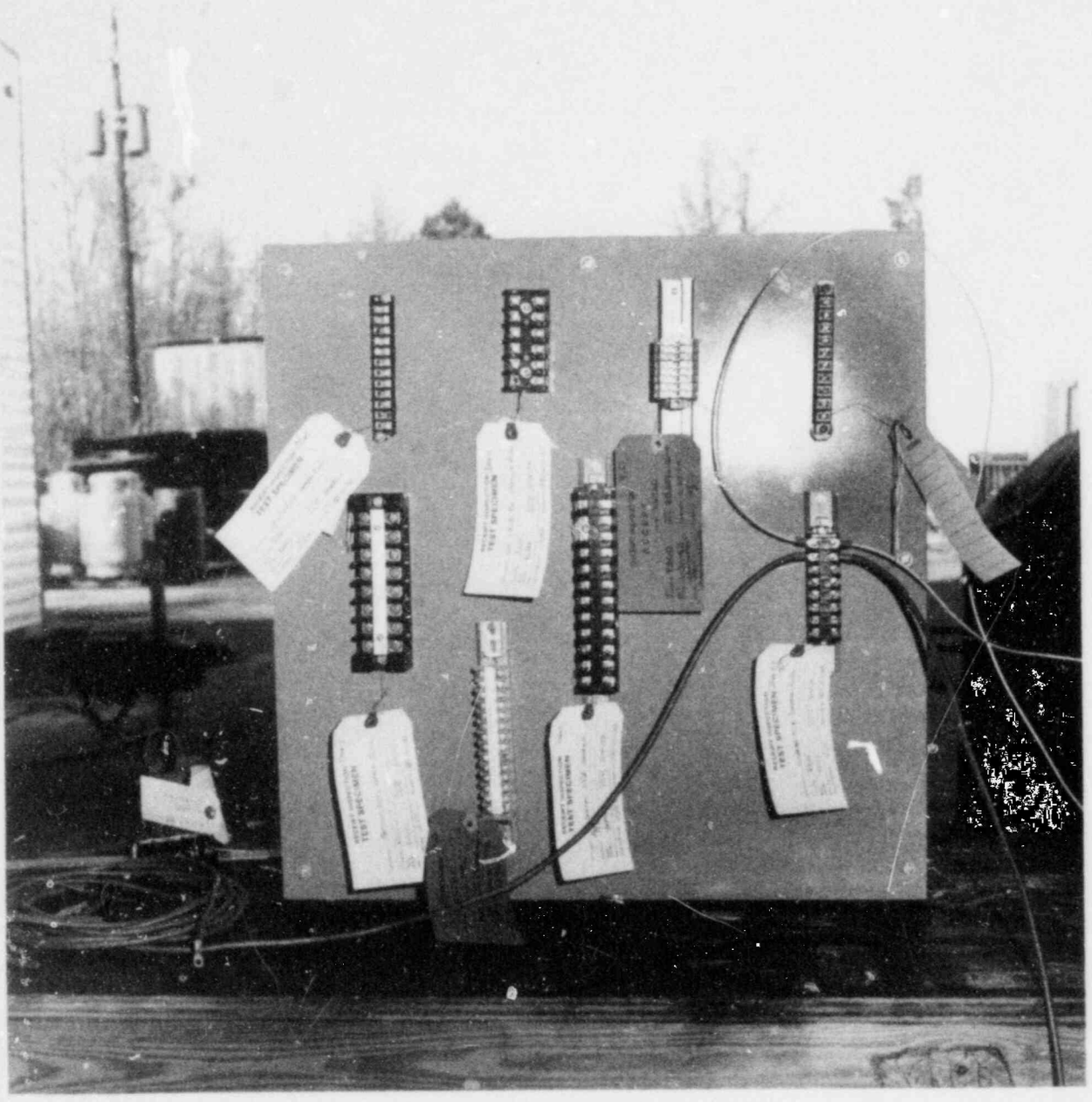
APPENDIX I

PHOTOGRAPHS



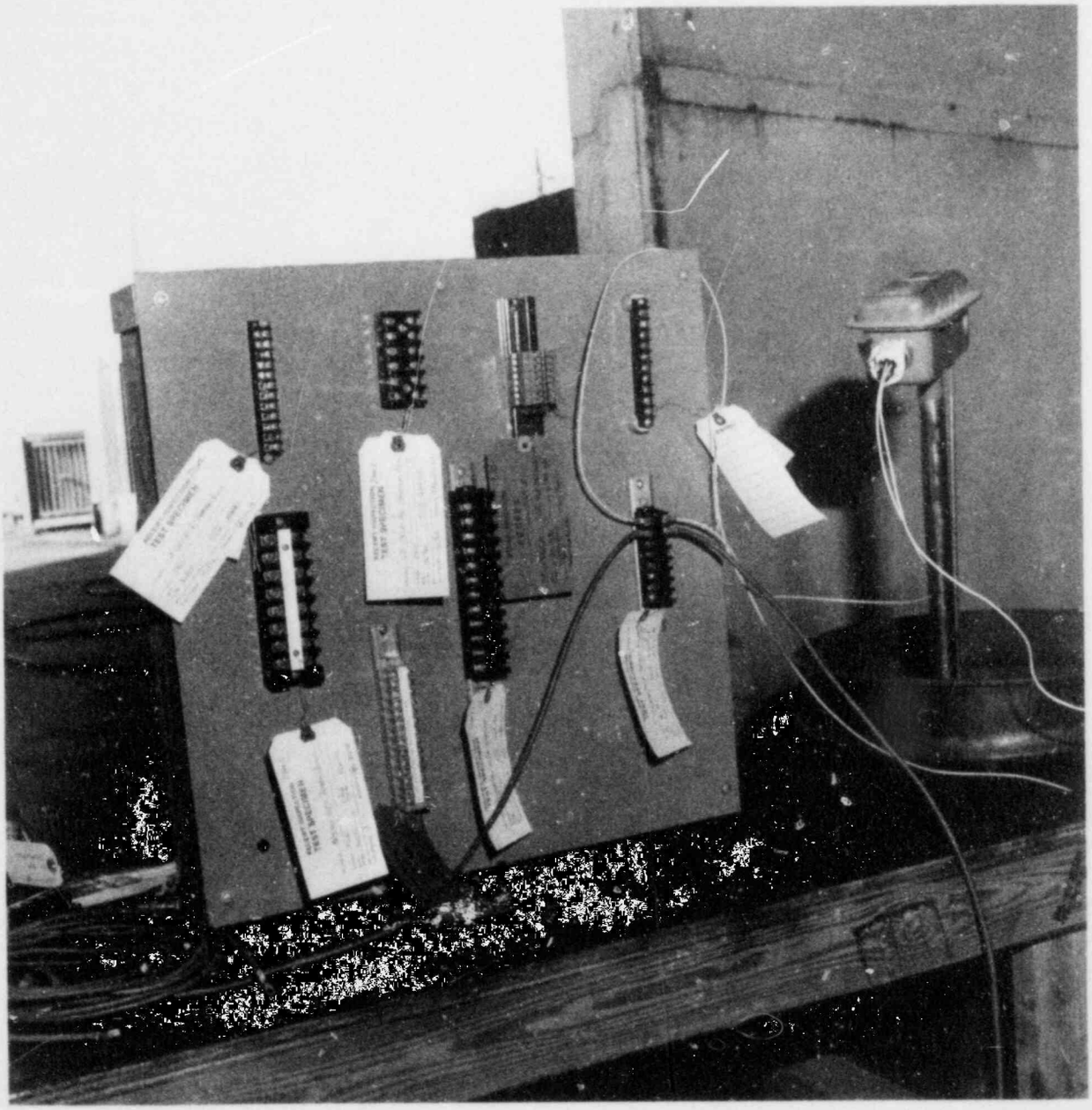
PHOTOGRAPH I-1

OVERCURRENT TEST SETUP SHOWING MULTI-AMP SETUP DURING OVERCURRENT TEST OF ITEM 5.0



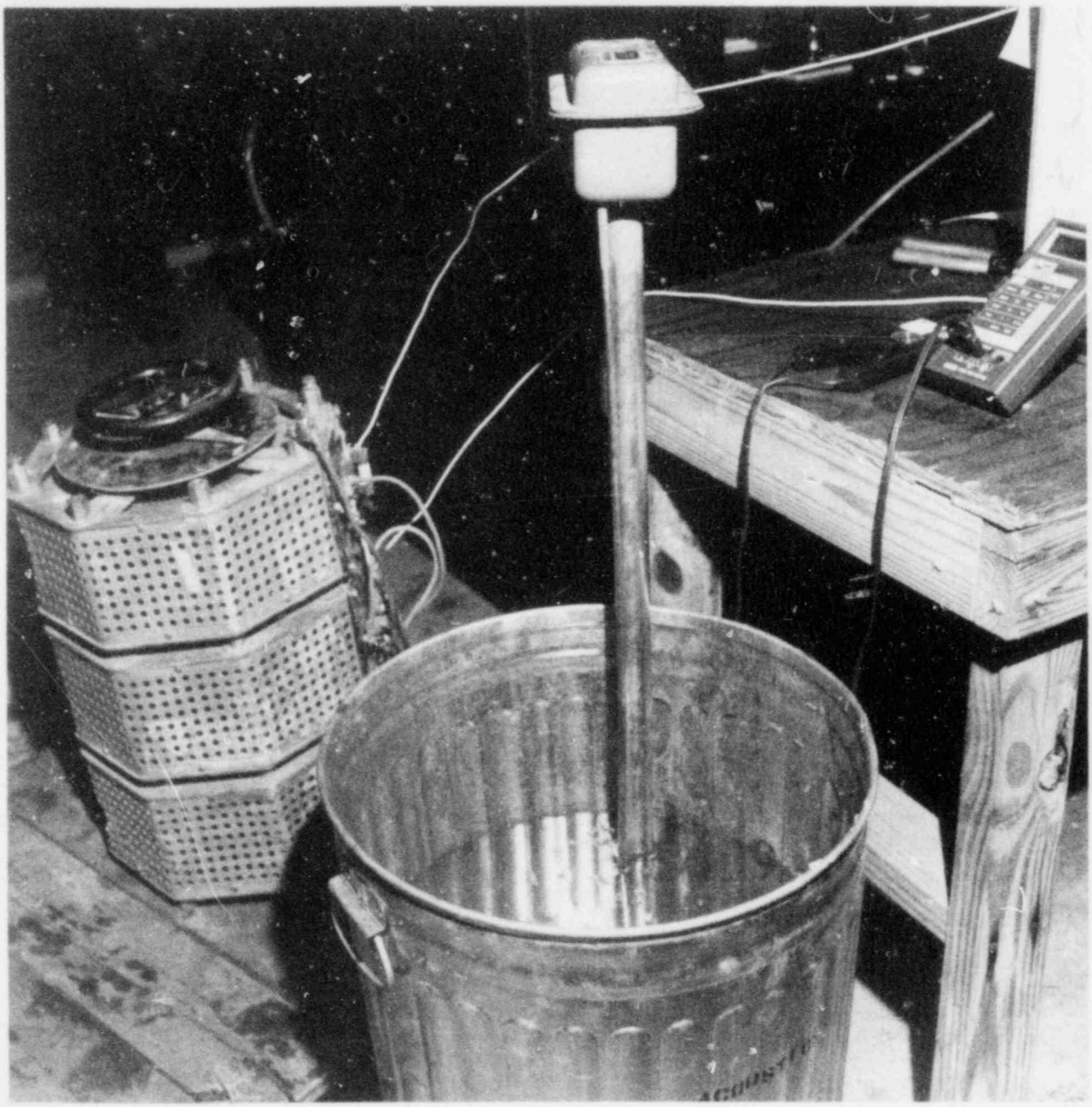
PHOTOGRAPH I-2

OVERCURRENT TEST SETUP OF ITEM 7.2



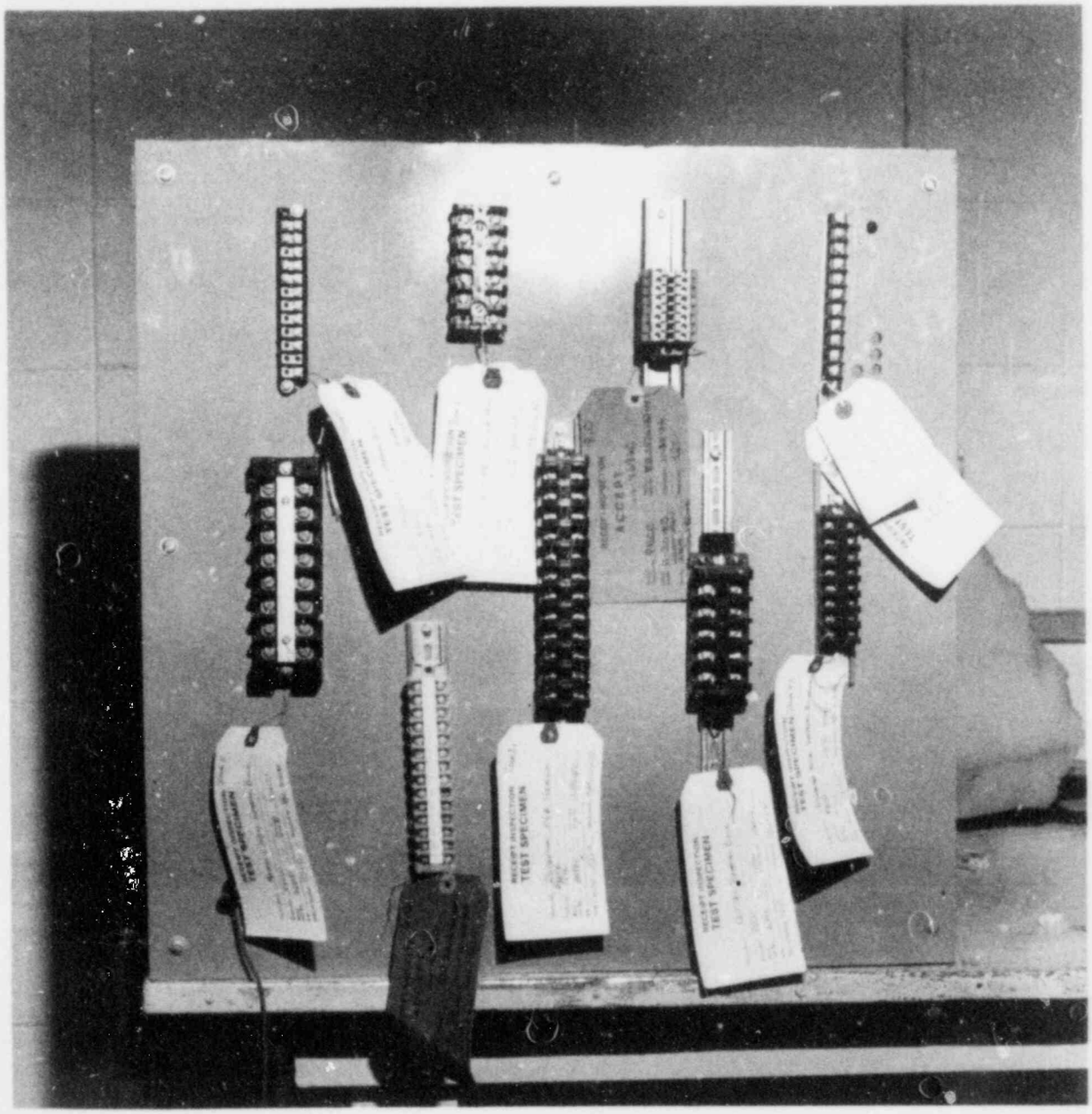
PHOTOGRAPH I-3

**OVERCURRENT TEST SETUP SHOWING 480 VAC/10 AMP
12 KW RESISTIVE LOAD**



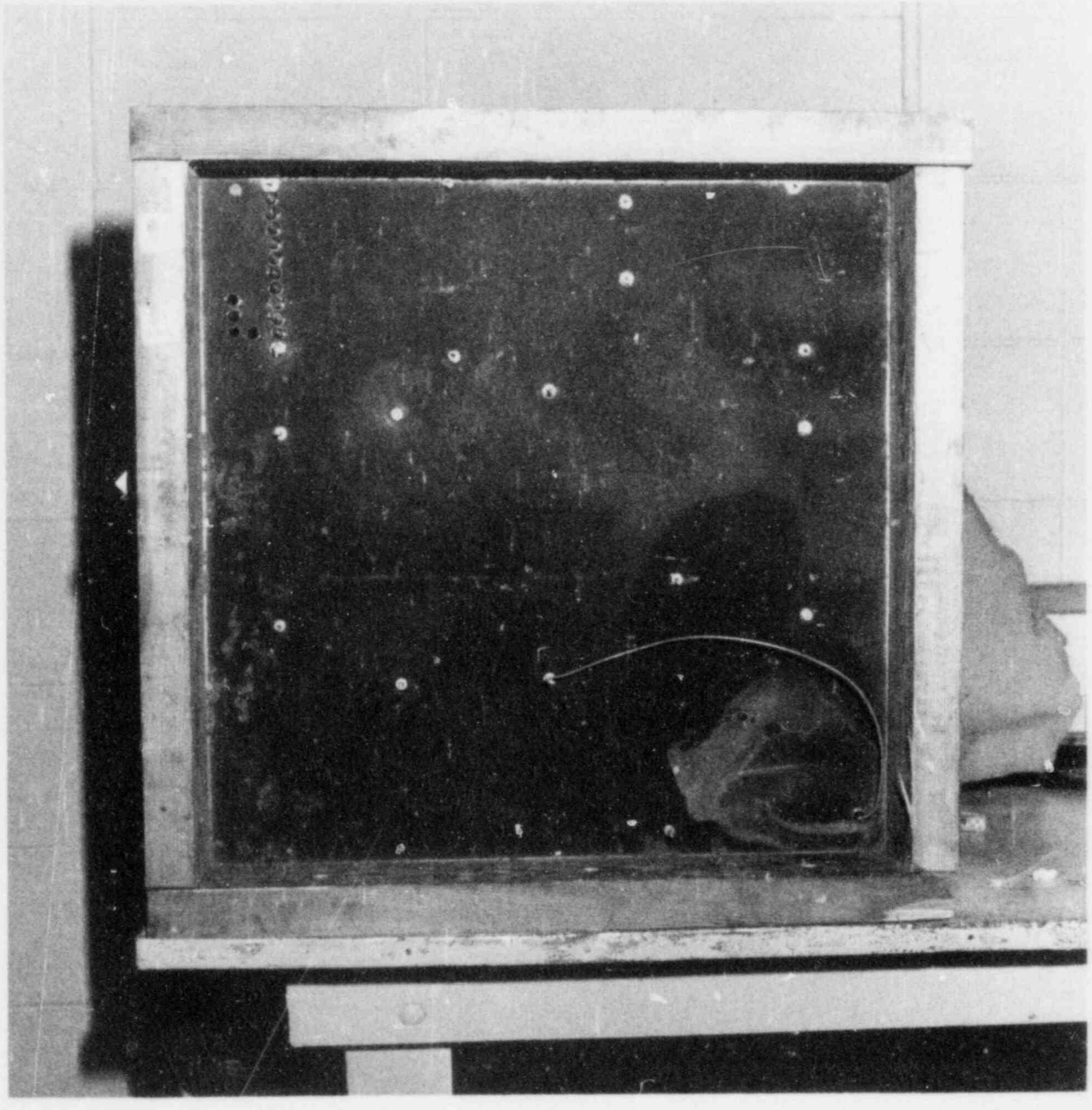
PHOTOGRAPH I-4

CLOSEUP VIEW OF 12 KW RESISTIVE LOAD CONNECTED TO POINT 1 ON TERMINAL BLOCK DURING OVERCURRENT TEST



PHOTOGRAPH I-5

POST-TEST VIEW OF SPECIMEN MOUNTING (FRONT) ON A 24" BY 18" BY 1/8" STEEL SHEET PLATE



PHOTOGRAPH I-6

**POST-TEST VIEW OF SPECIMEN MOUNTING (REAR)
ON A 24" BY 18" BY 1/8" STEEL SHEET PLATE
(Note Mounting of Item 4.0 in Upper Left Corner of Plate.)**

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APPENDIX II

DATA SHEETS
AND
INSTRUMENTATION EQUIPMENT SHEET

DATA SHEET

Customer PECO
Specimen Terminal Blocks
Part No. Various
Spec. WLTP 46960-2
Para. 3.2.3
S/N N/A
GSI N/A

Amb. Temp. 43°F
Photo YES
Test Med. Air
Specimen Temp. Ambient

WYLE LABORATORIES
Job No. 46960
Report No. 46960-4
Start Date 30 Nov 83

Test Title BASELINE Functional Test

Insulation Resistance Test

Acceptance Criterion: Measured insulation resistance shall be greater tha 1.6×10^6 Ohms with 500 VDC applied for 60 seconds.

Item No.	Part No.	Test Points			
1.0	GE CR151D70110	1 to GND	7.6×10^9 Ω		
		5 to Gnd	7.2×10^9 Ω		
2.0	GE CR151B6	1 to GND	4.0×10^{10} Ω		
		5 to GND	4.5×10^{10} Ω		
3.0	GE CR151A2	1 to GND	NOT INSTALLED		
		5 to GND			
4.0	GE PPD 137C6387P010	1 to GND	2.5×10^9 Ω		
		5 to GND	4.5×10^8 Ω		
5.0	Marathon 1600	1 to GND	2.5×10^9 Ω		
		5 to GND	4.0×10^9 Ω		
6.0	C.H. C381ST	1 to GND	2.5×10^{11} Ω		
		5 to GND	$>5.0 \times 10^{11}$ Ω		BUCHANON NQB (MEDIUM DUTY)
~~7.0~~ 7.1	Buchanan NQB (HEAVY DUTY)	1 to GND	3.5×10^{10} Ω	7.2	1.3×10^{10} Ω
		5 to GND	6.2×10^{10} Ω	7.2	3.5×10^{10} Ω
8.0	Weidmuller SAK-4	1 to GND	4.0×10^{11} Ω		
		5 to GND	$>5.0 \times 10^{11}$ Ω		

Specimen Failed
Specimen Passed ✓ N/A
NOA Written

Tested By [signature] Date: 30 Nov 83
Witness J. Gyketta (PECO) Date: 11/30/83
Sheet No. 1 of 2
Approved [signature] 11/30/83

WH-614A

DATA SHEET

Customer PECO
Specimen Terminal Blocks
Part No. Various
Spec. WLTP 46960-2
Para. 3.2.3
S/N N/A
GSI N/A

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

WYLE LABORATORIES
Job No. 46960
Report No. 46960-4
Start Date 1/6/84

Test Title BABELING Functional Test

Insulation Resistance Test

Acceptance Criterion: Measured insulation resistance shall be greater than 1.6×10^6 Ohms with 500 VDC applied for 60 seconds.

Item No.	Part No.	Test Points	
1.0	GE CR151D70110	1 to GND	N/A
		5 to Gnd	N/A
2.0	GE CR151B6	1 to GND	N/A
		5 to GND	N/A
3.0	GE CR151A2	1 to GND	$1.6 \times 10^{11}\ \Omega$
		5 to GND	$8.8 \times 10^{10}\ \Omega$
4.0	GE PPD 137C6387P010	1 to GND	$4.5 \times 10^{11}\ \Omega$
		5 to GND	$4.5 \times 10^{11}\ \Omega$
5.0	Marathon 1600	1 to GND	N/A
		5 to GND	N/A
6.0	C.H. C381ST	1 to GND	N/A
		5 to GND	N/A
7.1	Buchanan NQB ~~(large)~~ (HEAVY DUTY)	1 to GND	N/A
		5 to GND	N/A
7.2	Buchanan NQB ~~(small)~~ (MEDIUM DUTY)	1 to GND	N/A
		5 to GND	N/A

Specimen Failed
Specimen Passed ✓
NOA Written N/A

Tested By B. Rachel Date: 1/6/84
Witness N/A Date:
Sheet No. 2 of 2
Approved J. Hazlett 1/6/84

WH-614A

DATA SHEET

Customer PECO
Specimen Terminal Blocks
Part No. Various
Spec. WLTP 46960-2
Para. 3.2.4
S/N N/A
GSI N/A

Amb. Temp. 43°F
Photo YES
Test Med. Air
Specimen Temp. Ambient

WYLE LABORATORIES

Job No. 46960
Report No. 46960-4
Start Date 11/30/83

Test Title Over-Current Test

Acceptance Criterion: (1) 10 Amp circuit must maintain continuity
(2) No ignition with 100 Amps for 20 minutes

Item No.	Part No.	10 AMP CIRCUIT V/I Before	10 AMP CIRCUIT V/I After	TIME TO IGNITION (If Applicable)
1.0	GE CR151D70110	382V/10.0A	382V/9.9A	NO IGNITION IN 1200.14 SEC
2.0	GE CR151B6	388V/10.03A	340V/10.06A	NO IGNITION IN 1200.97 SEC
3.0	GE CR151A2	NOT INSTALLED DUE TO MISSING RAIL		
4.0	GE PPD 137C6387P010	NOT TESTED DUE TO CONFIGURATION CHANGE		
5.0	Marathon 1600	380V/10.0A	380V/9.9A	NO IGNITION IN 1200.26 SEC
6.0	C.H. C381ST	393V/10.0A	359V/10.09A	NO IGNITION IN 1205.56 SEC
~~7.0~~ 7.1	Buchanan NQB ~~Large~~ HEAVY DUTY	389V/10.0A	342V/10.08A	NO IGNITION IN 1205.67 SEC
7.2	Buchanan NQB ~~Small~~ MEDIUM DUTY	384V/10.05A	386V/10.08A	NO IGNITION IN 1200.91 SEC
8.0	Weidmuller SAK-4	399V/10.04A	384V/10.08A	NO IGNITION IN 1200.53 SEC

Specimen Failed _____
Specimen Passed ✓
NOA Written N/A

Tested By [signature] Date: 12/2/83
Witness J. GYRATH (PECO) Date: 12/2/83
Sheet No. 1 of 2
Approved [signature] 12/2/83

WH-614A

DATA SHEET

Customer PECO
Specimen Terminal Blocks
Part No. Various
Spec. WLTP 46960-2
Para. 3.2.4
S/N N/A
GSI N/A

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

WYLE LABORATORIES

Job No. 46960
Report No. 46960-4
Start Date 1/6/84

Test Title Over-Current Test

Acceptance Criterion: (1) 10 Amp circuit must maintain continuity
(2) No ignition with 100 Amps for 20 minutes

Item No.	Part No.	10 AMP CIRCUIT V/I Before	10 AMP CIRCUIT V/I After	TIME TO IGNITION (If Applicable)
1.0	GE CR151D70110	N/A		
2.0	GE CR151B6	N/A		
3.0	GE CR151A2	495V/10.03A	495V/9.99A	No IGNITION AFTER 1200.22 sec
4.0	GE PPD 137C6387P010	498V/10.05A	498V/10.03A	No IGNITION AFTER 1200.01 sec
5.0	Marathon 1600	N/A		
6.0	C.H. C381ST	N/A		
7.0	Buchanan NQB	N/A		
8.0	Weidmuller SAK-4	N/A		

Specimen Failed
Specimen Passed ✓
NOA Written N/A

Tested By B. Rochael Date: 1/6/84
Witness N/A Date:
Sheet No. 2 of 2
Approved J Hazlett 1/6/84

WH-614A

DATA SHEET

Customer PECO
Specimen Terminal Blocks
Part No. Various
Spec. WLTP 46960-2
Para. 3.2.5.2
S/N N/A
GSI N/A

Amb. Temp. 46°F
Photo YES
Test Med. Air
Specimen Temp. Ambient

WYLE LABORATORIES

Job No. 46960
Report No. 46960-4
Start Date 02 DEC 83

Test Title POST-TEST ~~PRE~~ Voltage Breakdown Test

Acceptance Criterion: There shall be no evidence of breakdown or flashover with an applied potential of 600 VAC for 60 seconds.

Item No.	Part No.	Test Points	Breakdown Volt.	Leakage Current
1.0	GE CR151D70110	1 to GND	N/A	17 μa
		5 to GND	74000 VAC	140 μa
2.0	GE CR151B6	1 to GND	N/A	15 μa
		5 to GND	74000 VAC	125 μa
3.0	GE CR151A2	1 to GND	NOT INSTALLED	
		5 to GND	" "	
4.0	GE PPD 137C638P010	1 to GND	NOT TESTED	
		5 to GND	" "	
5.0	Marathon 1600	1 to GND	N/A	19 μa
		5 to GND	74000 VAC	135 μa
6.0	C.H. C381ST	1 to GND	N/A	16 μa
		5 to GND	74000 VAC	115 μa
~~7.0~~ 7.1	Buchanan NQB (HEAVY DUTY)	1 to GND	N/A	18 μa
		5 to GND	74000 VAC	130 μa
8.0	Weidmuller SAK-4	1 to GND	N/A	19 μa
		5 to GND	74000 VAC	160 μa
7.2	BUCHANAN NQB (MEDIUM DUTY)	1-GND	N/A	19 μa
		5-GND	74000 VAC	160 μa

Specimen Failed
Specimen Passed ✓
NOA Written N/A

Tested By [signature] Date: 2 DEC 83
Witness J. GYNETH (PECO) Date: 12/2/83
Sheet No. 1 of 2
Approved [signature] 12/2/83

DATA SHEET

Customer PECO
Specimen Terminal Blocks
Part No. Various
Spec. WLTP 46960-2
Para. 3.2.5.2
S/N N/A
GSI N/A

Amb. Temp. 70°F
Photo VIS
Test Med. Air
Specimen Temp. Ambient

WYLE LABORATORIES
Job No. 46960
Report No. 46960-4
Start Date 1-6-97

Test Title ~~Post-~~ Test Voltage Breakdown Test

Acceptance Criterion: There shall be no evidence of breakdown or flashover with an applied potential of 600 VAC for 60 seconds.

Item No.	Part No.	Test Points	Breakdown Volt.	Leakage Current
1.0	GE CR151D70110	1 to GND	N/A	
		5 to GND	N/A	
2.0	GE CR151B6	1 to GND	N/A	
		5 to GND	N/A	
3.0	GE CR151A2	1 to GND	N/A	22 µa
		5 to GND	> 7000 VAC	170 µa
4.0	GE PPD 137C638P010	1 to GND	N/A	23 µa
		5 to GND	> 7000 VAC	160 µa
5.0	Marathon 1600	1 to GND	N/A	
		5 to GND	N/A	
6.0	C.H. C381ST	1 to GND	N/A	
		5 to GND	N/A	
7.1	Buchanan NQB ~~(large)~~ (HEAVY DUTY)	1 to GND	N/A	
		5 to GND	N/A	
7.2	Buchanan NQB ~~(small)~~ (MEDIUM DUTY)	1 to GND	N/A	
		5 to GND	N/A	
8.0	Weidmuller SAK-4	1 to GND	N/A	
		5 to GND	N/A	

Specimen Failed
Specimen Passed ✓
NOA Written N/A

Tested By B. Rachel Date: 1-6-97
Witness N/A Date: N/A
Sheet No. 2 of 2
Approved J. Hazelton 1-6-97

WH-614A

DATA SHEET

Customer PECO
Specimen Terminal Blocks
Part No. Various
Spec. WLTP 46960-2
Para. 3.2.3
S/N N/A
GSI N/A

Amb. Temp. 46°F
Photo YES
Test Med. Air
Specimen Temp. Ambient

WYLE LABORATORIES
Job No. 46960
Report No. 46960-4
Start Date 02 DEC 83

Test Title Post ~~TEST~~ Functional Test

Insulation Resistance Test

Acceptance Criterion: Measured insulation resistance shall be greater than 1.6 X 10^6 Ohms with 500 VDC applied for 60 seconds.

Item No.	Part No.	Test Points		
1.0	GE CR151D70110	1 to GND	3.5×10^9 Ω	
		5 to Gnd	1.2×10^{10} Ω	
2.0	GE CR151B6	1 to GND	4.5×10^9 Ω	
		5 to GND	6.2×10^9 Ω	
3.0	GE CR151A2	1 to GND	NOT INSTALLED	
		5 to GND	" "	
4.0	GE PPD 137C6387P010	1 to GND	NOT TESTED	
		5 to GND	" "	
5.0	Marathon 1600	1 to GND	1.3×10^8 Ω	
		5 to GND	3.0×10^9 Ω	
6.0	C.H. C381ST	1 to GND	750×10^{11} Ω	
		5 to GND	4.5×10^{10} Ω	BUCHANAN NQB (MEDIUM DUTY)
~~7.0~~ 7.1	Buchanan NQB (HEAVY DUTY)	1 to GND	3.5×10^{10} Ω	ITEM 7.2 5.0×10^{10} Ω
		5 to GND	4.0×10^{10} Ω	ITEM 7.2 1.7×10^{10} Ω
8.0	Weidmuller SAK-4	1 to GND	750×10^{11} Ω	
		5 to GND	750×10^{11} Ω	

Specimen Failed
Specimen Passed ✓
NOA Written N/A

Tested By [signature] Date: 2 Dec 83
Witness J. Gyrmth (PECO) Date: 12/2/83
Sheet No. 1 of 2
Approved [signature] 12/2/83

DATA SHEET

Customer PECO
Specimen Terminal Blocks
Part No. Various
Spec. WLTP 46960-2
Para. 3.2.3
S/N N/A
GSI N/A

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

WYLE LABORATORIES
Job No. 46960
Report No. 46960-4
Start Date 1/6/84

Test Title ~~Post~~ - TEST Functional Test

Insulation Resistance Test

Acceptance Criterion: Measured insulation resistance shall be greater than 1.6×10^6 Ohms with 500 VDC applied for 60 seconds.

Item No.	Part No.	Test Points	
1.0	GE CR151D70110	1 to GND	N/A
		5 to Gnd	N/A
2.0	GE CR151B6	1 to GND	N/A
		5 to GND	N/A
3.0	GE CR151A2	1 to GND	$4.5 \times 10^{11}\ \Omega$
		5 to GND	$5.0 \times 10^{11}\ \Omega$
4.0	GE PPD 137C6387P010	1 to GND	$2.0 \times 10^{11}\ \Omega$
		5 to GND	$7.0 \times 10^{10}\ \Omega$
5.0	Marathon 1600	1 to GND	N/A
		5 to GND	N/A
6.0	C.H. C381ST	1 to GND	N/A
		5 to GND	N/A
7.1	Buchanan NQB ~~(large)~~ (HEAVY DUTY)	1 to GND	N/A
		5 to GND	N/A
7.2	Buchanan NQB ~~(small)~~ (MEDIUM DUTY)	1 to GND	N/A
		5 to GND	N/A

Specimen Failed
Specimen Passed ✓
NOA Written N/A

Tested By B. Rochell Date: 1/6/84
Witness N/A Date:
Sheet No. 2 of 2
Approved J. Hazlett 1/6/84

WH-614A

INSTRUMENTATION EQUIPMENT SHEET

Date 1-6-84 Job No. 46960 Test Area Electronics Lab

Technician B. Bechtell Customer Peco Type Test Functional

No.	Instrument	Manufacturer	Model No.	Serial No.	Wyle or Gov't No.	Range	Accuracy	Calibration On	Calibration Due
1	Multimeter	Keithley	130A	N/A	100863	Multi.	Mfg	12-14-83	6-14-84
2	Power Supply	Fluke	38.2A	N/A	11560	Multi.	Mfg	9-15-83	3-15-84
3	Power Supply	Harrison	520A	N/A	100805	Multi.	Mfg	8-12-83	2-12-84
4	Hypot	Asso. Research	04030A	N/A	100165	Multi.	Mfg	10-26-83	4-26-84
5	Power Supply	Sorensen	DCR150	N/A	0862	Multi.	1%A±1%	2-23-83	1-23-84
6	Multimeter	Keithley	130	N/A	101029	Multi.	Mfg	12-13-83	6-13-84
7	Current Probe	Fluke	Y8100	N/A	94969	DC 200A	± 2%	12-9-83	6-9-84
8	Current Source	Digitec	3110	N/A	65112	0-100mA	± .01%	9-8-83	3-8-84
9	Multimeter	Hewlett Packard	3465A	N/A	11184	Multi	Mfg	8-12-83	2-12-84
10	Counter	Data Precision	5470	N/A	92484	Multi	Mfg	8-15-83	2-15-84
	Wyle A	1-11-84							

Instrumentation hm Lee 1-9-84 Wyle A 1-11-84 Checked & Received By J Hazeltine 1/9/84

WH 1029 Rev A 11/82

SECTION II

TEST PROGRAM — PANEL METERS

1.0 REQUIREMENTS

1.1 Acceptance Criteria

1.1.1 Operability Test (GE Model 180 Target Panel Meter ONLY)

The "target" General Electric Model 180 Panel Meter shall indicate 50% ±5% full scale with a 12.0 mA ±0.6 mA DC input applied during the overcurrent test.

2.0 PROCEDURES

2.1 Test Specimen Identification

An inspection was performed upon receipt of the test specimen components at Wyle Laboratories.

The manufacturer, model, and part numbers were found to be:

Item No.	Description
9.0	General Electric Model 180 Edgewise Panel Meter (#1)
10.0	General Electric Model 180 Edgewise Panel Meter (#2)
11.0	General Electric Model 180 Edgewise Panel Meter (#3)

2.2 Test Specimen Preparation

1. The two General Electric Model 180 Edgewise Panel Meters were taped together using a single wrap of 3M Number 69 glass tape such that the meters were in contact with each other.

2. The two meters were mounted in an instrumentation rack which simulated in-plant mounting.

2.0 PROCEDURES (Continued)

2.3 Baseline Functional Test

2.3.1 Accuracy Test

1. The following input currents were applied to Panel Meter #1:

Input Currrent (mA)	% Full Scale
4	I_{X1} = 0%
8	I_{X2} = 25%
12	I_{X3} = 50%
16	I_{X4} = 75%
20	I_{X5} = 100%

2. The meter indications were recorded.

3. The meter accuracy was defined as:

$$\text{Accuracy} = \frac{Ixn - Imeter}{I_{X5} - I_{X1}} \times 100\%$$

where Ixn = % full scale reading from table above

Imeter = indicated % full scale reading

4. The meter accuracy of 0%, 25%, 50%, 75% and 100% input current was computed and recorded.

2.4 Overcurrent/Overvoltage Test

1. A 12.0 mA $\pm$0.6 mA DC signal was applied to Panel Meter #1 (target meter).

2. The meter reading was recorded.

3. The input leads to Panel Meter #2 (fault meter) were shorted together.

4. A 600 VAC/1 Ø/60 Hz voltage was applied between the shorted Panel Meter #2 leads and the cabinet for a period of five minutes.

5. The reading on Panel Meter #1 was recorded.

6. A 200 mA DC current (10 times maximum input) at 2 VDC was applied to Panel Meter #2 for greater than 15 minutes. The output of Panel Meter #1 was monitored during the time this signal was applied.

2.0 PROCEDURES (Continued)

2.4 Overcurrent/Overvoltage Test (Continued)

7. The reading of Panel Meter #1 was recorded.

8. A 2 ampere current (100 times maximum input) at 20 VDC was applied to Panel Meter #2 until the meter's internal shunt open circuited. The output of Panel Meter #1 was monitored during the time this signal was applied.

9. The reading on Panel Meter #1 was recorded.

10. A 125 VDC voltage was applied to Panel Meter #2 until the meter's coil open circuited. The output of Panel Meter #1 was monitored during the time this signal was applied.

11. The reading on Panel Meter #1 was recorded.

12. Panel Meter #2 was replaced with a new GE Model 180 Edgewise Panel Meter.

13. A 5 ampere current (250 times the maximum input) at 50 VDC was applied to Panel Meter #3 until the meter's internal shunt open circuited. The output of Panel Meter #1 was monitored during the time this signal was applied.

14. The reading on Panel Meter #1 was recorded.

15. A 600 VAC/1Ø/60 Hz voltage was applied across the input leads of Panel Meter #3 until the meter's coil open circuited. The output of Panel Meter #1 was monitored during the time this signal was applied.

16. The reading on Panel Meter #1 was recorded.

17. Panel Meter #1 was de-energized.

18. Panel Meters #2 and #3 were disassembled and the internal damage photographed (see Photographs II-2 and II-3).

3.0 RESULTS

There was no evidence of any effect on Panel Meter #1 when the various overcurrent and overvoltage signals were applied to Panel Meters #2 and #3. Panel Meter #1 successfully met the acceptance criteria of Paragraph 1.1.1 when subjected to the overcurrent/overvoltage tests of Paragraph 2.4. It is therefore concluded that adequate physical and electrical separation exists when two GE Model 180 Edgewise Panel Meters are mounted in contact with each other during the application of any credible electrical fault at the Limerick Generating Station, Units 1 and 2.

3.0 RESULTS (Continued)

The following table lists the effects of the applied signals to Panel Meters #2 and #3:

Signal Applied	Effect on Target Meter (#1)	Effect on Faulted Meter (#2 or #3)
600 VAC from shorted leads to cabinet	None	No damage.
200 mA at 2 VDC	None	No damage (meter's internal 1/4 watt, 10 ohm resistor held current).
2 amperes at 20 VDC	None	Meter's shunt opened in less than 1 second.
125 VDC	None	Meter's coil opened with a small arc instantaneously.
5 amperes at 50 VDC	None	Meter's shunt opened in less than 1 second.
600 VAC across input leads	None	Meter's coil opened with a small arc instantaneously.

Figure II-1, which shows the internal circuitry to the GE Model 180 Edgewise Panel Meter, is presented in Appendix I of this section.

Photographs II-1 through II-3 are presented in Appendix II of this section. Photograph II-1 shows the test setup for the 600 VAC overvoltage test on Panel Meter #3. Photographs II-2 and II-3 show the internal damage to Panel Meters #2 and #3, respectively.

Data Sheets from the functional tests and the overcurrent/overvoltage tests are presented in Appendix III of this section.

The instrumentation utilized in these tests is contained on the Instrumentation Equipment Sheet in Appendix II of Section I.

APPENDIX I

INTERNAL METER CIRCUITRY

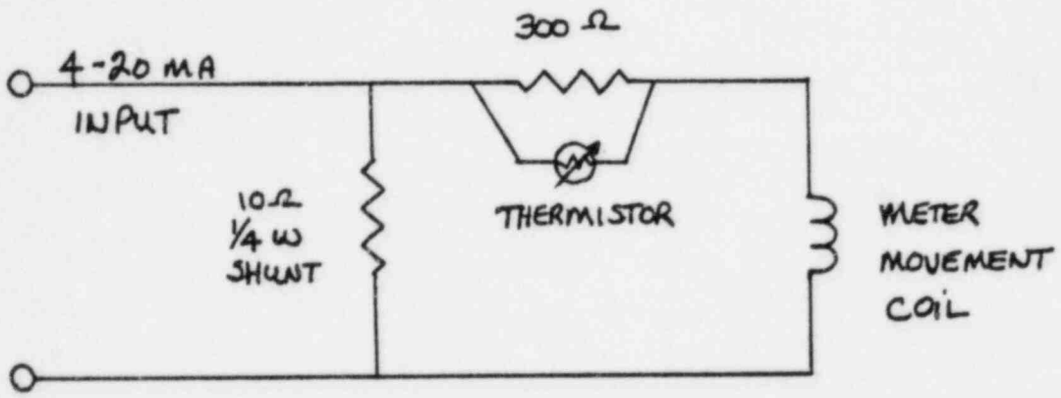
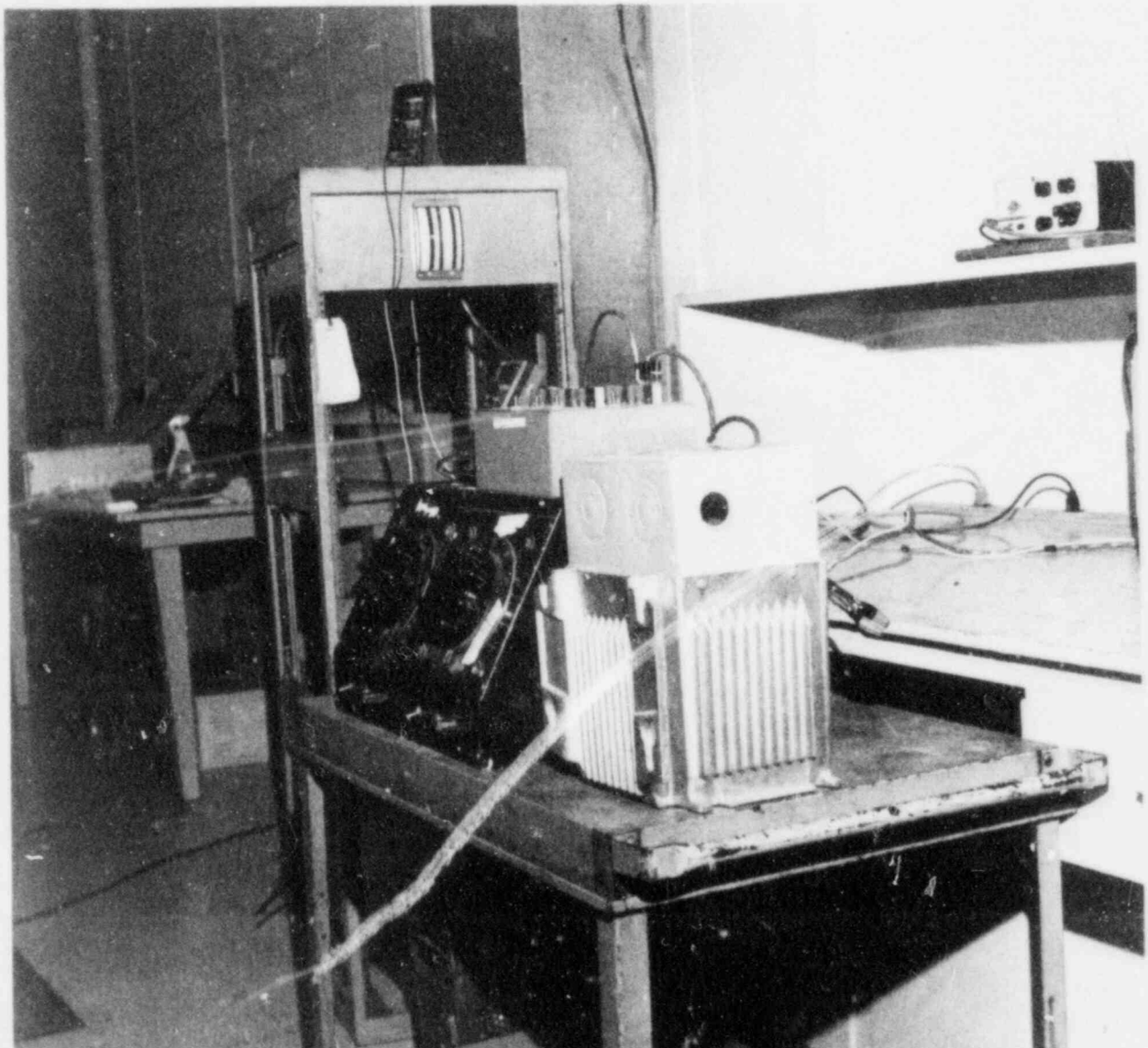


FIGURE II-1. INTERNAL CIRCUITRY TO
GE MODEL 180 EDGEWISE PANEL METER

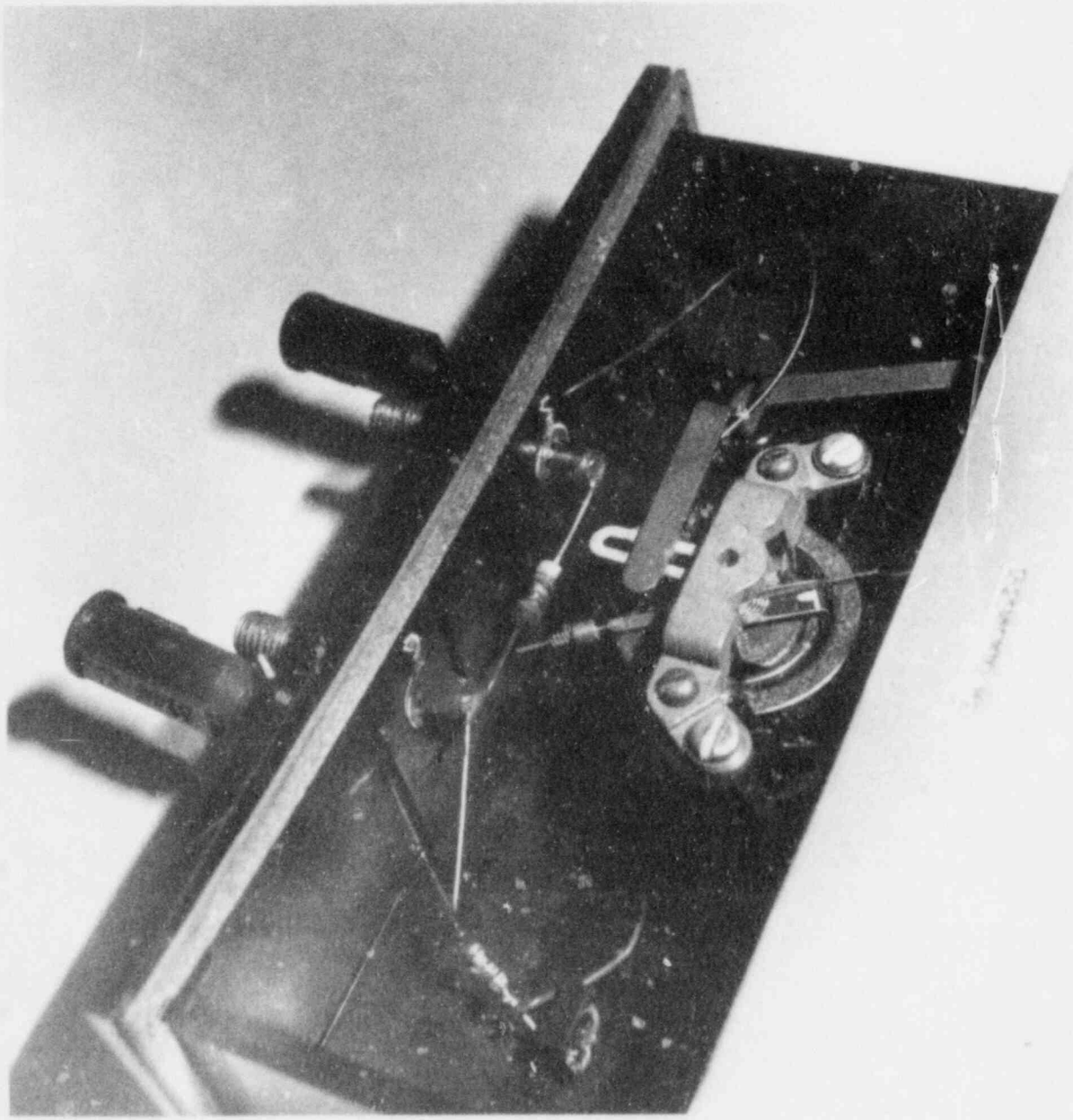
APPENDIX II

PHOTOGRAPHS



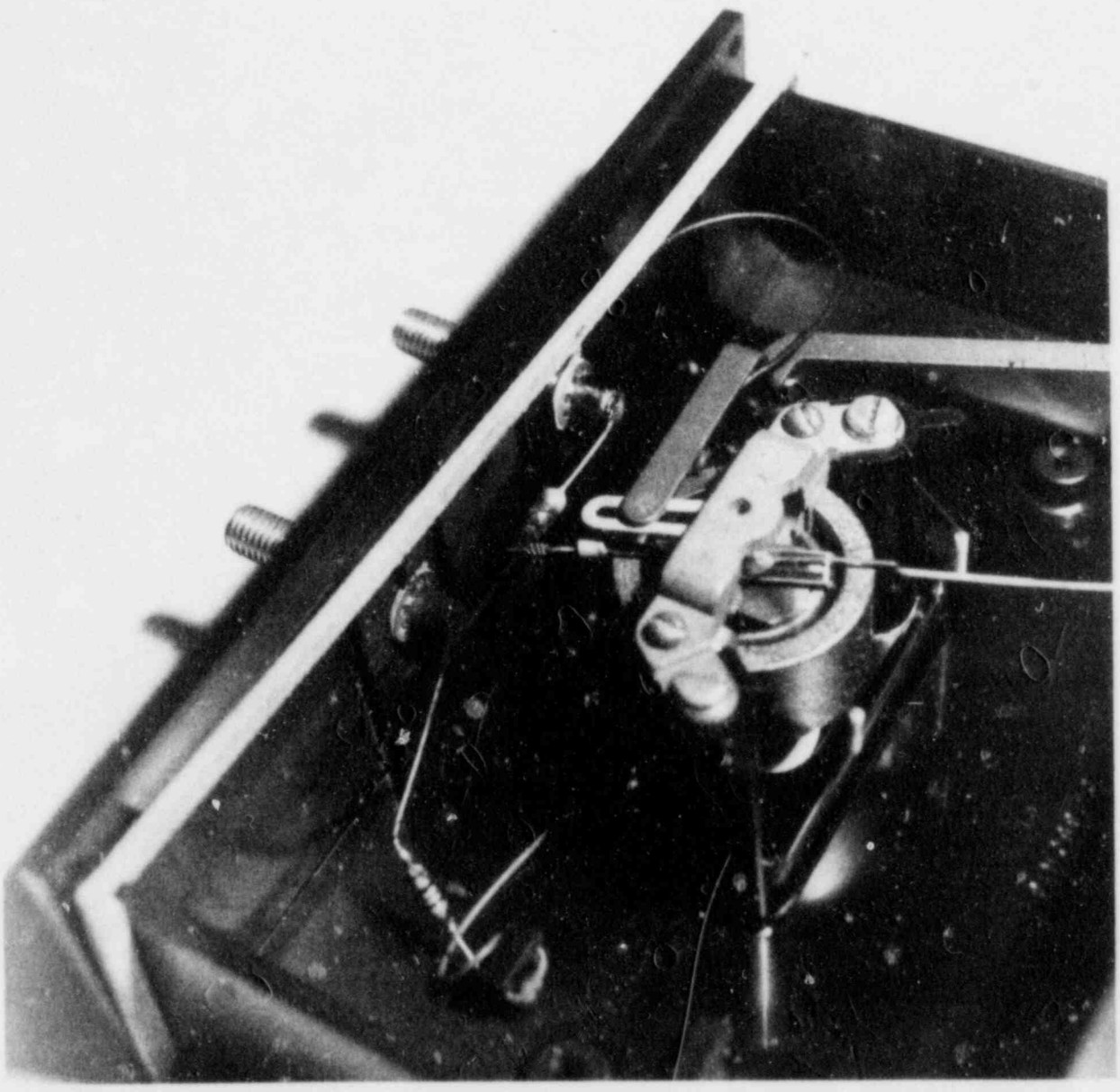
PHOTOGRAPH II-1

OVERCURRENT/OVERVOLTAGE TEST SETUP FOR GE MODEL 180 EDGEWISE PANEL METER



PHOTOGRAPH II-2

INTERNAL VIEW OF DAMAGE TO SHUNT RESISTOR OF PANEL METER #2



PHOTOGRAPH II-3

INTERNAL VIEW OF DAMAGE TO SHUNT RESISTOR OF PANEL METER #3

APPENDIX III

DATA SHEETS

DATA SHEET

Customer PECO
Specimen Panel Meter
Part No. GE Model 180
Spec. WLTP 46960-2
Para. 3.3.3
S/N N/A
GSI N/A

Amb. Temp. [illegible]
Photo [illegible]
Test Med. Air
Specimen Temp. Ambient

WYLE LABORATORIES
Job No. 46960
Report No. 46960-4
Start Date [illegible]

Test Title PRE-TEST Functional Test

Accuracy Test

Acceptance Criterion: Data taken for information only.

Input Current	Meter Reading	Accuracy*
4 mA	[illegible]	[illegible]
8 mA	[illegible]	[illegible]
12 mA	[illegible]	[illegible]
16 mA	[illegible]	[illegible]
20 mA	[illegible]	[illegible]

*Accuracy = $\frac{I_{xn} - I_{meter}}{I_{x6} - I_{x1}} \times 100\%$

Specimen Failed
Specimen Passed
NOA Written

Tested By B. Locher Date: [illegible]
Witness N/A Date:
Sheet No. 1 of 1
Approved J. Hazelton 1/9/84

WH-614A

DATA SHEET

Customer: PECO
Specimen: Panel Meters
Part No.: GE Model 180
Spec.: WLQP 46960-2
Para.: 3.3.4
S/N: N/A
GSI: N/A

Amb. Temp.: 70°F
Photo: YES
Test Med.: Air
Specimen Temp.: Ambient

WYLE LABORATORIES

Job No.: 46960
Report No.: 46960-4
Start Date: 1/9/84

Test Title: OVERCURRENT/OVERVOLTAGE TEST

ACCEPTANCE CRITERION: The "target" General Electric Model 180 Panel Meter shall read 50% ±5% of full scale with a 12 ±0.6 mA input during the overcurrent/overvoltage test.

Signal Applied to Panel Meter #2	Panel Meter #1 Reading	Damage to Panel Meter #2
600 VAC from shorted leads to cabinet	50% (NO CHANGE)	NONE
200 mA @ 2 VDC	50% (NO change)	None (meter pegged high) *
2000 mA @ 20 VDC	50% (NO CHANGE)	Meter's shunt opened in ≤ 1 second
125 VDC	50% (NO CHANGE)	SMALL ARC visible as meter's coil opened instantaneously

* Meter conducted the 200 m Amps for 1011.45 seconds THE 200 m Amps WAS removed at this time since there was no apparent damage occurring.

Tested By: E. Rachell Date: 1/9/84
Witness: N/A Date:
Sheet No.: 1 of 2
Approved: J Hazelton 1/9/84

Notice of Anomaly: N/A

DATA SHEET

WYLE LABORATORIES

Customer PECO
Specimen Panel Meters
Part No. GE Model 180
Spec. WLTP 46960-2
Para. 3.3.4
S/N N/A
GSI N/A

Amb. Temp. 70°F
Photo yes
Test Med. Air
Specimen Temp. Ambient

Job No. 46960
Report No. 46960-4
Start Date 1/9/84

Test Title OVERCURRENT/OVERVOLTAGE TEST (Continued)

Signal Applied to Panel Meter #3	Panel Meter #1 Reading	Damage to Panel Meter #3
5000 mA @	50%	Meter's shunt opened
50 VDC	(no change)	in < 1 second
600 VAC across	50%	Small arc visible
Input Leads	(no change)	as meter's coil
		open instantaneously

Tested By B Fischer Date: 1/9/84
Witness N/A Date:
Sheet No. 2 of 2
Approved J Hazeltine 1/9/84

Notice of Anomaly N/A

DATA SHEET

Customer PECO
Specimen Panel Meter
Part No. GE Model 180
Spec. WLTP 46960-2
Para. 3.3.3
S/N N/A
GSI N/A

Amb. Temp. 70°F
Photo Yes
Test Med. Air
Specimen Temp. Ambient

WYLE LABORATORIES

Job No. 46960
Report No. 46960-4
Start Date 1/10/94

Test Title Post TEST Functional Test

Accuracy Test

Acceptance Criterion: Data taken for information only.

Input Current	Meter Reading	Accuracy*
4 mA	5%	5%
8 mA	25%	0%
12 mA	50%	0%
16 mA	75%	0%
20 mA	105%	5%

*Accuracy = $\frac{I_{xn} - I_{meter}}{I_{x6} - I_{x1}} \times 100\%$

Specimen Failed
Specimen Passed ✓
NOA Written

Tested By B. Rochau Date: 1-10-94
Witness N/A Date:
Sheet No. 1 of 1
Approved J. Hazle 1/10/94

WH-614A

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TEST PROCEDURE

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

TEST PROCEDURE NO. 46960-2

DATE: November 1, 1983

REVISION A - 1/12/84

ELECTRICAL SEPARATION VERIFICATION TESTING
ON
TERMINAL BLOCKS AND PANEL METERS
FOR THE
PHILADELPHIA ELECTRIC COMPANY
LIMERICK GENERATING STATION
UNITS 1 AND 2

APPROVED BY
PROJECT MANAGER: J. R. Johnson 11/1/83
J. R. Johnson

APPROVED BY
QUALITY ENGINEER: W. B. Roberts 11/1/83
W. B. Roberts

PREPARED BY
PROJECT ENGINEER: J. Hazeltine 10/31/83
J. Hazeltine

REVISIONS

(DN259/gsp) FORM 1054-1 Rev. 4/74

REV. NO.	DATE	PAGES AFFECTED	BY	APP'L.	DESCRIPTION OF CHANGES
A	1/14/84	3, 5, 7, 8	JTH		Revised in accordance with Interim
			5/14/84	5/16/84 5/16/84	Procedure Revision IR-1 of 11/9/83.

TABLE OF CONTENTS

1.0 SCOPE

This document has been prepared by Wyle Laboratories for the Philadelphia Electric Company (PECO) and encompasses the testing of the physical separation, with respect to electrical faults, between redundant Class 1E systems and between Class 1E and nonClass 1E electrical systems in representative configurations at the Limerick Generating Station, Units 1 and 2. This document details follow-on testing of internal panel control wiring and is an appendix to the Design Verification Test Report, Internal Panel Control Wiring Separation Criteria, Philadelphia Electric Company Report No. 48503 dated September 1, 1982.

1.1 Objectives

The purpose of this procedure is to present the requirements, procedures, and sequence to test the design adequacy of worst case configurations in the following situations:

- o Terminal Block to Terminal Block Separation (see Figure 1)
- o Panel Mounted Meter to Panel Mounted Meter Separation (see Figure 2)

1.2 Applicable Documents

- o Wyle Laboratories' Quotation 543/0752/WB to Philadelphia Electric Company, dated June 29, 1983.
- o IEEE Standard 384-1981, "IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits."
- o Philadelphia Electric Company Report Number 48503, "Design Verification Test Report, Internal Panel Control Wiring Separation Criteria," dated September 1, 1982.

1.3 Equipment Description

This test procedure encompasses the testing of terminal blocks and panel meters as described below:

Item No.	Description
1.0	General Electric CR151D70110 Twelve Point Terminal Block
2.0	General Electric CR151B6 Six Point Terminal Block
3.0	General Electric CR151A2 Terminal Block
4.0	Kulka Ten Point Terminal Block (GE PPD #137C6387P010)
5.0	Marathon 1600 8-Point Terminal Block
6.0	Cutler Hammer C381ST Terminal Block
7.0	Buchanan NQB Terminal Block
8.0	Weidmuller SAK 4 Terminal Block
9.0	General Electric Model 180 Edgewise Panel Meter (2)

1.0 SCOPE

1.4 Test Sequence

This test program shall be performed in the following sequence:

- o Test Specimen Identification
- o Terminal Block Separation Tests
- o GE Model 180 Panel Meter Separation Test

2.0 TEST REQUIREMENTS

2.1 Acceptance Criteria

2.1.1 Insulation Resistance Test

Measured insulation resistance shall be greater than 1.6×10^6 ohms with an applied potential of 500 VDC for 60 seconds.

2.1.2 Terminal Block Overcurrent Test

- Terminal block ignition shall not occur with 100 amperes applied for 20 minutes.
- Adjacent terminal circuit continuity shall be maintained throughout the overcurrent test.
- There shall be no evidence of breakdown or flashover with a potential of 600 VAC applied for 60 seconds from the adjacent target terminal to ground.

2.1.3 Operability Test (GE Model 180 Panel Meter ONLY)

The "target" General Electric Model 180 Panel Meter shall indicate 50% ±5% full scale with a 12.0 mA ±0.6 mA DC input applied during the overcurrent test. A

3.0 TEST PROGRAM

3.1 Test Specimen Identification

An inspection shall be performed upon receipt of the test specimen components at Wyle Laboratories. This inspection will assure that the test specimens are as described in Paragraph 1.3. Applicable manufacturer, model, part and serial numbers shall be verified and recorded. The test specimens shall be labeled to facilitate identification throughout the test program.

3.2 Terminal Block Separation Tests

3.2.1 Purpose

The purposes of the terminal block separation tests are to: 1) prove that a fault on any terminal point on a terminal block will not adversely affect the circuitry connected to an adjacent point on that terminal block and 2) determine the breakdown voltage level across two (2) adjacent terminal points on representative terminal blocks used in the construction of the Limerick Generating Station, Units 1 and 2.

3.2.2 Test Specimen Preparation

The eight (8) PECO-supplied terminal blocks shall be prepared using the following procedure:

1. Manufacture a 24" by 18" steel plate attached to a 24" by 18" wooden frame.

2. Mount the following terminal blocks on the steel plate with the terminal points running vertically (allow a minimum of four (4) inches of clearance around each terminal block):

   Item 1.0 General Electric CR151D70110 12-point terminal block

   Item 2.0 General Electric CR151B6 6-point terminal block

   Item 3.0 General Electric CR151A2 terminal block (rail mounted)

   Item 4.0 Kulka 10-point terminal block (GE PPD #137C6387P010)

   Item 5.0 Marathon 1600 8-point terminal block

   Item 6.0 Cutler Hammer C381ST terminal block (rail mounted)

   Item 7.0 Buchanan NQB terminal block (rail mounted)

   Item 8.0 Weidmuller SAK-4 terminal block (rail mounted)

3. Mount the 24" by 18" test fixture vertically on a wooden test table.

3.0 TEST PROGRAM (CONTINUED)

3.2.2 Test Specimen Preparation (Continued)

4. Ground the steel plate.

5. Photograph the test setup.

3.2.3 Baseline Functional Tests

3.2.3.1 Insulation Resistance Tests

1. Connect a jumper from Point 2 of Item 1.0 to the mounting plate.

2. Using a megohmmeter, apply a potential of 500 VDC and record the minimum insulation resistance indicated over a period of 60 seconds between Point 1 and the mounting plate. A

3. Disconnect the jumper from Point 2 and attach it to Point 4 of Item 1.0.

4. Using a megohmmeter, apply a potential of 500 VDC and record the minimum insulation resistance indicated over a period of 60 seconds between Point 5 and the mounting plate. A

5. Disconnect the jumper from Point 4.

6. Repeat Steps 1 through 5 for Items 2.0 through 7.0.

For each performance of this test, the measured value shall be compared to the acceptance criterion, Paragraph 2.1.1, i.e., greater than 1.6×10^6 ohms.

3.2.4 Overcurrent Test

1. Connect 480 VAC/10 amperes/1 phase power to Point 1 of Item 1.0 per Figure 1.

2. Connect the Multi-Amp CB 8130 Test Set to Point 2 of Item 1.0 per Figure 1.

3. Adjust the Multi-Amp Test Set to supply 100 amperes through Point 2.

4. Allow the 100 amperes current to flow for twenty (20) minutes.

5. De-energize the Multi-Amp Test Set output and the 480 VAC power supply.

6. Record results of overcurrent test, particularly time of ignition, if applicable.

7. Repeat Steps 1 through 6 for Items 2.0 through 7.0.

3.0 TEST PROGRAM (CONTINUED)

3.2.5 Post-Overcurrent Test Functional Tests

3.2.5.1 Insulation Resistance Tests -- The insulation resistance tests of Paragraph 3.2.3.1 shall be repeated.

3.2.5.2 Voltage Breakdown Test

1. Connect a jumper from Point 4 to Item 1.0 to the mounting plate.

2. Using an AC Hi-Pot test assembly, connected to Point 5 of Item 1.0, increase voltage at a rate of approximately 100 volts per second until evidence of breakdown occurs or a voltage of 4,000 VAC is reached.

3. Record voltage level and leakage current at the point of breakdown.

4. Using an AC Hi-Pot Test Assembly, connected to Point 1 of Item 1.0, increase voltage to 600 VAC at a rate of 100 volts per second.

5. Maintain voltage at 600 VAC for a period of 60 seconds and record the maximum leakage current observed.

6. Repeat Steps 1 through 3 for Items 2.0 through 7.0.

For all performances of this test (Steps 4 and 5), the observed values shall be compared to the acceptance criterion, Paragraph 2.1.2, i.e., there shall be no evidence of insulation breakdown or flashover.

3.2.5.3 Photographs -- Photographs shall be taken of any noticable physical damage that might occur.

3.3 General Electric Model Edgewise 180 Panel Meter Separation Test

3.3.1 Purpose

The purpose of the GE Model 180 Edgewise Panel Meter Separation Test is to prove that an electrical fault in one GE Model 180 Edgewise Panel Meter will not adversely affect the operation of adjacent meters in contact with the faulted meter.

3.0 TEST PROGRAM (CONTINUED)

3.3.2 Test Specimen Preparation

1. The two (2) General Electric Model 180 Edgewise Panel Meters shall be taped together, using a single wrap of 3M Number 69 glass tape such that the meters are in contact with eacn other.

2. The two meters shall be mounted in an instrumentation rack which simulates in-plant mounting (see Figure 2).

3. Photograph the test setup.

3.3.3 Baseline Functional Test

3.3.3.1 Accuracy Test

1. Apply the following input currents to Panel Meter #1:

Input Current	% Full Scale
4 mA	I_{X1} = 0%
8	I_{X2} = 25%
12	I_{X3} = 50%
16	I_{X4} = 75%
20	I_{X5} = 100%

A

2. Record meter indications.

3. The meter accuracy shall be defined as:

$$\text{Accuracy} = \frac{Ixn - Imeter}{I_{X5} - I_{X1}} \times 100\%$$

where: Ixn = % full scale reading from table above

Imeter = indicated % full scale reading

4. Compute meter accuracy of 0%, 25%, 50%, 75%, and 100% input current.

3.0 TEST PROGRAM (CONTINUED)

3.3.4 Overcurrent/Overvoltage Test

1. Apply a 12.0 ±0.6 mA DC signal to Panel Meter #1. A
2. Record meter reading.
3. Apply a 600 VAC input to the two jumpered input leads of Meter #2 to ground.
4. Observe and record the reading of Panel Meter #1.
5. Apply a 5 ampere current to Panel Meter #2. Slowly increase the current until Meter #2 open circuits.
6. Observe and record the reading of Panel Meter #1.
7. Photograph the post-test damage to Panel Meters #1 and #2.

3.3.5 Post Overcurrent/Overvoltage Functional Test

The accuracy test of Paragraph 3.3.3.1 shall be repeated on Panel Meter #1.

3.4 Quality Assurance

All test equipment and instrumentation to be used in the performance of this test program will be calibrated in accordance with Wyle Laboratories' (Eastern Operations) Quality Assurance Program, which complies with the applicable portions of ANSI N45.2, 10 CFR 50, Appendix B, and Military Specification MIL-STD-45662. Standards used in performing all calibrations are traceable to the National Bureau of Standards.

3.7 Report

Ten (10) copies of the test report and one (1) reproducible copy shall be issued, describing the test requirements, procedures, and results. The report shall be prepared in accordance with the requirements of Section 8, Documentation, of IEEE Standard 323-1974, as applicable.

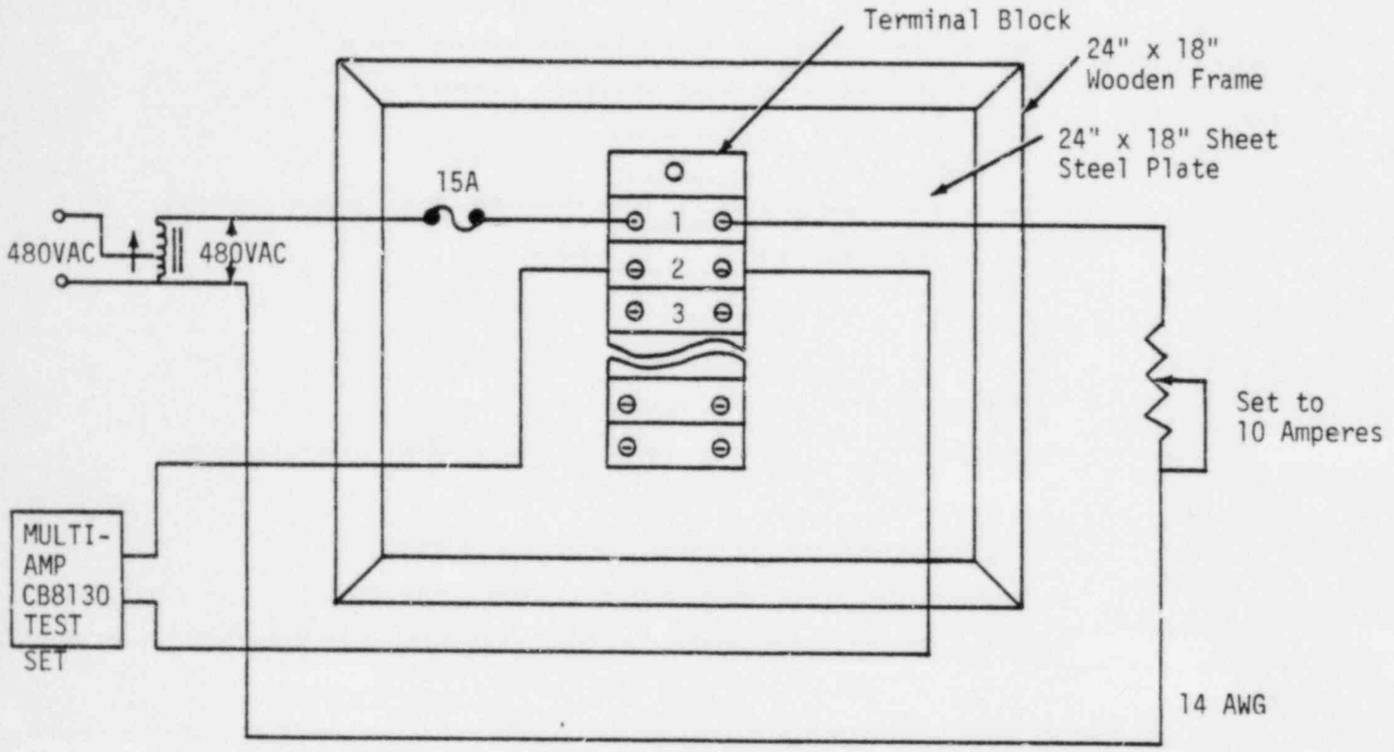

FIGURE 1. TYPICAL TEST SETUP FOR TERMINAL BLOCK SEPARATION TESTS

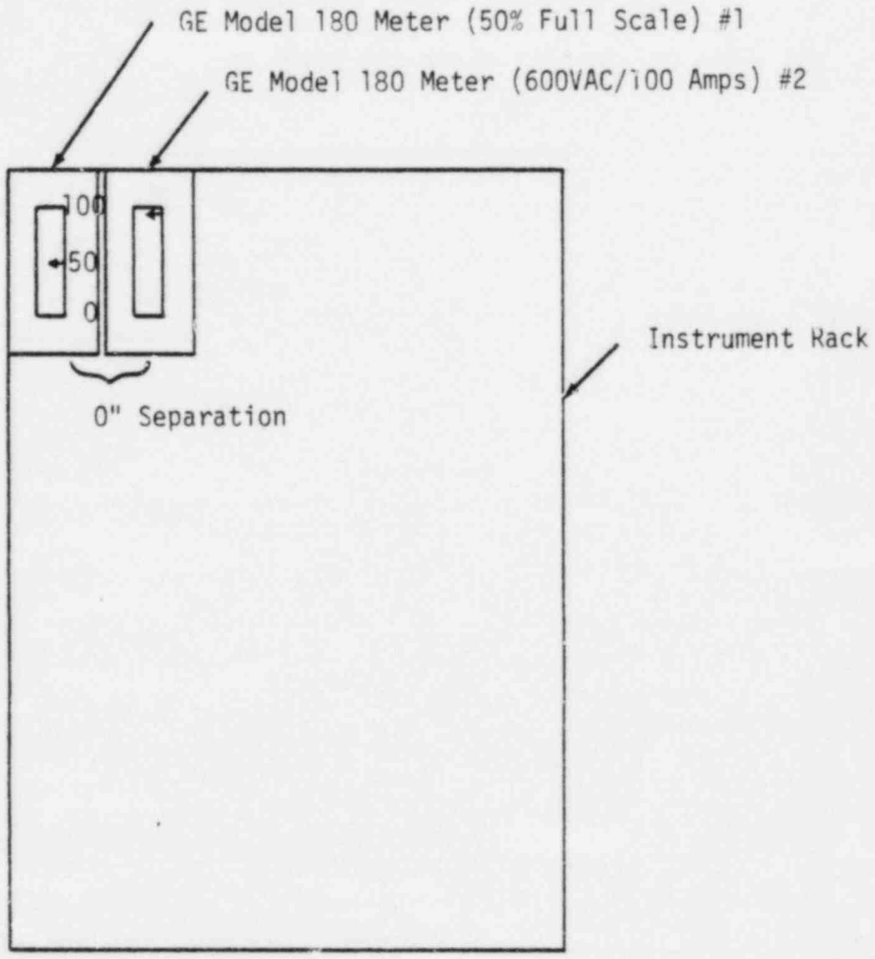

FIGURE 2. GE MODEL 180 EDGEWISE PANEL METER SEPARATION TEST SETUP