ATTACHMENT 4 TO AEP:NRC:0692DL

TEST REPORT CL-492
"AMPACITY TEST FOR POWER CABLES IN
RANDOMLY-FILLED TRAYS"

TEST REPORT
American Electric Power Service Corp.
Canton Laboratory
P.O. Box 487 Canton, Ohio 44701

Title: AMPACITY TEST FOR POWER CABLES IN RANDOMLY-FILLED TRAYS	Test No. CL-492 Date APRIL 5, 1983
Test By: G. W. SELLMEYER; J. P. McCALLIN Report By: J. P. McCALLIN Approved By: A. P. LITSKY	Made For: AEPSC-NEW YORK Sponsor: W. F. WILSON Test Completed: MARCH 15, 1983

I. INTRODUCTION

The results of this test will be used to determine requirements of Cook Plant modifications, along with trying to establish standards for de-rating of cables in trays. A conclusion will not be drawn as part of this report, but will be included in the sponsor's analyses of the data.

II. OBJECTIVE

The purpose of this test is to determine the ampacity of power cables in randomly-filled trays. The results should indicate the effect on cable ampacity by tray design (i.e. ventilated or solid), tray fill, cable size, and tray content, with and without a 3 M Company fire barrier envelope.

III. TEST METHOD

The generalized test procedure is as follows:

1.) Fill cable tray to specified tray fill.
2.) Attach thermocouples.
3.) Load cables to a specified amperage.
4.) Keeping ambient temperataure constant, increase current until conductor "hot spot" temperature is equal to the rated conductor temperature of 90°C.

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T. E. King	- New York

III. TEST METHOD (Cont'd.)

The detailed test procedure was as follows:

1. Equipment

1.1. Cable Tray and Cable Tray Cover

1.1.1. Cable tray and cable tray cover were AEP standard indoor, galvanized steel as follows:

B/M Item No.	Description
28-001	12" x 6" ventilated bottom tray
28-005	12" x 6" solid bottom tray
28-002	12" ventilated tray cover
28-006	12" solid tray cover.

1.1.2. A 12' tray and cover were cut to 8' to suit the test chamber, a minimum of 6' was required.

1.1.3. Tray cover was attached to the tray by means of ¼" hex washer head screw, item No. 28-525.

1.1.4. Cable tray ends were sealed during the test with thermal insulating material to prevent heat loss through these areas.

Note: This may have caused excessive heating of the cables passing through the thermal seal; therefore, temperature readings were taken a minimum of 1' from the thermal seal.

1.2 Fire Barrier Envelope and Support Structure.

1.2.1. Fire barrier envelope and Unistrut support structure were assembled as shown in the Appendix.

1.2.2. The ventilated fire barrier envelope top was made from the solid composite sheet with ¼" holes punched on 2" spacing.

1.2.3. The Unistrut support structure was sized for a minimum of air space between itself and the enclosed cable tray.

1.3. Cables

1.3.1. Cables were standard 600 V, copper triplexed, non-jacketed cable. Descriptions are in the Appendix.

1.3.2. Insulation was cross-linked polyethylene rated at 90°C.

III. TEST METHOD (Cont'd.)

1.3.3. Cable sizes used for testing were:

3TC #12 AWG
3TC #10 AWG
3TC #2/0 AWG
3TC 350 MCM
3TC 750 MCM.

1.3.4. The following data was recorded for each cable:

A) Manufacturer
B) Conductor diameter
C) Insulation thickness
D) Thermal resistivity of the insulation
E) dc resistance in Ω/ft.

1.4. Power Source, and Monitoring Equipment

1.4.1. Power sources and monitoring equipment are shown in Figure 1.

2. Test Setup

2.1 Cable Tray

2.1.1. Cable tray was supported 2½ feet above floor to allow for natural ventilation.

2.2. Cable

2.2.1. The cables were installed randomly in tray; spacing was not maintained.

2.2.2. The cable was "looped" through the tray to form the required number of cables within the tray.

2.2.3. The voltage and amperage of each "circuit" were monitored throughout the test.

2.3. Thermocouples

2.3.1. T-type thermocouples were used to measure temperatures of the following:

a) ambient air
b) tray outer surface (side and top)
c) air space in tray
d) conductors.

III. TEST METHOD (Cont'd.)

2.3.2. Thermocouples were installed against the insulation.

Note: Originally it was requested to measure the temperature on the conductor, but was determined to be faster and more accurate to measure at the insulation and add a correction factor.

2.3.3. Thermocouples were installed on the inward side of the conductors in a triplex arrangement as indicated in Figure 2.

2.3.4. Thermocouples were embedded in "Omegatherm 201 high thermal conductivity paste".

2.3.5. Thermocouples were installed on cables located in the center of the tray where:

1) heat generation is the greatest,
2) heat dissipation is the least (see Figure 3).

2.3.6. The minimum number of thermocouples used to measure conductor temperatures were as follows:

a) three for single cables in a tray
b) 1/3 times the number of circuits in the tray
c) two for each type of cable in the tray.

3. Procedure

3.1. Single Cables

3.1.1. For single cable tests, cable was energized to 90% of the rated ampacity as given in electrical plant design guideline 17.1 "Power Cable Sizing", Rev. 2, Jan. 17, 1978, originated by S. H. Zucker shown in the Appendix as Table No. 1.

3.1.2. Temperatures were allowed to stabilize. The "hot spot" temperature (hottest reading monitored) and the graph in Figure 4 determined the current which should heat the cable to its temperature rating. The current was raised to this determined value.

3.1.3. The temperature was allowed to stabilize around 90°C. Current, voltage, and temperature readings were recorded at 15-minute intervals during the entire test.

3.1. Multiple Like Cables

3.2.1. Cables were energized to 50% of the ampacity recorded in 3.1.3 above.

III. TEST METHOD (Cont'd.)

3.2.2. Procedures in steps 3.1.2. and 3.1.3. were then followed.

3.3. Cable Mixtures

3.3.1. Cables were energized to 75% of the ampacity recorded in 3.1.3. above.

3.3.2. Procedures in steps 3.1.2. and 3.1.3. were then followed.

3.4. Tests with Fire Barrier Envelope

3.4.1. Cables were energized to 50% of the ampacity recorded in 3.1.3. for ventilated tray -- ventilated cover.

3.4.2. Procedures in steps 3.1.2.and 3.1.3. were then followed.

4 Test Criteria

4.1. Data was recorded for temperature, current, and voltage.

4.2. Tests were done for the following tray installations:

a) ventilated tray, no cover
b) ventilated tray, ventilated cover
c) solid tray, solid cover
d) ventilated tray, no cover, solid fire barrier
e) ventilated tray, no cover, fire barrier with ventilated top.

IV. TEST RESULTS

The test results are tabulated on the data sheets. Thermocouple #4 is the ambient temperature and #5 is the air space inside the tray. Each thermocouple was attached to a 2" x 2" x ¼" copper piece to stabilize temperature readings. Thermocouples #6 and #7 measured the tray top and side respectively. Thermocouples #8-13 and 15 monitored the conductor temperatures.

All conductor readings on the data sheets were arrived at by taking the thermocouple reading on the insulation and adding a calculated correction factor as shown in Table #2.

On one test the thermocouples monitoring the tray top and tray side were found to be lifted the next morning. Both temperatures read near ambient, which probably shows they had lifted during the test, but were not noticed at the time.

IV. TEST RESULTS (Cont'd.)

On several other tests it is noted that the tray vibrated. The effect of this vibration on the test results has not yet been determined.

V. DISCUSSION

For future reference, the time involved per test once actual testing started was normally 7 hours, plus 1½ hour setup and teardown. Some tests ran longer. Tests with the fire barrier normally took 9 hours plus 1½ hour setup and teardown.

The single cable test with #12 wire was made with a different cable than used in the #12 multiple cable tests. The AEP M&E number was the same on both, but the single cable obtained from Ohio Power stock while waiting on the cable shipment to arrive from Rockport Plant did not have the teflon wrap between the conductor and the insulation like all other cables tested.

The fire barrier was assembled according to the 3 M Company directions except for one variation. Rather than screw the top on and off for each test, the top was attached with banding material. This method was approved by the 3 M Company representative, Jack Tuzinski, who was present for a portion of testing.

VI. APPENDIX

A. Data Sheets
B. Cable Specifications
C. Insulation to Conductor Temperature Correction
D. Test Setup
E. Plot of Conductor Temperature vs. Maximum Allowable Current

CANTON LABORATORY

AMERICAN ELECTRIC POWER SERVICE CORP., CANTON, OHIO

TEST DATA

TEST INFORMATION

[illegible] OF TEST: ☐ INTERRUPTING ☐ DIELECTRIC ☐ HIGH CURRENT ☐ HEAT RUN ☐ TIME-CURRENT ☐ RESISTANCE ☐ MECHANICAL ☐ MISC.

TEST MATERIAL: CABLE TRAY TYPE: VENTILATED

~~OBJECT OF TEST:~~ TRAY COVER TYPE: NONE

ALL TESTS

THERM. #	LOCATION
4	AMBIENT
5	AIR SPACE
6	TRAY TOP
7	TRAY SIDE

OPN. NO.

(A) TEST DATA

TEST NO.	CABLE	NO. OF RUNS	THERMOCOUPLE TEMPERATURES °C 4	5	6	7	8	9	10	11	12	13	15	AMPS	VOLTS	REMARKS
1	3TC #12	1	41.8	42.3		43.1	91.8	89.2	86.7					42.2	2.5	
~~2~~	~~3TC #12~~	~~21~~														
3	3TC #10	1	40.1	41.2		41.8	89.2	88.7	86.2					52.5	3.22	
~~4~~	~~3TC #10~~	~~18~~														
5	3TC 2/0	1	41.0	44.0		43.8	90.1	88.4	87.6					283	2.21	
~~[illegible]~~	~~3TC 2/0~~	~~7~~														
7	3TC 350MCM	1	40.3	43.0		44.1	87.6	88.3	*88.7			*88.5		480	4.6	THERM.# 10 & 1 * AT SAME PO
~~8~~	~~3TC 350MCM~~	~~4~~														
9	3TC 750 MCM	1	39.9	41.1		43.7	91.1	91.3	*89.8			*89.9		790	2.4	THERM# 10 & 13 * AT SAME POIN
~~10~~	~~3TC 750MCM~~	~~3~~														
~~11~~	~~3TC #12~~	~~15~~														
	~~3TC 750 MCM~~	~~1~~														
~~12~~	~~3TC #12~~	~~2~~														
	~~3TC 750 MCM~~	~~3~~														
~~13~~	~~3TC #12~~	~~6~~														
	~~3TC 2/0~~	~~3~~														
	~~3TC 750 MCM~~	~~1~~														
~~[illegible]~~	~~3TC #12~~	~~2~~														
	~~3TC 2/0~~	~~2~~														
	~~3TC 750 MCM~~	~~2~~														

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AMERICAN ELECTRIC POWER SERVICE CORP., CANTON, OHIO

TEST DATA

TEST INFORMATION

TYPE OF TEST: ☐ INTERRUPTING ☐ DIELECTRIC ☐ HIGH CURRENT ☐ HEAT RUN ☐ TIME-CURRENT ☐ RESISTANCE ☐ MECHANICAL ☐ MISC.

TEST MATERIAL: CABLE TRAY TYPE: VENTILATED

~~OBJECT OF TEST:~~ TRAY COVER TYPE: VENTILATED

ALL TESTS

THERM.#	LOCATION
4	AMBIENT
5	AIR SPACE
6	TRAY TOP
7	TRAY SIDE

OPN. NO. (B) TEST DATA

TEST NO.	CABLE	NO. OF RUNS	4	5	6	7	8	9	10	11	12	13	15	AMPS	VOLTS	REMARKS
			THERMOCOUPLE TEMPERATURES °C													
1	3TC #12	1	41.0	43.1	43.9	43.5	91.2	88.9	88.7					41.2	2.46	
2	3TC #12	21	40.7	59.9	54.5	48.7	92.8	97.1	94.0	83.8	94.5	88.6	80.8	25.3	32.0	
3	3TC #10	1	40.3	42.1	42.2	42.0	90.1	89.2	86.2					52.5	3.25	
4	3TC #10	18	40.5	64.3	54.0	48.9	88.9	88.6	89.2	82.5	84.5	87.7	89.9	38.5	27	
5	3TC 2/0	1	40.9	46.6	44.8	45.1	91.2	89.7	87.4					262	2.32	
6	3TC 2/0	7	41.4	57.2	54.7	53.8	82.8	89.4	84.1			84.6		207	6.03	
7	3TC 350MCM	1	40.2	57.9	45.9	48.0	89.0	89.3	87.9			87.2		446	4.3	
8	3TC 350MCM	4	40.1	54.1	51.2	54.0	89.3	87.4	91.2			90.7		400	4.1	
9	3TC 750 MCM	1	39.5	50.1	48.2	51.8	88.7	88.2	86.0			86.5		715	2.52	
10	3TC 750 MCM	3	40.9	68.9	58.9	60.5	89.1	89.3	88.3			88.4		685	4.5	
11	3TC #12	15	42.2	58.2	58.0	54.0			85.3	87.1	78.5	89.5	85.3	21.9	19.16	TRAY VIBRATION
	3TC 750 MCM	1	"	"	"	"	83.8	89.2						670	2.62	
12	3TC #12	2	41.6	70.6	60.8	60.3				90.1	89.2		90.1	22.5	3.32	
	3TC 750 MCM	3	"	"	"	"	90.4	88.9	88.8			87.7		660	4.3	
13	3TC #12	6	42.0	65.0	62.3	59.1					88.7	86.2	89.3	23.0	7.73	TRAY VIBRATION
	3TC 2/0	3	"	"	"	"			90.1	89.5				212	2.87	
	3TC 750 MCM	1	"	"	"	"	86.3	90.8						650	2.63	
14	3TC #12	2	41.3	62.6	*	57.1				91.1	88.6			21.0	3.09	* THERM. CAME LOOSE
	3TC 2/0	2	"	"	"	"						89.9	84.6	202	1.95	
	3TC 750 MCM	2	"	"	"	"	90.2	89.9	88.4					650	2.69	

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AMERICAN ELECTRIC POWER SERVICE CORP., CANTON, OHIO

TEST DATA

TEST INFORMATION

TYPE OF TEST: ☐ INTERRUPTING ☐ DIELECTRIC ☐ HIGH CURRENT ☐ HEAT RUN
☐ TIME-CURRENT ☐ RESISTANCE ☐ MECHANICAL ☐ MISC. ALL TESTS

TEST MATERIAL: CABLE TRAY TYPE: SOLID

~~OBJECT OF TEST:~~ TRAY COVER TYPE: SOLID

THERM.#	LOCATION
4	AMBIENT
5	AIR SPACE
6	TRAY TOP
7	TRAY SIDE

OPN. NO. — Ⓒ TEST DATA

TEST NO.	CABLE	NO. OF RUNS	THERMOCOUPLE TEMPERATURES °C 4	5	6	7	8	9	10	11	12	13	15	AMPS	VOLTS	REMARKS
1	3TC #12	1	40.4	46.8	44.1	45.5	92.7	87.9	90.8					37	2.22	
2	3TC #12	21	40.5	69.5	57.0	55.5	86.1	92.0	91.3	85.8	93.3	87.3	82.0	19	23.8	
~~3~~	~~3TC #10~~	~~1~~														
~~4~~	~~3TC #10~~	~~18~~														
5	3TC 2/0	1	40.7	52.5	*42.5	*43.8	87.3	89.8	89.1					225	1.94	* THERMS. WERE LIFTED NEXT MORNING
6	3TC 2/0	7	40.9	69.9	59.8	55.9	85.1	90.3	88.6			88.8		156	4.57	
~~7~~	~~3TC 350 MCM~~	~~1~~														
~~8~~	~~3TC 350 MCM~~	~~4~~														
9	3TC 750 MCM	1	39.3	65.9	60.2	65.7	89.6	88.9	86.9			87.2		530	2.26	TRAY VIBRATION
10	3TC 750 MCM	3	39.4	77.8	64.0	69.2	87.3	91.2	89.2			90.7		480	3.47	TRAY VIBRATION
~~11~~	~~3TC #12~~	~~15~~														
	~~3TC 750 MCM~~	~~1~~														
~~12~~	~~3TC #12~~	~~2~~														
	~~3TC 750 MCM~~	~~3~~														
~~13~~	~~3TC #12~~	~~6~~														
	~~3TC 2/0~~	~~3~~														
	~~3TC 750 MCM~~	~~1~~														
~~14~~	~~3TC #12~~	~~2~~														
	~~3TC 2/0~~	~~2~~														
	~~3TC 750 MCM~~	~~2~~														

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TEST DATA

TEST INFORMATION

[illegible] OF TEST: ☐ INTERRUPTING ☐ DIELECTRIC ☐ HIGH CURRENT ☐ HEAT RUN
☐ TIME-CURRENT ☐ RESISTANCE ☐ MECHANICAL ☐ MISC.

TEST MATERIAL: CABLE TRAY TYPE: VENTILATED (NO COVER)
TRAY COVER TYPE: SOLID FIRE BARRIER

~~OBJECT OF TEST:~~

ALL TESTS

THERM.#	LOCATION
4	AMBIENT
5	AIR SPACE
6	TRAY TOP
7	TRAY SIDE

OPN. NO.

(D) TEST DATA

TEST NO.	CABLE	NO. OF RUNS	4	5	6	7	8	9	10	11	12	13	15	AMPS	VOLTS	REMARKS
			THERMOCOUPLE TEMPERATURES °C													
1	3TC #12	1														
2	3TC #12	21	40.7	74.5	56.3	50.9	89.5	76.7	76.6	73.9	78.5	88.9	79.6	17.5	15.6	
3	3TC #10	1														
4	3TC #10	18	40.5	75.3	55.3	50.5	87.6	87.3	82.6	83.6	89.5	87.1	85.9	21.4	14.4	
5	3TC 2/0	1														
6	3TC 2/0	7	40.5	77.1	54.5	50.3	83.8	86.8	87.0	85.3	86.4	87.8	88.3	132	3.63	
[illegible]	3TC 350 MCM	1														
8	3TC 350 MCM	4	40.2	74.1	54.0	50.5	87.4	88.0	86.7	88.8	88.7	87.0	90.2	278	2.23	
9	3TC 750 MCM	1														
10	3TC 750 MCM	3	40.2	78.4	57.4	54.1	91.0	91.1	92.4	92.6	92.9	92.7	93.1	465	2.87	
11	3TC #12	15														
	3TC 750 MCM	1														
12	3TC #12	2														
	3TC 750 MCM	3														
13	3TC #12	6														
	3TC 2/0	3														
	3TC 750 MCM	1														
[illegible]	3TC #12	2														
	3TC 2/0	2														
	3TC 750 MCM	2														

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CANTON LABORATORY

AMERICAN ELECTRIC POWER SERVICE CORP., CANTON, OHIO

TEST DATA

TEST INFORMATION

E OF TEST: ☐ INTERRUPTING ☐ DIELECTRIC ☐ HIGH CURRENT ☐ HEAT RUN
☐ TIME-CURRENT ☐ RESISTANCE ☐ MECHANICAL ☐ MISC.

TEST MATERIAL: CABLE TRAY TYPE: VENTILATED

~~OBJECT OF TEST:~~ TRAY COVER TYPE: VENTILATED FIRE BARRIER

ALL TESTS

THERM.#	LOCATION
4	AMBIENT
5	AIR SPACE
6	TRAY TOP
7	TRAY SIDE

OPN. NO. (E) TEST DATA

TEST NO.	CABLE	NO. OF RUNS	THERMOCOUPLE TEMPERATURES °C 4	5	6	7	8	9	10	11	12	13	15	AMPS	VOLTS	REMARKS
~~1~~	~~3TC #12~~	~~1~~														
2	3TC #12	21	40.4	69.6	54.6	49.3	89.9	75.7	76.5	71.1	77.9	91.0	78.1	18.8	16.8	
~~3~~	~~3TC #10~~	~~1~~														
~~4~~	~~3TC #10~~	~~18~~														
~~5~~	~~3TC 2/0~~	~~1~~														
~~6~~	~~3TC 2/0~~	~~7~~														
~~7~~	~~3TC 350 MCM~~	~~1~~														
~~8~~	~~3TC 350 MCM~~	~~4~~														
~~9~~	~~3TC 750 MCM~~	~~1~~														
10	3TC 750 MCM	3	39.8	70.8	54.3	49.8	87.0	86.8	86.5	86.3	84.9	85.3	85.0	465	2.9	
~~11~~	~~3TC #12~~	~~15~~														
	~~3TC 750 MCM~~	~~1~~														
~~12~~	~~3TC #12~~	~~2~~														
	~~3TC 750 MCM~~	~~3~~														
~~13~~	~~3TC #12~~	~~6~~														
	~~3TC 2/0~~	~~3~~														
	~~3TC 750 MCM~~	~~1~~														
~~14~~	~~3TC #12~~	~~2~~														
	~~3TC 2/0~~	~~2~~														
	~~3TC 750 MCM~~	~~2~~														

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Cable Data

3TC #12 AWG for Single Tests

12 type use RHW - E11134 (UL) 600 V

3TC #12 AWG for Multiple Cable Tests

Pirelli Cable - EM 12 AWG (cu) type use RHH or, RHW Service Cable XLP - Power Cable 600 V (UL)

3TC #10 AWG

Pirelli Cable - EM 1982 45 mils FR-XLP 10 AWG cu 600 V M&E 55-4806

3TC #2/0 AWG

Anaconda S Durasheath XLP Power Cable Type use RHH or RHW 2/0 600 V (UL)

3TC 350 MCM

Rome Cable 95 mils FR-XLP Power Cable 600 V 1982 350 MCM cu

3TC 750 MCM

Anaconda S Durasheath XLP Power Cable Type use RHH or RHW 600 V (UL) 750 MCM cu.

TABLE 1

CABLE DATA (Cont'd.)

Cable	Cond. Diam. inches	Insul. Thick inches	Thermal Resistivity of insulation °C Ω/W	D.C. Resistance μΩ/ft. at 21°C	Ampacity from D.G. 17.1 Probable at 90°C	Initial Current
3TC #12 Single	.101	.042	500	1400	30	27
3TC #12 Multiple	.095	.0425	500	1450	30	27
3TC #10	.120	.045	500	950	40	36
3TC #2/0	.431	.0765	500	49	233	210
3TC 350 MCM	.664	.098	500	27	432	389
3TC 750 MCM	.995	.1235	500	15	687	618

TABLE 2

Insulation Temperature to Conductor Temperature
Equations obtained from W. F. Wilson, AEPSC-New York

Cable	Conductor Temperature
3TC #12 AWG	$T_c = 2.9835\ E\text{-}3 * I^2 + T_i$
3TC #10 AWG	$T_c = 1.5664\ E\text{-}3 * I^2 + T_i$
3TC #2/0 AWG	$T_c = 5.3877\ E\text{-}5 * I^2 + T_i$
3TC 350 MCM	$T_c = 1.6884\ E\text{-}5 * I^2 + T_i$
3TC 750 MCM	$T_c = 7.0803\ E\text{-}6 * I^2 + T_i$

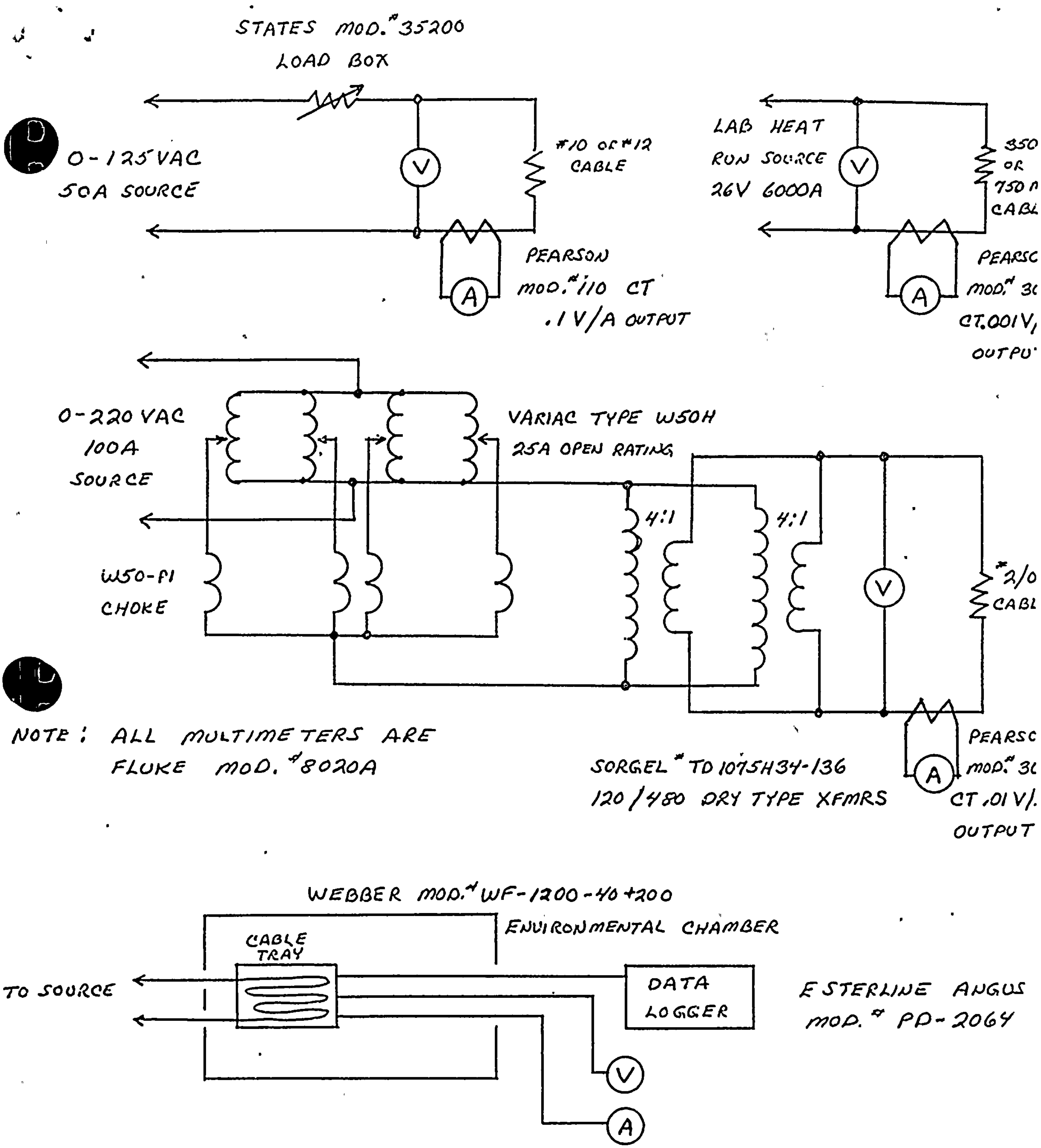

STATES MOD.# 35200
LOAD BOX
0-125 VAC
50A SOURCE
V
#10 OR #12
CABLE
PEARSON
MOD.# 110 CT
.1 V/A OUTPUT
A
LAB HEAT
RUN SOURCE
26V 6000A
V
350
OR
CABL
PEARSO
A
0-220 VAC
100A
SOURCE
VARIAC TYPE W50H
25A OPEN RATING
W50-P1
CHOKE
4:1
4:1
V
#2/0
CABL
A
PEARSO
NOTE: ALL MULTIMETERS ARE
FLUKE MOD. #8020A
SORGEL # TD 1075H34-136
120/480 DRY TYPE XFMRS
OUTPUT
WEBBER MOD.# WF-1200-40+200
ENVIRONMENTAL CHAMBER
CABLE
TRAY
TO SOURCE
DATA
LOGGER
ESTERLINE ANGUS
MOD. # PD-2064
V
A

FIGURE 1

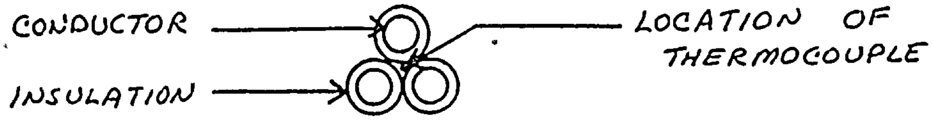


FIGURE 2

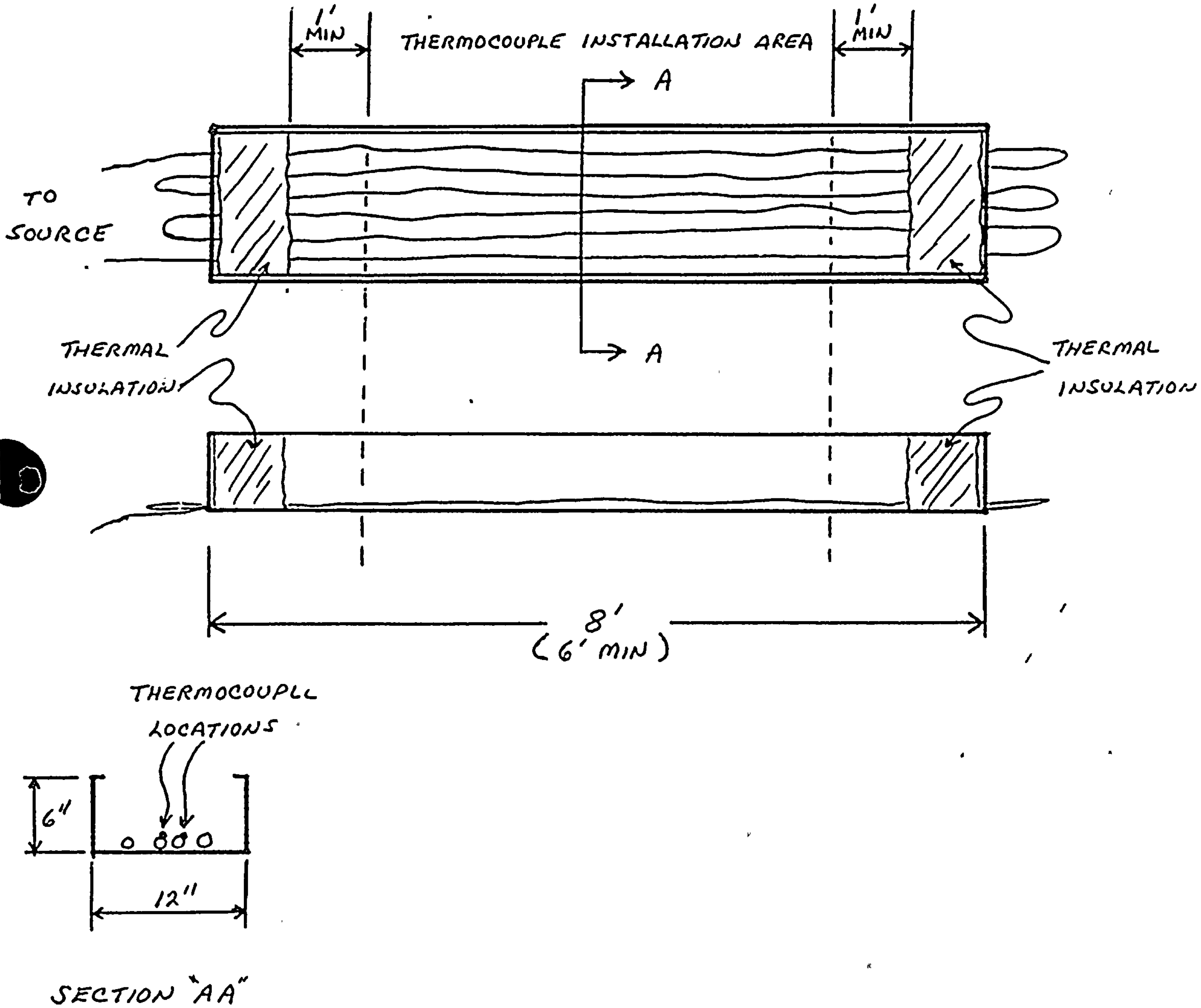
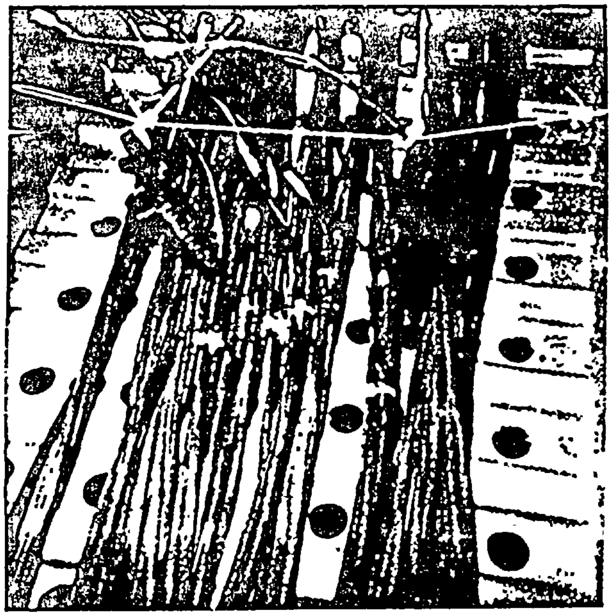


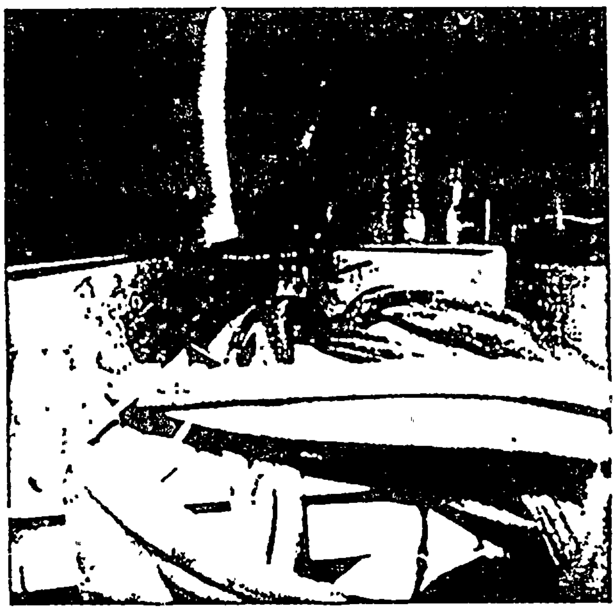
FIGURE 3

TEST 6C



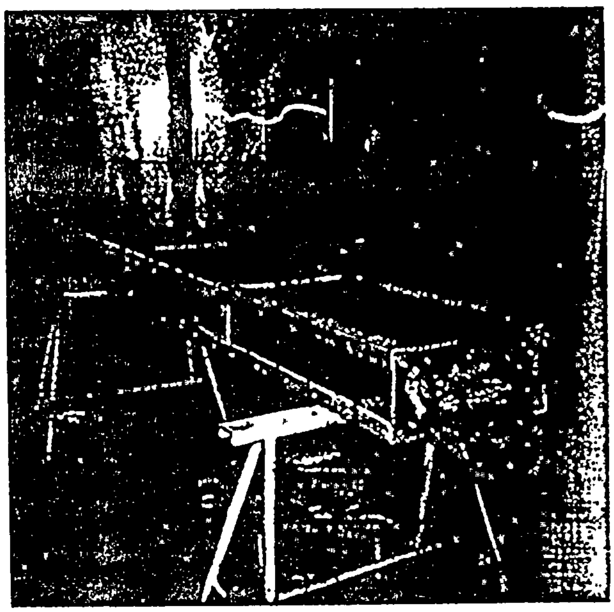
TEST 2B

THERMOCOUPLE INSTALLATIONS



TEST 6C

AIR SPACE MEASUREMENT



2D

COMPLETE FIRE BARRIER INSTALLATION

FIRE BARRIER ELECTRICAL RACEWAY PROTECTION SYSTEM

General Instructions:

The Fire Barrier Electrical Raceway Protection System is simplistic in design and consists of three operations. First, framing of the electrical raceway with a box system using Unistrut; second, attaching the Fire Barrier Composite Sheet to the box frame; and third, applying the seam protection system. Each operation follows basic design principles explained below to assure one hour fire performance.

Box Frame Electrical Raceway:

1. Construct Unistrut box frame around raceway using standard Unistrut fittings.
2. Connect Unistrut framework to raceway support system when possible.
3. All fittings (Unistrut) must end up inside the box frame.
4. Framework must be constructed so that all Fire Barrier Composite Sheet joints and edges end near a Unistrut support.
5. The Unistrut allows tie together of multiple Composite Sheet assuring joint performance under fire conditions.
6. For horizontal raceway systems, the box frame can rest on the raceway to give additional support to the protection system and to allow ease of construction.
7. For vertical runs, the box frame can be constructed around the raceway as tight as construction methods will allow.
8. Box frame can be constructed with a wall or floor as part of the system (the wall or floor must be rated as a minimum one hour fire barrier).

Fire Barrier Composite Sheet:

1. Fire Barrier Composite Sheet is designed similar to wall board material. It can be cut, drilled, formed or punched into desired configurations.
2. The Fire Barrier Composite Sheet is designed to be installed with the foil side facing away from the cable raceway.
3. The sheet is attached to the Unistrut framework with self-tapping and self-drilling screws.
4. These screws must end inside the Unistrut channel, with no screws ending inside the electrical raceway.
5. Use only enough screws to hold the Composite Sheet in place. Designed strength comes from the screws used to hold on the edge and seam systems.

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ISSUE	DATE	REV.	CH.	
2	8-23-82			GENERAL INSTRUCTIONS
NOT TO SCALE	CH			FIRE BARRIER ELECTRICAL RACEWAY PROTECTION SYSTEM
DR R. R. LICHT	APP			
5300-G2				

:lro-Products Division 3M

3M

6. All sheet edges and corners must be attached to a Unistrut channel.
7. All sheet edges must join together with a butt joint allowing no more seam opening larger than 1/8".
8. All sheet corners must be overlapped.
9. Seam joints over 1/8" must be caulked with CP-25 Caulk.

Fire Barrier Seam System:

1. All sheet connection points (edges, corners) must be protected with the Fire Barrier Seam System.
2. The seam system utilizes a dual layer approach; (1) Fire Barrier Mat M20A with aluminum foil on one side; and (2) a restraining wire, 1/2" welded hardware cloth.
3. The seam material is installed by laying the Mat M20A, with the Composite Sheet edge or corner at the center, onto the system, covering the Mat M20A with the restraining wire and holding in place with self-drilling, self-tapping screws.
4. Screws must end inside the Unistrut channel and be spaced at 6" ± 1" intervals down the center of the restraining systems.
5. Seaming systems detailed in drawings must be followed.

Reference:

1. Unistrut General Engineering Catalog Ø9
   Unistrut Building Systems
   GTE Products Corp.
   35005 Michigan Ave. West
   Wayne, MI 48184

2. Fire Barrier Electrical Raceway Protection Systems Installation Details
   Fire Barrier Products
   3M Center, Bldg. 225-4N
   St. Paul, MN 55144

ISSUE	DATE	REV.	CH.	
2	8-23-82			GENERAL INSTRUCTIONS
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5300-G2				

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ASSEMBLY MATERIALS AND TOOLS REQUIRED

Materials	3M #	Description
Fire Barrier Composite Sheet	80-6101-1873-1	41" x 36"
Fire Barrier Composite Sheet	80-6101-1650-3 (new) 80-6101-0778-3 (old)	36" x 36"
Fire Barrier Composite Sheet	80-6101-1651-1 (new) 80-6101-0780-0 (old)	36" x 24"
Fire Barrier Mat M20A	80-6101-1874-9	4" x 50' rolls
Fire Barrier Mat M20A	80-6101-1875-6	24" x 30' rolls
Fire Barrier Mat M20A	80-6101-2301-2	49" x 25' rolls
Fire Barrier Caulk CP-25	80-6100-9622-6	10 oz. cartridge
Fire Barrier Putty 303	80-6100-9622-0	1 gal. can
Fire Barrier Cord 34	80-6101-2087-7	1400' roll
Bit Tip Self Drilling Screws	--	10 - 16 x 3/4", 5/16" head
Unistrut System	--	See 5300-U1
Restraining Wire	--	1/2" welded hardware cloth (.060" diameter)
Washers	--	5/8" x 1/4"

Tools (supplied by customer)

Metal Brake	Saber Saw
Metal Shear	Ruler
Electric Screwdriver	Clamps, C-type
Wrenches	Socket Set
Power Stud Driver	Staple Gun

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ISSUE	DATE	REV.	CH.	
3	8-6-82			FIRE BARRIER MATERIALS AND ASSEMBLY EQUIPMENT
NOT TO SCALE		CH		
DR R. R. LICHT		APP		
5300-TT-1				

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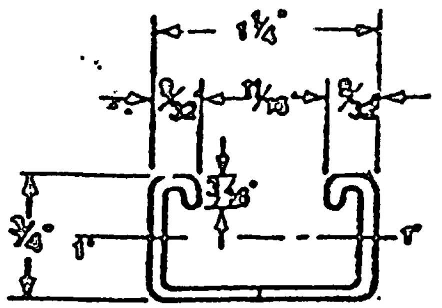
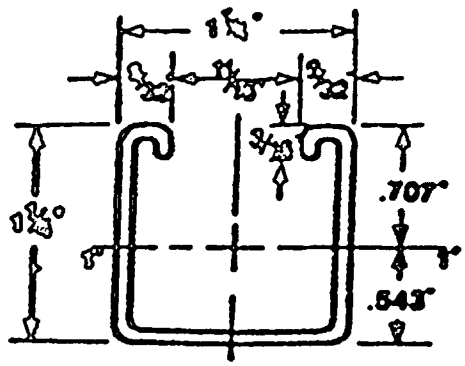
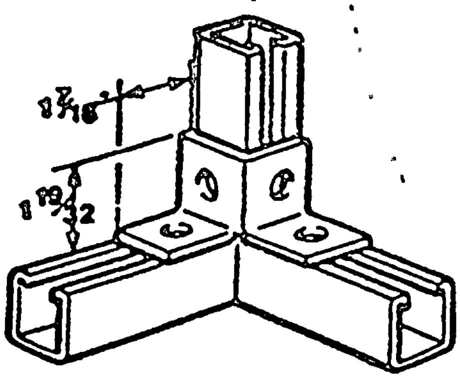


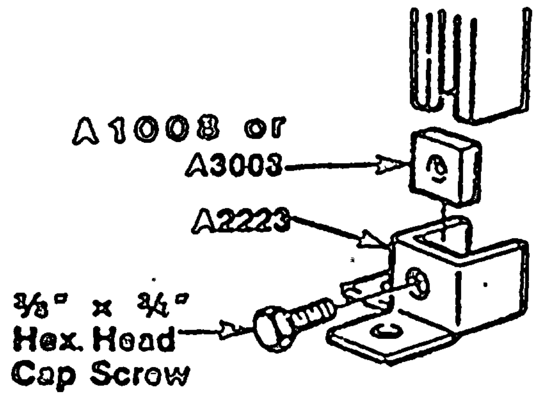
A3300 Unistrut



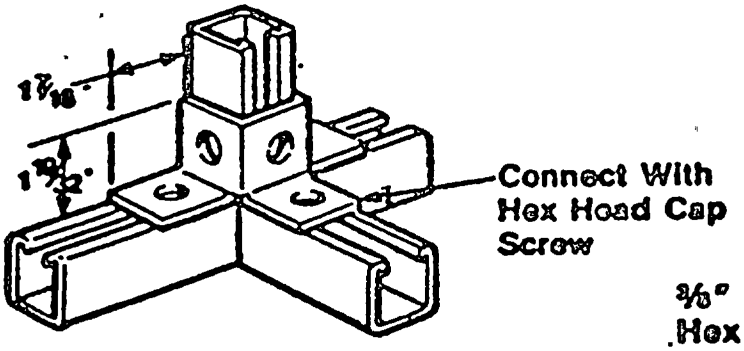
A1000 Unistrut



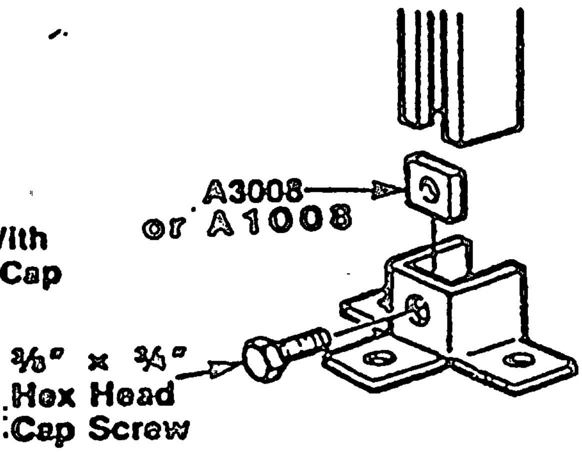
A2223 Fitting



A2223 and Bolting



A2227 Fitting



A2227 and Bolting

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ISSUE 3	DATE 6/AUG/82	REV	CH.		TYPICAL UNISTRUT FITTINGS
NOT TO SCALE		CH SAT			
DR J.F. FRENIK		APP [signature]			
ctro-Products Division/3M	3M	5300 U1			

INSTALLATION DETAILS

[illegible]allation Instructions

1. Assemble Unistrut or engineering approved equivalent box frame on cable tray (see 5300-T1 and 5300-U1-1).

2. Cut Fire Barrier Composite Sheet to fit onto exterior of box frame. All corner seams must be constructed so that one Fire Barrier Sheet overlaps the other sheet (reference drawing 5300-S2).

3. Attach Fire Barrier Composite Sheet to box frame. Use 3/4" bit tip screws; use only enough screws to hold sheets in place.

4. Cover all seams and edges with Fire Barrier Mat M20A 4" wide as described in details 5300-S1-1, 5300-S2-1, and 5300-S1A-1.

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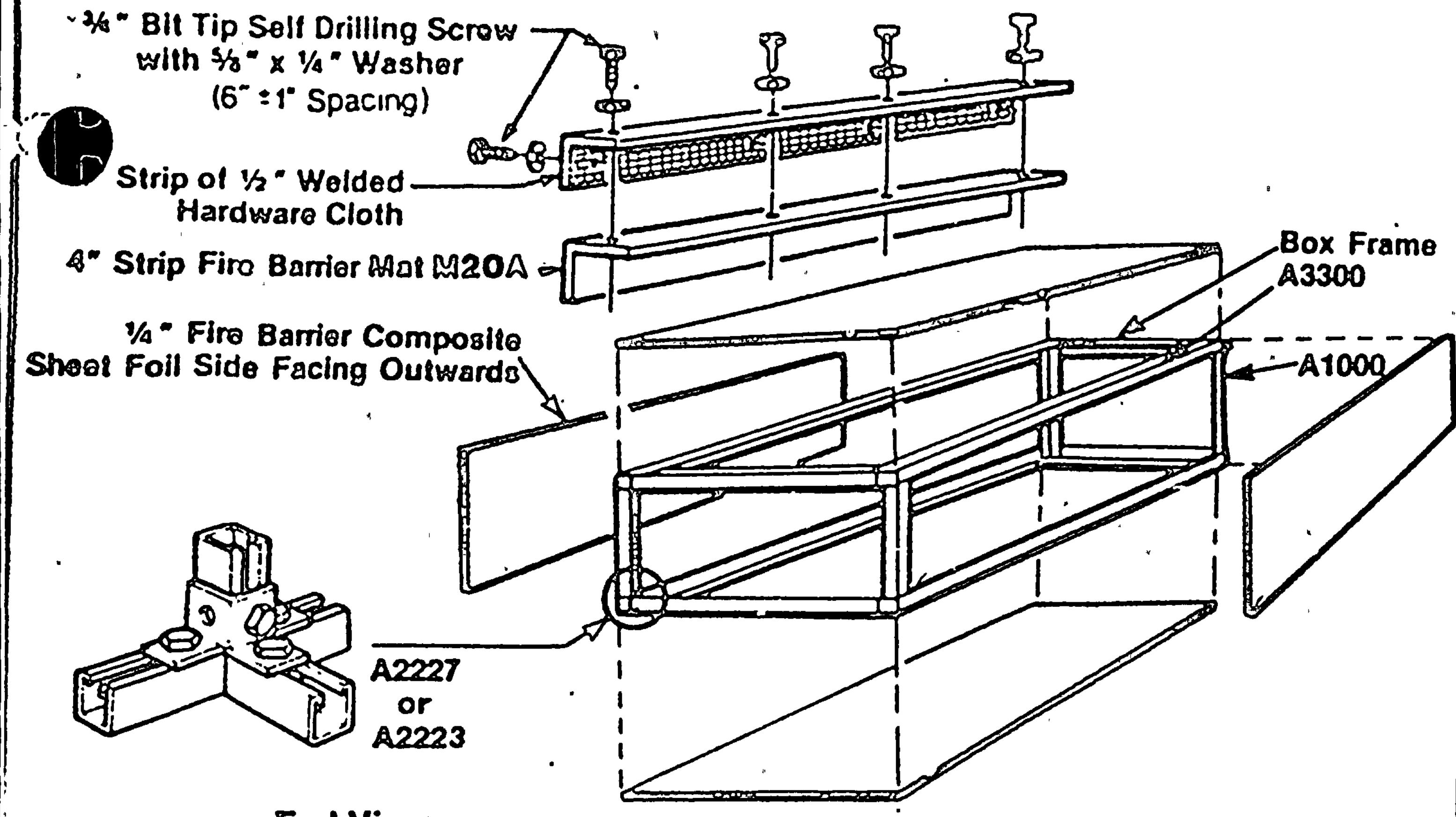
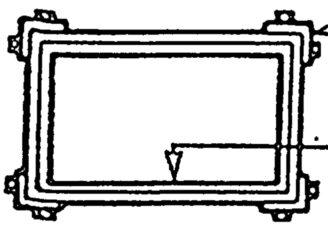
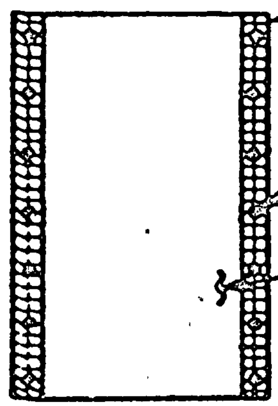
	ISSUE 2	DATE 8-6-82	REV.	CH.	FIRE BARRIER CABLE TRAY PROTECTION SYSTEM
	NOT TO SCALE		CH		
	DR R. R. LICHT		APP		
:tro-Products Division/3M 3M	5300-T1-1				



End View



Plan View



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NOTE:
Fire Barrier Composite Sheet And Fire Barrier Mat M20A Must Be Installed With Aluminum Foil Side Facing Away From Protected Item.

ISSUE	DATE	REV	CH.	
4	24/AUG/82			**Fire Barrier Cable Tray Protection System** 3M
DR. J.F.KRENIK				

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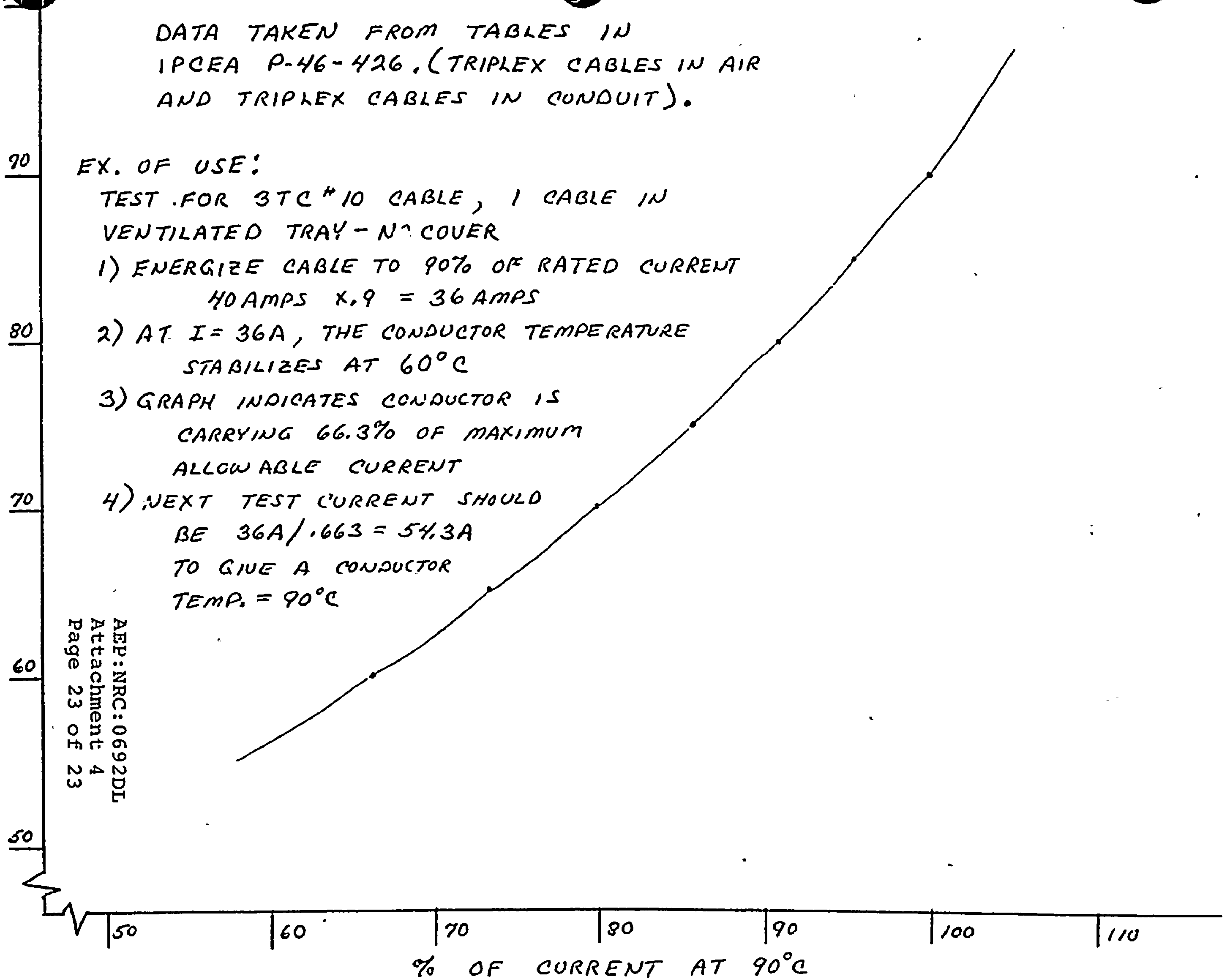
5300-T1



CONDUCTOR TEMPERATURE VS. MAXIMUM ALLOWABLE CURRENT
FIGURE 4

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ATTACHMENT 5 TO AEP:NRC:0692DL

COMPARISON TABLES PROVIDING
BASE INFORMATION REGARDING TRAYS AND CONDUITS,
CABLE FULL LOAD AMPERES, AND COMPARISON OF
CALCULATED AMPACITIES vs ICEA AMPACITIES

TRAY# 1AI-P1
TRAY SIZE 12"W x6"D
FIRE BARRIER 1 HOUR RATED THERMO-LAG

CABLE NO	CABLE TYPE	CBL OD	CBL. OD SQ	FLA	MODELLED AMPACITY	ICEA * AMPACITY	% MARGIN
8255R	3TC#12CU	0.32	0.1024	0.33	17.25	18.01	98.17
8174R	3TC#12CU	0.32	0.1024	4.00	17.25	18.01	77.79
8177R	3TC#12CU	0.32	0.1024	4.00	17.25	18.01	77.79
8113R	3TC#12CU	0.32	0.1024	0.33	17.25	18.01	98.17
8119R	3TC#12CU	0.32	0.1024	0.33	17.25	18.01	98.17
8300R	3TC#12CU	0.32	0.1024	0.33	17.25	18.01	98.17
8304R	3TC#12CU	0.32	0.1024	0.33	17.25	18.01	98.17
8308R	3TC#12CU	0.32	0.1024	0.33	17.25	18.01	98.17
8311R	3TC#12CU	0.32	0.1024	0.33	17.25	18.01	98.17
8294R	3TC#12CU	0.32	0.1024	0.33	17.25	18.01	98.17
8026R	3TC#12CU	0.32	0.1024	2.10	17.25	18.01	88.34
8027R	3TC#12CU	0.32	0.1024	1.00	17.25	18.01	94.45
1623R	3TC#12CU	0.32	0.1024	2.00	17.25	18.01	88.90
1642R	4/C#12CU	0.52	0.2704	10.00	18.87	25.35	60.55
2536R	3TC#8AL	0.60	0.36	25.00	28.91	41.83	40.23
9086R	3TC#12CU	0.32	0.1024	1.60	17.25	18.01	91.12
9092R	3TC#12CU	0.32	0.1024	1.60	17.25	18.01	91.12
9645R	3TC#12CU	0.32	0.1024	2.90	17.25	18.01	83.90
8755RH	3TC#6AL	0.69	0.4761	44.00	46.31	60.64	27.44
80083R	3TC#12CU	0.32	0.1024	3.48	17.25	18.01	80.68
28765R	3 1/C 4/0CU			SPARE			

SUM OD SQ IN: 2.8473
DEPTH OF FILL: 0.237
ACTUAL % TRAY FILL: 3.95
* ICEA AMPACITY BASED ON % TRAY FILL: 10.00

ACTUAL WATTS / FT 12.18
LOWEST MODELLED WATTS / FT 31.41

TRAY# 1AI-P2
TRAY SIZE 12"W x6"D
FIRE BARRIER 1 HOUR RATED THERMO-LAG

CABLE NO	CABLE TYPE	CBL OD	CBL. OD SQ	FLA	MODELLED AMPACITY	ICEA * AMPACITY	% MARGIN
8116G	3TC#12CU	0.32	0.1024	0.33	17.58	17.65	98.13
8119G	3TC#12CU	0.32	0.1024	0.33	17.58	17.65	98.13
8185G	3TC#12CU	0.32	0.1024	0.33	17.58	17.65	93.13
8194G	3TC#12CU	0.32	0.1024	3.20	17.58	17.65	81.87
8197G	3TC#12CU	0.32	0.1024	0.33	17.58	17.65	98.13
8250G	3TC#12CU	0.32	0.1024	0.33	17.58	17.65	98.13
8300G	3TC#12CU	0.32	0.1024	0.33	17.58	17.65	98.13
8304G	3TC#12CU	0.32	0.1024	0.33	17.58	17.65	98.13
8308G	3TC#12CU	0.32	0.1024	0.33	17.58	17.65	98.13
8311G	3TC#12CU	0.32	0.1024	0.33	17.58	17.65	98.13
8270G	3TC#12CU	0.32	0.1024	0.70	17.58	17.65	96.03
2978G	3TC#6AL		0	SPARE			
2559G	3TC#6AL		0	SPARE			
8756GH	3TC350MCM AL	1.9	3.61	150.80	236.52	291	48.18
8751GH	3TC#6AL	0.69	0.4761	15.50	45.53	59.42	73.91
8753GH	3TC#2AL	0.93	0.8649	49.40	73.24	125.98	60.79
8755GH	3TC#6AL	0.69	0.4761	37.80	45.53	59.42	36.39
1500G	3TC 2/0 AL	1.27	1.6129	50.30	121.34	148	66.01

SUM OD SQ IN 8.1664
DEPTH OF FILL 0.6805
*ACTUAL % TRAY FILL 11.34
& ICEA AMPACITY BASIS

ACTUAL WATTS / FT 16.87
LOWEST MODELLED WATTS / FT 41.74

3TC # 2/0 AL& 3TC # 350 MCM AL ampacities taken from ICEA P-54-440 table 3.21.

TRAY# 1AI-P4
TRAY SIZE 12"W x6"D
FIRE BARRIER 1 HOUR RATED THERMO-LAG

CABLE NO	CABLE TYPE	CBL OD	CBL. OD SQ	FLA	MODELLED AMPACITY	ICEA * AMPACITY	% MARGIN
8116G	3TC#12CU	0.32	0.1024	0.40	27	29.04	98.62
8119G	3TC#12CU	0.32	0.1024	0.40	27	29.04	98.62
2560G	3TC#6AL	0.69	0.4761	** 60 00	60.27	60.64	

SUM OD SQ IN 0.6809
DEPTH OF FILL 0.0567
ACTUAL % TRAY FILL 0.95 ACTUAL WATTS / FT 9.15
* ICEA AMPACITY 10.00 LOWEST MODELLED WATTS / FT 17.55
BASED ON % TRAY FILL EXCEPT 3TC# 12 CU BASED ON 4.00 % FILL
**NOTE: THIS IS A WELDING RECEPTICLE SWITCH RATING. CONNECTED LOAD IS SMALLER AND SHORT TIME RATING

TRAY# 1AZ-P8
TRAY SIZE 12"W x6"D
FIRE BARRIER 1 HOUR RATED THERMO-LAG

CABLE NO	CABLE TYPE	CBL OD	CBL. OD SQ	FLA	MODELLED AMPACITY	ICEA * AMPACITY	% MARGIN	
1470R	3TC#12CU	0.32	0.1024	3.80	21.58	29.04	86.91	
1469R	3TC#12CU	0.32	0.1024	16.00	21.58	29.04	44.90	
8067R	3TC#12CU	0.32	0.1024	1.20	21.58	29.04	95.87	
8024R	3TC#12CU	0.32	0.1024	1.10	21.58	29.04	96.21	
8187R	3TC#12CU	0.32	0.1024	8.48	21.58	29.04	70.80	valve load **
8026R	3TC#12CU	0.32	0.1024	2.70	21.58	29.04	90.70	
8027R	3TC#12CU	0.32	0.1024	1.20	21.58	29.04	95.87	
2349R	3TC#12CU	0.32	0.1024	1.90	21.58	29.04	93.46	
1476R	3TC#12CU	CUT AND TAPED IN TRAY						
1488R	3TC#12CU	0.32	0.1024	3.80	21.58	29.04	86.91	revised connected load
1991R	3TC#2AL	0.93	0.8649	60.00	90.67	128.58	53.34	
16666R-2	3TC#12CU	0.32	0.1024	2.50	21.58	29.04	91.39	

SUM OD SQ IN 1.8889
DEPTH OF FILL **0.1574**
ACTUAL % TRAY FILL **2.62** ACTUAL WATTS / FT **9.7**
* ICEA AMPACITY **10.00** LOWEST MODELLED WATTS / FT **36.22**
BASED ON % TRAY FILL EXCEPT 3TC # 12 CU BASED ON 4.00 % FILL
** Refer to section 2.4.7 for valve load considerations.

TRAY# 1AZ-P9
TRAY SIZE 12"W x6"D
FIRE BARRIER 1 HOUR RATED THERMO-LAG .

CABLE · NO	CABLE TYPE	CBL OD	CBL. OD SQ	FLA	MODELLED AMPACITY	ICEA * AMPACITY	% MARGIN
8113R	3TC#12CU	0.32	0.1024	0.71	20.86	29.04	97.56
8119R	3TC#12CU	0.32	0.1024	0.71	20.86	29.04	97.56
1623R	3TC#12CU	0.32	0.1024	2.60	20.86	29.04	91.05
1642R	4/C#12CU	0.52	0.2704	6.40	22.72	25.35	74.75
8026R	3TC#12CU	0.32	0.1024	2.70	20.86	29.04	90.70
8027R	3TC#12CU	0.32	0.1024	1.20	20.86	29.04	95.87
2349R	3TC#12CU	0.32	0.1024	1.90	20.86	29.04	93.46
9217R	3TC#12CU	0.32	0.1024	0.17	20.86	29.04	99.41
9221R	3TC#12CU	0.32	0.1024	0.17	20.86	29.04	99.41
1440R	3TC#2AL	0.93	0.8649	60.00	86.52	128.58	53.34
8753RH	3TC#4AL	0.8	0.64	53.00	63.47	88.68	40.23

SUM OD SQ IN 2.5945
DEPTH OF FILL 0.2162
ACTUAL % TRAY FILL 3.60 ACTUAL WATTS / FT 8.57
* ICEA AMPACITY 10.00 LOWEST MODELLED WATTS / FT 38.63
BASED ON % TRAY FILL EXCEPT 3TC # 12 CU BASED ON 4.00 % FILL

TRAY# 1A-P20
TRAY SIZE 12"W x6"D
FIRE BARRIER 1 HOUR RATED THERMO-LAG

CABLE NO	CABLE TYPE	CBL OD	CBL. OD SQ	FLA	MODELLED AMPACITY	ICEA * AMPACITY	% MARGIN
8113R	3TC#12CU	0.32	0.1024	0.71	16.67	19.06	96.27
8119R	3TC#12CU	0.32	0.1024	0.71	16.67	19.06	96.27
1623R	3TC#12CU	0.32	0.1024	2.60	16.67	19.06	86.36
1642R	4/C#12CU	0.54	0.2916	6.40	18.25	26.83	76.15
8026R	3TC#12CU	0.32	0.1024	2.70	16.67	19.06	85.83
8027R	3TC#12CU	0.32	0.1024	1.20	16.67	19.06	93.70
8294R	3TC#12CU	0.32	0.1024	0.71	16.67	19.06	96.27
2349R	3TC#12CU	0.32	0.1024	1.90	16.67	19.06	90.03
3249R	3TC#6AL	0.69	0.4761	12.70	37.68	64.18	80.21
1509R	3TC#12CU			SPARE			
2353R	4/C#12CU	0.52	0.2704	16.00	18.25	26.83	40.37
2354R	4/C#12CU	0.54	0.2916	16.00	18.25	26.83	40.37
2355R	3TC#12CU	0.32	0.1024	1.50	16.67	19.06	92.13
2356R	3TC#4AL	0.8	0.64	36.00	51.16	88.68	59.40
8984R	3TC#12CU	0.32	0.1024	15.60	16.67	19.06	18.15
8987R	3TC#12CU	0.32	0.1024	15.60	16.67	19.06	18.15
1656R	3TC#2AL	0.93	0.8649	60.00	69.55	128.58	53.34
9217R	3TC#12CU	0.32	0.1024	0.71	16.67	19.06	96.27
9221R	3TC#12CU	0.32	0.1024	0.71	16.67	19.06	96.27
2348R	3TC#12CU	0.32	0.1024	6.80	16.67	19.06	64.32
2962R	3TC#12CU	0.32	0.1024	6.80	16.67	19.06	64.32
2361R	3TC#6AL	0.69	0.4761	31.40	37.68	60.64	48.22
1440R	3TC#2AL	0.93	0.8649	60	69.55	128.58	53.34
8753RH	3TC#4AL	0.8	0.64	49	51.16	88.68	44.75

SUM OD SQ IN 5.942
DEPTH OF FILL 0.4952
ACTUAL % TRAY FILL 8.25
* ICEA AMPCTY % FILL 9.00
Except 10.00 % for 3TC # 2 AL & 3TC # 4 AL.

ACTUAL WATTS / FT 25.18
LOWEST MODELLED WATTS / FT 56.8

TRAY# 2AZ-P3
TRAY SIZE 12"W x6"D
FIRE BARRIER 1 HOUR RATED THERMO-LAG

CABLE NO	CABLE TYPE	CBL OD	CBL. OD SQ	FLA	MODELLED AMPACITY	ICEA * AMPACITY	% MARGIN	
8332G	3TC#12CU	0.32	0.1024	3.80	18.15	19.06	80.06	
9665G	3TC#12CU			SPARE				
1970G	4/C#12CU	0.52	0.2704	6.70	19.22	26.83	75.03	
9696G	3TC#12CU			SPARE				
3001G	3TC#2CU	1.08	1.1664	1.38	100.13	109	98.73	
13945G	3TC#2AL	0.93	0.8649	73.00	73.22	136.08	46.36	
3010G	3TC#12CU	0.32	0.1024	1.50	18.15	19.06	92.13	
3012G	4/C#12CU	0.52	0.2704	16.00	19.22	26.83	40.37	
3013G	4/C#12CU	0.52	0.2704	16.00	19.22	26.83	40.37	
8987G	3TC#12CU	0.32	0.1024	16.00	18.15	19.06	16.05	
3014G	3TC#6AL	0.69	0.4761	36.00	39.8	64.18	43.91	
9965G	4/C#12CU	0.52	0.2704	7.9	19.22	26.83	70.56	
9958G	3TC#12CU	0.32	0.1024	1.00	18.15	19.06	94.75	
8645G	3TC#12CU	0.32	0.1024	2.90	18.15	19.06	84.78	
8138G	3TC#12CU			CONTROL				
8204G	3TC#12CU	0.32	0.1024	18.00	18.15	19.06	5.56	valve load **
8317G	3TC#12CU	0.32	0.1024	3.80	18.15	19.06	80.06	
8756GH	3TC#2/0AL	1.27	1.6129	96.40	121.34	148	34.86	
8050GH	7/C#12CU			CONTROL				
8053GH	3TC#8CU	0.72	0.5184	12.89	40.95	68.2	81.10	

SUM OD SQ IN 6.4371
DEPTH OF FILL 0.5364
ACTUAL % TRAY FILL 8.94
* ICEA AMPACITY 9.00
BASED ON % TRAY FILL

ACTUAL WATTS / FT 22.63
LOWEST MODELLED WATTS / FT 51.32

** Refer to section 2.4.7 for valve load considerations.
3TC # 2/0 AL and 3TC #2 CU ampacities taken from ICEA P-54-440 table 3.21 & 3.6 resp.

TRAY# 2A-P2
TRAY SIZE 12"W x6"D
FIRE BARRIER 1 HOUR RATED THERMO-LAG

CABLE NO	CABLE TYPE	CBL OD	CBL. OD SQ	FLA	MODELLED AMPACITY	ICEA * AMPACITY	% MARGIN
3010G	3TC#12CU	0.32	0.1024	1.75	22.76	29.04	93.97
3012G	4/C#12CU	0.52	0.2704	16.00	24.72	25.35	36.88
3013G	4/C#12CU	0.52	0.2704	16.00	24.72	25.35	36.88
8987G	3TC#12CU	0.32	0.1024	16.00	22.76	29.04	44.90
9217G	3TC#12CU	0.32	0.1024	0.71	22.76	29.04	97.56
3014G	3TC#6CU	0.85	0.7225	36.00	71.23	95.92	62.47
8984G	3TC#10CU	0.46	0.2116	15.60	34.00	32.65	52.22

SUM OD SQ IN 1.7821
DEPTH OF FILL 0.1485
ACTUAL % TRAY FILL 2.48
* ICEA AMPACITY 10.00
BASED ON % TRAY FILL

ACTUAL WATTS / FT 8.79
LOWEST MODELLED WATTS / FT 30.44

TRAY# 2AZ-P10
TRAY SIZE 12"W x6"D
FIRE BARRIER 1 HOUR RATED TI ERMO-LAG

CABLE NO	CABLE TYPE	CBL OD	CBL. OD SQ	FLA	MODELLED AMPACITY	ICEA * AMPACITY	% MARGIN	
8755RH	3TC#2AL	0.93	0.8649	50.30	73.61	128.58	60.88	
8753RH	3TC#4AL	0.8	0.64	50.30	54.17	88.68	43.28	
8756RH	3TC 2/0AL	1.27	1.6129	100.50	120.86	148	32.09	
1500R	3TC#2AL	0.93	0.8649	50.30	73.61	128.58	60.88	
8206R	3TC#12CU	0.32	0.1024	18.00	17.67	18.01	0.06	valve load**
9962R	3TC#12CU			SPARE				
9951R	3TC#12CU	0.32	0.1024	0.80	17.67	18.01	95.56	
9901R	3TC#12CU	0.32	0.1024	2.99	17.67	18.01	83.40	
9908R	3TC#12CU	0.32	0.1024	2.99	17.67	18.01	83.40	
16666R	3TC#12CU	0.32	0.1024	2.14	17.67	18.01	88.12	
8327R	3TC#12CU	0.32	0.1024	2.99	17.67	18.01	83.40	
8024R	3TC#12CU	0.32	0.1024	1.00	17.67	18.01	94.45	
2481R	3TC#2CU	1.08	1.1664	1.38	100.65	109	98.73	
8274R	3TC#12CU	0.32	0.1024	2.20	17.67	18.01	87.78	
9221R	3TC#12CU	0.32	0.1024	0.71	17.67	18.01	96.06	
9217R	3TC#12CU	0.32	0.1024	0.71	17.67	18.01	96.06	
8030R	3TC#12CU	0.32	0.1024	1.34	17.67	18.01	92.56	
8560R	3TC#12CU	0.32	0.1024	3.29	17.67	18.01	81.73	

SUM OD SQ IN 6.3779
DEPTH OF FILL 0.5315
ACTUAL % TRAY FILL 8.86
* ICEA AMPACITY 10.00
BASED ON % TRAY FILL

ACTUAL WATTS / FT 16.52
LOWEST MODELLED WATTS / FT 51.03

** Refer to section 2.4.7 for valve load considerations.
3TC # 2/0 AL and 3TC #2 CU ampacities taken from ICEA P-54-440 table 3.21 & 3.6 resp.

CONDUITS

ALL CONDUITS ARE PROTECTED WITH 1 HOUR RATED THERMO-LAG AND INDIVIDUALLY WRAPPED

CABLE NUMBER	CONDUIT SIZE	CABLE SIZE	ACTUAL		MODELLED		IPCEA #P-46-426/ NEC AMPACITY*	% MARGIN
			FLA	WATTS/FT	AMPACITY	WATTS/FT		
8003R-1	4	3TC#2AL**	57.5	3.32	99.45	9.94	112	49
8004R-1	4	3TC#2AL**	64.6	4.2	99.45	9.94	112	42
8004G-1	4	3TC#2AL**	64.6	4.2	99.45	9.94	112	42
8026R-1	1/2	3TC#12CU	2.7	0.045	24.38	3.68	27.3	90
8505-R1	1	3TC#12CU	2.6	0.042	26.01	4.19	27.3	90
8506R-1	1	3TC#12CU	2.6	0.042	26.01	4.19	27.3	90
8003R-2	4	3TC#2AL**	57.5	3.32	99.45	9.94	112	49
8004R-2	4	3TC#2AL**	64.6	4.2	99.45	9.94	112	42
8004G-2	4	3TC#2AL**	59	3.5	99.45	9.94	112	47
8154G-2	1	3TC#12CU	2.6	0.042	26.01	4.19	27.3	90
8155G-2	1	3TC#12CU	2.6	0.042	26.01	4.19	27.3	90
8744R-2	3	3TC#2AL**	71.9	5.2	95.25	9.12	112	36

% MARGIN =((Conventional Ampacity - FLA) / Conventional Amapcity) *100

** 5 KV CABLE

*IPCEA PUB.# P-46-426 PAGE 264 TABLES USED FOR # 8 AND LARGER CABLES.
NEC 310-16 TABLE USED FOR 3 TC # 12 CU CABLE.

NOTE: THIS TABLE IS PREPARED USING REV.1 OF OUR DOCUMENTATION DATED 7/26/84.
REVISION REFLECTS CHANGE IN CONDUIT PARAMETERS. CHANGE IN CONDUIT PARAMETERS
DID NOT CHANGE % MARGIN.

ATTACHMENT 6 TO AEP:NRC:0692DL

AMPACITY vs DEPTH OF FILL PLOT FOR
#12 AWG COPPER CABLE IN TRAY

Calculation to support the verification of the CNP Thermal Model applied to conduit

Test (Fill Width)	Cable Type (Diameter)	Test Loading (A)	No. of Runs (Contributing Width)	Highest Measured Temperature (°C)	Predicted Ampacity (A)	Predicted Watts/Ft (w/ft)
5	3TC#2AL SHIELDED (1.14")	72.0	1 (1.14")	65.0	62.7	3.64

* Predicted values are based on the highest measured temperature as the conductor temperature.

Calculated heat generated per conductor by resistive heating = # of conductors x I^2 x R_{ac}
where I = connected load (A)
R_{ac} = AC resistance (Ω/ft)

Applied to the modelling of Test 5 using the predicted ampacity, the modelled heat generated is:

3TC#2AL = $3 \times 62.7^2 \times 30.9E\text{-}5^*$ = 3.64 W/ft

Applied to the actual loading in Test 5 above, the total calculated heat generated is:

3TC#2AL = $3 \times 72^2 \times 30.9E\text{-}5^*$ = 4.8 W/ft

* Resistance has been adjusted to correspond to the respective measured temperature listed above

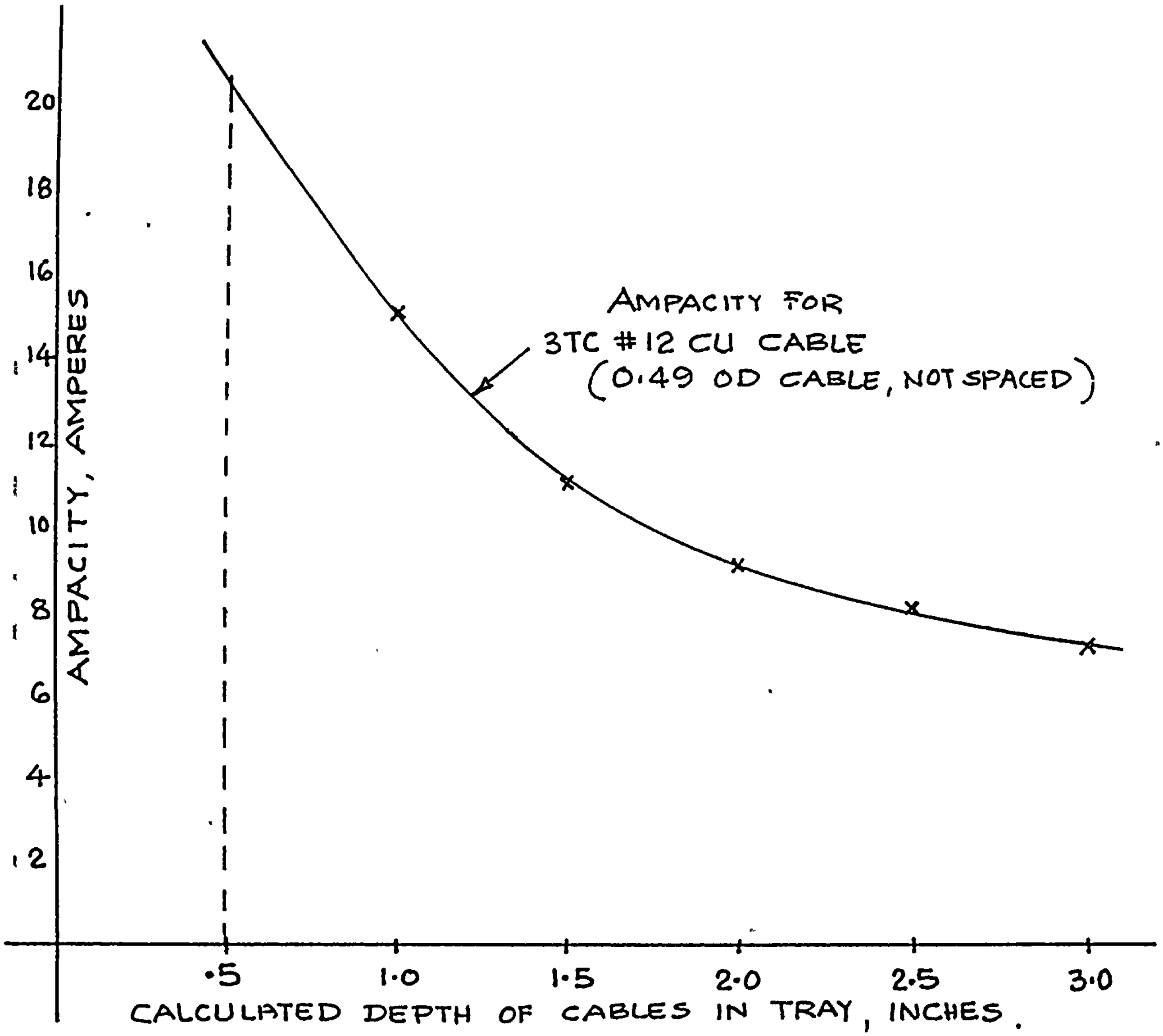
A comparison of the predicted heat generated (3.64 W/ft) and the actual heat generated (4.8 W/ft) for the given test case above demonstrates that the CNP thermal modelling approach is conservative. This is considered conservative since this establishes the "limit" for which other identical raceways can be compared to for acceptance (i.e. - those identical candidate raceways must have a total heat value less than this limit thereby ensuring that the heat generated is less than the heat corresponding to a known temperature).

7223(9-83)
FORM GE-8 (C)

ENGINEERING DEPT.
AMERICAN ELECTRIC POWER SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OHIC

SHEET 1 OF 1
DATE 2-11-97 BY SK CK.
COMPANY INDIANA MICHIGAN POWER G.O.
PLANT COOK NUCLEAR PLANT

SUBJECT AMPACITY V/S DEPTH OF FILL PLOT FOR # 12 AWG CU CABLE IN TRAY.



REF: ICEA STANDARD P-54-440, Table 3-6
AMPACITY PLOT FOR # 12 AWG CABLE

AEP:NRC:0692DL
ATTACHMENT 6
PAGE 1 OF 1