



UNITED STATES
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

March 25, 1994

MEMORANDUM FOR: Martin J. Virgilio, Acting Director
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

FROM: Conrad E. McCracken, Chief
Plant Systems Branch
Division of Systems Safety and Analysis

SUBJECT: SUMMARY OF MARCH 16, 1994, MEETING BETWEEN NRC STAFF AND
NUCLEAR ENERGY INSTITUTE REPRESENTATIVES AND INDUSTRY
THERMO-LAG TEST PROGRAM

On March 16, 1994, staff members of the Office of Nuclear Reactor Regulation (NRR) met with representatives of the Nuclear Energy Institute (NEI), formerly Nuclear Management and Resources Council (NUMARC), to discuss Thermo-Lag issues. Enclosure 1 is a list of attendees.

During this meeting, NEI representatives explained that NUMARC had merged with the U. S. Council for Energy Awareness (USCEA), the American Nuclear Energy Council (ANEC) and the Edison Electric Institute (EEI) to form the Nuclear Energy Institute (NEI). Following a brief overview of the meeting agenda, NEI presented the preliminary results of NEI Thermo-Lag Phase 2 test program (Enclosure 2 and 3). The test results led NEI to conclude that most upgrades performed as anticipated, but while the test results for one-hour upgrades appear to meet the NEI acceptance criteria, three-hour upgrades did not. The staff concluded that, based on test results, upgrades of 3-hour barriers did not provide satisfactory results and suggested that alternative solutions may have to be considered. Phase 2 test reports have not yet been submitted to the staff for review.

NEI presented its draft Application Guide to Evaluate Thermo-Lag Fire Barriers. Several handouts were distributed by NEI during the course of the presentation (Enclosures 4, 5, and 6). One of the handouts (Enclosure 7) illustrates the kind of evaluation licensees may generate by following the Application Guide methodology for comparing tested to installed configurations. NEI plans to give guidance on the use of the Application Guide to licensees during an industry workshop scheduled for April 20-21, 1994. NEI emphasized the importance of obtaining feedback from the staff and stated their intention to incorporate staff comments in the Application Guide prior to the workshop. NEI invited the staff to attend the workshop. The staff raised a number of questions and concerns about the Application Guide and agreed to try to have written comments to NEI by April 8, 1994, to support the workshop.

The staff distributed copies of Information Notice 94-22 "Fire Endurance and Ampacity Derating Test Results for 3-hour Fire Rated Thermo-Lag 330-1 Fire Barriers", and informed attendees that GL 86-10 Supplement 1 was under Commission review and expected to be issued shortly.

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PDR REVOP ERGNUMRC
PDR

003033

MHTS-3-1B
X CHM-7 NUMARC
X CHM-6 meeting

DFB

RETURN TO REGULATORY CENTRAL FILES

March 25, 1994

Martin Virgilio

-2-

During the closing remarks, participants discussed the upcoming June meeting with the Advisory Committee on Reactor Safeguards and the agenda of the NRR/NEI senior management meeting scheduled for April 8, 1994.

Original signed by

Conrad E. McCracken, Chief
Plant Systems Branch
Division of Systems Safety and Analysis

Enclosures:
As stated

cc w/out enclosures:
J. Colvin, NUMARC

DISTRIBUTION W/ENCLOSURES:

Central File
SPLB TSI File
NRC PDR
GMulley, OIG
EPawlik, RIII/OI

DISTRIBUTION W/OUT ENCLOSURES:

LPlisco	FMiraglia
DOudinot	WRussell
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MGamberoni	SWest
JHolmes	PMadden
ASingh	CBerlinger
AThadani	A(Paul)Gill
RJenkins	OPA

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SW
SPLB:DSSA
SWest
3/25/94

CA
SPLB:DSSA
CMcCracken
3/25/94

ATTENDANCE

<u>Name</u>	<u>Organization</u>	<u>Phone No.</u>
Marsha Gameroni	NRR/NRC	301-504-3024
Loren Plisco	OEDO	301-504-3024
Morton Fleishman	OCMKR	301-504-1850
Daniele Oudinot	NRR	301-504-3731
Amarjit Singh	NRR/SPLB	301-504-1237
Jan MacGregor	Winston and Strawn	202-371-5798
Patrick Madden	NRR/SPLB	301-504-2854
Edward Connell	NRR/SPLB	301-504-2838
Ronaldo Jenkins	NRR/EELB	301-504-2985
Steven West	NRR/SPLB	301-504-1220
Conrad McCracken	NRR/SPLB	301-504-2873
Alex Marion	NUMSRC/NEI	202-739-8000
Biff Bradley	NEI	202-739-8083
Morris Schreim	NUMARC/NEI	202-739-8082
Rick Dible	VECTRA	817-737-1045
Cal Banning	VECTRA	817-737-1115
Theresa Sutter	Bechtel	301-417-8818
Rubin Feldman	TSI	314-349-1233
James J Raleigh	Southern Technical Services	301-652-2500

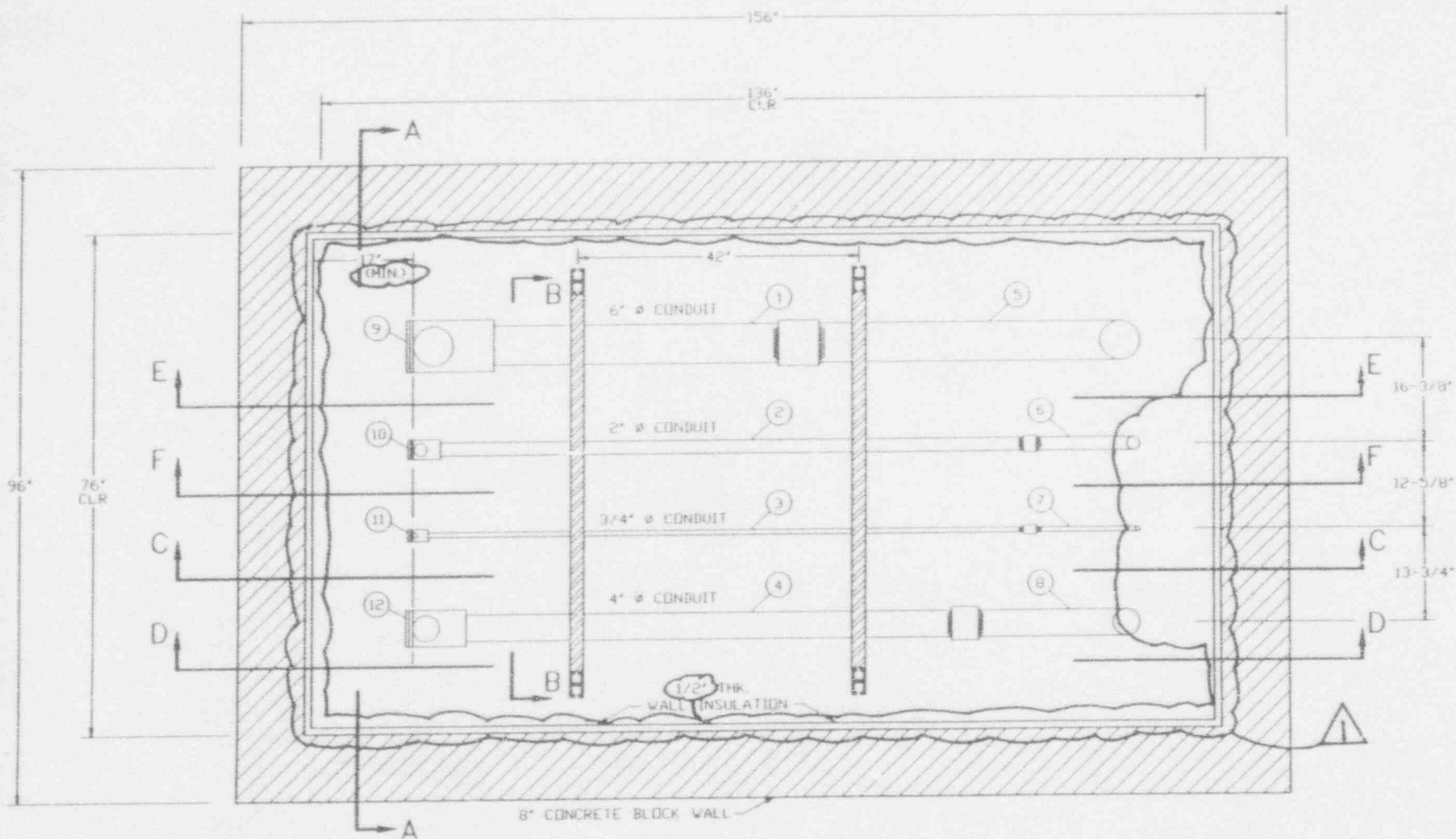
PHASE 2 TESTING

NEI THERMO-LAG TEST PROGRAM RESULTS

PHASE 2 TESTING

- TEST 2-1 BASELINE CONDUITS
1 HOUR

REV.	DWN	ORIG	VER	APVD
1	ELT	RLO 2/4/24	REP 2/4/24	RLO 2/4/24



NOTES:

1. DIMENSIONS WITH ASTERISK (*) ARE NONCRITICAL AND PROVIDED FOR INFORMATION AND GENERAL CONFIGURATION PURPOSES.
2. ALL OTHER DIMENSIONS HAVE WORKING TOLERANCE OF $\pm 2'$ UNO.
3. ○ - DENOTES BILL OF MATERIAL ITEM NO. (SEE SH 11)
4. REFER TO DWG. 0784-00001-D-000 FOR REVISION HISTORY, DESIGN CHANGE STATUS AND USE DESIGNATION.
5. INSTRUMENTATION REQUIREMENTS - THERMOCOUPLES SHALL BE INSTALLED AT 6" INTERVALS ALONG THE BOTTOM EXTERNAL SURFACE OF ALL CONDUITS AND FITTINGS. THERMOCOUPLES SHALL ALSO BE INSTALLED AT 6" INTERVALS ALONG A #8 AWG BARE COPPER CONDUCTOR LOCATED INSIDE EACH CONDUIT ASSEMBLY.

ABB IMPELL CORP. PROJ. NO. 0784-00001
NUMARC PHASE 2 TEST PROGRAM
DWG. 0784-00001-D-001 SH 2 REV.1
TEST 2-1 (CI-A-75a/CI-A-2a/CI-A-4a/CI-A-6a)
FIG. 2 PLAN VIEW -BELOW DECK

PHASE 2 TESTING

- **TEST 2-1 BASELINE CONDUITS
1 HOUR**
 - ◆ **3/4", 2", 4" AND 6" DIAMETER CONDUITS**
 - ◆ **PRE-BUTTERED JOINTS**
 - ◆ **RESULTS:**
 - » **3/4" EXCEEDED SINGLE MAX. AND AVERAGE TEMPERATURE CRITERION AT 27 MINUTES**
 - » **2" EXCEEDED AVERAGE TEMPERATURE CRITERION AT 39 MINUTES**
 - » **4" EXCEEDED AVERAGE TEMPERATURE CRITERION AT 48 MINUTES**

PHASE 2 TESTING

- **TEST 2-1**

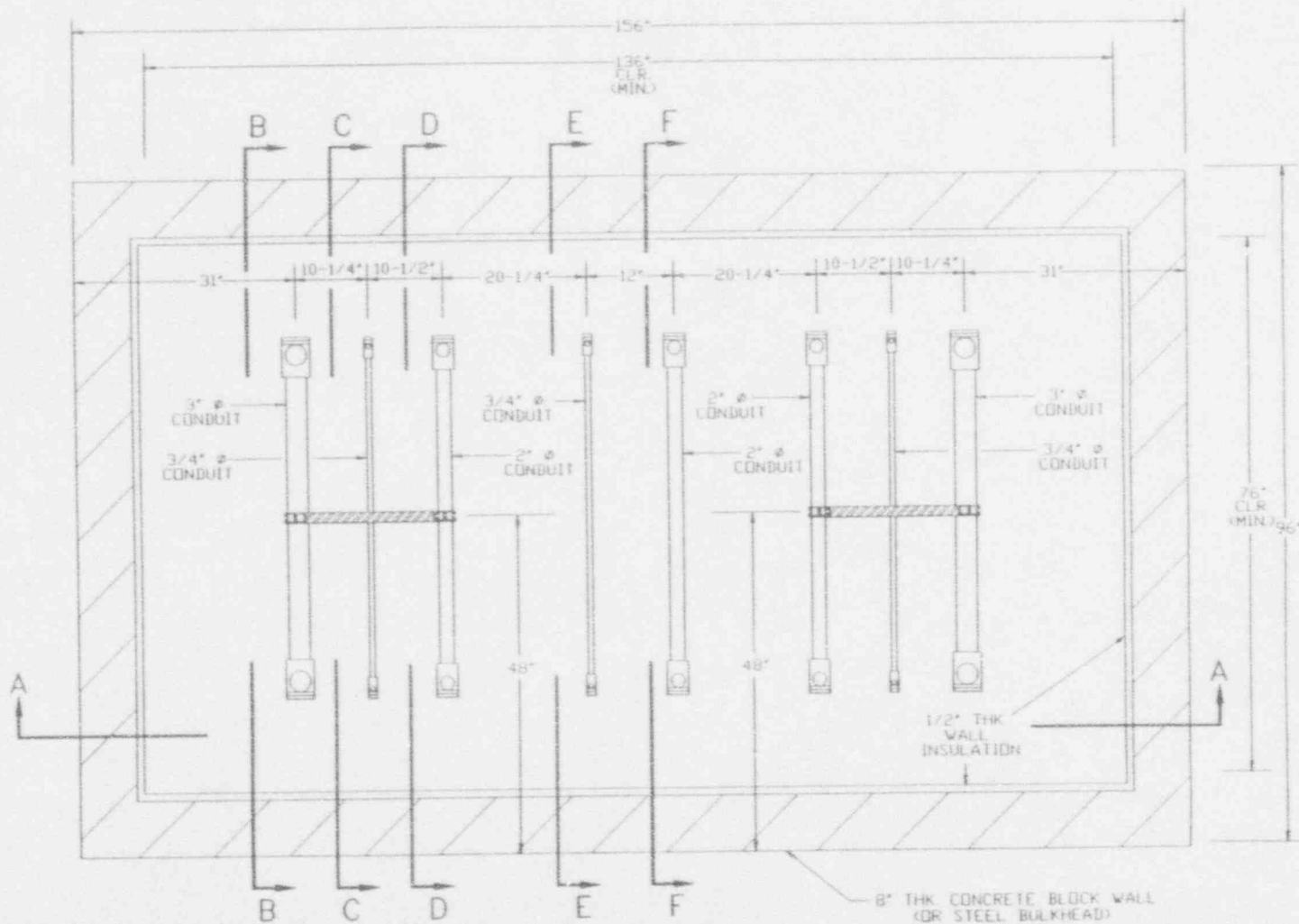
- ◆ **Results (Cont.)**

- » **6" EXCEEDED AVERAGE TEMPERATURE CRITERION AT 50 MINUTES**
 - » **SATISFACTORY BARRIER CONDITION FOLLOWING HOSE STREAM TEST FOR 2", 4" AND 6" CONDUITS**
 - » **BARRIER OPENING FOLLOWING HOSE STREAM TEST FOR 3/4"**

PHASE 2 TESTING

- TEST 2-2 BASELINE AND UPGRADE BOX CONFIGURATION AROUND CONDUITS AND OUTDOOR CONDUIT APPLICATIONS- 1 HOUR

REV	DWN	DRG	VER	APVD
0	ELT	R20	Ref	R20
		1/14/94	1/19/94	1/19/94

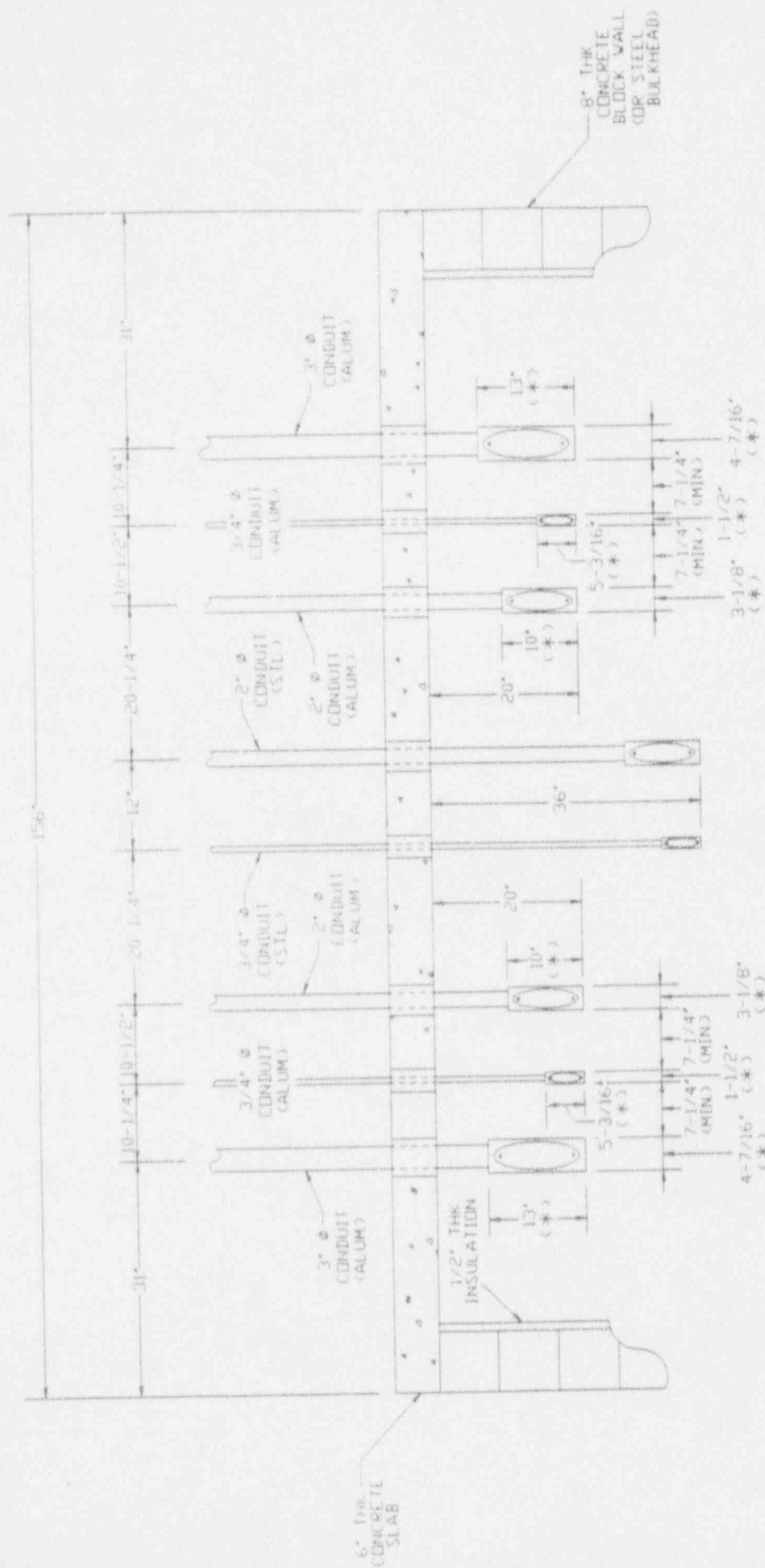


NOTES:

1. DIMENSIONS WITH ASTERISK (*) ARE NONCRITICAL AND PROVIDED FOR INFORMATION AND GENERAL CONFIGURATION PURPOSES.
2. ALL OTHER DIMENSIONS HAVE WORKING TOLERANCE OF +/- 2" UNL.
3. ○ DENOTES BILL OF MATERIAL ITEM NO. (SEE SH. 13A AND 13B)
4. REFER TO DWG. 0784-00001-D-000 FOR REVISION HISTORY, DESIGN CHANGE STATUS AND USE DESIGNATION.
5. INSTRUMENTATION REQUIREMENTS - THERMOCOUPLES SHALL BE INSTALLED AT 6" INTERVALS ALONG THE BOTTOM EXTERNAL SURFACE OF ALL CONDUITS AND FITTINGS. THERMOCOUPLES SHALL ALSO BE INSTALLED AT 6" INTERVALS ALONG A

ABB IMPELL CORP. PROJ. NO. 0784-00001
NUMARC PHASE 2 TEST PROGRAM
DWG. 0784-00001-D-002 SH. 3 REV. 0
TEST 2-2 (B1-A-Co/C1-E-75s/ C1-E-2s/B1-B-CoX)
FIG. 3 PLAN VIEW - BELOW DECK

REV	DWN	DRG	VP	APVD
0	ELT	RED 1/19/94	RED 1/19/94	RLO 1/19/94



FRONT VIEW
(A-A)

ABB IMPELL CORP PROJ. NO. 0784-00001
NUMARC PHASE 2 TEST PROGRAM REV. 0
DWG. 0784-00001-D-002 SH
TEST 2-2 (BI-A-Co/CI-E) CI-E-2s/BI
FIG 4 - FRONT

- NOTES:
1. DIMENSIONS WITH ASTERISK (*) ARE NONCRITICAL AND PROVIDED FOR INFORMATION AND GENERAL CONFIGURATION PURPOSES.
 2. ALL OTHER DIMENSIONS HAVE WORKING TOLERANCE OF $\pm 1/8$ " UNL.
 3. ○ DENOTES BILL OF MATERIAL ITEM NO. (SEE SH. 13A AND 13B)
 4. REFER TO DWG. 0784-00001-D-000 FOR REVISION HISTORY, DESIGN CHANGE STATUS AND USE DESIGNATION.

PHASE 2 TESTING

- TEST 2-2 BASELINE AND UPGRADE BOX CONFIGURATION AROUND CONDUITS AND OUTDOOR CONDUIT APPLICATIONS- 1 HOUR
 - ◆ 3/4", 2" AND 3" DIAMETER CONDUITS IN EACH BOX
 - ◆ 3/4" AND 2" DIAMETER CONDUITS FOR OUTDOOR APPLICATIONS W/ PRE-BUTTERED JOINTS
 - ◆ BASELINE BOX: PRE-BUTTERED 1/2" PANELS
 - ◆ UPGRADE BOX: POST-BUTTERED 1/2" PANELS WITH STRESS SKIN AND TROWEL GRADE REINFORCED AT JOINTS

PHASE 2 TESTING

- **TEST 2-2 (Cont.)**
 - ◆ **BOXES HILTI BOLTED TO CONCRETE SLAB**
 - ◆ **RESULTS:**
 - » **ALL CONDUIT TEMPERATURES IN BASELINE AND UPGRADE BOX APPLICATIONS MAINTAINED ACCEPTABLE TEMPERATURES FOR ONE HOUR**
 - » **3/4" OUTDOOR APPLICATION CONDUIT EXCEEDED AVERAGE TEMPERATURE CRITERION AT 26 MINUTES**

PHASE 2 TESTING

- **TEST 2-2**

- ◆ **RESULTS (Cont.)**

- » **2" OUTDOOR APPLICATION CONDUIT EXCEEDED AVERAGE TEMPERATURE CRITERION AT 35 MINUTES**
 - » **SATISFACTORY BARRIER CONDITION FOLLOWING HOSE STREAM TEST FOR THE UPGRADED BOX AND 2" OUTDOOR CONDUIT BARRIER APPLICATION**
 - » **3/4" OUTDOOR APPLICATION CONDUIT EXHIBITED BURN THROUGH AND THE BASELINE BOX HAD OPENINGS AT JOINTS FOLLOWING THE HOSE STREAM TEST**

PHASE 2 TESTING

- TEST 2-3 BASELINE CONDUITS
3 HOUR

REV.	DWN.	ORIG.	VER.	APVD.
1	ELT	DW 2/14/04	REP 2/14/04	DW 2/14/04

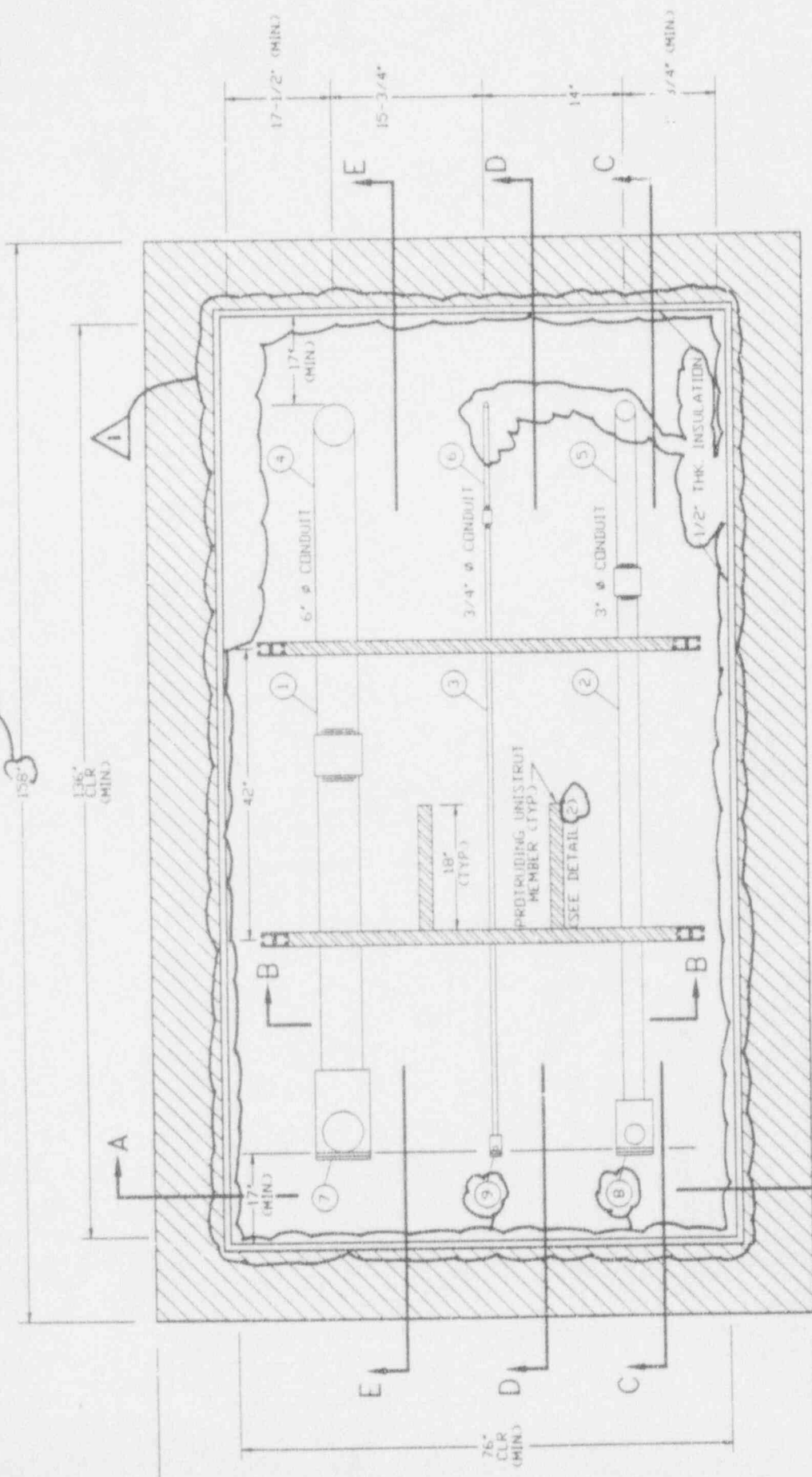


ABB IMPELL CORP PROJ. NO. 0784-00001
NUMERIC PHASE 2 TEST PROGRAM REV 1
TEST 2-3 (C3-A-750/C3-A-30/C3-A-60)
FIG. 2 PLAN VIEW -BELDU DECK

- NOTES:
1. DIMENSIONS WITH ASTERISK (*) ARE NONCRITICAL AND PROVIDED FOR INFORMATION AND GENERAL CONFIGURATION PURPOSES.
 2. ALL OTHER DIMENSIONS HAVE WORKING TOLERANCE OF +/- 2" UNL.
 3. () DENOTES BILL OF MATERIAL ITEM NO. (SEE SH 11)
 4. REFER TO DWG. 0784-00001-D-000 FOR REVISION HISTORY, DESIGN CHANGE STATUS AND USE DESIGNATION.
 5. INSTRUMENTATION REQUIREMENTS - THERMOCOUPLES SHALL BE INSTALLED AT 6" INTERVALS ALONG THE BOTTOM EXTERNAL SURFACE OF ALL CONDUITS AND FITTINGS. THERMOCOUPLES SHALL ALSO BE INSTALLED AT 6" INTERVALS ALONG A 6" AWG BARE COPPER CONDUCTOR LOCATED INSIDE EACH CONDUIT ASSEMBLY.
 6. FOR PROTECTING INSTANT MEMBER DETAIL SEE SH10.

PHASE 2 TESTING

- **TEST 2-3 BASELINE CONDUITS
3 HOUR**

- ◆ 3/4", 3" AND 6" DIAMETER CONDUITS

- ◆ PRE-BUTTERED JOINTS

- ◆ RESULTS:

- » 3/4" EXCEEDED AVERAGE TEMPERATURE CRITERION AT 63 MINUTES AND SINGLE MAX. TEMPERATURE CRITERION AT 69 MINUTES

- » 3" EXCEEDED SINGLE MAX. TEMPERATURE CRITERION AT 91 MINUTES AND AVERAGE TEMPERATURE CRITERION AT 99 MINUTES

PHASE 2 TESTING

- TEST 2-3

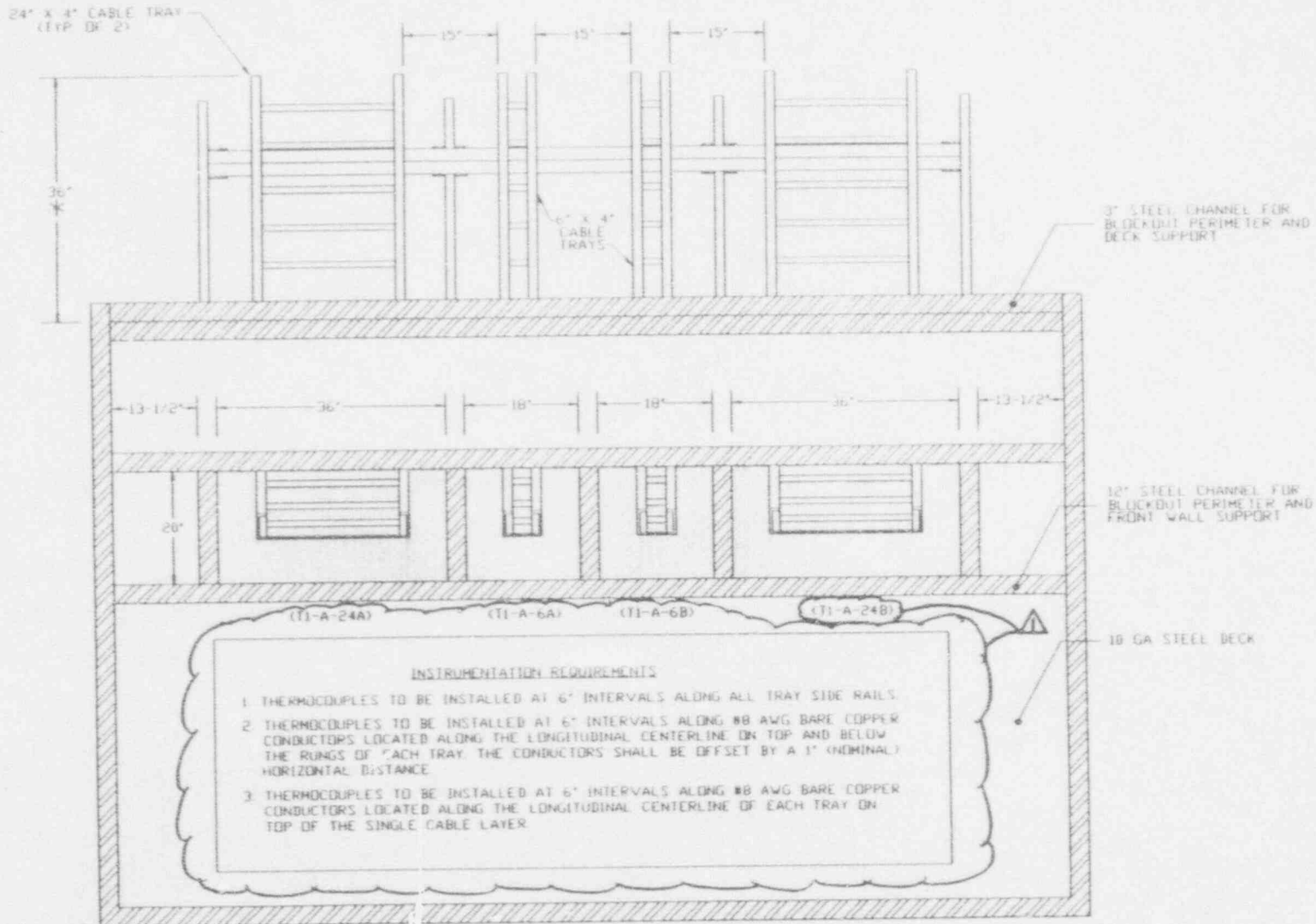
- ◆ RESULTS (Cont.)

- » 6" EXCEEDED AVERAGE TEMPERATURE CRITERION AT 102 MINUTES
 - » FOLLOWING THE HOSE STREAM TEST SIGNIFICANT BURN THROUGH WAS NOTED FOR THE 3/4" AND SMALL OPENINGS WERE OBSERVED IN THE BARRIER FOR THE 3" AND 6" CONDUITS

PHASE 2 TESTING

- TEST 2-7 BASELINE CABLE TRAYS
1 HOUR

REV	BY	DATE	APP	DATE
1	ELT	12/20/93	ALD	12/20/93

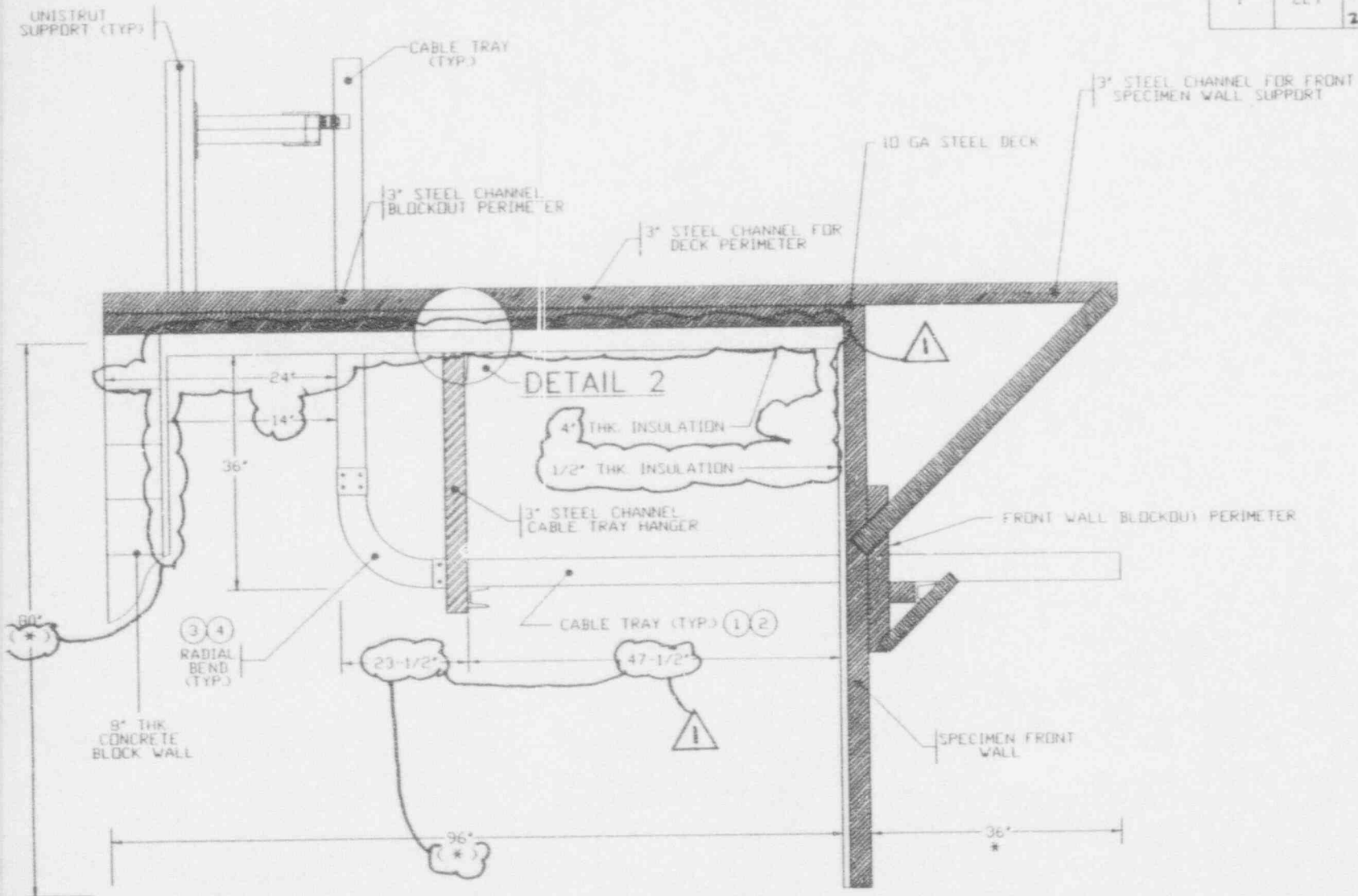


NOTES:

1. DIMENSIONS WITH ASTERISK (*) ARE NONCRITICAL AND PROVIDED FOR INFORMATION AND GENERAL CONFIGURATION PURPOSES.
2. ALL OTHER DIMENSIONS HAVE WORKING TOLERANCE OF ± 0.25 UNLESS OTHERWISE SPECIFIED.
3. - DENOTES BILL OF MATERIAL ITEM NO. (SEE SH 7).
4. REFER TO DWG. 0784-00001-D-000 FOR REVISION HISTORY, DESIGN CHANGE STATUS AND USE DESIGNATION.
5. BLOCKOUTS IN FRONT WALL TO BE FILLED WITH 60W CORNING 3-6548 RTV SILICONE FOAM TO 12" DEPTH.
6. TEST INSTRUMENTATION REQUIREMENTS ARE SPECIFIED ABOVE. REFER TO TEST PLAN FOR FURTHER INFORMATION.

ABB IMPELL CORP PROJ NO. 0784-00001
NUMARC PHASE 2 TEST PROGRAM
DWG. 0784-00001-D-007 SH 2 REV 1
TEST 2-7 (T1-A-6A / T1-A-6B) (T1-A-24A / T1-A-24B)
FIG 2 - FRONT ELEVATION

REV.	DWN	ORIG	VER	APVD
1	ELT	RLO	REP	RLO
		2/21/94	2/21/94	2/21/94



NOTES:

1. DIMENSIONS WITH ASTERISK (*) ARE NONCRITICAL AND PROVIDED FOR INFORMATION AND GENERAL CONFIGURATION PURPOSES.
2. ALL OTHER DIMENSIONS HAVE WORKING TOLERANCE OF +/- 2" UNLT
3. () DENOTES BILL OF MATERIAL ITEM NO (SEE SH 7)
4. REFER TO DWG. 0784-00001-D-000 FOR REVISION HISTORY, DESIGN CHANGE STATUS AND USE DESIGNATION

ABB IMPELL CORP.
PROJ. NO. 0784-00001

NUMARC PHASE 2 TEST PROGRAM

DWG. 0784-00001-D-007 SH 3
REV 1

TEST 2-7
(T1-A-6A / T1-A-6B)
(T1-A-24A / T1-A-24B)

FIG. 3 TYPICAL ELEVATION VIEW

PHASE 2 TESTING

- **TEST 2-7 BASELINE CABLE TRAYS
1 HOUR**

- ◆ TWO CABLE TRAYS, BASELINE FOUR PANEL APPLICATION- TRAY A- 24" WIDE x 4" DEEP, TRAY B- 6" WIDE x 4" DEEP
- ◆ TWO CABLE TRAYS, BASELINE SCORE AND FOLD APPLICATION- TRAY D- 24" WIDE x 4" DEEP, TRAY C- 6" WIDE x 4" DEEP
- ◆ PRE-BUTTERED JOINTS
- ◆ SINGLE LAYER OF CABLES - APPROXIMATELY 15% FILL

PHASE 2 TESTING

- TEST 2-7 (Cont.)

- ◆ RESULTS:

- » TRAY A (24" x 4") FOUR PIECE APPLICATION EXCEED SINGLE MAX. TEMPERATURE CRITERION ON THE BARE # 8 CONDUCTOR BELOW TRAY RUNGS AT 21 MINUTES
 - » TRAY D (24" x 4") SCORE AND FOLD APPLICATION EXCEEDED SINGLE MAX. TEMPERATURE CRITERION ON THE BARE # 8 CONDUCTOR BELOW TRAY RUNGS AT 23 MINUTES

PHASE 2 TESTING

- TEST 2-7

- ◆ RESULTS (Cont.)

- » TRAY C (6" x 4") SCORE AND FOLD APPLICATION EXCEEDED AVERAGE AND SINGLE MAX. TEMPERATURE CRITERION ON THE TRAY RAILS AT 48 MINUTES
 - » TRAY B (6" x 4") FOUR PIECE APPLICATION EXCEEDED AVERAGE TEMPERATURE CRITERION ON THE TRAY RAILS AT 48 MINUTES
 - » SATISFACTORY BARRIER CONDITION FOLLOWING HOSE STREAM TEST FOR TRAY B

PHASE 2 TESTING

- TEST 2-7

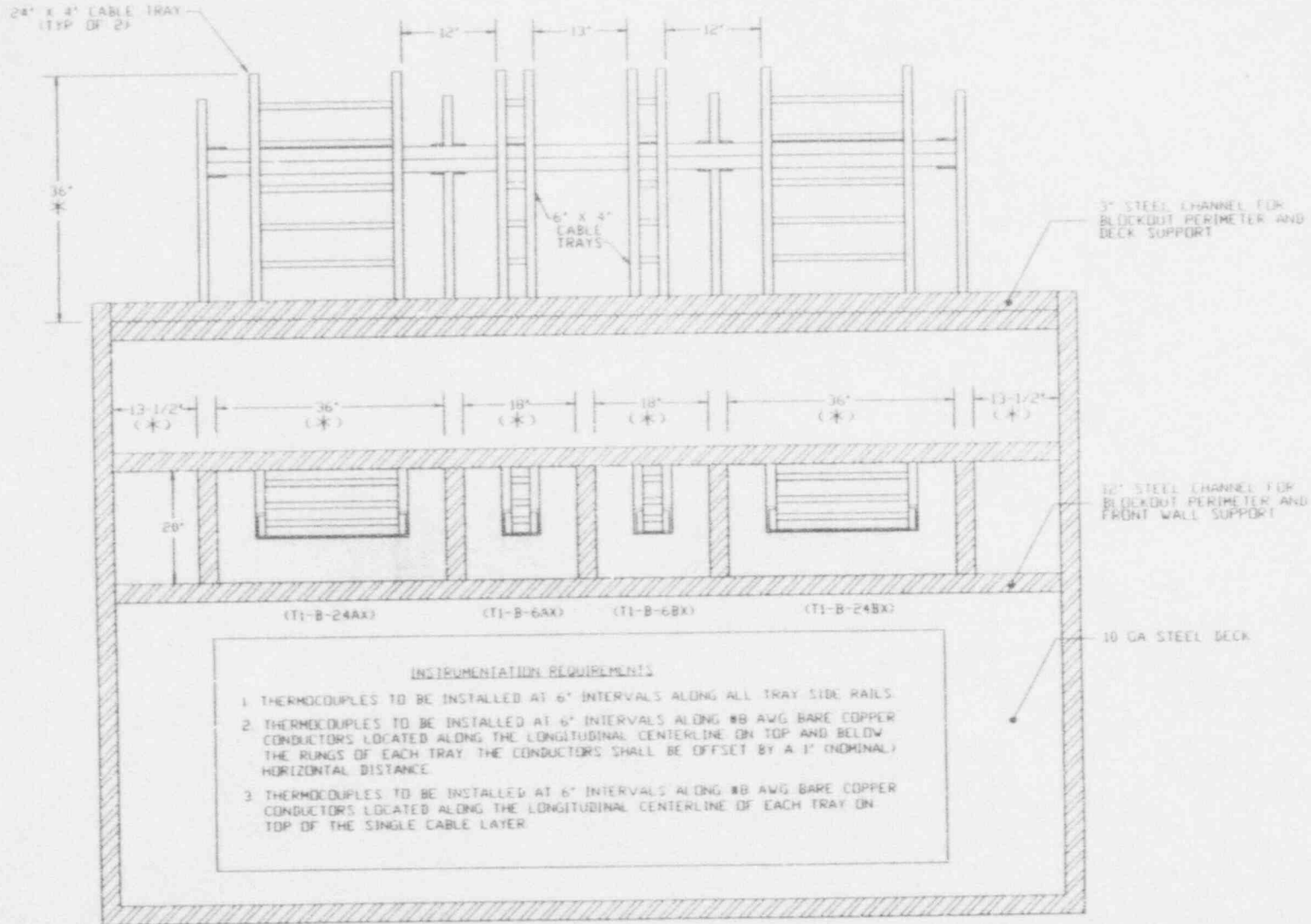
- ◆ RESULTS (Cont.)

- » BURN THROUGH BARRIER OPENINGS WERE OBSERVED FOLLOWING THE HOSE STREAM TEST FOR TRAYS A, C AND D

PHASE 2 TESTING

- TEST 2-8 CABLE TRAYS UPGRADE
1 HOUR

REV	DWN	ORIG	YER	APVD
0	ELT	RLO	REP	RLO
		1/1/94	1/1/94	1/1/94



INSTRUMENTATION REQUIREMENTS

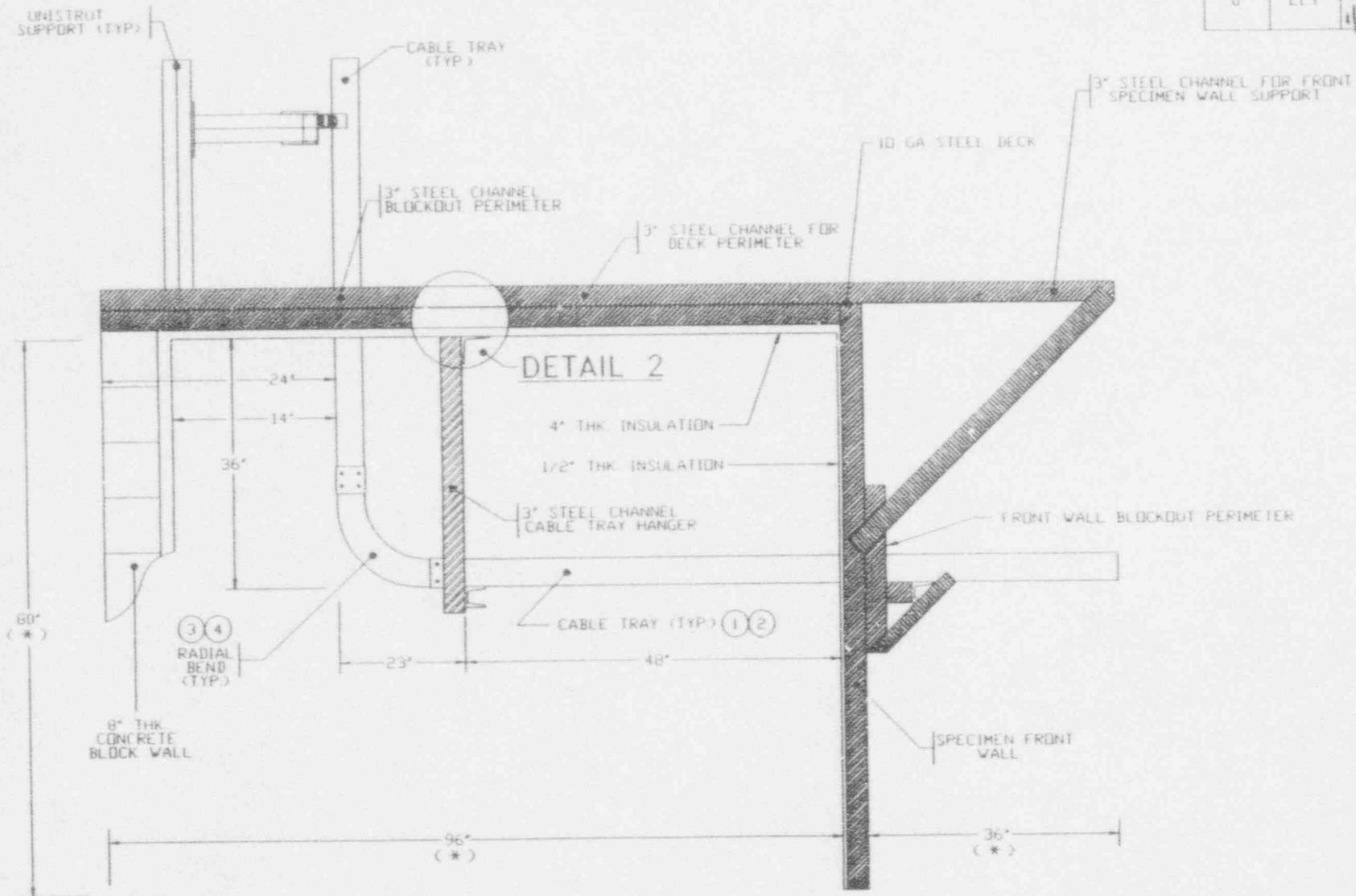
1. THERMOCOUPLES TO BE INSTALLED AT 6" INTERVALS ALONG ALL TRAY SIDE RAILS.
2. THERMOCOUPLES TO BE INSTALLED AT 6" INTERVALS ALONG #8 AWG BARE COPPER CONDUCTORS LOCATED ALONG THE LONGITUDINAL CENTERLINE ON TOP AND BELOW THE RINGS OF EACH TRAY. THE CONDUCTORS SHALL BE OFFSET BY A 1" (NOMINAL) HORIZONTAL DISTANCE.
3. THERMOCOUPLES TO BE INSTALLED AT 6" INTERVALS ALONG #8 AWG BARE COPPER CONDUCTORS LOCATED ALONG THE LONGITUDINAL CENTERLINE OF EACH TRAY ON TOP OF THE SINGLE CABLE LAYER.

NOTES:

1. DIMENSIONS WITH ASTERISK (*) ARE NONCRITICAL AND PROVIDED FOR INFORMATION AND GENERAL CONFIGURATION PURPOSES.
2. ALL OTHER DIMENSIONS HAVE WORKING TOLERANCE OF $\pm 2'$ UNL.
3. ○ DENOTES BILL OF MATERIAL ITEM NO. (SEE SH 7)
4. REFER TO DWG. 0784-00001-D-000 FOR REVISION HISTORY, DESIGN CHANGE STATUS AND USE DESIGNATION.
5. BLOCKOUTS IN FRONT WALL TO BE FILLED WITH DOW CORNING J-654B RTV SILICONE FOAM TO 12" DEPTH.
6. TEST INSTRUMENTATION REQUIREMENTS ARE SPECIFIED ABOVE. REFER TO TEST

ABB IMPELL CORP PRD. NO. 0784-00001
NUMARC PHASE 2 TEST PROGRAM
DWG. 0784-00001-D-000 SH 2 REV. 0
TEST 2-B (T1-B-6AX / T1-B-6BX) (T1-B-24AX / T1-B-24BX)
FIG. 2 - FRONT ELEVATION

REV	DWN	ORIG	VER	APVD
0	ELI	RLO 1/11/94	RLO 1/11/94	RLO 1/11/94



NOTES:

1. DIMENSIONS WITH ASTERISK (*) ARE NONCRITICAL AND PROVIDED FOR INFORMATION AND GENERAL CONFIGURATION PURPOSES.
2. ALL OTHER DIMENSIONS HAVE WORKING TOLERANCE OF $\pm 2"$ UNL.
3. () - DENOTES BILL OF MATERIAL ITEM NO (SEE SH 7)
4. REFER TO DWG 0784-00001-D-000 FOR REVISION HISTORY, DESIGN CHANGE STATUS AND USE DESIGNATION.

ABB IMPELL CORP. PROJ. NO. 0784-00001
NUMARC PHASE 2 TEST PROGRAM
DWG. 0784-00001-D-008 SH 3 REV. 0
TEST 2-B (T1-B-6AX / T1-B-6BX) (T1-B-24AX / T1-B-24BX)
FIG. 3 TYPICAL ELEVATION VIEW

PHASE 2 TESTING

- **TEST 2-8 CABLE TRAYS UPGRADE
1 HOUR**
 - ◆ TWO CABLE TRAYS, UPGRADE FOUR PANEL APPLICATION- TRAY A (24" x 4"), W/ FIRE STOP, TRAY B (6" x 4")
 - ◆ TWO CABLE TRAYS, UPGRADE SCORE AND FOLD APPLICATION- TRAY D (24" x 4"), TRAY C (6" x 4")
 - ◆ POST-BUTTERED BASELINE JOINTS
 - ◆ EXTERNAL TROWEL GRADE 330-1 AND STRESS SKIN REINFORCEMENT AT JOINTS
 - ◆ SINGLE LAYER OF CABLES - APPROXIMATELY 15% FILL

PHASE 2 TESTING

- TEST 2-8 (Cont.)

- ◆ RESULTS:

- » TRAYS B, C AND D EXHIBITED ACCEPTABLE TEMPERATURES THROUGHOUT THE TEST
 - » TRAY A (24" x 4") FOUR PIECE APPLICATION EXCEEDED SINGLE MAX. TEMPERATURE CRITERION ON THE TRAY RAILS ADJACENT TO THE TRAY FIRE STOP AT 57 MINUTES. ALL OTHER THERMOCOUPLES FOR THIS TRAY EXHIBITED TEMPERATURES WELL BELOW TEMPERATURE CRITERION

PHASE 2 TESTING

- TEST 2-8

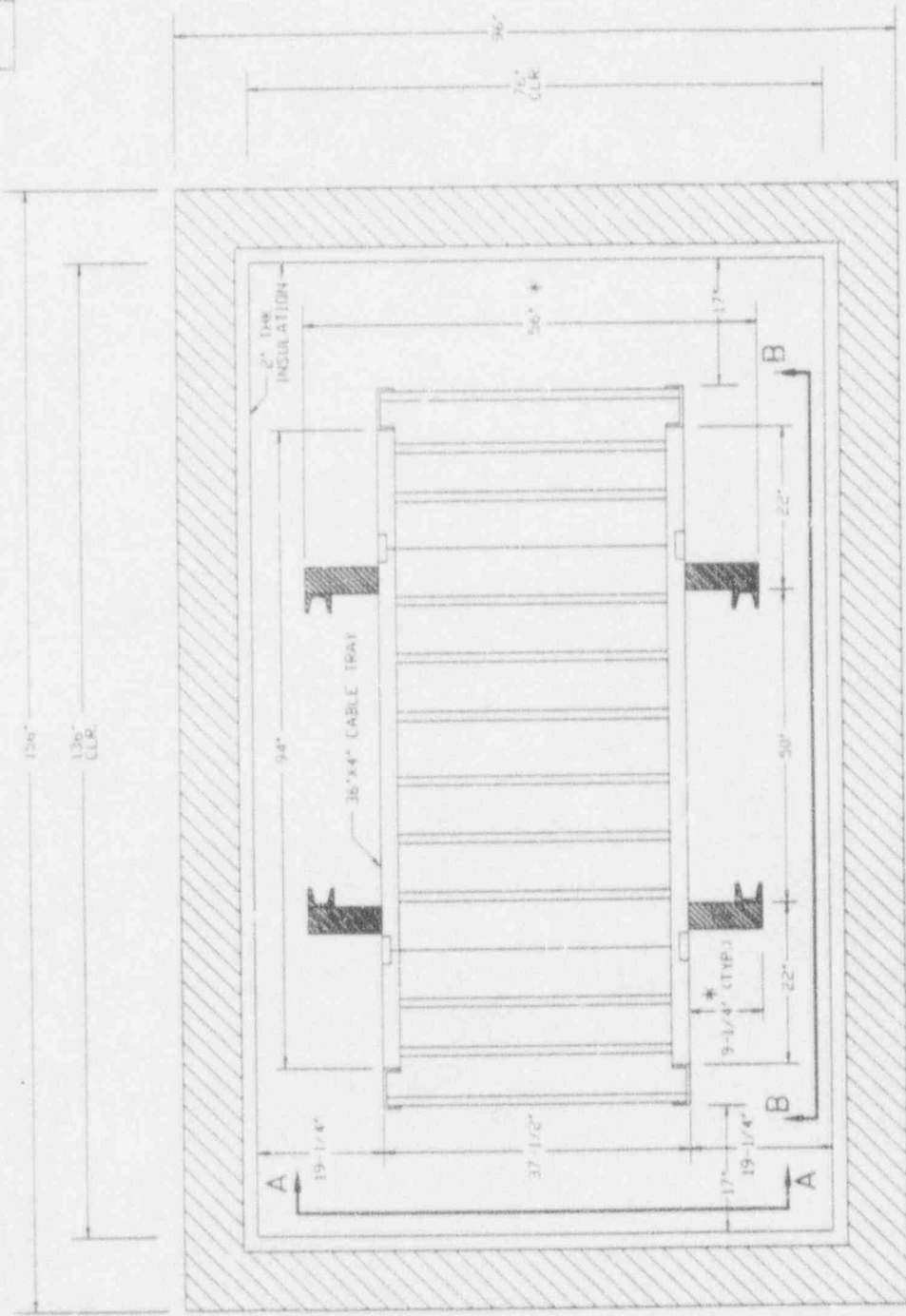
- ◆ RESULTS (Cont.)

- » SATISFACTORY BARRIER CONDITION
FOLLOWING HOSE STREAM TEST FOR
ALL TRAYS

PHASE 2 TESTING

- TEST 2-9 CABLE TRAY UPGRADE
1 HOUR

REV	DATE	BY	CHK	APP
0	ELT	REB	RJD	CBS
		11/10/17 12:14:53		



FRONT

8" CONCRETE BLOCK WALL

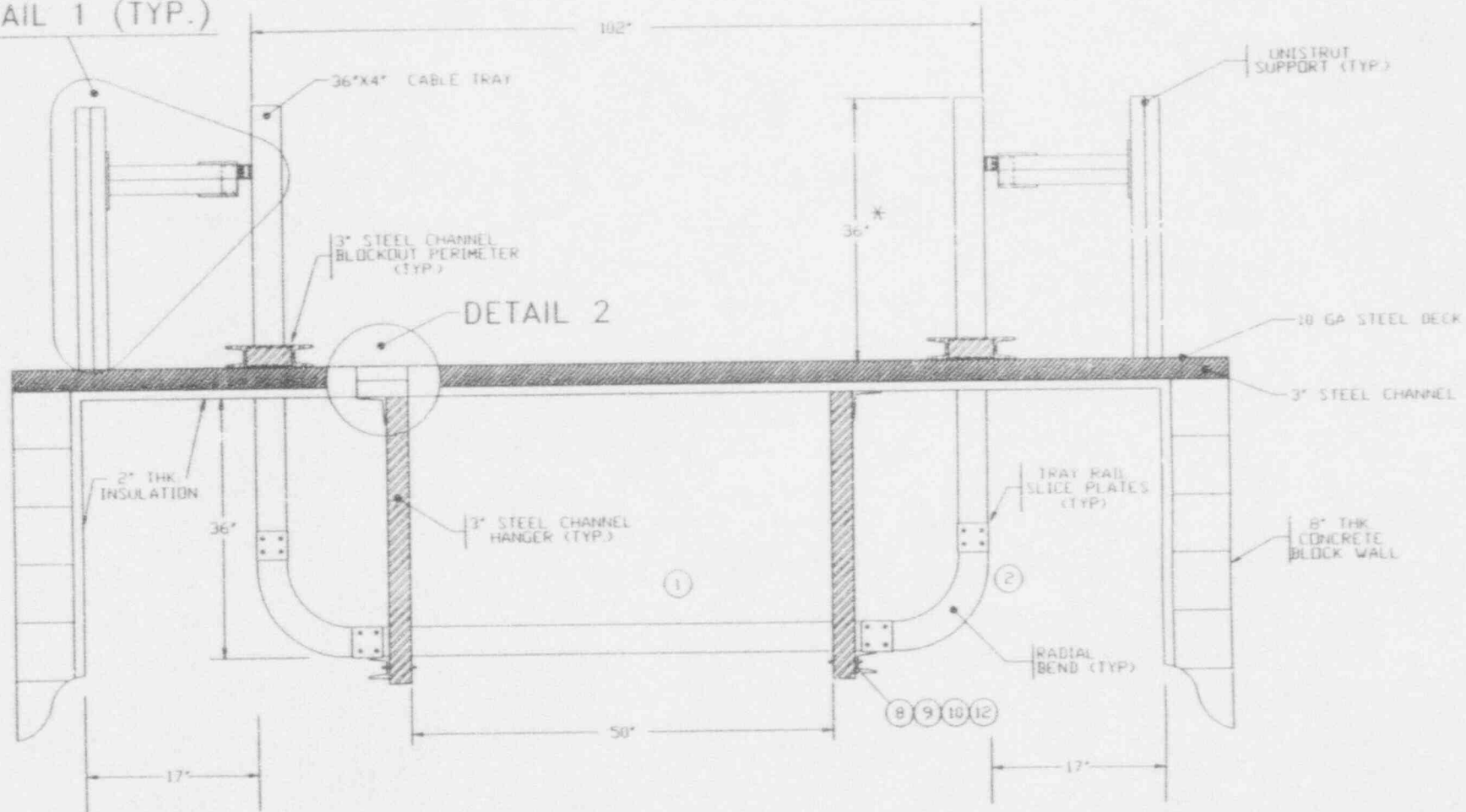
NOTES:

- 1 - DENOTES BILL OF MATERIAL ITEM NO. (SEE SH 7)
- 2 - K - DENOTES NOMINAL DIMENSION PROVIDED FOR INFORMATION AND GENERAL CONFIGURATION PURPOSES.
- 3 - ALL OTHER DIMENSIONS HAVE WORKING TOLERANCE OF +/- 2" UNL.
- 4 - SEE DWG. 0784-00001-D-000 FOR REVISION HISTORY, DESIGN CHANGE STATUS AND USE DESIGNATION.
- 5 - INSULATION MATERIALS REQUIREMENTS - THE ANCHORS, INSTALLED AT 6" INTERVALS ALONG BOTH TRAY SLIP WALLS, THE BRACKETS, INSTALLED AT 6" INTERVALS ALONG RB AND BARE COPPER CONDUCTORS AS FOLLOWS: (1) CONDUCTOR SECURED TO TOP OF TRAY RINGS, (2) CONDUCTOR POSITIONED ON TOP OF CABLES, (3) CONDUCTOR SECURED TO BOTTOM OF TRAY RINGS, (4) SLIGHTLY OFFSET FROM CONDUCTOR ON TOP OF TRAY RINGS.

ABB IMPELL CORP PROJ. NO. 0784-00001
NUMARC PHASE 2 TEST PROGRAM DWG. 0784-00001-D-009 SH 2 REV. 0
VEST 2-9 (11-A-36X)
FIG. 2 PLAN VIEW - BELOW DECK

REV	DWN	ORIG	VER	APVD
0	E.L.T.	REP 12/8/93	RLD 12/13/93	APVD 12-14-93

DETAIL 1 (TYP.)



SECTION B-B

NOTES:

- 1 ○ DENOTES BILL OF MATERIAL ITEM NO. (SEE SH 7)
- 2 * DENOTES NONCRITICAL DIMENSION PROVIDED FOR INFORMATION AND GENERAL CONFIGURATION PURPOSES
- 3 ALL OTHER DIMENSIONS HAVE WORKING TOLERANCE OF $\pm .2$ UNL
- 4 SEE DWG. 0784-00001-D-000 FOR REVISION HISTORY, DESIGN CHANGE STATUS AND USE DESIGNATION

ABB IMPELL CORP. PROJ. NO. 0784-00001
NUMARC PHASE 2 TEST PROGRAM
DWG. 0784-00001-D-009 SH 4 REV. 0
TEST 2-9 (T1-A-36X)
FIG. 4 ELEVATION VIEW

PHASE 2 TESTING

- TEST 2-9 CABLE TRAY UPGRADE
1 HOUR
 - ◆ 36" WIDE x 4" DEEP FOUR PIECE APPLICATION
 - ◆ BASELINE PRE-BUTTERED
 - ◆ EXTERNAL TROWEL GRADE AND STRESS SKIN REINFORCEMENT AT JOINTS
 - ◆ INTERNAL PRE-BANDING
 - ◆ SINGLE LAYER CABLE FILL (APPROX. 15%)
 - ◆ RESULTS:
 - » ALL TEMPERATURES WERE BELOW TEMPERATURE CRITERION THROUGHOUT THE TEST

PHASE 2 TESTING

- TEST 2-9

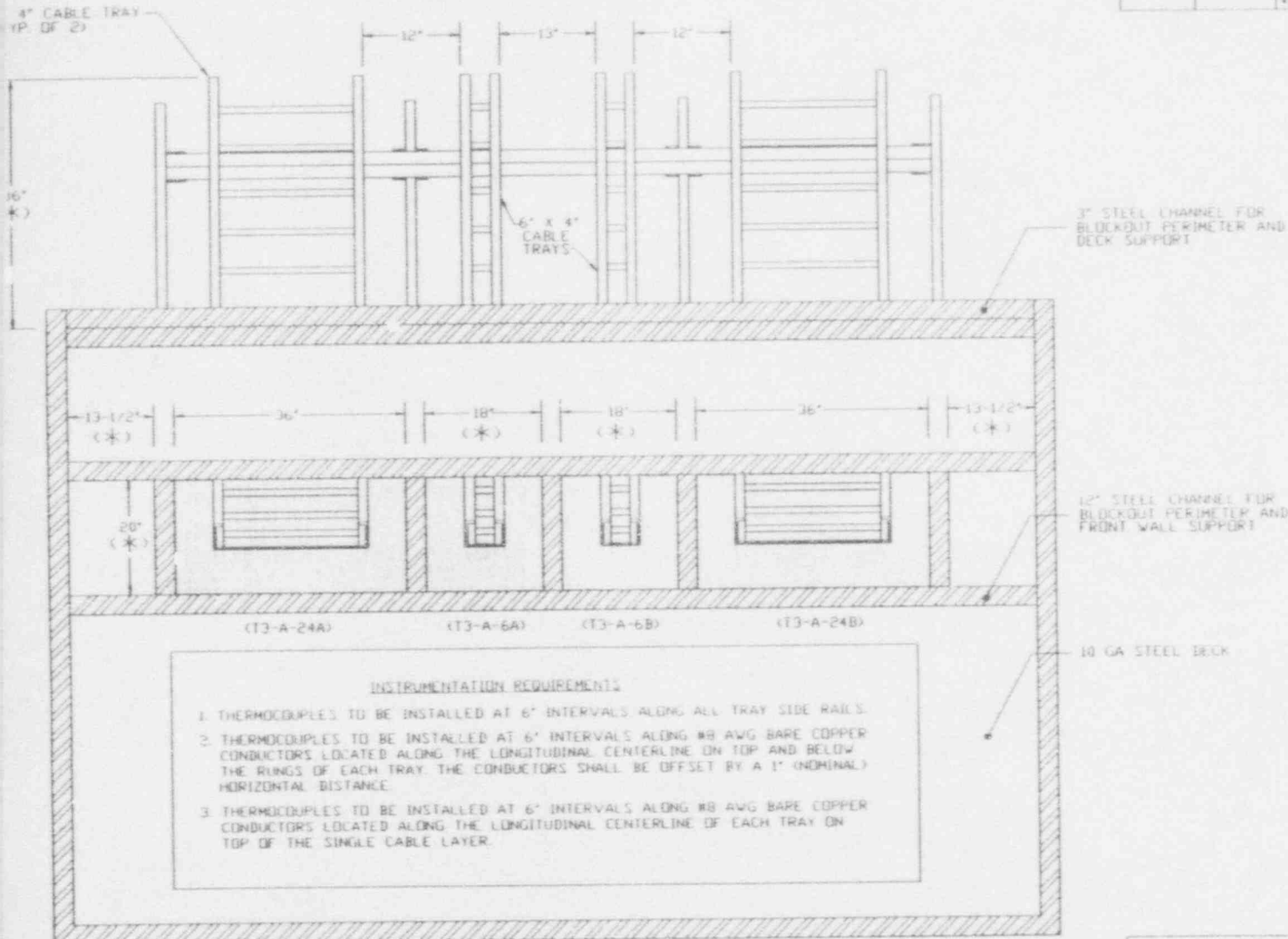
- ◆ RESULTS (Cont.)

- » SATISFACTORY BARRIER CONDITION
FOLLOWING HOSE STREAM TEST

PHASE 2 TESTING

- TEST 2-10 BASELINE CABLE TRAYS
3 HOUR

REV	DWN	DRG	VER	APVD
0	ELT	RLD 1/4/94	REP 1/5/94	RLD 1/5/94



NOTES:

1. DIMENSIONS WITH ASTERISK (*) ARE NONCRITICAL AND PROVIDED FOR INFORMATION AND GENERAL CONFIGURATION PURPOSES.
2. ALL OTHER DIMENSIONS HAVE WORKING TOLERANCE OF +/- .2" UNL.
3. ○ DENOTES BILL OF MATERIAL ITEM NO. (SEE SH B).
4. REFER TO DWG. 0784-00001-D-000 FOR REVISION HISTORY, DESIGN CHANGE STATUS AND USE DESIGNATION.
5. BLOCKOUTS IN FRONT WALL TO BE FILLED WITH DOW CORNING 3-6548 RTV SILICONE FOAM TO 12" DEPTH.
6. TEST INSTRUMENTATION REQUIREMENTS ARE SPECIFIED ABOVE. REFER TO TEST PLAN FOR FURTHER INFORMATION.

ABB IMPELL CORP.
PROJ. NO. 0784-00001

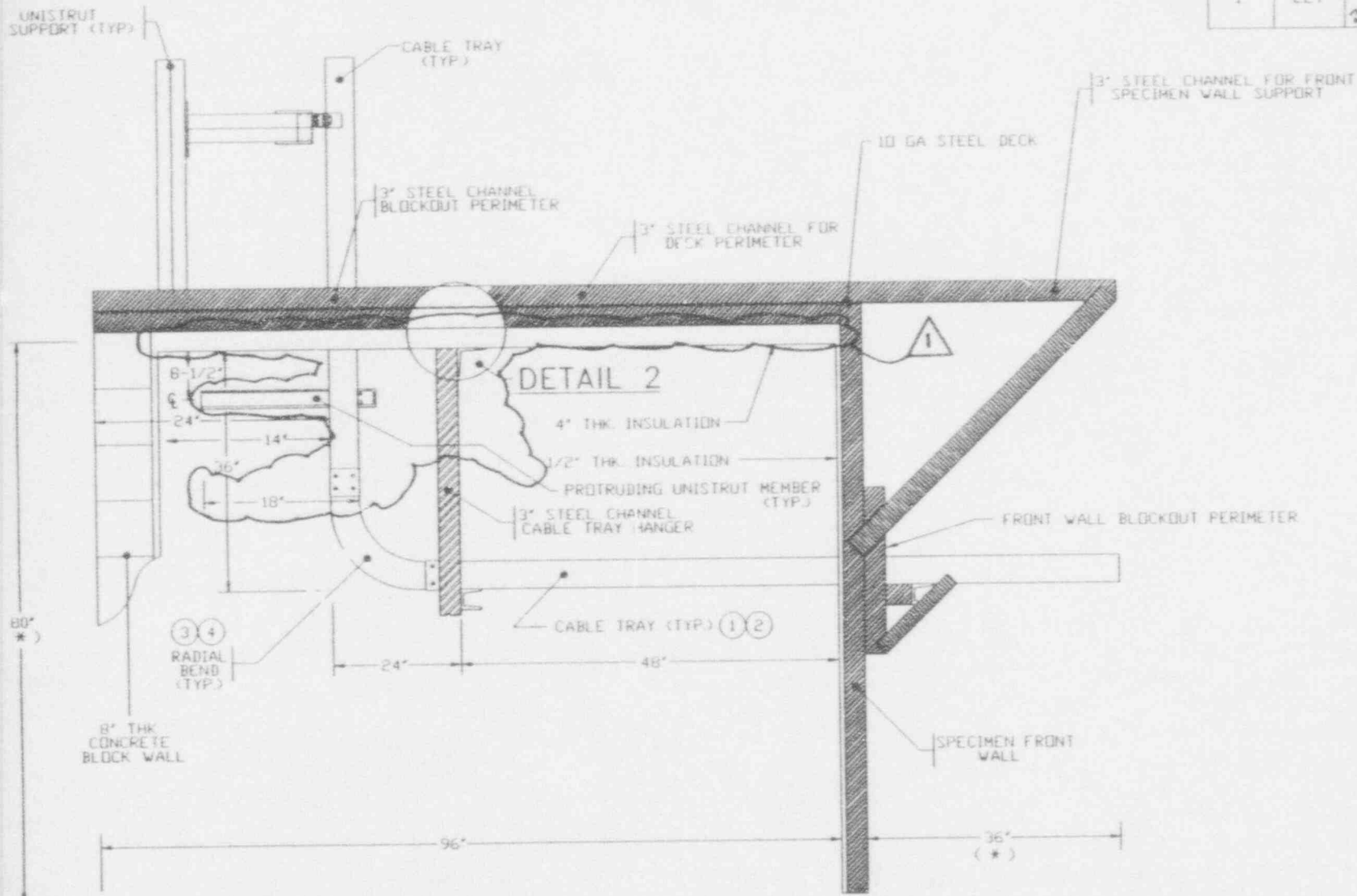
NUMARC PHASE 2 TEST PROGRAM

DWG. 0784-00001-D-010 SH 2
REV 0

TEST 2-10
(T3-A-6A / T3-A-6B)
(T3-A-24A / T3-A-24B)

FIG. 2 - FRONT ELEVATION

REV	DWN	ORIG	VER	APVD
1	ELT	RLO 2/21/94	REP 2/21/94	RLO 2/21/94



NOTES

- 1 DIMENSIONS WITH ASTERISK (*) ARE NONCRITICAL AND PROVIDED FOR INFORMATION AND GENERAL CONFIGURATION PURPOSES.
- 2 ALL OTHER DIMENSIONS HAVE WORKING TOLERANCE OF $\pm .2"$ UNO
- 3 \bigcirc - DENOTES BILL OF MATERIAL ITEM NO (SEE SH B)
- 4 REFER TO DWG. 0784-00001-B-000 FOR REVISION HISTORY, DESIGN CHANGE STATUS AND USE DESIGNATION.
- 5 FOR PROTRUDING UNISTRUT DETAIL SEE SH 7

ABB IMPELL CORP. PROJ. NO. 0784-00001
NUMARC PHASE 2 TEST PROGRAM
DWG. 0784-00001-B-010 SH 3 REV. 1
TEST 2-10 (T3-A-6A / T3-A-6B) (T3-A-24A / T3-A-24B)
FIG. 3 TYPICAL ELEVATION VIEW

PHASE 2 TESTING

- **TEST 2-10 BASELINE CABLE TRAYS
3 HOUR**

- ◆ TWO CABLE TRAYS, BASELINE FOUR PANEL APPLICATION- TRAY A- 24"WIDE x 4" DEEP, TRAY B- 6" WIDE x 4" DEEP
- ◆ TWO CABLE TRAYS, BASELINE SCORE AND FOLD APPLICATION- TRAY D- 24" WIDE x 4" DEEP, TRAY C- 6" WIDE x 4" DEEP
- ◆ PRE-BUTTERED BASELINE JOINTS
- ◆ SINGLE LAYER OF CABLES - APPROXIMATELY 15% FILL

PHASE 2 TESTING

- TEST 2-10 (Cont.)

- ◆ RESULTS:

- » TRAY A (24" x 4") FOUR PIECE APPLICATION EXCEED SINGLE MAXIMUM TEMPERATURE CRITERION ON THE TRAY RAILS AT 86 MINUTES
 - » TRAY D (24" x 4") SCORE AND FOLD APPLICATION EXCEEDED SINGLE MAXIMUM TEMPERATURE CRITERION ON THE BARE #8 CONDUCTOR BELOW TRAY RUNGS AT 85 MINUTES WHEN THE BARRIER OPENED

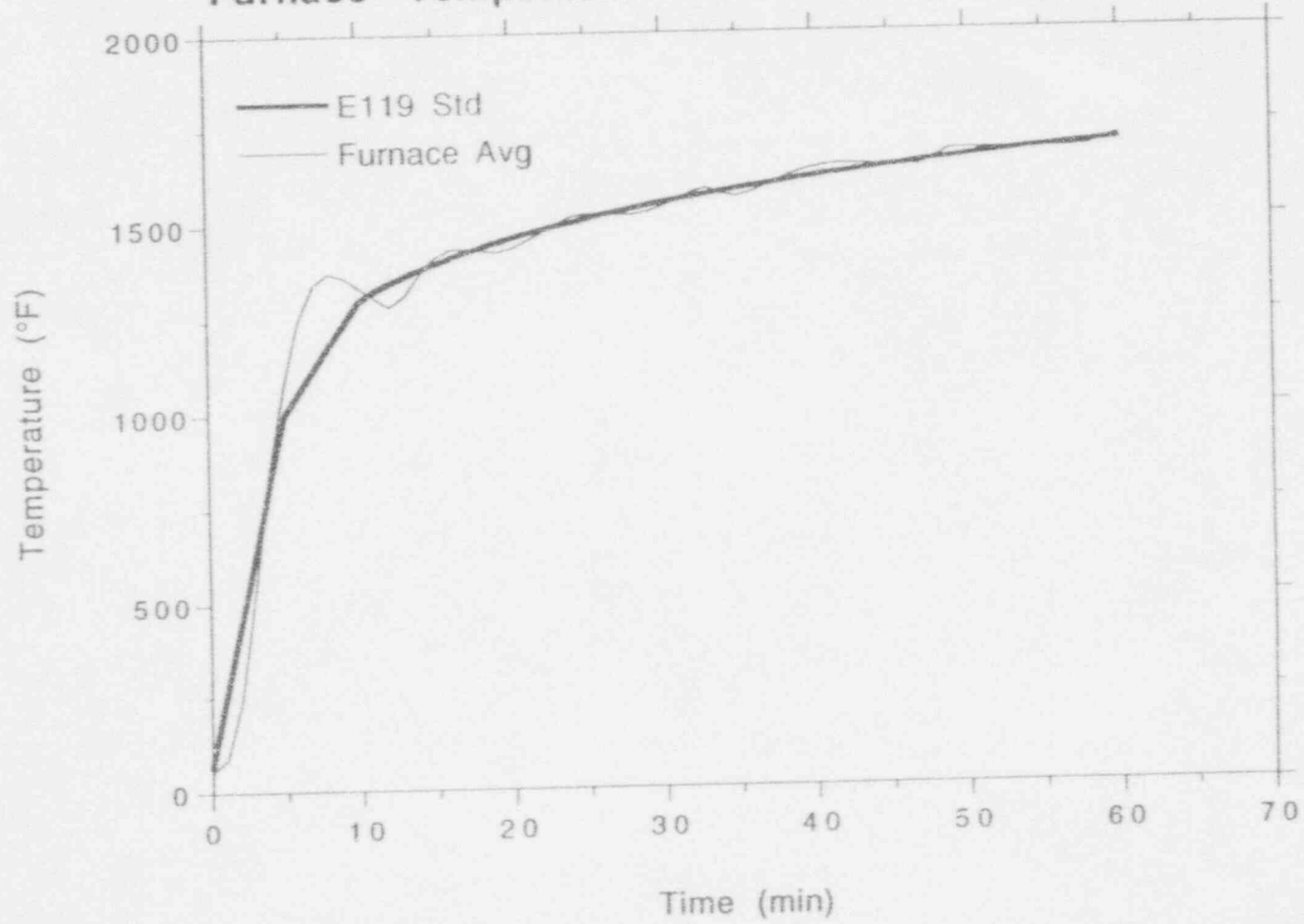
PHASE 2 TESTING

- TEST 2-10

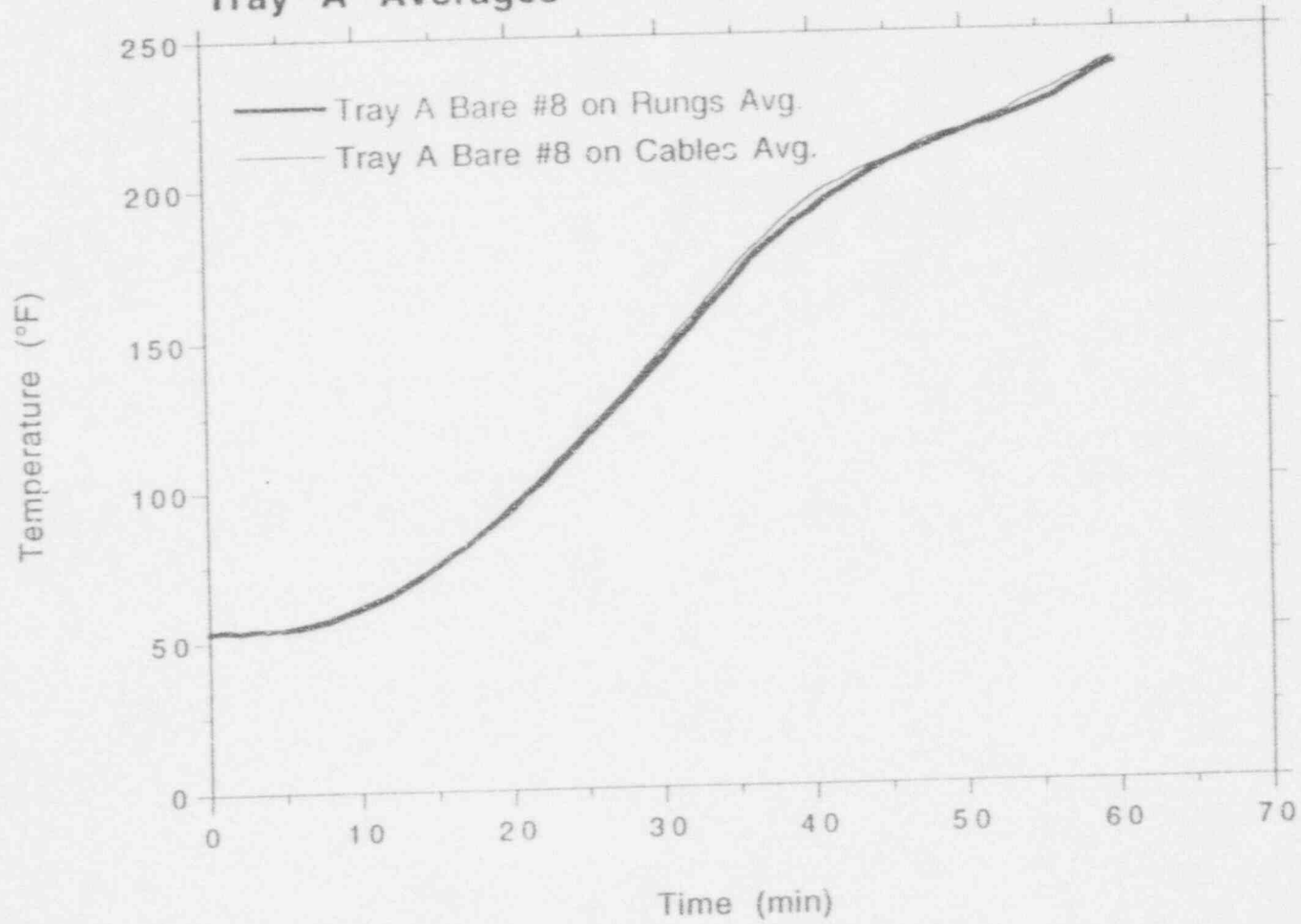
- ◆ RESULTS CONT.

- » TRAYS B AND C HAD TEMPERATURES BELOW TEMPERATURE CRITERION WHEN THE TEST WAS TERMINATED AT 86 MINUTES
 - » SATISFACTORY BARRIER CONDITION FOLLOWING HOSE STREAM TEST FOR TRAYS B AND C
 - » BARRIER OPENING NOTED FOR TRAY A FOLLOWING THE HOSE STREAM TEST
 - » BARRIER OPENED ON TRAY D AT 85 MINUTES

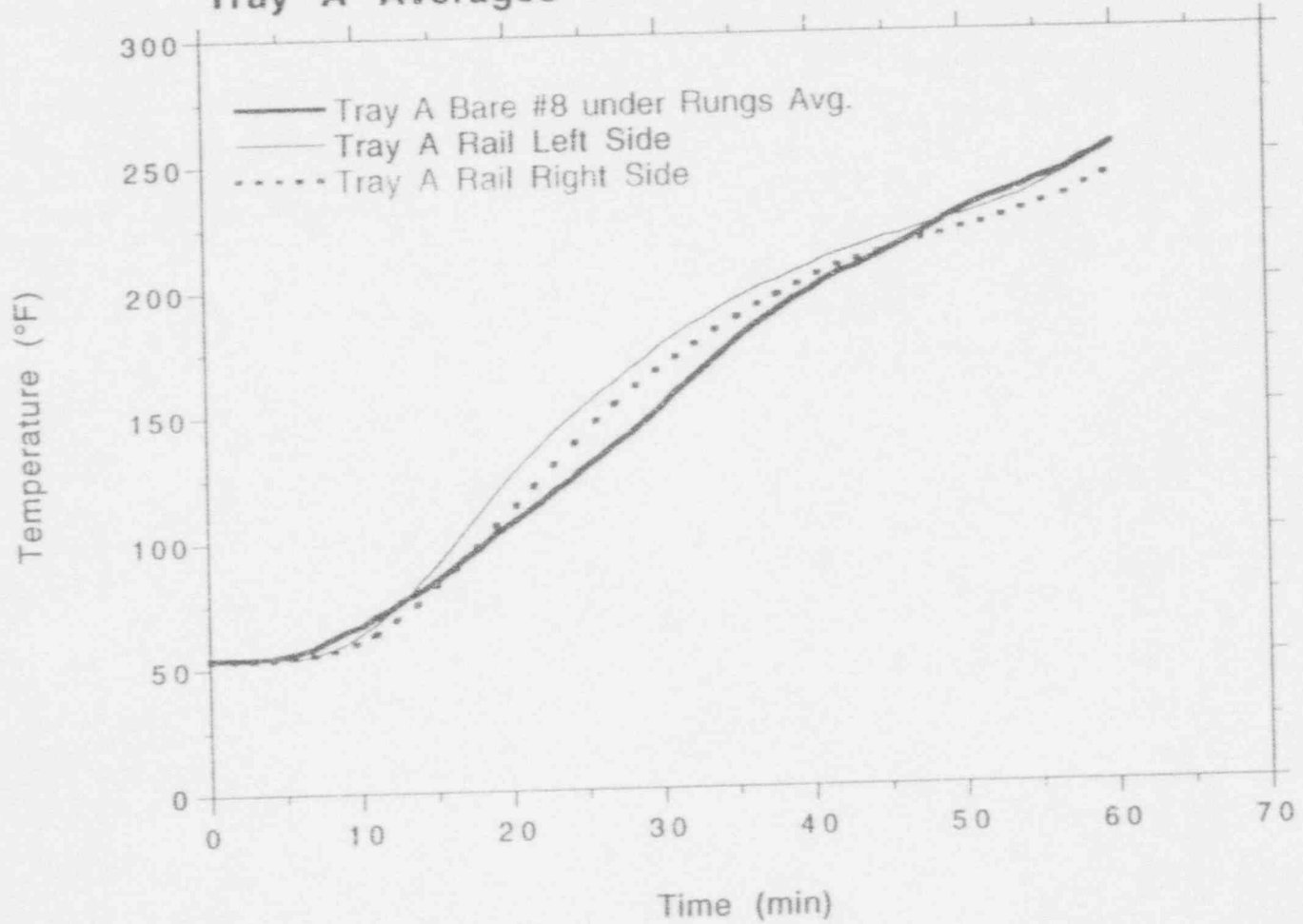
NUMARC Phase 2
Project No. 13890-96148
Test 2-8
Furnace Temperature



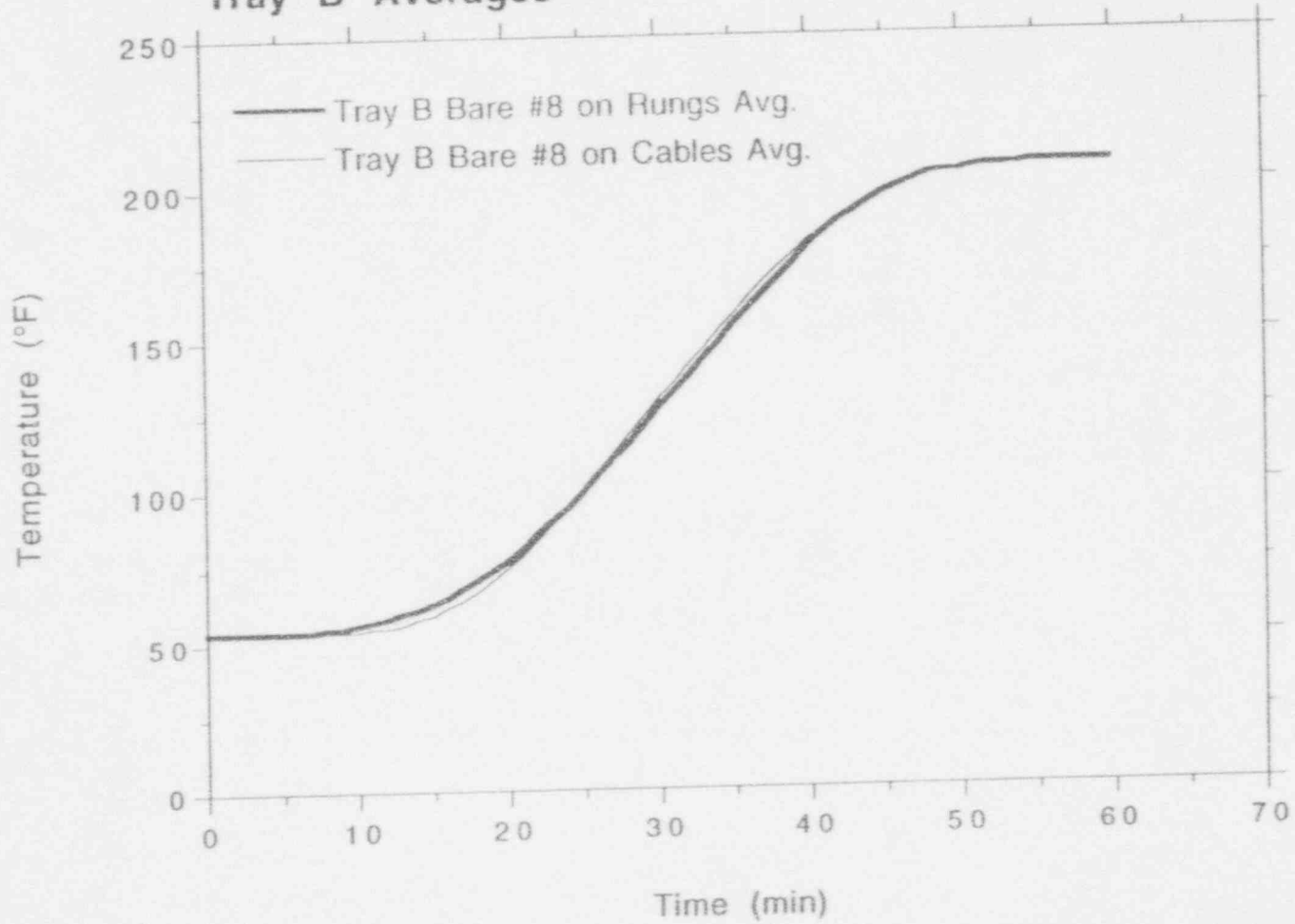
NUMARC Phase 2
Project No. 13890-96148
Test 2-8
Tray A Averages



NUMARC Phase 2
Project No. 13890-96148
Test 2-8
Tray A Averages

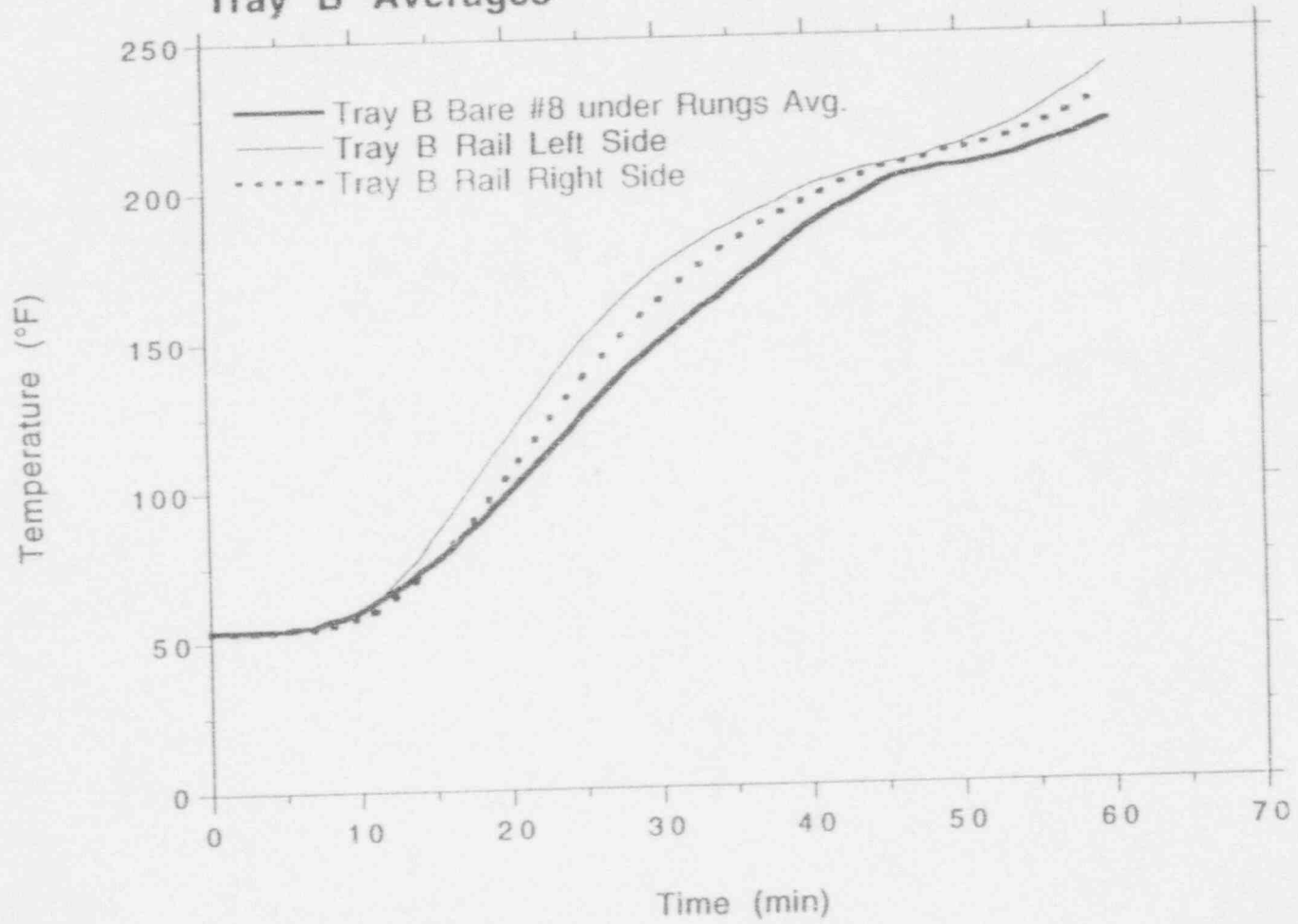


NUMARC Phase 2
Project No. 13890-96148
Test 2-8
Tray B Averages



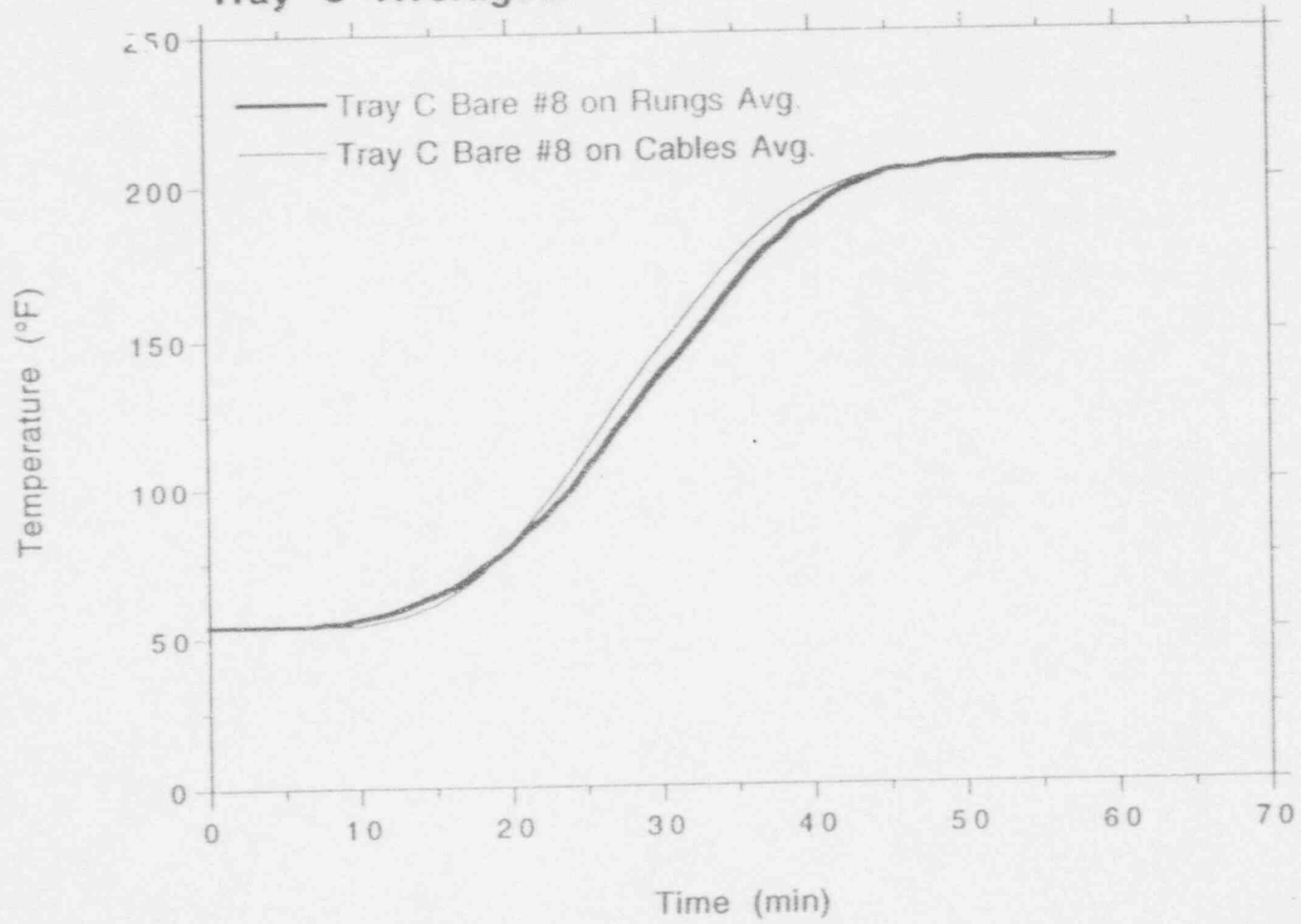
NUMARC Phase 2
Project No. 13890-96148
Test 2-8
Tray B Averages

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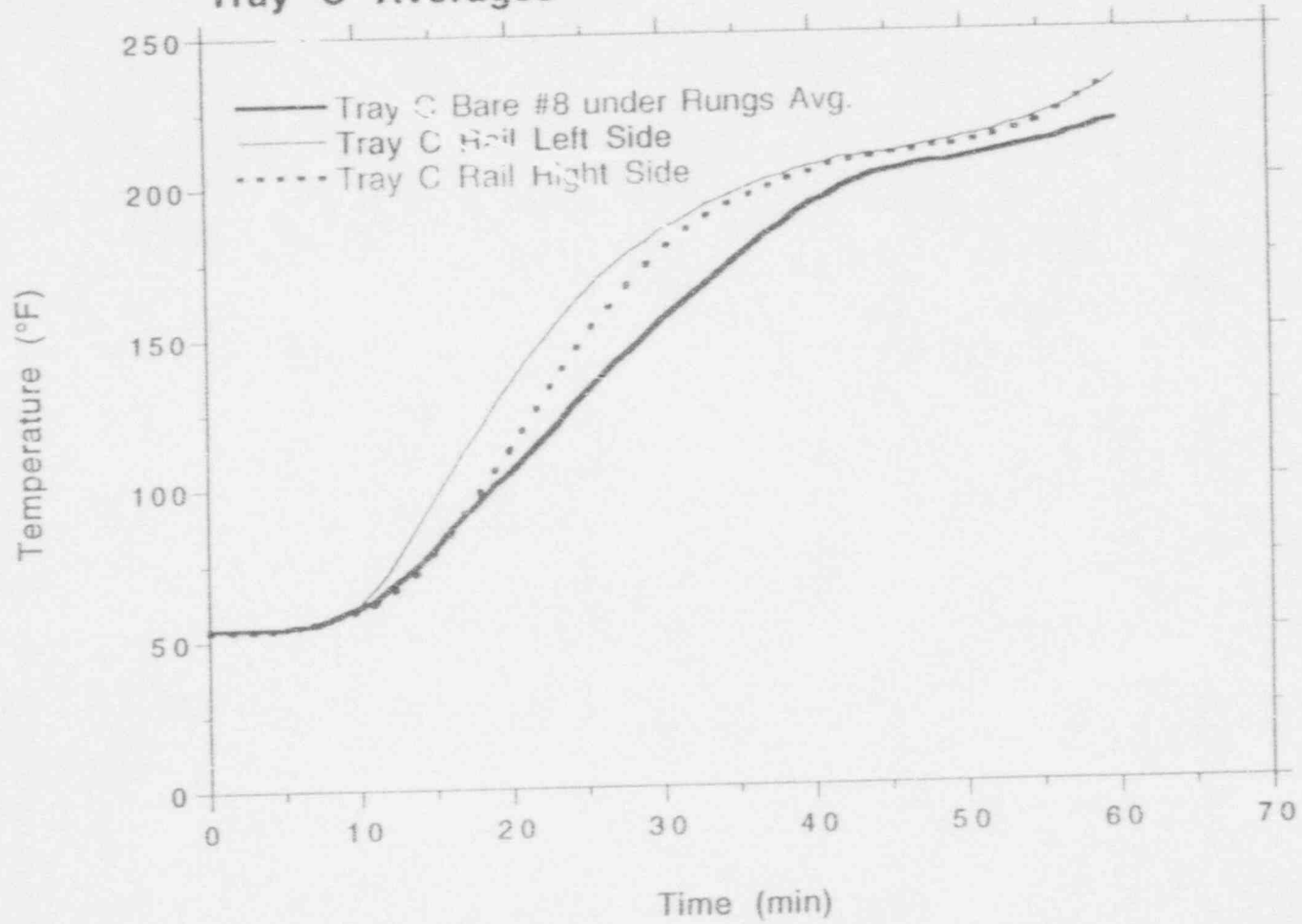


NUMARC Phase 2
Project No. 13890-96148
Test 2-8
Tray C Averages

13 AET

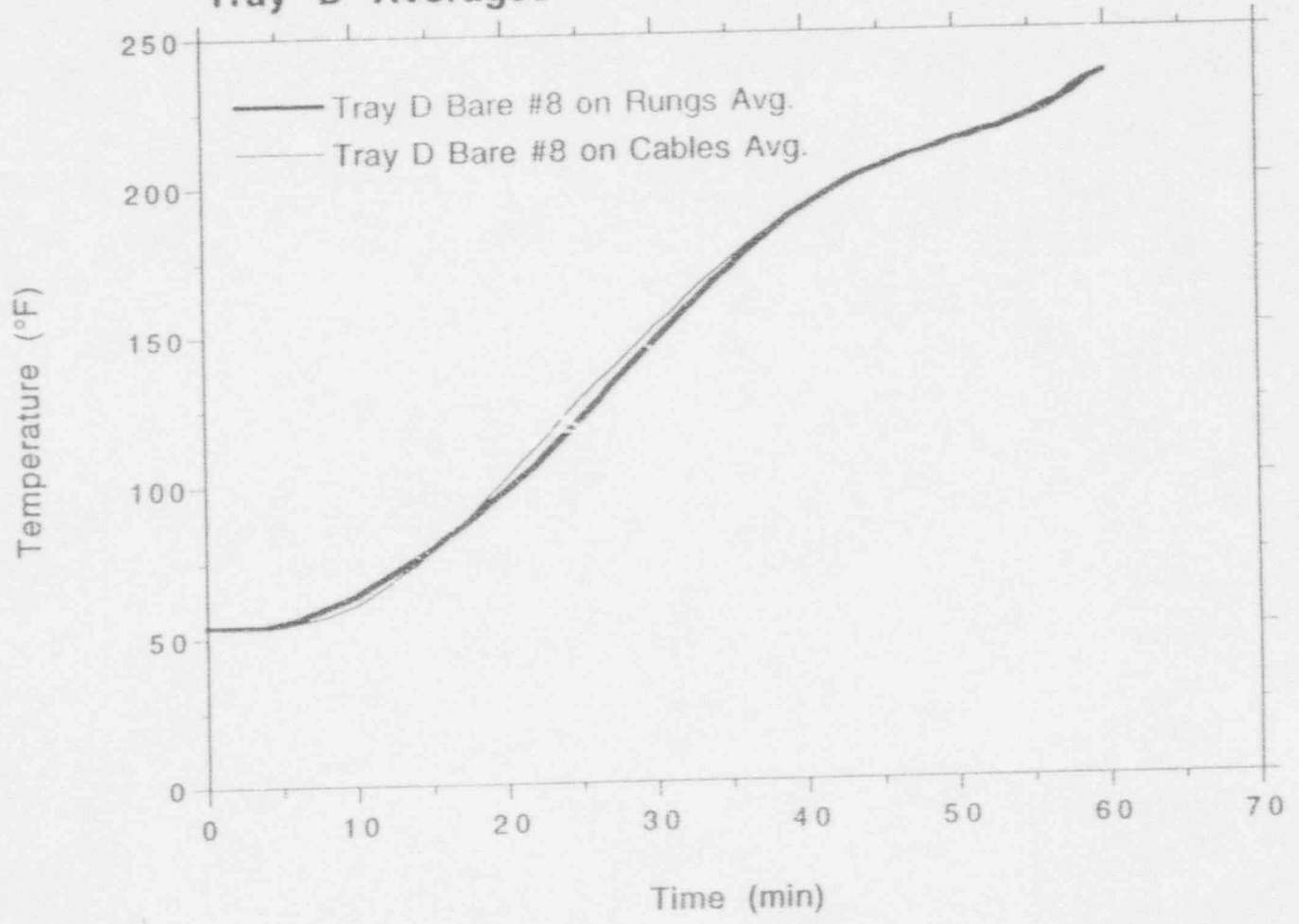


NUMARC Phase 2
Project No. 13890-96148
Test 2-8
Tray C Averages

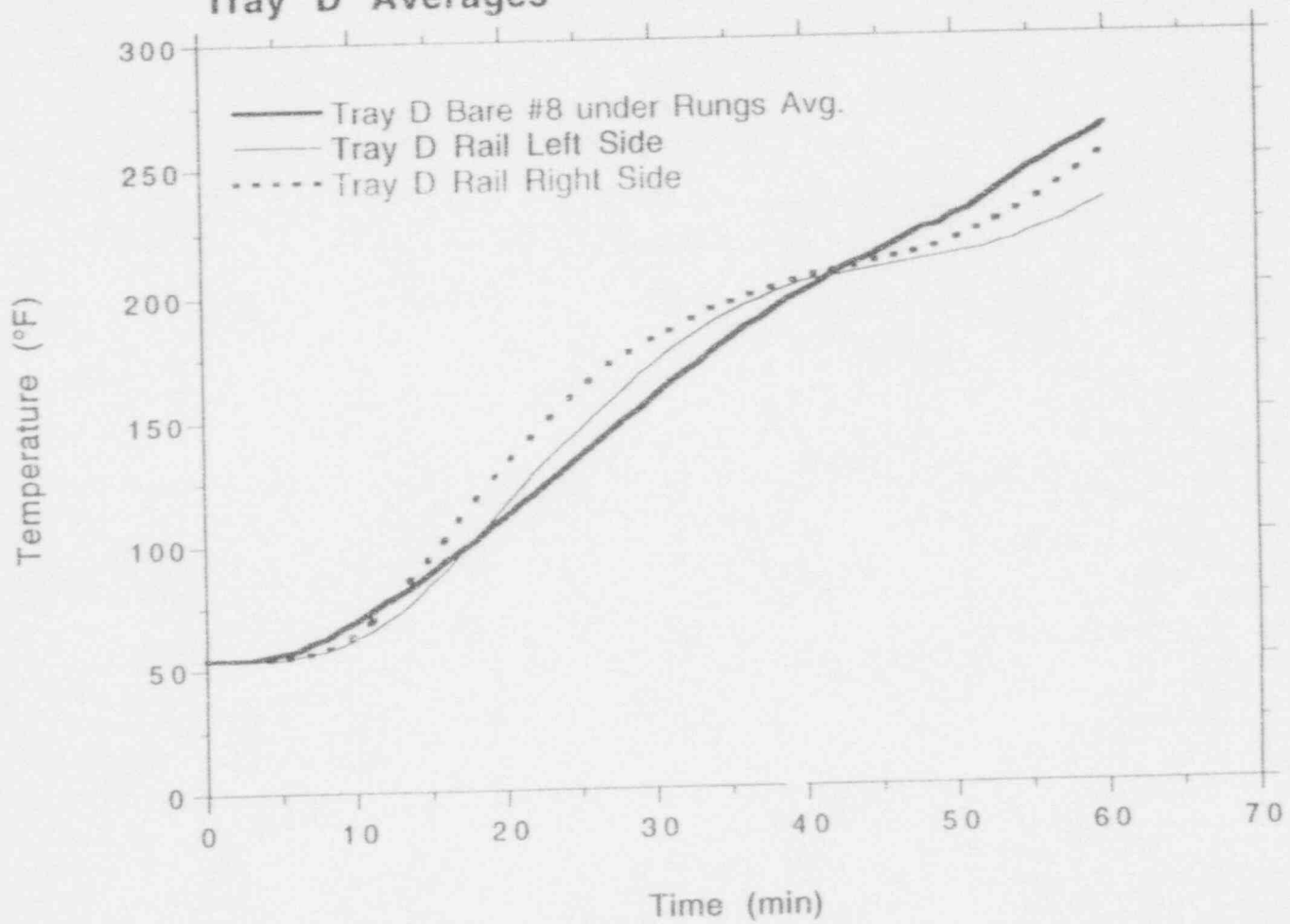


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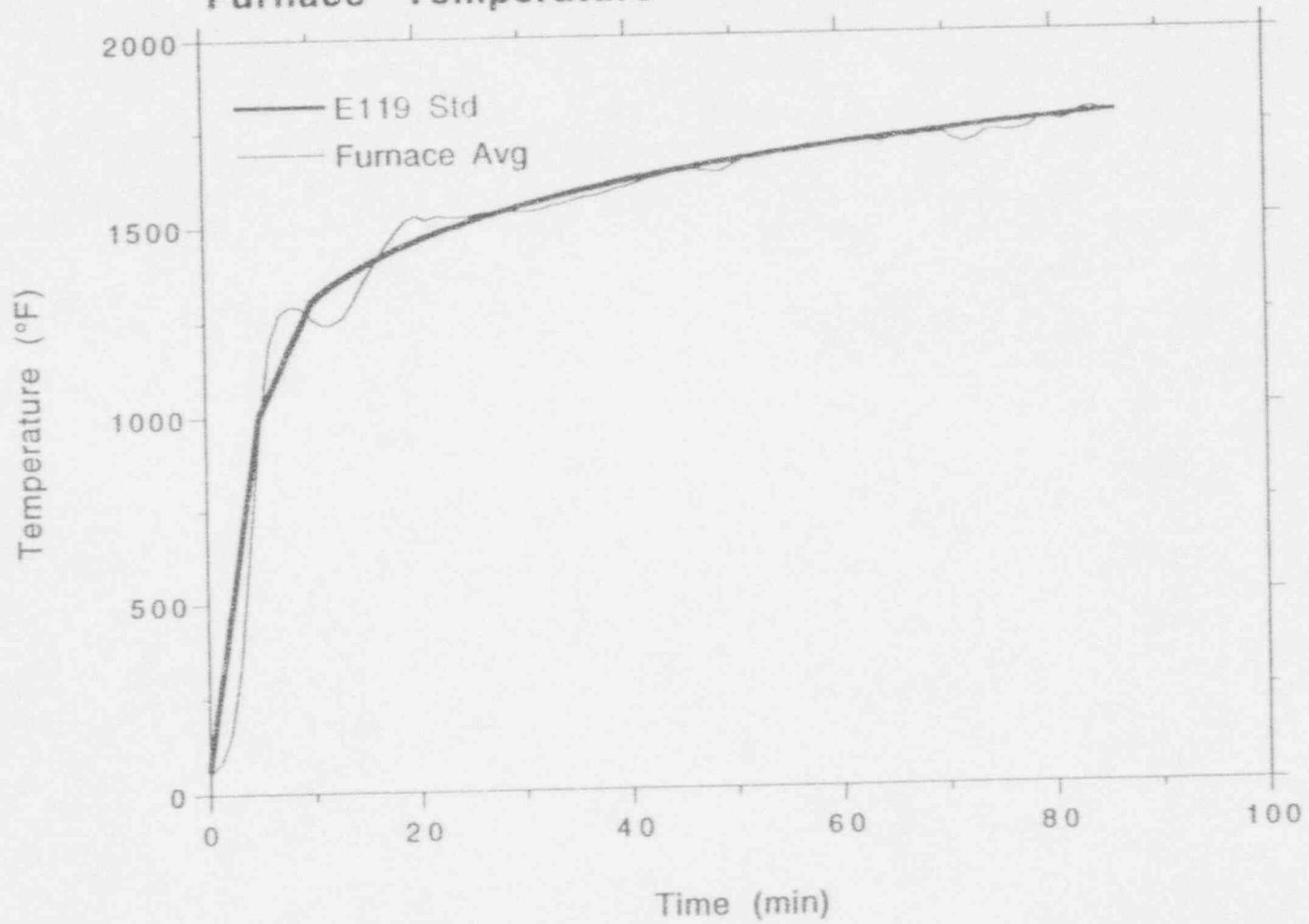
NUMARC Phase 2
Project No. 13890-96148
Test 2-8
Tray D Averages



NUMARC Phase 2
Project No. 13890-96148
Test 2-8
Tray D Averages

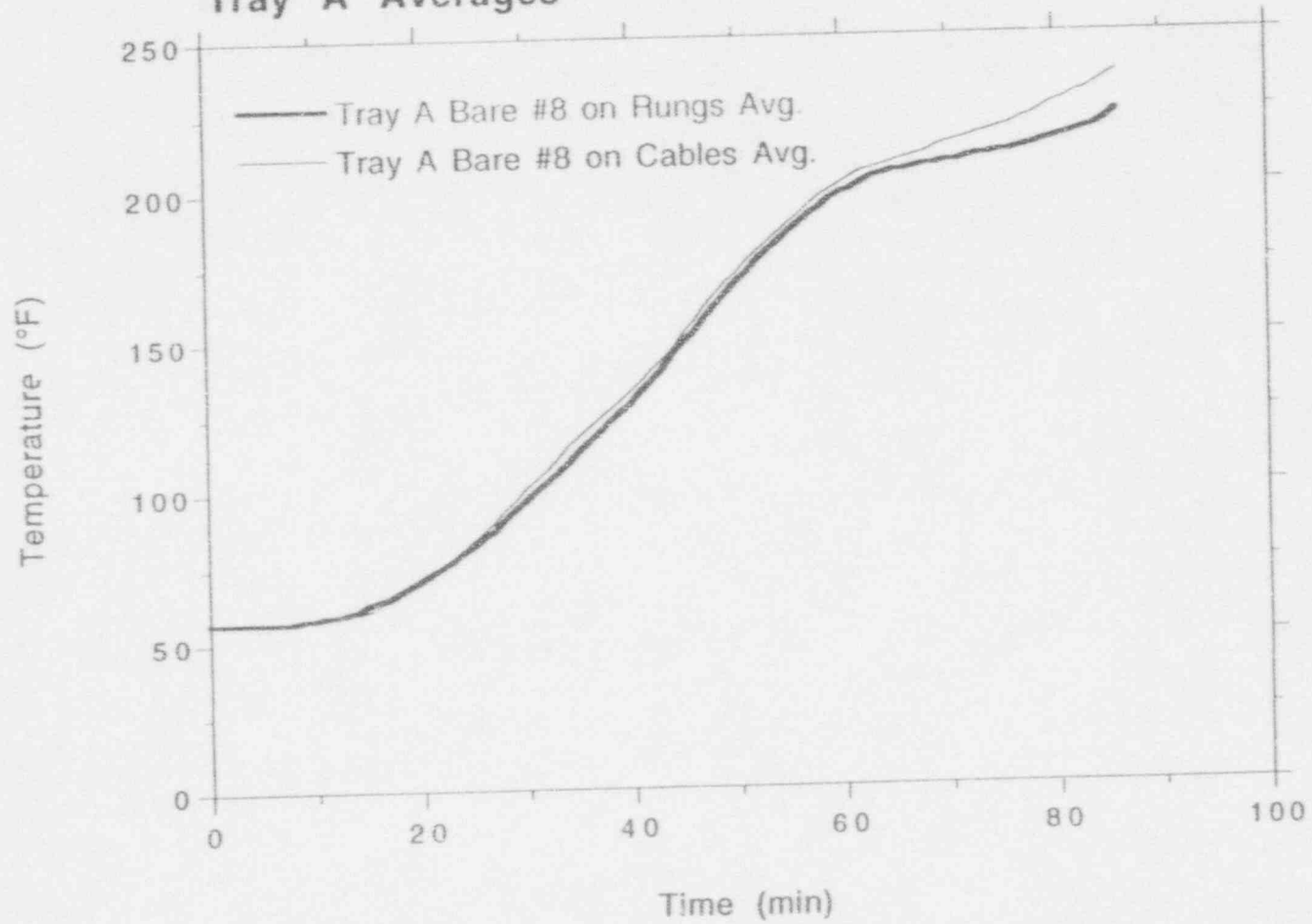


NUMARC Phase 2
Project No. 13890-96150
Test 2-10
Furnace Temperature

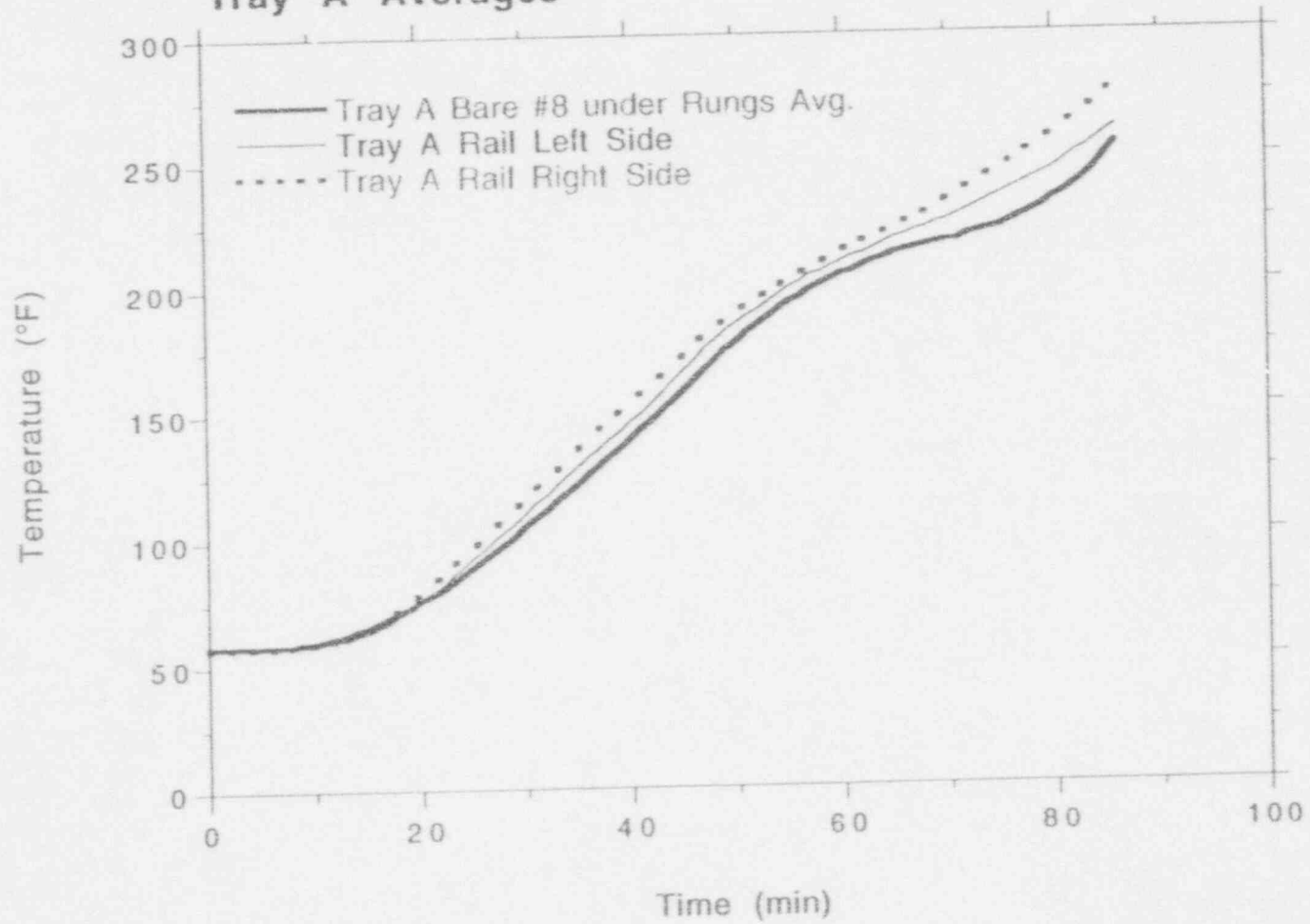


NUMARC Phase 2
Project No. 13890-96150
Test 2-10
Tray A Averages

REPORT

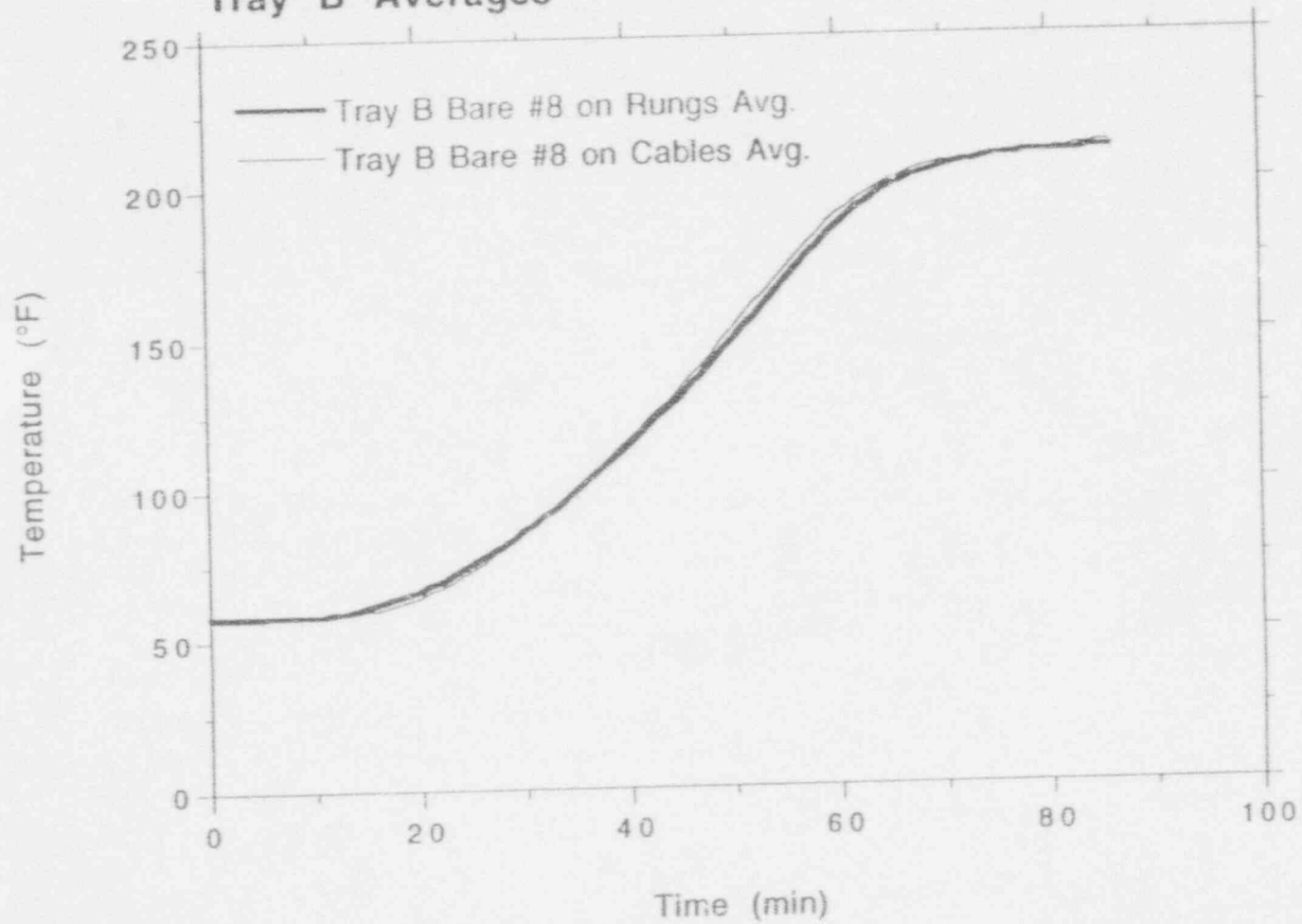


NUMARC Phase 2
Project No. 13890-96150
Test 2-10
Tray A Averages



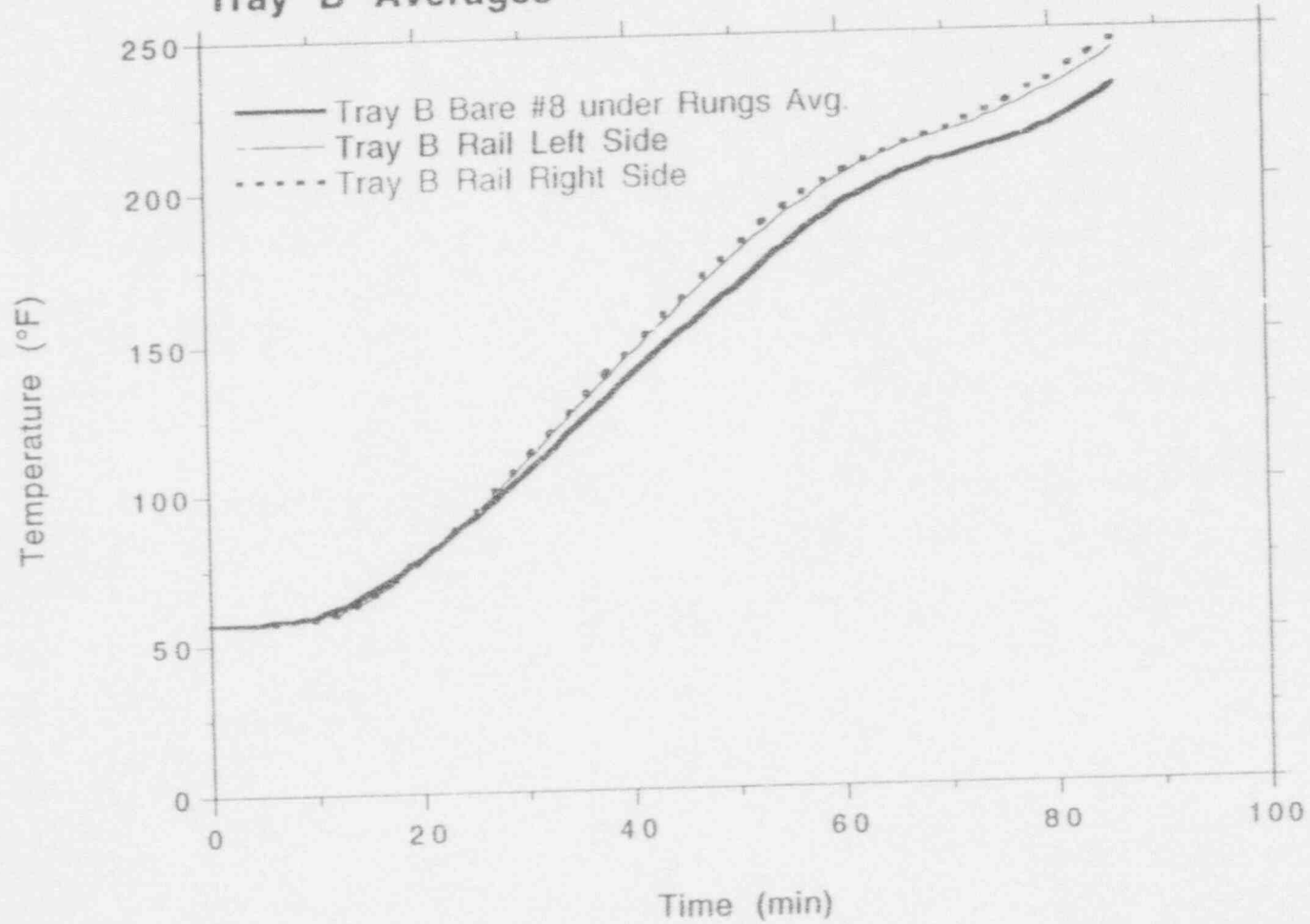
NUMARC Phase 2
Project No. 13890-96150
Test 2-10
Tray B Averages

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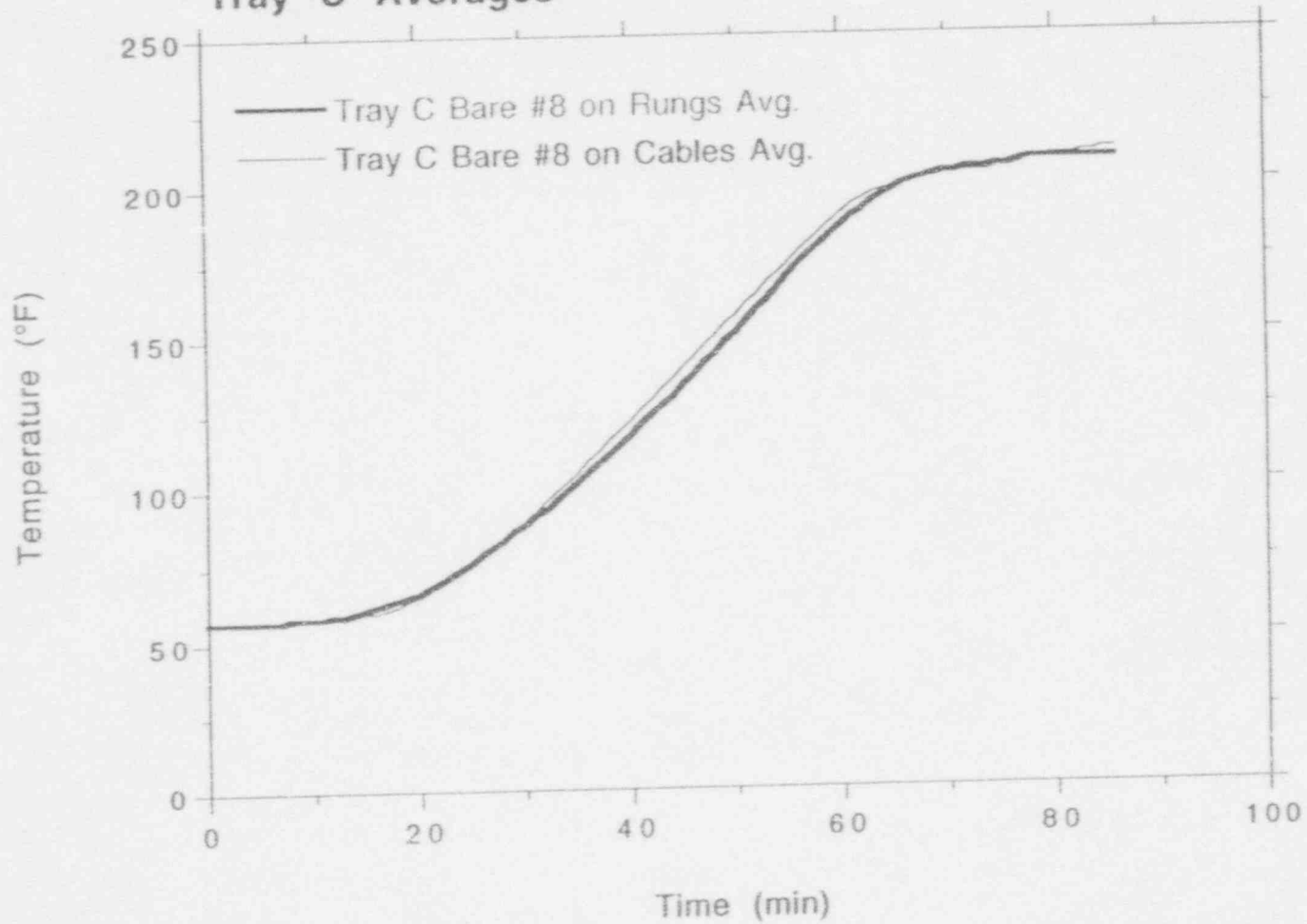
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NUMARC Phase 2
Project No. 13890-96150
Test 2-10
Tray B Averages



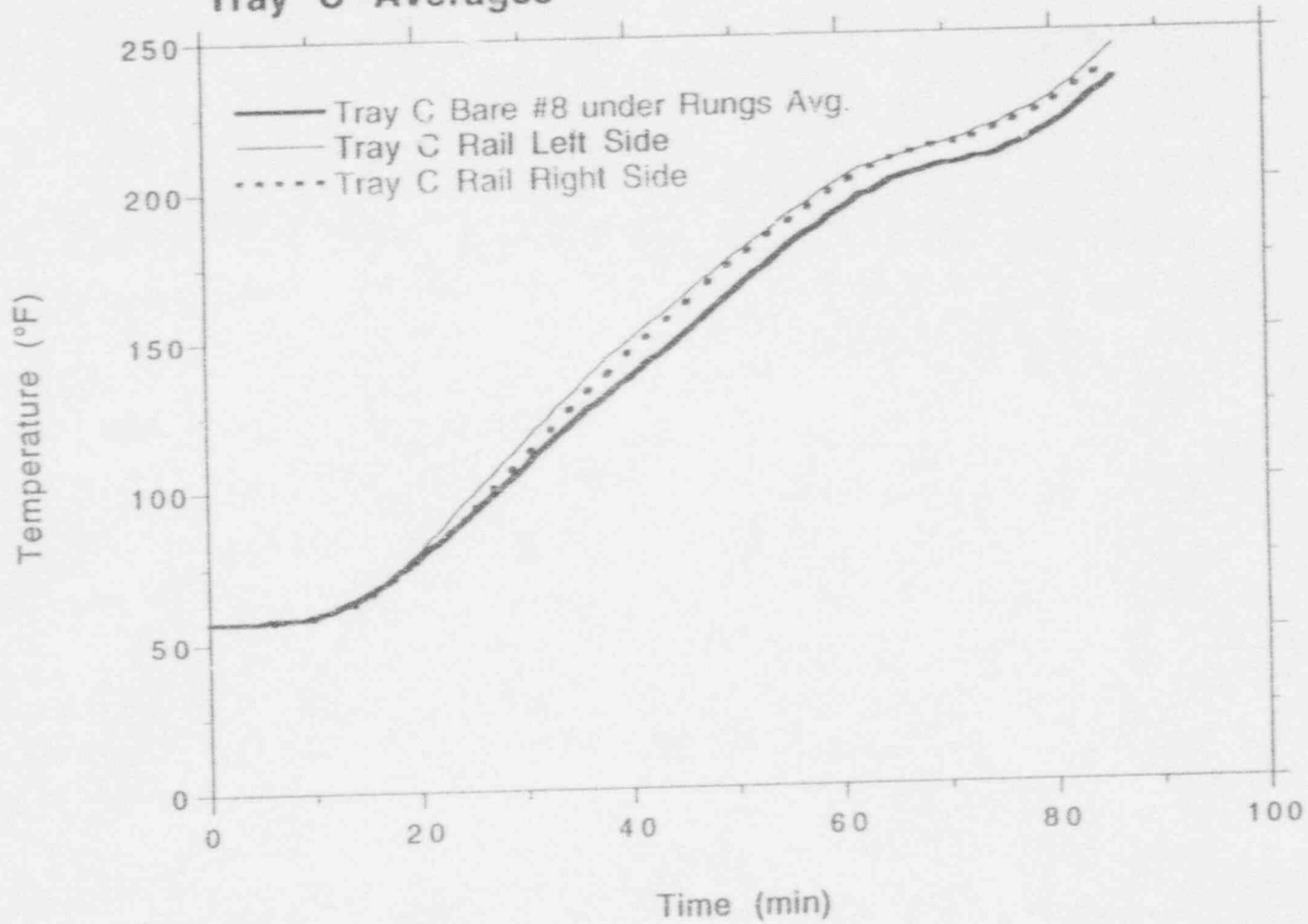
NUMARC Phase 2
Project No. 13890-96150
Test 2-10
Tray C Averages

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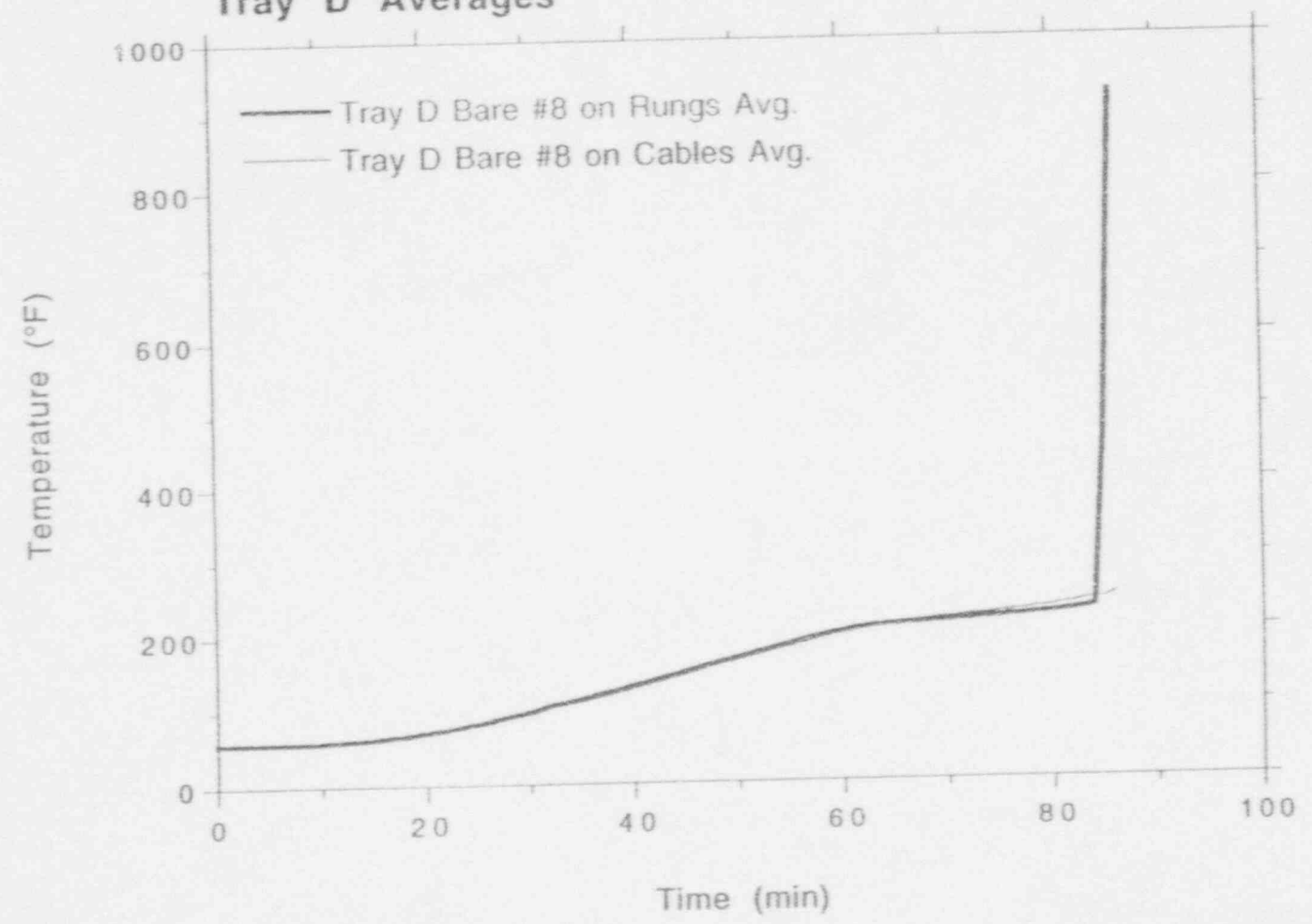
NUMARC Phase 2
Project No. 13890-96150
Test 2-10
Tray C Averages

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NUMARC Phase 2
Project No. 13890-96150
Test 2-10
Tray D Averages

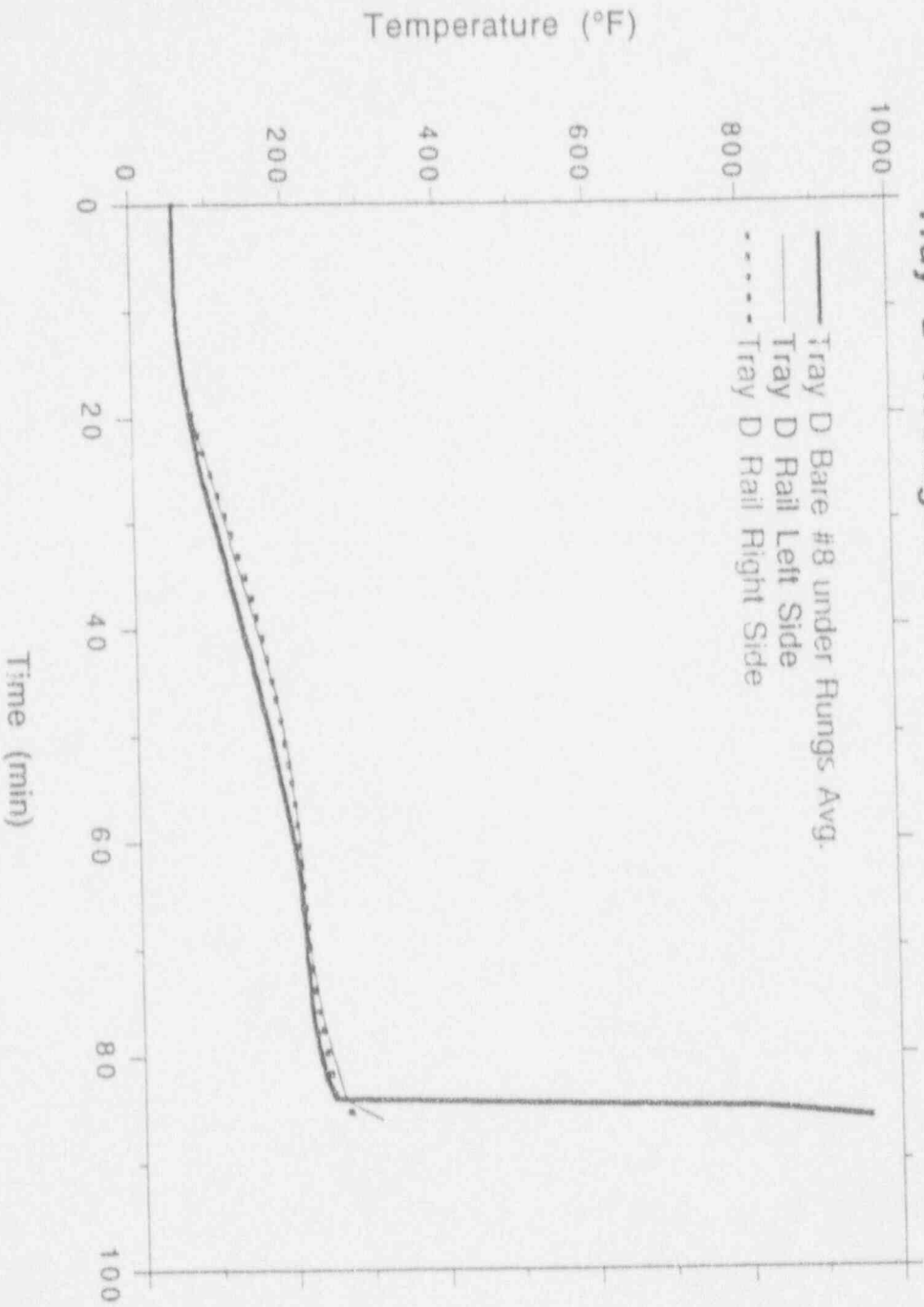


NUMARC Phase 2

Project No. 13890-96150

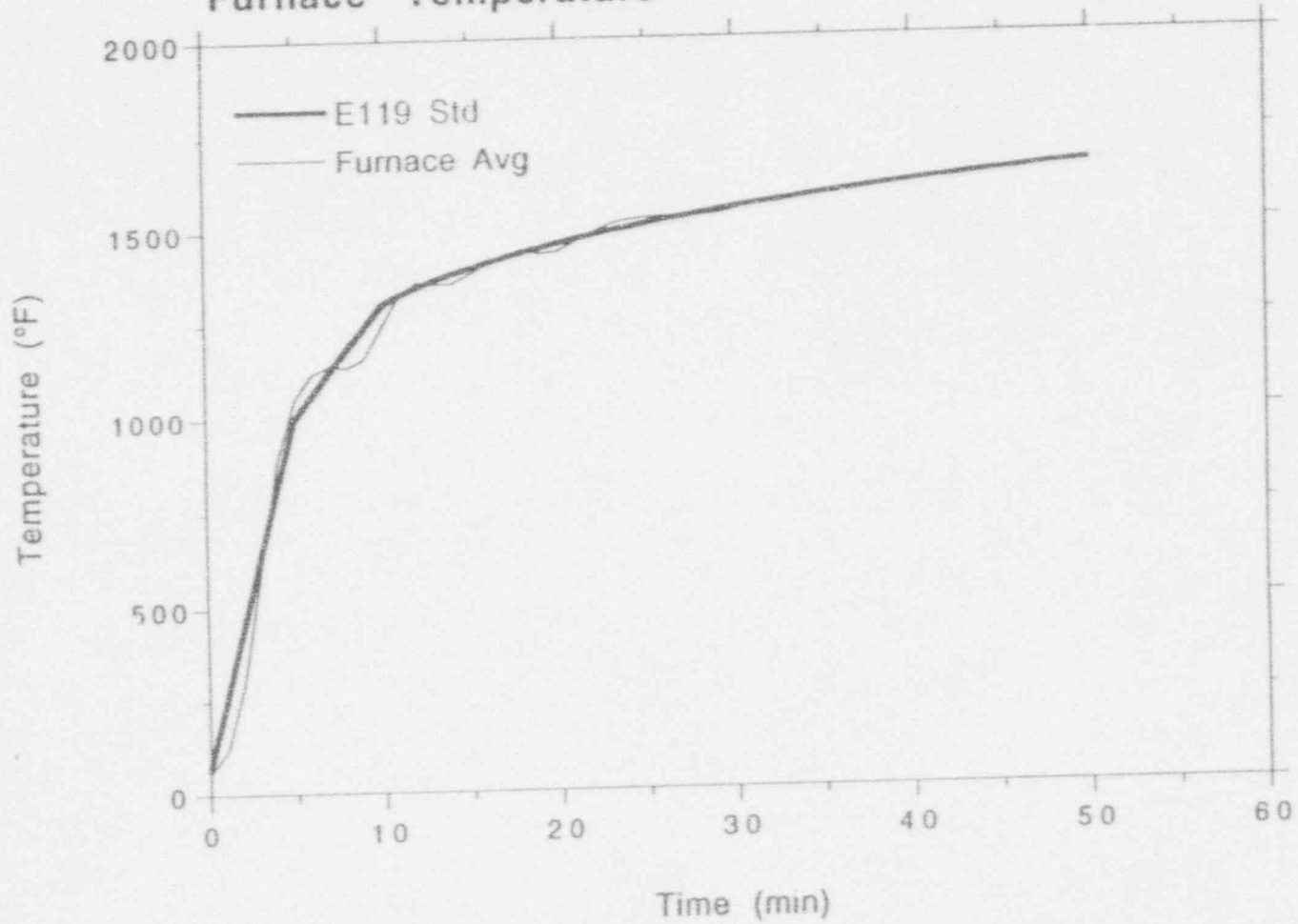
Test 2-10

Tray D Averages



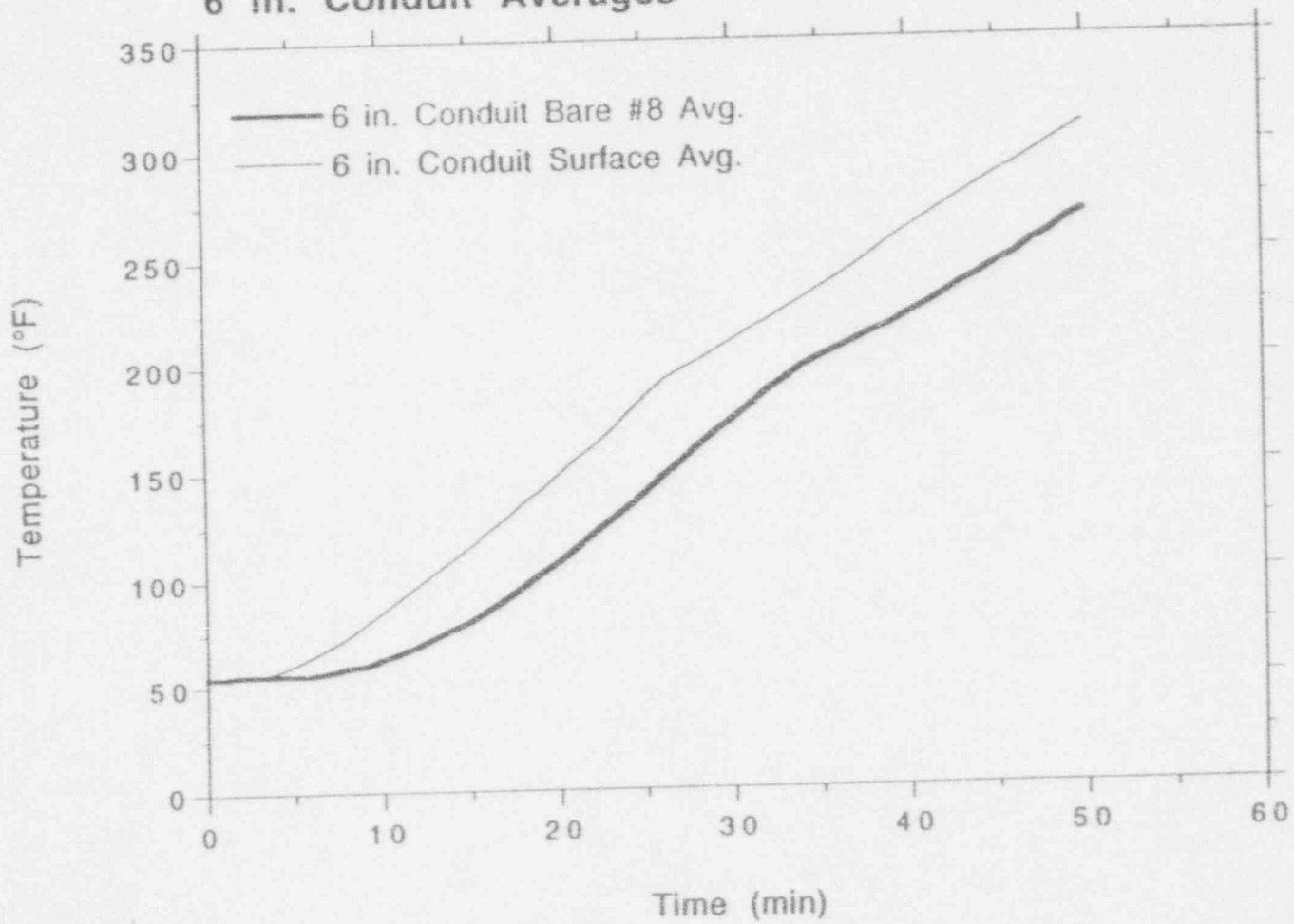
NUMARC Phase 2
Project No. 13890-96141
Test 2-1
Furnace Temperature

DRAFT

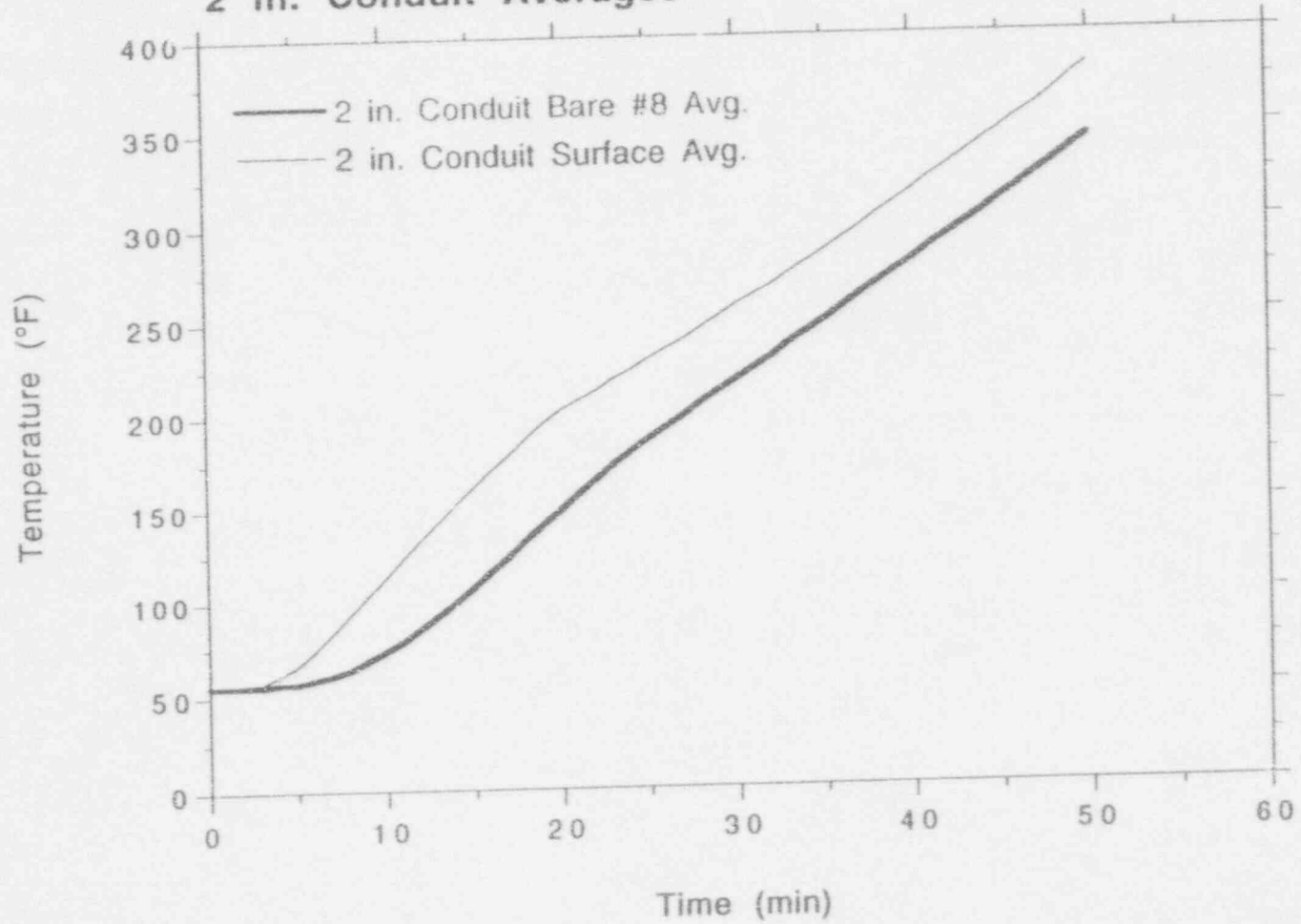


NUMARC Phase 2
Project No. 13890-96141
Test 2-1
6 in. Conduit Averages

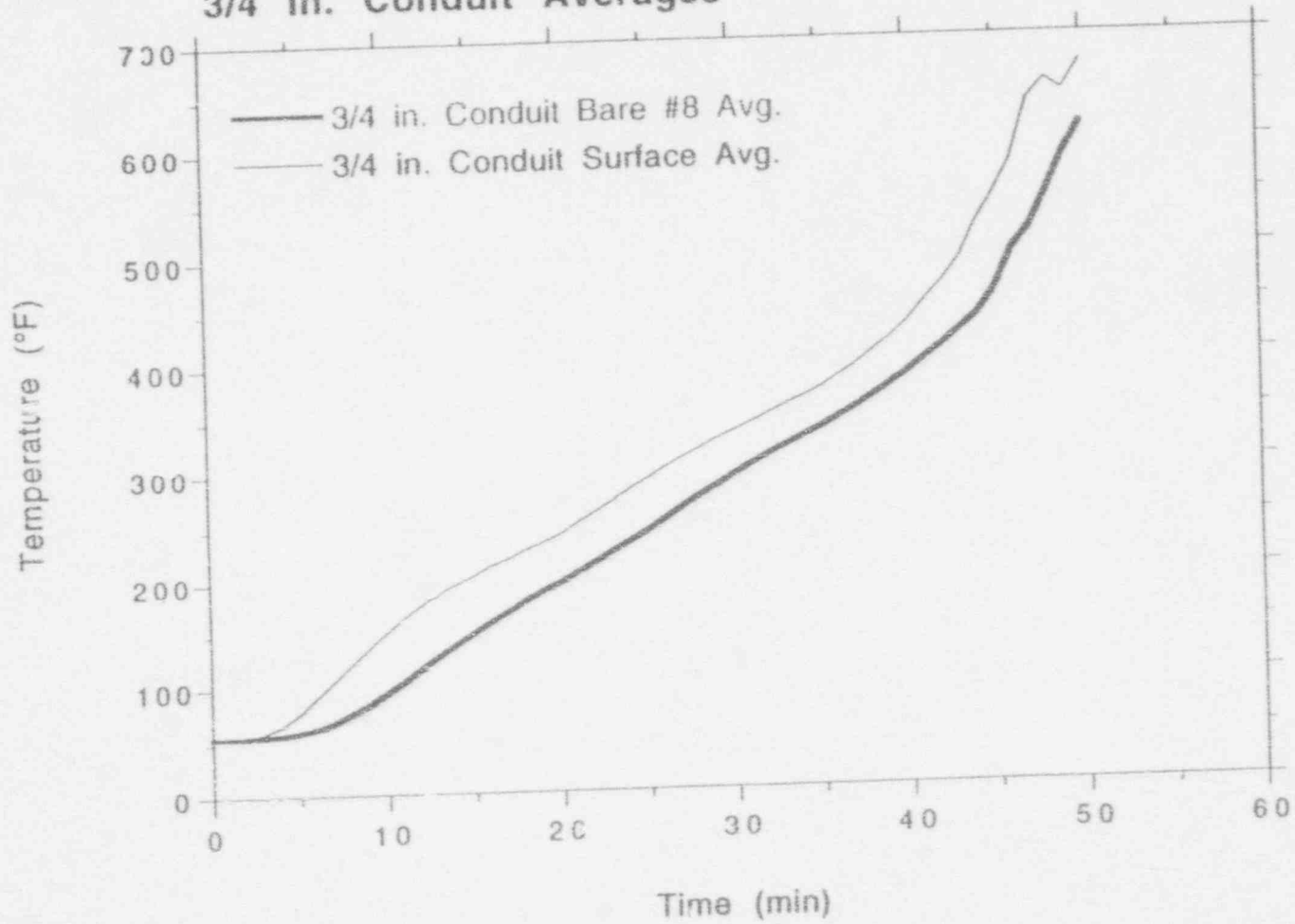
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NUMARC Phase 2
Project No. 13890-96141
Test 2-1
2 in. Conduit Averages

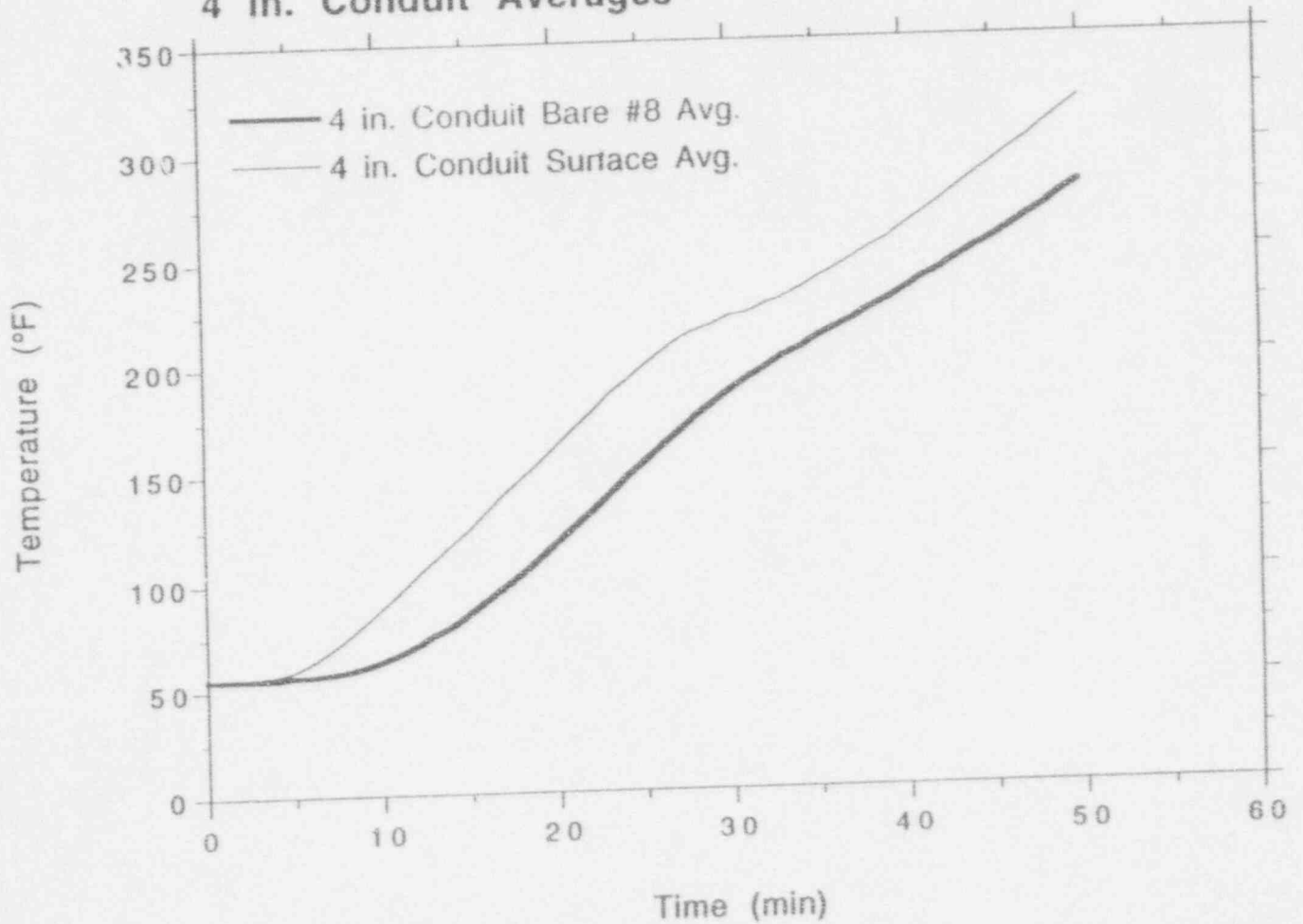


NUMARC Phase 2
Project No. 13890-96141
Test 2-1
3/4 in. Conduit Averages



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NUMARC Phase 2
Project No. 13890-96141
Test 2-1
4 in. Conduit Averages



Appendix A
Tested Assemblies

ENCLOSURE 4

**1 HOUR
CONDUITS**

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
3/4 in. Aluminum with Radial Bend	1/2 in. preshaped conduit sections with post-buttered joints. Baseline layer reinforced with trowel grade and stress skin at couplings and supports. Additional overlay of 1/4 in. preshaped sections with pre-buttered joints. Overlay layer reinforced with Trowel grade and stress skin at all joints and at entire radial bend area.	Satisfactory conduit temperatures Satisfactory barrier condition	NUMARC 1-6
3/4 in. Aluminum with Radial Bend	1/2 in. preshaped conduit sections with pre-buttered joints. Separate "mitered" pieces at radial bend areas. Baseline application, no reinforcement of joints or additional overlay or trowel grade for conduit or radial bends.	Single point and average conduit temperature requirements exceeded at 27 minutes Through opening in barrier developed	NUMARC 2-1
3/4 in. Steel with Radial Bend	1/2 in. preshaped conduit sections with pre-buttered joints. Additional overlay of 1/4 in. preshaped sections with pre-buttered joints. Overlay layer reinforced with trowel grade buildup and stress skin at entire radial bend area.	Indeterminate conduit temperatures (refer to Appendix B, Note 1) Satisfactory barrier condition Satisfactory cable visual inspection Satisfactory cable functionality	TU Electric Scheme 9-1
2 in. Aluminum with Radial Bend	1/2 in. preshaped conduit sections with pre-buttered joints. Separate "mitered" pieces at radial bend areas. Baseline application, no reinforcement of joints or additional overlay or trowel grade for conduit or radial bends.	Average conduit temperature requirements exceeded at 39 minutes Satisfactory barrier condition	NUMARC 2-1
2 in. Steel with Radial Bend	1/2 in. preshaped conduit sections with pre-buttered joints. Trowel grade buildup and stainless steel mesh reinforcement over radial bend areas only.	Satisfactory cable visual inspection Satisfactory cable functionality	TU Electric Scheme 13-2
3 in. Aluminum with Radial Bend	1/2 in. preshaped conduit sections with post-buttered joints. Baseline joints reinforced with trowel grade buildup and stress skin. Additional trowel grade buildup and stress skin at couplings, supports and over entire radial bend area.	Satisfactory conduit temperatures Satisfactory barrier condition	NUMARC 1-6

Appendix A Tested Assemblies

1 HOUR CONDUITS

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
3 in. Steel with Radial Bend	1/2 in. preshaped conduit sections with post-buttered joints. Baseline joints reinforced with trowel grade buildup and stress skin. Additional trowel grade buildup and stress skin at couplings, supports and over entire radial bend area.	Satisfactory conduit temperatures Satisfactory barrier condition	NUMARC 1-6
3 in. Steel with Radial Bend	1/2 in. preshaped conduit sections with pre-buttered joints. Trowel grade buildup and stress skin over entire radial bend area.	Indeterminate conduit temperatures (refer to Appendix B, Note 1) Satisfactory barrier condition Satisfactory cable visual inspection Satisfactory cable functionality	TU Electric Scheme 9-1
3 in. Steel	1/2 in. preshaped conduit sections with pre-buttered joints.	Indeterminate conduit temperatures (refer to Appendix B, Note 1) Satisfactory barrier condition Satisfactory cable visual inspection Satisfactory cable functionality	TU Electric Scheme 10-1 and Scheme 10-2
4 in. Aluminum with Radial Bend	1/2 in. preshaped conduit sections with pre-buttered joints. Separate "mitered" pieces at radial bend areas. Baseline application, no reinforcement of joints or additional overlay or trowel grade for conduit or radial bends.	Average conduit temperature requirements exceeded at 48 minutes Satisfactory barrier condition	NUMARC 2-1
5 in. Aluminum with Radial Bend	1/2 in. preshaped conduit sections with post-buttered joints. Baseline joints reinforced with trowel grade buildup and stress skin. Additional trowel grade buildup and stress skin at couplings, supports and over entire radial bend area.	Satisfactory conduit temperatures Satisfactory barrier condition	NUMARC 1-6

Appendix A Tested Assemblies

1 HOUR CONDUITS

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
5 in. Steel with Radial Bend	1/2 in. preshaped conduit sections with pre-buttered joints. Trowel grade buildup and stress skin over entire radial bend area.	Indeterminate conduit temperatures (refer to Appendix B, Note 1) Satisfactory barrier condition Satisfactory cable visual inspection Satisfactory cable functionality	TU Electric Scheme 9-1
6 in. Aluminum with Radial Bend	1/2 in. preshaped conduit sections with pre-buttered joints. Separate "mitered" pieces at radial bend areas. Baseline application, no reinforcement of joints or additional overlay or trowel grade for conduit or radial bends.	Average conduit temperature requirements exceeded at 50 minutes Satisfactory barrier condition	NUMARC 2-1

Appendix A Tested Assemblies

3 HOUR CONDUITS

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
3/4 in. Aluminum with Radial Bend	1 in. preshaped conduit sections with pre-buttered joints. Separate "mitered" pieces at radial bend areas. Baseline application, no reinforcement of joints or additional overlay or trowel grade for conduit or radial bend.	Average conduit temperature requirement exceeded at 63 minutes Through openings in barrier developed	NUMARC 2-3
3/4 in. Steel with Radial Bend	1 in. preshaped conduit sections with post-buttered joints. Additional overlay of 7/8 in. preshaped sections with pre-buttered joints. Overlay layer reinforced with trowel grade buildup and stress skin at all joints and at entire radial bend area.	Satisfactory conduit temperatures Satisfactory barrier condition	NUMARC 1-7
3 in. Aluminum with Radial Bend	1 in. preshaped conduit sections with pre-buttered joints. Separate "mitered" pieces at radial bend areas. Baseline application, no reinforcement of joints or additional overlay or trowel grade for conduit or radial bend.	Single point conduit temperature requirement exceeded at 91 minutes Through openings in barrier developed	NUMARC 2-3
3 in. Steel with Radial Bend	1 in. preshaped conduit sections with post-buttered joints. Trowel grade buildup and stress skin reinforcement at joints and over entire radial bend area.	Single point conduit temperature requirement exceeded at 112 minutes Satisfactory barrier condition	NUMARC 1-7
5 in. Steel with Radial Bend	1 in. preshaped conduit sections with post-buttered joints. Trowel grade buildup and stress skin reinforcement at joints and over entire radial bend area.	Average conduit temperature requirement exceeded at 113 minutes Satisfactory barrier condition	NUMARC 1-7
6 in. Aluminum with Radial Bend	1 in. preshaped conduit sections with pre-buttered joints. Separate "mitered" pieces at radial bend areas. Baseline application, no reinforcement of joints or additional overlay or trowel grade for conduit or radial bend.	Average conduit temperature requirement exceeded at 102 minutes Through openings in barrier developed	NUMARC 2-3

Appendix A Tested Assemblies

1 HOUR BOXED COMMODITIES (OTHER THAN CABLE TRAYS)

3/4 in. Aluminum LBD Condulet (Long Leg Vertical)	1/2 in. V-rib panels with post-buttered joints. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces.	Satisfactory surface temperatures Satisfactory barrier condition	NUMARC 1-6
3/4 in. Aluminum LBD Condulet (Long Leg Vertical)	1/2 in. V-rib panels with pre-buttered joints. Baseline application, no reinforcement or additional trowel grade at joints or conduit interfaces.	Later	NUMARC 2-1
3/4 in. Steel LBD Condulet (Long Leg Vertical)	1/2 in. flat panels with pre-buttered joints. Trowel grade buildup and stress skin reinforcement at joints and interfaces.	Indeterminate surface temperatures (Refer to Appendix B, Note 1) Satisfactory barrier condition Satisfactory cable visual inspection Satisfactory cable functionality	TU Electric Scheme 9-1
2 in. Aluminum LBD Condulet (Long Leg Vertical)	1/2 in. V-rib panels with pre-buttered joints. Baseline application, no reinforcement or additional trowel grade at joints or conduit interfaces.	Later	NUMARC 2-1
3 in. Aluminum LBD Condulet (Long Leg Horizontal)	1/2 in. V-rib panels with post-buttered joints. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces.	Satisfactory surface temperatures Satisfactory barrier condition	NUMARC 1-6
3 in. Steel LBD Condulet (Long Leg Vertical)	1/2 in. V-rib panels with post-buttered joints. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces.	Satisfactory surface temperatures Satisfactory barrier condition	NUMARC 1-6
3 in. Steel LBD Condulet (Long Leg Vertical)	1/2 in. flat panels with pre-buttered joints. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces.	Indeterminate surface temperatures (Refer to Appendix B, Note 1) Satisfactory barrier condition Satisfactory cable visual inspection Satisfactory cable functionality	TU Electric Scheme 9-1, Scheme 10-1 and Scheme 10-2

Appendix A Tested Assemblies

1 HOUR BOXED COMMODITIES (OTHER THAN CABLE TRAYS)

3 in. Steel LBD Condulet (Long Leg Horizontal)	1/2 in. flat panels with pre-buttered joints. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces.	Indeterminate surface temperatures (refer to Appendix B, Note 1) Satisfactory barrier condition Satisfactory cable visual inspection Satisfactory cable functionality	TU Electric Scheme 10-1 and Scheme 10-2
4 in. Aluminum LBD Condulet (Long Leg Vertical)	1/2 in. V-rib panels with pre-buttered joints. Baseline application, no reinforcement or additional trowel grade at joints or conduit interfaces.	Later	NUMARC 2-1
5 in. Aluminum LBD Condulet (Long Leg Vertical)	1/2 in. V-rib panels with post-buttered joints. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces.	Satisfactory surface temperatures Satisfactory barrier condition	NUMARC 1-6
5 in. Steel LBD Condulet (Long Leg Vertical)	1/2 in. flat panels with pre-buttered joints. Panel scored to conform to LBD curvature; scores filled with trowel grade. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces.	Indeterminate surface temperatures (Refer to Appendix B, Note 1) Satisfactory barrier condition Satisfactory cable visual inspection Satisfactory cable functionality	TU Electric Scheme 9-1
6 in. Aluminum LBD Condulet (Long Leg Vertical)	1/2 in. V-rib panels with pre-buttered joints. One panel scored to accommodate curvature of fitting. Baseline application, no reinforcement or additional trowel grade material at joints or conduit interfaces.	Later	NUMARC 2-1
18 in. x 12 in. x 6 in. Steel Junction Box (12 in. Side Vertical) and 18 in. x 12 in. x 6 in. Steel Junction Box (6 in. Side Vertical)	1/2 in. flat panels with pre-buttered joints. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces.	Indeterminate surface temperatures (Refer to Appendix B, Note 1) Satisfactory barrier condition Satisfactory cable visual inspection Satisfactory cable functionality	TU Electric Scheme 10-2

Appendix A Tested Assemblies

1 HOUR BOXED COMMODITIES (OTHER THAN CABLE TRAYS)

<p>18 in. x 12 in. x 6 in. Steel Junction Box (12 in. Side Vertical) and 18 in. x 12 in. x 6 in. Steel Junction Box (6 in. side vertical)</p>	<p>1/2 in. flat panels with pre-buttered joints. Additional overlay of 1/2 in. V-rib panels with pre-buttered joints. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces (outer layer only).</p>	<p>Indeterminate surface temperatures (Refer to Appendix B, Note 1) Satisfactory barrier condition Satisfactory cable visual inspection Satisfactory cable functionality</p>	<p>TU Electric Scheme 10-1</p>
<p>24 in. x 12 in. x 8 in. Aluminum Junction Box (12 in. Side Vertical)</p>	<p>1/2 in. V-rib panels with post-buttered joints. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces.</p>	<p>Satisfactory surface temperatures Satisfactory barrier condition</p>	<p>NUMARC 1-6</p>
<p>3/4 in., 2 in. and 3 in. Aluminum Conduits with LBD Condulets inside 46 in. (long) x 26 in. (wide) x 22 in. (deep) five-sided enclosure</p>	<p>1/2 in. V-rib panels (2) with "score and fold" method used to construct sides and bottom of box. Panels flared out onto underside of concrete test slab, pre-buttered with trowel grade material and secured with 1/4 in. x 2-1/4 in. anchor bolts at 12 in. intervals. Butt joint between panels pre-buttered. Scored panel areas filled with trowel grade material. Ends of box used separate panel pieces with pre-buttered joints. End panels also flared out onto underside of test slab, pre-buttered with trowel grade material and secured with anchor bolts at 12 in. intervals. Stainless steel banding used around entire enclosure. Baseline application with no upgrades applied to reinforce joints and seams.</p>	<p>Satisfactory conduit temperatures Through opening in barrier developed Informational thermocouples on unexposed panel surfaces reached 407°F average temperature and 430°F single point maximum temperature.</p>	<p>NUMARC 2-2</p>

**Appendix A
Tested Assemblies**

**1 HOUR
BOXED COMMODITIES (OTHER THAN CABLE TRAYS)**

<p>3/4 in., 2 in. and 3 in. Aluminum Conduits with LBD Condulets inside 46 in. (long) x 26 in. (wide) x 22 in. (deep) five-sided enclosure</p>	<p>1/2 in. V-rib panels (2) with "score and fold" method used to construct sides and bottom of box. Panels flared out onto underside of concrete test slab, pre-buttered with trowel grade material and secured with 1/4 in. x 2-1/4 in. anchor bolts at 12 in. intervals. Butt joint between panels post-buttered. Scored panel areas filled with trowel grade material. Ends of box used separate panel pieces with post-buttered joints. End panels also flared out onto underside of test slab, pre-buttered with trowel grade material and secured with anchor bolts at 12 in. intervals. Stainless steel banding used around entire enclosure. All joints between panels and seams in scored areas reinforced with additional trowel grade buildup and stress skin secured with staples and tie wires.</p>	<p>Satisfactory conduit temperatures Satisfactory barrier condition Informational thermocouples on unexposed panel surfaces reached 362°F average temperature and 377°F single point maximum temperature.</p>	<p>NUMARC 2-2</p>
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Appendix A Tested Assemblies

3 h_oUR BOXED COMMODITIES (OTHER THAN CABLE TRAYS)

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
3/4 in. Aluminum LBD Condulet (Long Leg Vertical)	1 in. V-rib panels with pre-buttered joints. Baseline application, no reinforcement or additional trowel grade at joints or conduit interfaces.	Later	NUMARC 2-3
3/4 in. Steel LBD Condulet (Long Leg Vertical)	1 in. V-rib panels with post-buttered joints. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces. Additional overlay of 5/8 in. V-rib panels with pre-buttered joints. Outer panel layer joints stitched with tie wire and reinforced with trowel grade and stress skin. Trowel grade buildup and stress skin reinforcement at conduit interfaces.	Satisfactory surface temperatures Satisfactory barrier condition	NUMARC 1-7
3 in. Aluminum LBD Condulet (Long Leg Vertical)	1 in. V-rib panels with pre-buttered joints. Baseline application, no reinforcement or additional trowel grade at joints or conduit interfaces.	Later	NUMARC 2-3
3 in. Steel LBD (Long Leg Horizontal)	1 in. V-rib panels, post-buttered. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces. Additional overlay of 5/8 in. V-rib panels with pre-buttered joints. Outer panel layer joints stitched with tie wire and reinforced with trowel grade and stress skin. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces.	Satisfactory surface temperatures Satisfactory barrier condition	NUMARC 1-7
5 in. Steel LBD (Long Leg Vertical)	1 in. V-rib panels with post-buttered joints. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces. Additional overlay of 5/8 in. V-rib panels with pre-buttered joints. Outer panel layer joints stitched with tie wire and reinforced with trowel grade and stress skin. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces.	Single point surface temperature requirement exceeded at 151 minutes Satisfactory barrier condition	NUMARC 1-7

**Appendix A
Tested Assemblies**

**3 HOUR
BOXED COMMODITIES (OTHER THAN CABLE TRAYS)**

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
6 in. Aluminum LBD Condulet (Long Leg Vertical)	1 in. V-rib panels with pre-buttered joints. One panel scored to accommodate curvature of fitting. Baseline application, no reinforcement or additional trowel grade at joints or conduit interfaces.	Later	NUMARC 2-3
22 in. x 12 in. x 9 in. Steel Junction Box (12 in. side vertical)	1 in. V-rib panels with post-buttered joints. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces. Additional overlay of 5/8 in. V-rib panels with pre-buttered joints. Outer panel layer joints stitched with tie wire and reinforced with trowel grade and stress skin. Trowel grade buildup and stress skin reinforcement at joints and conduit interfaces.	Satisfactory surface temperatures Satisfactory barrier condition	NUMARC 1-7

Appendix A Tested Assemblies

1 HOUR CABLE TRAYS

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
6 in. x 4 in. Aluminum Ladder Back with Radial Bend (4 piece design)	1/2 in. V-rib panels with pre-buttered joints, V-ribs parallel to tray rails on top and bottom of tray. Separate mitered panel pieces on inside and outside face of radial bend. Baseline application with no upgrades applied.	Satisfactory raceway temperatures at 48 minutes when test was terminated Satisfactory barrier condition	NUMARC 2-7
6 in. x 4 in. Aluminum Ladder Back with Radial Bend (Score & Fold)	1/2 in. V-rib panels with pre-buttered joints. Score and fold single panel for bottom and sides on horizontal and vertical tray segments with separate top panel. V-ribs parallel to tray rails. Separate mitered panel pieces on inside and outside face of radial bend. Baseline application with no upgrades applied.	Single point raceway temperature requirements exceeded at 48 minutes Through opening in barrier developed	NUMARC 2-7
6 in. x 4 in. Aluminum Ladder Back with Radial Bend (4 piece design)	1/2 in. V-rib panels with post-buttered joints, V-ribs parallel to tray rails on top and bottom of tray. Separate mitered panel pieces on inside and outside face of radial bend. Baseline barrier reinforced with external trowel grade and stress skin fastened with staples and tie-wires.	Satisfactory raceway temperatures Satisfactory barrier condition	NUMARC 2-8
6 in. x 4 in. Aluminum Ladder Back with Radial Bend (Score & Fold)	1/2 in. V-rib panels with post-buttered joints. Score and fold single panel for bottom and sides on horizontal and vertical tray segments with separate top panel. V-ribs parallel to tray rails. Separate mitered panel pieces on inside and outside face of radial bend. Baseline barrier reinforced with external trowel grade and stress skin fastened with staples and tie-wires.	Satisfactory raceway temperatures Satisfactory barrier condition	NUMARC 2-8
12 in. x 4 in. Steel Ladder Back with Radial Bends (4 piece design)	1/2 in. V-rib panels with pre-buttered joints. V-ribs perpendicular to tray rails on top and bottom of tray. Scored panels on inside and outside face of radial bends; scores filled with trowel grade. Longitudinal joints at side panels reinforced with trowel grade buildup and stress skin. Butt joints between panels stitched at various locations.	Satisfactory raceway temperatures Satisfactory barrier condition	TU Electric Scheme 13-1

Appendix A Tested Assemblies

1 HOUR CABLE TRAYS

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
12 in. x 4 in. Steel Ladder Back with Radial Bends (4 piece design)	1/2 in. V-rib panels with pre-buttered joints. V-ribs perpendicular to tray rails on top and bottom of tray. Scored panels on inside and outside face of radial bends; scores filled with trowel grade. Baseline application with no upgrades applied.	Satisfactory cable visual inspection Satisfactory cable functionality	TU Electric Scheme 13-2
24" x 4" Aluminum Ladder Back with Radial Bend (4 piece design)	1/2 in. V-rib panels with pre-buttered joints, V-ribs parallel to tray rails on top and bottom of tray. Separate mitered panel pieces on inside and outside face of radial bend. Baseline application with no upgrades applied.	Single point raceway temperature requirements exceeded at 29 minutes. Through openings in barrier developed prior to ending the test at 48 minutes	NUMARC 2-7
24" x 4" Aluminum Ladder Back with Radial Bend (Score & Fold)	1/2 in. V-rib panels with pre-buttered joints. Score and fold single panel for bottom and sides on horizontal and vertical tray segments with separate top panel. V-ribs parallel to tray rails. Separate mitered panel pieces on inside and outside face of radial bend. Baseline application with no upgrades applied.	Single point raceway temperature requirements exceeded at 29 minutes. Through openings in barrier developed prior to ending the test at 48 minutes	NUMARC 2-7
24 in. x 4 in. Aluminum Ladder Back with Radial Bend and Fire Stop (4 piece design)	1/2 in. V-rib panels with post-buttered joints, V-ribs parallel to tray rails on top and bottom of tray. Separate mitered panel pieces on inside and outside face of radial bend. Thermo-Lag fire stop in horizontal tray segment to close envelope. Longitudinal joints at side panels and butt joints between panels reinforced with trowel grade and stress skin.	Satisfactory raceway temperatures (Single point temperature requirements exceeded on one tray rail near fire stop at 57 min.) Satisfactory cable visual inspection Satisfactory barrier condition	NUMARC 2-8
24 in. x 4 in. Aluminum Ladder Back with Radial Face Bend (Score & Fold)	1/2 in. V-rib panels with post-buttered joints. Score and fold single panel for bottom and sides on horizontal and vertical tray segments with separate top panel. V-ribs parallel to tray rails. Separate mitered panel pieces on inside and outside face of radial bend. Longitudinal score and fold seams at side panels and butt joints between panels reinforced with trowel grade and stress skin.	Satisfactory raceway temperatures Satisfactory barrier condition	NUMARC 2-8

Appendix A Tested Assemblies

1 HOUR CABLE TRAYS

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
24 in. x 4 in. Steel Ladder Back with Radial Bend (4 piece design)	Internal banding installed on cable tray. 1/2 in. V-rib panels with pre-buttered joints, V-ribs perpendicular to tray rails on top and bottom of tray. Scored panels on inside and outside face of radial bend, scores filled with trowel grade. Longitudinal joints at side panels reinforced with trowel grade and stress skin.	Satisfactory raceway temperatures Satisfactory barrier condition	TU Electric Scheme 11-5
24 in. x 4 in. Steel Ladder Back with Radial Bend (4 piece design)	Internal banding installed on cable tray. 1/2 in. V-rib panels with pre-buttered joints, V-ribs perpendicular to tray rails on top and bottom of tray. Scored panels on inside and outside face of radial bend, scores filled with trowel grade. 1 in. wide ceramic banding installed around tray envelope at 24 in. intervals.	Satisfactory cable visual inspection Satisfactory barrier condition Satisfactory cable functionality	TU Electric Scheme 11-5
24 in. x 4 in. Steel Ladder Back with Radial Bend, 90° Square Fitting and Tee Section (4 piece design)	Internal banding installed on cable tray. 1/2 in. V-rib panels with pre-buttered joints, V-ribs perpendicular to tray rails on top and bottom of tray. Scored panels on inside and outside face of radial bend, scores filled with trowel grade. Longitudinal joints at side panels reinforced with trowel grade and stress skin. Butt joints between panels stitched at various locations and reinforced with stress skin.	Satisfactory raceway temperatures Satisfactory barrier condition	TU Electric Scheme 12-2
30 in. x 4 in. Steel Ladder Back with Radial Bends (4 piece design)	Internal banding installed on cable tray. 1/2 in. V-rib panels with pre-buttered joints, V-ribs perpendicular to tray rails on top and bottom of tray. Scored panels on inside and outside face of radial bends, scores filled with trowel grade. Longitudinal joints at side panels reinforced with trowel grade and stress skin. Butt joints between panels stitched at various locations and reinforced with stress skin.	Satisfactory raceway temperatures Satisfactory barrier condition	TU Electric Scheme 12-1

Appendix A Tested Assemblies

1 HOUR CABLE TRAYS

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
30 in. x 4 in. Steel Ladder Back with Radial Bend, 90° Square Fitting and Tee Section (4 piece design)	Internal banding installed on cable tray. 1/2 in. V-rib panels with pre-buttered joints, V-ribs perpendicular to tray rails on top and bottom of tray. Scored panels on inside and outside face of radial bends; scores filled with trowel grade. Longitudinal joints at side panels reinforced with trowel grade and stress skin. Butt joints between panels reinforced with trowel grade and stress skin.	Satisfactory cable visual inspection Satisfactory cable functionality	TU Electric Scheme 14-1
36 in. x 4 in. Steel Ladder Back with Radial Bends (4 piece design)	1/2 in. V-rib panels with post-buttered joints, V-ribs parallel to tray rails on top and bottom of tray. Scored panels on inside and outside face of one radial bend; scores filled with trowel grade. Separate mitered panel pieces on inside and outside face of other radial bend. Longitudinal joints at side panels and butt joints between panels reinforced with trowel grade and stress skin.	Single point temperature requirements exceeded at 54 minutes for conductor on top of cable layer Through opening in barrier developed	NUMARC 1-1
36 in. x 4 in. Aluminum Ladder Back with Radial Bends (4 piece design)	Internal banding installed on cable tray. 1/2 in. V-rib panels with pre-buttered joints; V-ribs parallel to tray rails on top and bottom of tray. Scored panels on inside and outside face of one radial bend; scores filled with trowel grade. Separate mitered panel pieces on inside and outside face of other radial bend. Longitudinal joints at side panels and butt joints between panels reinforced with trowel grade and stress skin.	Satisfactory raceway temperatures Satisfactory barrier condition	NUMARC 2-9
36 in. x 4 in. Steel Ladder Back with Radial Bends (4 piece design)	Internal banding installed on cable tray. 1/2 in. V-rib panels with pre-buttered joints, V-ribs perpendicular to tray rails on top and bottom of tray. Scored panels on inside and outside face of radial bends; scores filled with trowel grade. Longitudinal joints at side panels reinforced with trowel grade and stress skin. Butt joints between panels reinforced with trowel grade and stress skin.	Satisfactory raceway temperatures Satisfactory barrier condition	TU Electric Scheme 15-1

Appendix A Tested Assemblies

3 HOUR CABLE TRAYS

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
6 in. x 4 in. Aluminum Ladder Back with Radial Bend (4 piece design)	1 in. V-rib panels with pre-buttered joints, V-ribs parallel to tray rails on top and bottom of tray. Separate mitered panel pieces on inside and outside face of radial bend. Baseline application with no upgrades applied.	Satisfactory raceway temperatures at 86 minutes when test was terminated Satisfactory barrier condition	NUMARC 2-10
6 in. x 4 in. Aluminum Ladder Back with Radial Bend (Score & Fold)	1 in. V-rib panels with pre-buttered joints. Score and fold single panel for bottom and sides on horizontal and vertical tray segments with separate top panel. V-ribs parallel to tray rails. Separate mitered panel pieces on inside and outside face of radial bend. Baseline application with no upgrades applied.	Satisfactory raceway temperatures at 86 minutes when test was terminated Satisfactory barrier condition	NUMARC 2-10
24 in. x 4 in. Aluminum Ladder Back with Radial Bends and Tee Section (4 piece design)	1/2 in. v-rib panels with post-buttered joints. V-ribs parallel to tray rails on top and bottom of tray and on inside and outside panels above radial bends. V-ribs perpendicular on inside and outside of radial bends. Panels on inside and outside of left radial bend and tee section radius were scored. Inside and outside panels on right radial bend were mitered. Additional overlay of 5/8 in. V-rib panels with V-ribs perpendicular to tray rails. Joints were pre-buttered. Butt joints were stitched and reinforced with trowel grade and stress skin. Longitudinal joints reinforced with stitches, trowel grade and stress skin.	Single point raceway temperature requirement exceeded at 172 minutes Hose stream dislodged panel creating through opening	NUMARC 1-5
24 in. x 4 in. Steel Ladder Back with Radial Bends (4 piece design)	1/2 in. v-rib panels with post-buttered joints. V-ribs parallel to tray rails on top and bottom of tray and on inside and outside panels above radial bends. V-ribs perpendicular on inside and outside of radial bends. Panels on inside and outside of right radial bend were scored. Inside and outside panels on left radial bend were mitered. Additional overlay of 5/8 in. V-rib panels with V-ribs perpendicular to tray rails. Joints were pre-buttered. Butt joints were stitched and reinforced with trowel grade and stress skin. Longitudinal joints reinforced with stitches, trowel grade and stress skin.	Satisfactory raceway temperatures Satisfactory barrier condition	NUMARC 1-4

**Appendix A
Tested Assemblies**

**3 HOUR
CABLE TRAYS**

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
24 in. x 4 in. Aluminum Ladder Back with Radial Bend (4 piece design)	1 in. V-rib panels with pre-buttered joints, V-ribs parallel to tray rails on top and bottom of tray. Separate mitered panel pieces on inside and outside face of radial bend. Baseline application with no upgrades applied.	Single point raceway temperature requirements exceeded at 86 minutes	NUMARC 2-10
24 in. x 4 in. Aluminum Ladder Back with Radial Bend (Score & Fold)	1 in. V-rib panels with pre-buttered joints. Score and fold single panel for bottom and sides on horizontal and vertical tray segments with separate top panel. V-ribs parallel to tray rails. Separate mitered panel pieces on inside and outside face of radial bend. Baseline application with no upgrades applied.	Single point raceway temperature requirements exceeded at 85 minutes when barrier opened Through openings in barrier developed	NUMARC 2-10
36 in. x 4 in. Steel Ladder Back with Radial Bends (4 piece design)	1/2 in. v-rib panels with post-buttered joints. V-ribs parallel to tray rails on top and bottom of tray and on inside and outside panels above radial bends. V-ribs perpendicular on inside and outside of radial bends. Panels on inside and outside of left radial bend were scored. Inside and outside panels on right radial bend were mitered. Additional overlay of 5/8 in. V-rib panels with V-ribs perpendicular to tray rails. Joints were pre-buttered. Butt joints were stitched and reinforced with trowel grade and stress skin. Longitudinal joints reinforced with stitches, trowel grade and stress skin.	Single point raceway temperature requirement exceeded at 167 minutes Through opening in barrier developed	NUMARC 1-3

Appendix A Tested Assemblies

1 HOUR AIR DRCS

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
Two 750KCM Power Cables in Exposed 36 in. x 4 in. Steel Ladder Back Tray	Two layers 330-660 Flexi-Blanket on each cable, seams on second layer pre-buttered with 330-660 trowel grade. Note: Protected cables laid in horizontal cable tray. Tray was exposed (no Thermo-Lag applied).	Satisfactory cable visual inspection Satisfactory barrier condition Satisfactory cable functionality	TU Electric Scheme 15-2
Cable Bundle (3 cables) exiting 1-1/2 in. vertical conduit stub; entering fire stop in end of horizontal cable tray	Two layers 330-660 Flexi-Blanket, seams on second layer pre-buttered with 330-660 trowel grade. Flexi-Blanket reinforced at conduit stub interface with staples	Satisfactory cable temperatures Satisfactory barrier condition	TU Electric Scheme 11-2
Cable bundle (4 cables) exiting 2 in. vertical conduit stub; entering horizontal cable tray	Two layers 330-660 Flexi-Blanket, seams on second layer pre-buttered with 330-660 trowel grade. Flexi-Blanket reinforced at conduit stub interface with staples and at tray interface with stainless steel mesh and trowel grade.	Single point temperature exceeded on cable at 59 minutes Satisfactory barrier condition Satisfactory cable visual inspection Satisfactory cable functionality	TU Electric Scheme 11-2
Single nonessential cable protruding from vertical cable tray replicating thermal short	Two layers 330-660 Flexi-Blanket, overlap on second layer pre-buttered with 330-660 trowel grade. Flexi-Blanket reinforced at tray interface with stainless steel mesh and trowel grade.	Satisfactory raceway temperatures Satisfactory barrier condition	TU Electric Scheme 11-2
Cable bundle (1 cable) exiting 1 in. vertical conduit stub; entering fire stop in end of horizontal cable tray	Three layers 330-660 Flexi-Blanket, seams on all layers pre-buttered with 330-660 trowel grade. Flexi-Blanket reinforced at conduit stub with staples.	Satisfactory cable temperatures Satisfactory barrier condition	TU Electric Scheme 11-1

Appendix A Tested Assemblies

1 HOUR AIR DROPS

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
Cable bundle (5 cables) exiting 2 in. vertical conduit stub; entering fire stop in end of horizontal cable tray	Three layers 330-660 Flexi-Blanket, seams on all layers pre-buttered with 330-660 trowel grade. Flexi-Blanket reinforced at conduit stub with staples	Satisfactory cable temperatures Satisfactory barrier condition	TU Electric Scheme 11-1
Cable bundle (10 cables) exiting 3 in. vertical conduit stub; entering fire stop in end of horizontal cable tray	Two layers 330-660 Flexi-Blanket, seams on both layers pre-buttered with 330-660 trowel grade. Flexi-Blanket reinforced at conduit stub with staples	Satisfactory cable temperatures Satisfactory barrier condition	TU Electric Scheme 11-1
Cable bundle (14 cables) exiting 5 in. vertical conduit stub; entering horizontal cable tray	Two layers 330-660 Flexi-Blanket, seams on both layers pre-buttered with 330-660 trowel grade. Flexi-Blanket reinforced at conduit stub with staples and at tray interface with additional 1/2 in. flat panel, 330-660 Flexi-Blanket and trowel grade.	Satisfactory cable temperatures Satisfactory barrier condition	TU Electric Scheme 11-1
Single nonessential cable protruding from vertical cable tray replicating thermal short	Two layers 330-660 Flexi-Blanket, seams on all layers pre-buttered with 330-660 trowel grade. Flexi-Blanket reinforced at tray interface with additional 1/2 in. flat panel, 330-660 Flexi-Blanket and trowel grade.	Satisfactory raceway cable temperatures Satisfactory barrier condition	TU Electric Scheme 11-1
Single nonessential cable protruding from 5 in. (essential) cable drop replicating thermal short	Two layers 330-660 Flexi-Blanket, seams on all layers pre-buttered with 330-660 trowel grade.	Satisfactory essential cable temperatures Satisfactory barrier condition	TU Electric Scheme 11-1

Appendix A Tested Assemblies

1 HOUR AIR DROPS

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
24 air drop cables from two 24 in. x 4 in. steel ladder back horizontal cable trays (stacked) through embedded sleeves	2'-11-1/2" (W) x 1'-7-1/2" (H) x 11-1/2" (D) box design enclosure around air drop cables and embedded sleeves. 1/2 in. V-rib panels on top, front and sides of box with pre-buttered joints. V-ribs perpendicular to trays on top panel. V-ribs vertical on front and sides. 1/2 in. flat panel on bottom with pre-buttered joints. All joints reinforced with trowel grade buildup and stress skin. Panel butt joints at concrete wall interface reinforced using stress skin and 2 in wide flat panel pieces mechanically fastened to wall.	Satisfactory cable temperature Hose stream opened joint between panels causing through opening Satisfactory cable visual inspection Satisfactory cable functionality	TU Electric Scheme 11-4

Appendix A
Tested Assemblies

3 HOUR
AIR DROPS

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
2 bare copper conductors exiting 5 in. vertical conduit stub into horizontal cable tray	1 in. preshaped conduit sections with post-buttered joints. Trowel grade buildup and stress reinforcement at longitudinal and butt seams.	Average conductor temperature requirement exceeded at 104 minutes Satisfactory barrier condition	NUMARC 1-4

Appendix A Tested Assemblies

1 HOUR SUPPORT/INTERVENING STEEL

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
P1001 Unistrut- Vertical	1/2 in. V-rib panels with pre-buttered joints. No reinforcement or additional trowel grade at joints. Protected distance was 9 in. from nearest conduit envelope. Conduit envelopes were baselines.	Later	NUMARC 2-1
P1001 Unistrut - Vertical	1/2 in. V-rib panels with post-buttered joints. Joints between panels reinforced with trowel grade buildup and stress at interface with conduits. Protected distance was 9 in. from nearest conduit envelope. Conduit envelopes were upgrades.	Satisfactory conduit temperatures Satisfactory barrier condition	NUMARC 1-6
P1001 Unistrut - Vertical	1/2 in. flat panels with pre-buttered joints. No reinforcement or additional trowel grade at joints. Protected distance was 9 in. from nearest conduit envelope. Conduit envelopes were baselines for 3 in. and 5 in. conduits and upgrade for 3/4 in. conduit.	Indeterminate conduit temperatures (refer to Appendix B, Note 1) Satisfactory barrier condition	TU Electric Scheme 9-1
3 in. Steel Channel (C3 x 4.1) - Vertical	1/2 in. V-rib panels with pre-buttered joints. No reinforcement or additional trowel grade at joints. Protected distance was 9 in. from nearest cable tray envelope. Cable tray envelopes were baselines.	Later	NUMARC 2-7
3 in. Steel Channel (C3 x 4.1) - Vertical	1/2 in. V-rib panels with post-buttered joints. No reinforcement or additional trowel grade at joints. Protected distance was 9 in. from nearest cable tray envelope. Cable tray envelopes were upgrades.	Satisfactory raceway temperatures Satisfactory barrier condition	NUMARC 2-8
3 in. Steel Channel (C3 x 4.1) - Vertical	1/2 in. V-rib panels with pre-buttered joints. No reinforcement or additional trowel grade at joints. Protected distance was 9 in. from cable tray envelope. Cable tray envelope was upgrade.	Satisfactory raceway temperatures Satisfactory barrier condition	NUMARC 2-9
3 in. Steel Channel (C3 x 4.1) - Vertical	1/2 in. flat panels with pre-buttered joints. No reinforcement or additional trowel grade at joints. Protected distance was 9 in. from nearest cable tray envelope. Cable tray envelopes were upgrades.	Satisfactory raceway temperatures Satisfactory barrier condition	TU Electric Schemes 11-1, 11-2, 11-4, 11-5, 12-1, 12-2, 13-1, 14-1, 15-1

Appendix A
Tested Assemblies

1 HOUR
SUPPORT/INTERVENING STEEL

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
3 in. Tube Steel - Vertical	1/2 in. flat panels with pre-buttered joints. No reinforcement or additional trowel grade at joints. Protected distance was 9 in. from junction box envelope. Junction box envelopes were upgrades	Satisfactory junction box surface temperatures Satisfactory barrier condition	TU Electric Schemes 10-1, and 10-2

Appendix A Tested Assemblies

3 HOUR SUPPORT/INTERVENING STEEL

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
P1001 Unistrut - Vertical	1 in. V-rib panels with pre-buttered joints. No reinforcement or additional trowel grade at joints. Protected distance was entire length of support members. Conduit envelopes were baselines.	Later	NUMARC 2-3
P1001 Unistrut - Horizontal	1 in. V-rib panels with pre-buttered joints. No reinforcement or additional trowel grade at joints. Unistrut member was attached to protected support steel, not in direct contact with conduit envelopes, i.e., unistrut member was a secondary attachment to raceway barrier. Protected distance was 18 in. from nearest conduit envelope. Conduit envelopes were baselines.	Later	NUMARC 2-3
3 in. Steel Channel (C3 x 4.1) - Vertical	1 in. V-rib panels with pre-buttered joints. No reinforcement or additional trowel grade at joints. Protected distance was entire length of support members. Cable tray envelopes were baselines.	Later	NUMARC 2-10
P1001 Unistrut - Horizontal	1 in. V-rib panels with pre-buttered joints. No reinforcement or additional trowel grade at joints. Protected distance was 18 in. from nearest cable tray envelope. Cable tray envelopes were baselines.	Later	NUMARC 2-10
3 in. Steel Channel (C3 x 4.1) - Vertical	1 in. V-rib panels with post-buttered joints. Additional overlay of 5/8 in. V-rib panels with pre-buttered joints and stitched along longitudinal joints. Protected distance was entire length of support members. Cable tray envelope was upgrade.	Satisfactory raceway temperatures Satisfactory barrier condition	NUMARC 1-3
P1001 Unistrut - Horizontal	1 in. V-rib panels with post-buttered joints. Additional overlay of 5/8 in. V-rib panels with pre-buttered joints and stitched along longitudinal joints. Protected distance was 18 in. from cable tray envelope. Cable tray envelope was upgrade.	Satisfactory raceway temperatures Satisfactory barrier condition	NUMARC 1-3

Appendix A Tested Assemblies

1 HOUR CABLE TRAY FIRE STOP

Commodity Tested	Fire Resistive Barrier Construction	Test Acceptance Basis	Test Number
36 in. x 4 in. Steel Ladder Back (Vertical Orientation) with 40% Cable Fill	5 in. deep Thermo-Lag 330-1 (trowel grade) internal fire stop extended across entire inside width of tray. Exposed tray and cabling extended 12 in. beyond fire stop in test furnace. Remainder of cable tray (including portion containing fire stop) covered with 1/2 in. V-rib panels with pre-buttered joints. V-ribs on top and bottom panels oriented perpendicular to tray rails. No reinforcement or additional tray grade applied to joints of tray envelope.	Satisfactory cable temperatures inside tray envelope Through openings developed in barrier during straight stream hose test, but did not penetrate or dislodge fire stop Fire stop met acceptance criteria of IEEE 634	TU Electric Scheme 4
24 in. x 4 in. Aluminum Ladder Back (Horizontal Orientation) with Single Cable Layer	4 in. (min.) to 5 in. (max.) deep fire stop constructed of 1/2 in. V-rib panels, pre-buttered together. Fire stop extended across entire inside width of tray. Trowel grade used to fill around edges of panels forming fire stop. Exposed tray and cabling extended 6 in. beyond fire stop in test furnace. Remainder of cable tray (including portion containing fire stop) covered with 1/2 in. V-rib panels with post-buttered joints. V-ribs on top and bottom panels oriented perpendicular to tray rails. All joints of tray envelope reinforced with trowel grade buildup and stress skin. External steel bracket installed around tray envelope at fire stop location to support bottom panel of tray coverage.	Satisfactory raceway temperatures (single point temperature requirements exceeded on one tray rail near fire stop at 57 min.) Satisfactory cable visual inspection Satisfactory barrier condition	NUMARC 2-8

Industry Application Guide

- Provide method for use of test results, comparison to installed configurations
- Submitted in Draft to NRC on 3/4
- Makes use of all test data
- Addresses acceptance criteria evolution
- Intent: Achieve agreement with NRC on content, provide to industry ASAP

Industry Application Guide

- Approach
 - Simplify evaluation process where possible
 - Identify need for and type of engineering evaluation if simple application of guide does not provide needed result

- Does not address
 - Details of engineering evaluations
 - Fire modeling or determination of actual hazards

Industry Application Guide

- Contents
 - Background, purpose, scope
 - Definitions
 - Acceptance Criteria
 - Performance parameter tables
 - Methodology
 - Tested assemblies tables
 - Example applications

Industry Application Guide

- Methodology
 - Identify configurations (segments)
 - Determine tests to be utilized
 - Evaluate performance parameters
 - Address result

Industry Application Guide

- Results of evaluation:
 - PP bounded and upgrade tests satisfactory on temperature and barrier integrity
 - » acceptable for upgrade
 - PP bounded and tests results exceeded threshold temperatures
 - » Engineering evaluation for component operability at elevated temperatures

or

 - » Evaluation of actual fire hazards versus barrier performance for exemption, deviation basis

Industry Application Guide

- Results of evaluation (Cont):
 - PP not bounded
 - » GL 86-10 engineering evaluation to address aggregate of PP

APPLICATION GUIDE

TECHNICAL POSITIONS FOR TEST RESULTS

- **Four Positions Stated:**

- ◆ Use Of Baseline Time/Temperature Data Independent Of Barrier Inspection Results
- ◆ Use Of Cable Tray Test Data Independent Of Bare Copper Conductors Installed During Tests
- ◆ Use of Test Data Based On Total Enclosed Mass Per Ft. (Raceway + Cabling) To Evaluate Similar Installed Barrier Configurations
- ◆ Use Of Specific Temperature Profile Data For Utility Cable Functionality Evaluations

Position 1: Use of Time/Temperature Data Independent Of Barrier Inspection Results Following Hose Stream Tests

- **Baseline Conduit Barriers**

- ◆ **Test Methodology**

- » Tests Performed Without Cabling
- » Multiple Conduits of Various Sizes Tested in Common Assemblies
- » Fire Exposure Continued Until All Conduits Exceeded Temperature Criteria

- ◆ **Test Results**

- » Small Diameter Conduits Exceeded Acceptance Temperatures First
- » Barrier Condition Continued to Degrade For Up to 39 Minutes Prior to Hose Stream Application
- » Barrier Performance Not Influenced By Loss of Material Structural Integrity

Position 1: Use of Time/Temperature Data Independent Of Barrier Inspection Results Following Hose Stream Tests

- **Baseline Conduit Barriers**

- ◆ **Test Results (Cont.)**

- » Substantial Barrier Quantities Remaining At Specific Times Temperature Criteria Were Exceeded
 - » 1 Hr. Conduit Barriers ≥ 2 " Dia.: No Openings After 50 Minute Fire Exposure and Hose Stream Test
 - » 3 Hr. Conduit Barriers ≥ 3 " Dia.: Bulk Material Quantities Remained With Isolated Through Openings After 102 Min. Exposure and Hose Stream Test
 - » Bare Conductor Temperatures Inside Conduits Averaged 40° F Lower Than Conduit Surfaces When Temperature Criteria Was Exceeded

Position 1: Use of Time/Temperature Data Independent Of Barrier Inspection Results Following Hose Stream Tests

- **Baseline Conduit Barriers**

- ◆ **Conclusion - Baseline Time/Temperature Data Can Be Used To Evaluate Installed Conduit Barrier Configurations Independent of Post Hose Steam Inspection Results**
 - » Remaining Thermo-Lag Material When Temperature Criteria Exceeded In Conjunction With Conduits Themselves Provide Sufficient Protection Of Enclosed Cabling From Falling Debris
 - » Hose Stream Test Not Required by Latest ASTM E05.11 Draft Standard

Position 1: Use of Time/Temperature Data Independent Of Barrier Inspection Results Following Hose Stream Tests

- **Baseline Cable Tray Barriers**

- ◆ **Test Methodology**

- » Two 24" and Two 6" Wide Trays Tested In Common Assemblies For 1 And 3 Hr. Applications
- » Temperatures Recorded On Tray Rails And On #8 AWG Conductors Positioned On Rungs, On Top Of Cabling And Below Rungs
- » 1 Hr. Test Continued Until All Trays Exceeded Temperature Criteria (48 Min.)
- » 3 Hr. Test Terminated At 86 Min. When Both 24" Trays Exceeded Temperature Criteria And One Barrier Had Opened

Position 1: Use of Time/Temperature Data Independent Of Barrier Inspection Results Following Hose Stream Tests

- **Baseline Cable Tray Barriers**

- ◆ **Test Results**

- » 24" Wide Trays Exceeded Temperature Criteria First
- » 24" Tray Barriers In 1 Hr. Test Continued To Degrade For Up To 27 Minutes Prior To Hose Stream Application
- » Test Data From Extensive Instrumentation Demonstrates Barrier Integrity Maintained For Tray Envelopes Until Temperature Criteria Was Exceeded

Position 1: Use of Time/Temperature Data Independent Of Barrier Inspection Results Following Hose Stream Tests

- **Baseline Cable Tray Barriers**

- ◆ **Test Results (Cont.)**

- » Following Hose Stream Tests 1/4"-3/8" Of Uncharred Material Quantities Remained Across Tray Spans Where Damage To Cabling From Falling Debris Could Credibly Occur
 - » Areas With Little Or No Material Remaining Were At Panel Edges Along Side Rails And At Joints On Undersides Of Tray Barriers

Position 1: Use of Time/Temperature Data Independent Of Barrier Inspection Results Following Hose Stream Tests

- **Baseline Cable Tray Barriers**

- ◆ Conclusion - Baseline Time/Temperature Data Can Be Used To Evaluate Installed Cable Tray Barrier Configurations Independent Of Post Hose Stream Inspection Results
 - » Reasonable Approach Is Use Of Last Satisfactory Time/Temperature Data Points And Consider Barrier Condition Acceptable At That Time
 - » Hose Stream Test Not Required By Latest ASTM E05.11 Draft Standard

Position 2: Use of Cable Tray Test Data Without Bare Copper Conductors Utilized During Tests

- **Cable Tray Test Instrumentation**

- ◆ **TU Electric Testing**

- » Tray Side Rails Instrumented At 12" Intervals
- » Single Layer Of Cables Installed
- » Cables Instrumented At 6" Intervals: Power Cable Positioned In Center, Control/Instrument Cables Along Side Rails
- » Side Rail And Cable Temperatures Demonstrated Satisfactory Barrier Performance

Position 2: Use of Cable Tray Test Data Without Bare Copper Conductors Utilized During Tests

- **Cable Tray Test Instrumentation**

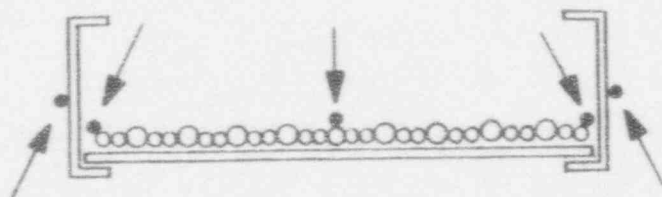
- ◆ NUMARC Phase 1 Testing

- » Tray Side Rails Instrumented At 6" Intervals
 - » Single Layer Of Cables Installed
 - » Bare Copper Conductors Installed On Tray Rungs And On Top Of Cables - Instrumented At 6" Intervals
 - » Side Rail And Conductor Temperatures Demonstrated Satisfactory Barrier Performance

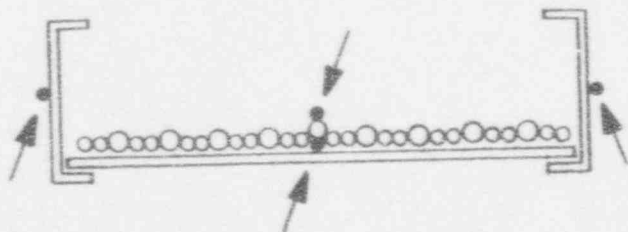
Position 2: Use of Cable Tray Test Data Without Bare Copper Conductors Utilized During Tests

- Cable Tray Test Instrumentation
 - ◆ NUMARC Phase 2 Testing
 - » Tray Side Rails Instrumented At 6" Intervals
 - » Single Layer Of Cables Installed
 - » Bare Copper Conductors Installed On Tray Rungs, On Top Of Cables And Below Tray Rungs - instrumented At 6" Intervals
 - » Side Rail And Conductor Temperatures Demonstrated Satisfactory Barrier Performance

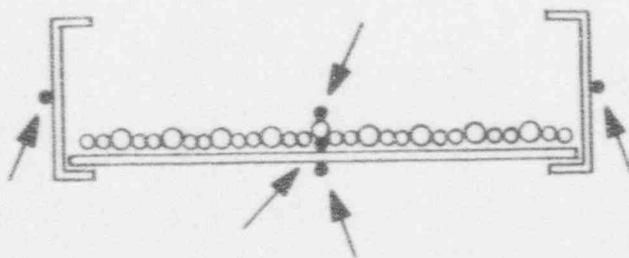
COMPARISON OF CABLE TRAY TEST INSTRUMENTATION



TU ELECTRIC



NUMARC PHASE 1



NUMARC PHASE 2

Position 2: Use of Cable Tray Test Data Without Bare Copper Conductors Utilized During Tests

- Phase 2 Testing - Bare Copper Conductor Below Tray Rungs
 - ◆ General
 - » Conductor Below Rungs Provides Early Indication Of Envelope Breach
 - » Side Rail Temperatures Dominant For 3 Hr. Configurations - Both 24" And 6" Trays
 - » Side Rail Temperatures Dominant For 1 Hr. Configurations With 6" Trays
 - » Results Less Conclusive For 1 Hr. Configurations With 24"-36" Trays As Early Structural Failure Skewed Temperature Data
 - » However, Trending Indicates Maximum Temperatures Also Occurs On Side Rails For 1 Hr. Configurations With 24"-36" Trays

Position 2: Use of Cable Tray Test Data Without Bare Copper Conductors Utilized During Tests

- Phase 2 Testing - Bare Copper Conductor Below Tray Rungs
 - ◆ 3 Hr. Test
 - » Extensive Instrumentation Demonstrated Side Rail Average And Single Maximum Temperatures 11°-57°F Higher Than Conductors Below Rungs
 - » Both 24" And 6" Wide Trays
 - » Temperature Difference Attributed To 1" Thick Panels Which Resisted Pronounced Sag Effects And Prevented Excessive Heat Entry Through Bottom Joints

Position 2: Use of Cable Tray Test Data Without Bare Copper Conductors Utilized During Tests

- Phase 2 Testing - Bare Copper Conductor Below Tray Rungs
 - ◆ 1 Hr. Tests
 - » 6" Trays: Extensive Instrumentation Demonstrated Average Side Rail Temperatures 10°-36°F Higher Than Conductors Below Rungs
 - » 6" Trays: Temperature Difference Attributed To Short Panel Spans Which Resisted Pronounced Sag Effects And Prevented Excessive Heat Entry Through Bottom Joints
 - » 24"-36" Trays: Results Less Conclusive As Early Structural Failure Skewed Temperature Data
 - » 24"-36" Trays: Average Temperatures Of Conductors Below Rungs Approximately 10°F Higher Than Side Rails

Position 2: Use of Cable Tray Test Data Without Bare Copper Conductors Utilized During Tests

- Phase 2 Testing - Bare Copper Conductor Below Tray Rungs
 - ◆ 1 Hr. Tests (Cont.)
 - » 24"-36" Trays: Temperature Difference Attributed To 1/2" Thick Panels With Wide Spans, Resulting Sag Induced Stresses On Bottom Joints Which Facilitated Heat Entry
 - » 24"-36" Trays: Trending Of Test Results Indicates Maximum Temperatures Still Occur On Side Rails
 - » Test 2-9: Satisfactory Test Of 36" Tray Upgrade Had Maximum Side Rail Temperature 30°F Higher Than Conductor Below Rungs

Position 2: Use of Cable Tray Test Data Without Bare Copper Conductors Utilized During Tests

- **Conclusions**

- ◆ Phase 2 Cable Tray Test Results Demonstrate Use Of Side Rail Temperature Profiles Is Appropriate To Evaluate Similar Installed Configurations
 - » Four Cable Tray Tests Performed With Conductors Below Tray Rungs
 - » Extensive Instrumentation
- ◆ Accordingly, Side Rail Temperature Data From TU Electric And NUMARC Phase 1 Testing Can Be Used To Evaluate Similar Installed Configurations
- ◆ General Cable Types, Cable Quantity And Total Enclosed Mass Must Still Be Assessed In Performing Evaluations Of Installed Configurations

Position 3: Use of Test Data Based On Total Enclosed Mass To Evaluate Similar Installed Configurations

- **Bounding Position**

- ◆ Total Enclosed Mass (i.e., Raceway + Cabling) Within Tested Configurations May Be Used To Evaluate Installed Configurations Of Similarly Constructed Raceways And Barriers
 - » If Total Enclosed Mass Per Length (lbm/ft.) Is Greater Than That Tested, The Installed Configurations Can Be Bounded
 - » Basis: Greater Enclosed Mass And Associated Thermal Capacity Provides Higher Thermal Resistance Of Contents And Results In Lower Internal Temperatures

Position 3: Use of Test Data Based On Total Enclosed Mass To Evaluate Similar Installed Configurations

- **Bounding Position**

- ◆ **Restrictions**

- » Raceway And Barrier Configurations Must Be Truly Comparable, e.g., Ladder Back Cable Trays With Low Cable Fills Would Not Bound Expanded Metal Wireways With Higher Cable Fills Even If Enclosed Mass Was Equal
 - » General Cable Types And Applicable Temperature Effects Must Still Be Assessed In Evaluating Installed Configurations

Position 4: Use of Temperature Profile Data For Utility Cable Functionality Evaluations

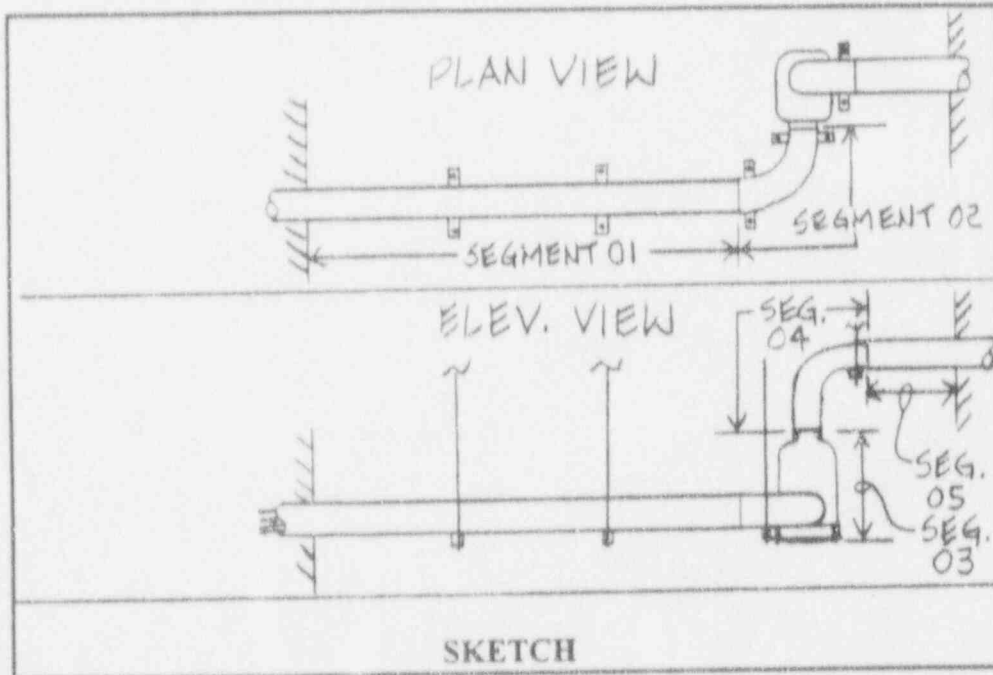
- **Temperature Profile Data For Performance Of Cable Functionality Evaluations**
 - ◆ **Conduit Barriers**
 - » Temperatures Recorded By Thermocouples On #8 AWG Bare Copper Conductors Contained Within Conduit Test Assemblies
 - ◆ **Cable Tray Barriers**
 - » Temperatures Recorded By Thermocouples Installed On Tray Side Rail Surfaces Or On #8 AWG Bare Copper Conductors Located On Or Above Tray Rungs
 - ◆ **Methodology For Performance Of Cable Functionality Evaluations Is Outside Scope Of Application Guide**

Thermo-Lag Fire Barrier System: SC-TL-4101

Fire Area Location: SC 101 SAFEGUARDS BUILDING
FIRE AREA SC, ROOM 101, 1ST LEVEL

Required Rating: 1 HOUR

Unique Segments: SC-TL-4101-SEGMENT 01-4" Φ STEEL CONDUIT
STRAIGHT RUN
SC-TL-4101-SEGMENT 02-4" Φ STEEL CONDUIT
RADIAL BEND (HORIZ.)
SC-TL-4101-SEGMENT 03-4" Φ STEEL CONDUIT
LB
SC-TL-4101-SEGMENT 04-4" Φ STEEL CONDUIT
RADIAL BEND (VERT.)
SC-TL-4101-SEGMENT 05-4" Φ STEEL CONDUIT
STRAIGHT RUN



SEE ATTACHED THERMO-LAG INSTALLATION DETAILS FOR DIMENSIONS

AS-BUILT TO TESTED EVALUATION

<p>PERFORMANCE PARAMETERS</p>	<p>FIRE RESISTIVE BARRIER: <u>SC-TL-4101</u> SEGMENT: <u>01 & 05 4" ϕ CONDUIT STRAIGHT RUN</u> RATING: <u>1 HOUR</u></p>		
<p>COMMODITY</p>	<p>AS BUILT CONFIGURATION</p>	<p>TESTED CONFIGURATION(S) UTILIZED FOR EVALUATION</p>	<p>EVALUATION</p>
<p>TYPE</p>	<p>CONDUIT STRAIGHT RUN</p>	<p>CONDUIT 4" ϕ NUMARC TEST 2-1 CONDUIT 3" ϕ TUE SCHEME 9-1</p>	<p>TESTED CONFIGURATIONS SAME FOR ALL PERFORMANCE PARAMETERS</p>
<p>SIZE</p>	<p>4" ϕ</p>	<p>4" ϕ 3" ϕ</p>	<p>4" ϕ IS THE SAME, 3" ϕ WOULD BOUND THE INSTALLED CONFIGURATION (TABLE 4-1) SMALLEST CONDUIT REPRESENTS, SMALLEST THERMAL CAPACITY, LEAST THERMAL RESISTANCE AND LARGEST EXTERNAL SURFACE AREA TO THERMAL CAPACITY RATIO.</p>
<p>MATERIAL</p>	<p>STEEL</p>	<p>4" ϕ ALUMINUM 3" ϕ STEEL</p>	<p>3" ϕ SAME MATERIAL, 4" ϕ ALUMINUM WOULD BOUND STEEL (TABLE 4-1) LESS THERMAL RESISTANCE</p>
<p>CONTENTS</p>	<p>4" ϕ STEEL = 10.79# / lin. ft. CABLE FILL 3 - 3/4" #6 POWER 3 - 3/4" #8 POWER CABLE WT. = 1.01# / lin. ft. 4" ϕ STEEL TOTAL = 11.80# / lin. ft.</p>	<p>4" ϕ ALUM. - NO CABLE FILL - CONDUIT 3.40# / lin. ft. 3" ϕ STEEL - CABLE 2.33# / lin. ft. (Cable Fill - CONDUIT 7.58# / lin. ft. IEEE 383 See Attached) 3" ϕ TOTAL = 9.91# / lin. ft.</p>	<p>THERMAL MASS lb. / lin. ft. OF INSTALLED CONFIGURATION IS GREATER THAN EITHER TESTED CONFIGURATION AND IS THEREFORE BOUNDED</p>
<p>ORIENTATION</p>	<p>HORIZONTAL</p>	<p>HORIZONTAL</p>	<p>SAME - N/A</p>

AS-BUILT TO TESTED EVALUATION

PAGE 3 OF 27

PERFORMANCE PARAMETERS	FIRE RESISTIVE BARRIER: <u>SC-TL-4101</u> SEGMENT: _____ COMMODITY: <u>01 & 05 4" ϕ CONDUIT STRAIGHT RUN</u> RATING: <u>1 HOUR</u>		
BARRIER	AS BUILT CONFIGURATION	TESTED CONFIGURATION(S) UTILIZED FOR EVALUATION	EVALUATION
MATERIAL TYPE	THERMO-LAG 330-1 PRESHAPED CONDUIT SECTIONS	THERMO-LAG 330-1 PRESHAPED CONDUIT SECTIONS	SAME - N/A
THICKNESS	0.625" \pm .125"	4" ϕ 0.50" \pm 0.125" - 0" 3" ϕ 0.625" \pm 0.125"	INSTALLED CONFIGURATION HAS THICKER BARRIER MAT'L THAN 4" ϕ TESTED AND EQUIVALENT THICKNESS TO 3" ϕ TESTED, AND IS THEREFORE BOUNDED
STIFFENER (V-RIB) LOCATION/ ORIENTATION	N/A	N/A	N/A
STRESS SKIN LOCATION	INTERNAL	INTERNAL	SAME - N/A

AS-BUILT TO TESTED EVALUATION

<p>PERFORMANCE PARAMETERS</p>	<p>FIRE RESISTIVE BARRIER: <u>SL-TL-4101</u> SEGMENT: <u>02 & 05 4" ϕ CONDUIT STRAIGHT RUN</u> COMMODITY: RATING: <u>1 HR</u></p>		
<p>BARRIER</p>	<p>AS BUILT CONFIGURATION</p>	<p>TESTED CONFIGURATION(S) UTILIZED FOR EVALUATION</p>	<p>EVALUATION</p>
<p>JOINT TYPE</p>	<p>PRE-BUTTERED BUTT JOINTS</p>	<p>PRE-BUTTERED BUTT JOINTS FOR BOTH TESTED CONFIGURATIONS</p>	<p>SAME - N/A</p>
<p>FASTENERS</p>	<p>TIE-WIRES 8" O.C. TYP. SPACING 2" MAX. SPACING FROM BUTT JOINTS</p>	<p>4" ϕ - 1/2" WIDE STAINLESS STEEL BANDS 12" O.C. MAX. SPACING AND 2" MAX. SPACING FROM BUTT JOINTS 3" ϕ - 1/2" WIDE STAINLESS STEEL BANDS AND TIE-WIRES 12" MAX. SPACING O.C. AND 2" MAX. SPACING FROM BUTT JOINTS</p>	<p>IN ACCORDANCE WITH TABLE 4-1 (STRUCTURALLY AND THERMALLY) BANDS WOULD BOUND TIE-WIRES. IN ADDITION 8" TYPICAL SPACING WOULD BE BOUNDED STRUCTURALLY BY 12" MAX. SPACING UTILIZED IN BOTH TESTS. THERMALLY CLOSER SPACING IS NOT BOUNDED, HOWEVER WITH USE OF TIE-WIRES FOR INSTALLED CONFIG. AND PREVIOUS TESTING WITH CLOSE SPACING OF FASTENERS ON RADIAL BENDS, THERE WILL BE NO THERMAL IMPACT.</p>

AS-BUILT TO TESTED EVALUATION

PAGE 5 OF 27

PERFORMANCE PARAMETERS	FIRE RESISTIVE BARRIER: <u>SL-TL-4101</u> SEGMENT: <u>01405 4" ϕ CONDUIT STRAIGHT RUN</u> COMMODITY: RATING: <u>1 HR.</u>		
BARRIER	AS BUILT CONFIGURATION	TESTED CONFIGURATION(S) UTILIZED FOR EVALUATION	EVALUATION
UNSUPPORTED SPAN	N/A FOR CONDUITS - HALF ROUNDS CONTINUOUSLY SUPPORTED BY CONDUIT FOR THERMAL CONSIDERATIONS 3'-6" MAX SPACING BETWEEN SUPPORTS	4" ϕ CONDUIT - 3'-7 1/2" BETWEEN SUPPORTS 3" ϕ CONDUIT - 4'-0" ON RADIAL BEND WITH NO SUPPORTS.	AS DISCUSSED UNDER AS-BUILT CONFIG - UNSUPPORTED SPAN STRUCTURAL CONSIDERATION IS INTENDED FOR CABLE TRAY WIDTHS. THERMALLY INSTALLED CONFIG. IS BOUNDED.
JOINT REINFORCEMENT	N/A	N/A	NO ADDITIONAL JOINT REINFORCEMENT ON STRAIGHT RUN FOR INSTALLED AND TESTED CONFIGURATIONS
STRUCTURAL AND INTERVENING STEEL PROTECTION	9" PROTECTION ON STEEL FROM BARRIER ENVELOPE	9" PROTECTION ON STEEL FROM BARRIER ENVELOPE	SAME - N/A

AS-BUILT TO TESTED EVALUATION

PAGE 6 OF 27

PERFORMANCE PARAMETERS	FIRE RESISTIVE BARRIER: <u>SC-TL-4101</u> SEGMENT COMMODITY: <u>01 & 05 4" & CONDUIT STRAIGHT RUN</u> RATING: <u>1 HR.</u>		
BARRIER	AS BUILT CONFIGURATION	TESTED CONFIGURATION(S) UTILIZED FOR EVALUATION	EVALUATION
BOX ENCLOSURE PERFORMANCE	N/A	N/A	N/A

Thermo-Lag Fire Barrier System: SC-TL-4101

Segment Nos:

SEGMENTS 01 & 05 4" ϕ STEEL CONDUIT
STRAIGHT RUN

Required Rating:

1 HOUR

Additional
Evaluation:

AS DISCUSSED IN THE INSTALLED TO
TESTED PARAMETER COMPARISON,
THE INSTALLED CONFIGURATION IS
BOUNDED BY THE TESTED CONFIGURATIONS.

NUMARC TEST 2-1 HAD THINNER BARRIER
MATERIAL, ALUMINUM 4" ϕ CONDUIT AND
LESS THERMAL MASS. THE TEMPERATURE
CRITERION ON THE OUTSIDE OF THE CONDUIT
FOR AVERAGE TEMPERATURE WAS EXCEEDED
AT 48 MINUTES (305°F). AT 50 MINUTES
WHEN THE TEST WAS STOPPED THE TEMPERATURE
ON THE OUTSIDE OF THE CONDUIT WAS 375°F S.H.
AND 321°F AVERAGE. THE TEMP. ON THE INSIDE
OF THE CONDUIT WAS STILL BELOW TEMPERATURE
CRITERION (336°F S.H. and 281°F AVG.). THE
BARRIER CONDITION WAS SATISFACTORY FOLLOWING
THE HOSE STREAM TEST.

THE SCHEME 9-1 HAD EQUIVALENT THICKNESS
BARRIER MATERIAL AND STEEL CONDUIT WHICH IS
CONSISTANT WITH THE INSTALLED CONFIG. 9-1 HAD LESS
THERMAL MASS DUE TO THE SMALLER 3" ϕ CONDUIT (SEE Pg. 2)
THE TEMPERATURE ON INTERNAL CABLES
AT 60 MINUTES WAS 309°F S.H. AND 204°F
AVERAGE ON THE INSTRUMENTATION CABLE. (WORST CASE)
THERMOCOUPLES ON THE OUTSIDE - CONTINUED -

Thermo-Lag Fire Barrier System: SC-TL-4101

Segment Nos: SEGMENT-01#05 4" ϕ STEEL CONDUIT
STRAIGHT RUN

Required Rating: 1 HOUR

Additional
Evaluation:

-CONTINUED-

OF CONDUIT HAD INDETERMINATE
TEMPERATURES DUE TO ANOMOLIES
DISCUSSED IN THE TEST REPORT. THE
BARRIER CONDITION WAS SATISFACTORY
FOLLOWING THE HOSE STREAM TEST.

BASED ON THE ACCEPTABLE AND LOWER INTERNAL
CONDUIT TEMPERATURE PERFORMANCE
FOR THE SMALLER 3" ϕ DIAMETER STEEL
CONDUIT AS COMPARED TO THE 4" ϕ
ALUMINUM CONDUIT INTERNAL TEMPERATURES
WHICH WERE ACCEPTABLE AT 50 MINUTES
WHEN THE TEST WAS TERMINATED, IT
IS CONCLUSIVE THAT THE THICKER BARRIER
MATERIAL AS INSTALLED OVER STEEL CONDUITS PERFORMS
CONSIDERABLY BETTER THERMALLY. IN
ADDITION IN BOTH TESTS STRUCTURAL
INTEGRITY WAS MAINTAINED FOLLOWING
THE HOSE STREAM TEST.

IT IS THEREFORE CONCLUDED THAT THE DATA AND
PARAMETER COMPARISON TO TESTED CONFIGURATIONS
PROVIDES REASONABLE ASSURANCE THAT
THE INSTALLED 4" ϕ STEEL CONDUIT WITH THE .625 \pm .125
BARRIER THICKNESS AND GREATER THERMAL MASS HAS
EQUIVALENT FIRE ENDURANCE TO A 1 HR. RATED ASSEMBLY.
IN ADDITION, NO INTERNAL CONDUIT TEMPERATURES FOR
EITHER TESTED CONFIG. EXCEEDED THE 4750F LOCA

QUALIFICATION WARM AIR OVEN TEST QUALIFICATION FOR
THE INSTALLED CABLE (SEE ATTACHED DOCUMENTATION)

AS-BUILT TO TESTED EVALUATION

<p>PERFORMANCE PARAMETERS</p>	<p>FIRE RESISTIVE BARRIER: <u>SC-TL-4101</u> SEGMENT: <u>02 & 04 4" CONDUIT RADIAL BEND</u> RATING: <u>1 HOUR</u></p>		
<p>COMMODITY</p>	<p>AS BUILT CONFIGURATION</p>	<p>TESTED CONFIGURATION(S) UTILIZED FOR EVALUATION</p>	<p>EVALUATION</p>
<p>TYPE</p>	<p>CONDUIT RADIAL BENDS SEGMENT-02 HORIZ. SEGMENT-04 HORIZ./VERT.</p>	<p>CONDUIT RADIAL BEND 3" ϕ NUMARC TEST 1-6 4" ϕ NUMARC TEST 2-1 3" ϕ TUE TEST 9-1</p>	<p>SAME TESTS UTILIZED FOR ALL PARAMETER COMPARISONS. EXCEPT TUE 9-1 UTILIZED ONLY ON PG. 15 & 16</p>
<p>SIZE</p>	<p>4" ϕ</p>	<p>3" ϕ - TEST 1-6 (NUMARC) 4" ϕ - TEST 2-1 (NUMARC)</p>	<p>SMALLER ϕ TESTED CONFIGURATION OR SAME SIZE BOUNDS INSTALLED CONFIG. (TABLE 4-1)</p>
<p>MATERIAL</p>	<p>STEEL</p>	<p>3" ϕ - STEEL 4" ϕ - ALUMINIUM</p>	<p>ALUMINIUM BOUNDS STEEL (TABLE 4-1)</p>
<p>CONTENTS</p>	<p>4" ϕ STEEL CONDUIT CABLE WT. = 1.01#/lin.ft. STEEL CONDUIT = 10.79#/lin.ft. TOTAL = 11.80#/lin.ft.</p>	<p>4" ϕ ALUM CONDUIT (2-1) (NO CABLE) CONDUIT = 3.40#/lin.ft. 3" ϕ STEEL CONDUIT (6-1) (NO CABLE) CONDUIT = 7.58#/lin.ft.</p>	<p>THERMAL MASS OF INSTALLED CONFIG. > TESTED CONFIGS. AND IS THEREFORE BOUNDED</p>
<p>ORIENTATION</p>	<p>SEG. 02 - HORIZ. SEG. 04 - HORIZ./VERT.</p>	<p>4" ϕ - HORIZ./VERT. 3" ϕ - HORIZ./VERT.</p>	<p>RADIAL BENDS IN TESTED CONFIG. HAD PORTIONS IN BOTH VERT. & HORIZ. ORIENTATION AND THEREFORE BOUND INSTALLED</p>

AS-BUILT TO TESTED EVALUATION

FIRE RESISTIVE BARRIER: <u>SC-TL-4101</u> COMMODITY: <u>02-04</u> RATING: <u>1 HOUR</u>			
PERFORMANCE PARAMETERS	AS BUILT CONFIGURATION	TESTED CONFIGURATION(S) UTILIZED FOR EVALUATION	EVALUATION
BARRIER	THERMO-LAG 330-1 PRESHAPED CONDUIT SECTIONS	THERMO-LAG 330-1 PRESHAPED CONDUIT SECTIONS	SAME - N/A
MATERIAL TYPE	THERMO-LAG 330-1 PRESHAPED CONDUIT SECTIONS	THERMO-LAG 330-1 PRESHAPED CONDUIT SECTIONS	SAME - N/A
THICKNESS	0.625" ± 0.125"	4" φ 0.50" + 0.125" - 0" 3" φ BASELINE 0.50 + .125" - 0" UPGRADE - 330-1 SKIM COAT OVER NUMBER 2 STRESS SKIN	4" φ TESTED CONDUIT BARRIER MATERIAL IS LESS THICKNESS AND THEREFORE BOUNDS INSTALLED 3" φ TESTED CONDUIT BARRIER THICKNESS WITH UPGRADE IS SLIGHTLY THICKER THAN INSTALLED
STIFFENER (V-RIB) LOCATION/ ORIENTATION	N/A	N/A	N/A
STRESS SKIN LOCATION	INTERNAL	4" φ - INTERNAL 3" φ - INTERNAL - BASELINE EXTERNAL - UPGRADE (EIT. TRUCK GRADE + STRESS SKIN)	4" φ TESTED - SAME - N/A 3" φ TESTED - SHOULD PERFORM BETTER STRUCTURALLY DURING HOSE STREAM BOTH UPGRADED AND NON-UPGRADED CONDUIT RADIAL BENDS HAVE NOT EXHIBITED STRUCTURAL FAILURES AS A LIMITING PARAMETER

AS-BUILT TO TESTED EVALUATION

<p>PERFORMANCE PARAMETERS</p>	<p>FIRE RESISTIVE BARRIER: <u>SC-TL-4101</u> SEGMENTS COMMODITY: <u>02 ± 04</u> RATING: <u>1 HOUR</u></p>		
<p>BARRIER</p>	<p>AS BUILT CONFIGURATION</p>	<p>TESTED CONFIGURATION(S) UTILIZED FOR EVALUATION</p>	<p>EVALUATION</p>
<p>JOINT TYPE</p>	<p>PRE-BUTTERED BUTT JOINTS - MITERED PIECES W/ BUTT JOINTS ON RADIAL BEND</p>	<p>4" φ - PRE-BUTTERED BUTT JOINTS - MITERED PIECES W/ BUTT JOINTS ON RADIAL BEND 3" φ BASELINE - POST BUTTERED BUTT JOINTS - MITERED PIECES W/ BUTT JOINTS ON RADIAL BEND UPGRADE - TROWEL GRADE 320-1 SKIM COAT & EXTERNAL STRESS SKIN</p>	<p>4" φ - SAME - N/A 3" φ - STRUCTURAL - UPGRADE IS BETTER STRUCTURALLY THAN INSTALLED. HOWEVER 4" φ BASELINE WITH THINNER BARRIER MATERIAL EXHIBITED NO OPENINGS AND 1" CHAR DEPTH WITH 1/8" to 1/4" UNCHARRED THERMOLAG REMAINING IN AREAS OF THE RADIAL BEND</p>
<p>FASTENERS</p>	<p>TIE-WIRES 1 or 2 MAX. TIE WIRES PER MITERED SECTION AS REQUIRED FOR TIGHT FIT.</p>	<p>4" φ & 3" φ - SAME SPACING ON BASELINE ONLY WITH 1/2 WIDE BANDS.</p>	<p>STRUCTURALLY TESTED CONFIGURATIONS BOUND INSTALLED THERMALLY BANDS WOULD INHIBIT T.L. EXPANSION AND ACTIVATION AND THEREFORE WOULD BOUND INSTALLED</p>

AS-BUILT TO TESTED EVALUATION

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PERFORMANCE PARAMETERS	FIRE RESISTIVE BARRIER: <u>SC-TL-4101</u> SEGMENTS: <u>02 & 04</u> COMMODITY: _____ RATING: _____		
BARRIER	AS BUILT CONFIGURATION	TESTED CONFIGURATION(S) UTILIZED FOR EVALUATION	EVALUATION
UNSUPPORTED SPAN	N/A - FOR CONDUITS	N/A FOR CONDUITS	N/A
JOINT REINFORCEMENT	NONE	4" ϕ - NONE 3" ϕ - UPGRADE WITH EXTERNAL TROWEL GRADE 330-1 AND STRESS SKIN	4" ϕ TESTED - SAME N/A 3" ϕ TESTED DOES NOT BOUND INSTALLED
STRUCTURAL AND INTERVENING STEEL PROTECTION	SEE SEG. 1 & 5	SEE SEG 1 & 5	SEE SEG 1 & 5

AS-BUILT TO TESTED EVALUATION

<p>PERFORMANCE PARAMETERS</p>	<p>FIRE RESISTIVE BARRIER: <u>SC-TL-4101</u> SEGMENTS: <u>02 & 04</u> COMMODITY: _____ RATING: _____</p>		
<p>BARRIER</p>	<p>AS BUILT CONFIGURATION</p>	<p>TESTED CONFIGURATION(S) UTILIZED FOR EVALUATION</p>	<p>EVALUATION</p>
<p>BOX ENCLOSURE PERFORMANCE</p>	<p>N/A</p>	<p>N/A</p>	<p>N/A</p>

Thermo-Lag Fire Barrier System: SC-TL-4101

Segment Nos:

02 & 04

Required Rating:

1 HR.Additional
Evaluation:

THERMALLY, THE INSTALLED CONFIGURATION FOR RADIAL BENDS WITH THICKER 0.625" ± 0.125" BASELINE MATERIAL WOULD PERFORM CONSISTANT WITH THE TESTED CONFIGURATION IN ASSEMBLY 1-0 WHICH HAD ACCEPTABLE TEMPERATURES FOR THE ONE HR. FIRE DURATION AND THE SCHEME 9-1 FOR STRAIGHT RUN CONDUIT (SEE SEGMENTS 1 & 5 PARAMETER COMPARISONS) IN BOTH CASES, TEMPERATURES WERE ACCEPTABLE FOR 3" Ø CONDUITS WHICH WOULD PERFORM WORSE THERMALLY (PER TABLE 4-1). IN ADDITION, NUMARC TEST 2-1 WITH NON-UPGRADED THINNER MATERIAL HAD ACCEPTABLE INTERNAL CONDUIT TEMPERATURES AT THE RADIAL BEND WHEN THE TEST WAS TERMINATED AT 50 MINUTES. IN CONCLUSION, WHEN COMPARING T.C. DATA, PRE SHAPED HALF ROUNDS ON RADIAL BEND PERFORM THERMALLY EQUIVALENT OR BETTER THAN STRAIGHT RUN APPLICATIONS.

STRUCTURALLY, TEST 2-1 BASELINE 4" Ø ALUMINUM RADIAL BEND HAD SATISFACTORY BARRIER CONDITION FOLLOWING THE HOSE STREAM TEST WITH APPROXIMATELY A 1" CHAR LAYER AND 1/8" - 1/4" UNCHARRED MATERIAL AGAINST THE CONDUIT IN (CONTINUED)

AS-BUILT TO TESTED EVALUATION

PAGE 17 OF 27

PERFORMANCE PARAMETERS	FIRE RESISTIVE BARRIER: <u>SC-TL-4101</u> SEGMENT: <u>03 4" ϕ CONDULET BOX</u> RATING: <u>1 HR.</u>		
COMMODITY	AS BUILT CONFIGURATION	TESTED CONFIGURATION(S) UTILIZED FOR EVALUATION	EVALUATION
TYPE	4" ϕ CONDUIT LB (CONDULET)	NUMARC TEST 1-6 3" ϕ CONDULET-STEEL NUMARC TEST 2-1 4" ϕ CONDULET-ALUM.	TESTED CONFIG. SAME FOR ALL PERFORMANCE PARAMETERS
SIZE	4"	4" ϕ 3" ϕ	4" ϕ CONDULET IS THE SAME AND 3" ϕ WOULD BOUND INSTALLED CONFIGURATION TABLE 4-1
MATERIAL	STEEL	4" ϕ ALUMINUM 3" ϕ STEEL	SEE SEGMENT 01 & 05 DISCUSSION
CONTENTS	SEE SEG. 01 & 05	SEE SEG. 01 & 05	SEE SEGMENT 01 & 05 DISCUSSION
ORIENTATION	VERTICAL	VERTICAL FOR BOTH 4" ϕ AND 3" ϕ	SAME - N/A

AS-BUILT TO TESTED EVALUATION

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PERFORMANCE PARAMETERS	FIRE RESISTIVE BARRIER: <u>SC-TL-4101</u> SEGMENT <u>03</u> COMMODITY: <u>4" ϕ CONDULET BOX</u> RATING: <u>1 HR</u>		
BARRIER	AS BUILT CONFIGURATION	TESTED CONFIGURATION(S) UTILIZED FOR EVALUATION	EVALUATION
MATERIAL TYPE	THERMO-LAG 330-1 V-GROOVED PANELS	THERMO-LAG 330-1 Y-GROOVED PANELS	N/A - SAME
THICKNESS	0.625" \pm .125"	4" ϕ AND 3" ϕ 0.50 + 0.125 - 0	THINNER TESTED MATERIAL WOULD BOUND INSTALLED
STIFFENER (V-RIB) LOCATION/ ORIENTATION	INTERNAL - NOT CRITICAL	INTERNAL - NOT CRITICAL	SAME - N/A
STRESS SKIN LOCATION	INTERNAL	INTERNAL - 4" ϕ & 3" ϕ EXTERNAL - 3" ϕ SEE JOINT REINFORCEMENT	FOR THIS PARAMETER ONLY INTERNAL STRESS SKIN EVALUATED SAME - N/A

AS-BUILT TO TESTED EVALUATION

<p>PERFORMANCE PARAMETERS</p>	<p>FIRE RESISTIVE BARRIER: <u>SC-TL-4101</u> SEGMENT <u>03</u> COMMODITY: <u>4" ϕ CONDULET BOX</u> RATING: <u>1 HR.</u></p>		
BARRIER	AS BUILT CONFIGURATION	TESTED CONFIGURATION(S) UTILIZED FOR EVALUATION	EVALUATION
<p>JOINT TYPE</p>	<p>PRE-BUTTERED BUTT JOINT</p>	<p>4" ϕ - PRE-BUTTERED BUTT JOINT 3" ϕ - POST-BUTTERED BUTT JOINT BASELINE</p>	<p>FOR BASELINE JOINTS TESTED CONFIGURATIONS BOUND INSTALLED</p>
<p>FASTENERS</p>	<p>TIE WIRES AND 1/2" WIDE STAINLESS STEEL BANDS ON BOX</p>	<p>4" ϕ CONDULET AND 3" ϕ CONDULET - 1/2" WIDE S.S. BANDS</p>	<p>TESTED BOUNDS INSTALLED (SEE TABLE 4-1)</p>

AS-BUILT TO TESTED EVALUATION

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PERFORMANCE PARAMETERS	FIRE RESISTIVE BARRIER: <u>SC-TL-4101</u> SEGMENT COMMODITY: <u>03 4" ϕ CONDULET BOX</u> RATING: <u>1HR</u>		
BARRIER	AS BUILT CONFIGURATION	TESTED CONFIGURATION(S) UTILIZED FOR EVALUATION	EVALUATION
UNSUPPORTED SPAN	N/A	N/A	N/A
JOINT REINFORCEMENT	N/A	4" ϕ CONDUIT - N/A 3" ϕ CONDUIT - EXTERNAL TROWEL GRADE 330-1 AND STRESS SKIN AT JOINTS	4" ϕ CONDULET NUMARC TEST 2-1 BASELINE HAD SATIS- FACTORY BARRIER COND. FOLLOWING 50 MIN. DURATION AND HOSE STREAM 3/4" CHAR DEPTH AND 1/8" to 1/4" UNCHARRE MATERIAL REMAINING FOLLOWING H.S. INTERFACE POINTS BETWEEN BOX & CONDUITS INTACT. 3" ϕ CONDULET NUMARC TEST 1-6 WITH EXTERNAL JOINT UPGRADE HAD SATISFACTORY
STRUCTURAL AND INTERVENING STEEL PROTECTION	N/A	N/A	N/A BARRIER CONDITION FOLLOWING HOSE STREAM AND 60 MIN. FIRE DURATION. INSTALLED NOT BOUNDED BY TESTED

AS-BUILT TO TESTED EVALUATION

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<p>PERFORMANCE PARAMETERS</p>	<p>FIRE RESISTIVE BARRIER: <u>SC-TL-4101</u> SEGMENT COMMODITY: <u>03 4" ϕ CONDULET BOX</u> RATING: <u>1HR.</u></p>		
<p>BARRIER</p>	<p>AS BUILT CONFIGURATION</p>	<p>TESTED CONFIGURATION(S) UTILIZED FOR EVALUATION</p>	<p>EVALUATION</p>
<p>BOX ENCLOSURE PERFORMANCE</p>	<p>BOX W/ 1 hr. PANELS PROTECTING CONDULET (SEE PARAMETER COMPARISONS)</p>	<p>4" ϕ CONDULET - SAME 3" ϕ CONDULET - UPGRADED WITH EXTERNAL TROWEL GRADE & STRESS SKIN</p>	<p>SEE NEXT PAGE</p>

Thermo-Lag Fire Barrier System: SC-TL-4101

Segment Nos: 03 4" ϕ CONDULET BOX

Required Rating: 1 HR.

Additional
Evaluation:

THE INSTALLED CONFIGURATION IS BOUNDED BY TESTED CONFIGURATIONS EXCEPT FOR THE UPGRADE OF JOINTS ON TEST 1-6 (3" ϕ CONDULET W/ EXTERNAL STRESS SKIN & TROWEL GRADE) THERMALLY, WITH THE INSTALLED THICKER BARRIER MATERIAL AND INCREASED THERMAL MASS OF THE CONDULET, THE CONDULET BARRIER WILL PERFORM BETTER THAN THE CONDUIT BARRIER. FOR REFERENCED CONDUIT TESTS TEMPERATURES AT CONDULETS TRACK WELL BELOW THE AVERAGE FOR THE CONDUIT RUN. (SEE ATTACHED T.C. CURVES)

STRUCTURALLY, AT 50 MINUTES THE NON-UPGRADED BOX (TEST 2-1) HAD SATISFACTORY TEMPERATURES AND BARRIER INTEGRITY. FOLLOWING THE ROSE STREAM TEST THERE WAS RESIDUAL NON-CHARRED MATERIAL (1/8" - 1/4") AND AN APPROXIMATE 3/4" CHAR LAYER. THE UPGRADED BOX (TEST 1-6) HAD ACCEPTABLE STRUCTURAL AND THERMAL PERFORMANCE FOR THE FULL 1 HR. TEST DURATION.

IN CONCLUSION, SINCE THE JOINTS OF THE INSTALLED CONFIGURATION ARE NOT BOUNDED BY A TESTED CONFIGURATION FOR MORE THAN 50 MIN, THE BARRIER CANNOT BE EXPLICITLY CONSIDERED TO STRUCTURALLY PROVIDE 1 HR. FIRE ENDURANCE CONTINUED

Thermo-Lag Fire Barrier System: SC-TL-4101

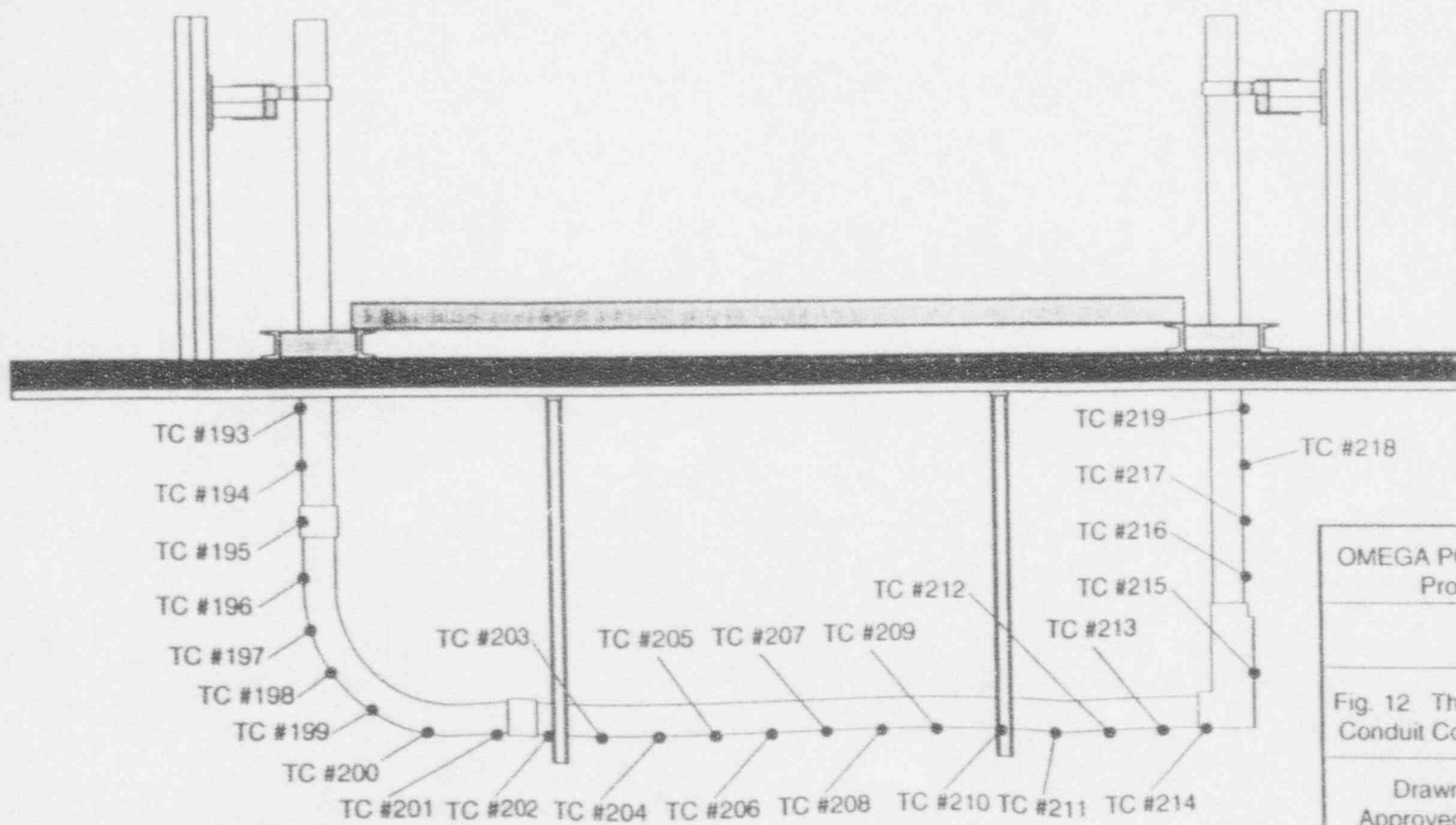
Segment Nos: 03 4" ϕ CONDULET BOX

Required Rating: 1 HR.

Additional Evaluation: CONTINUED

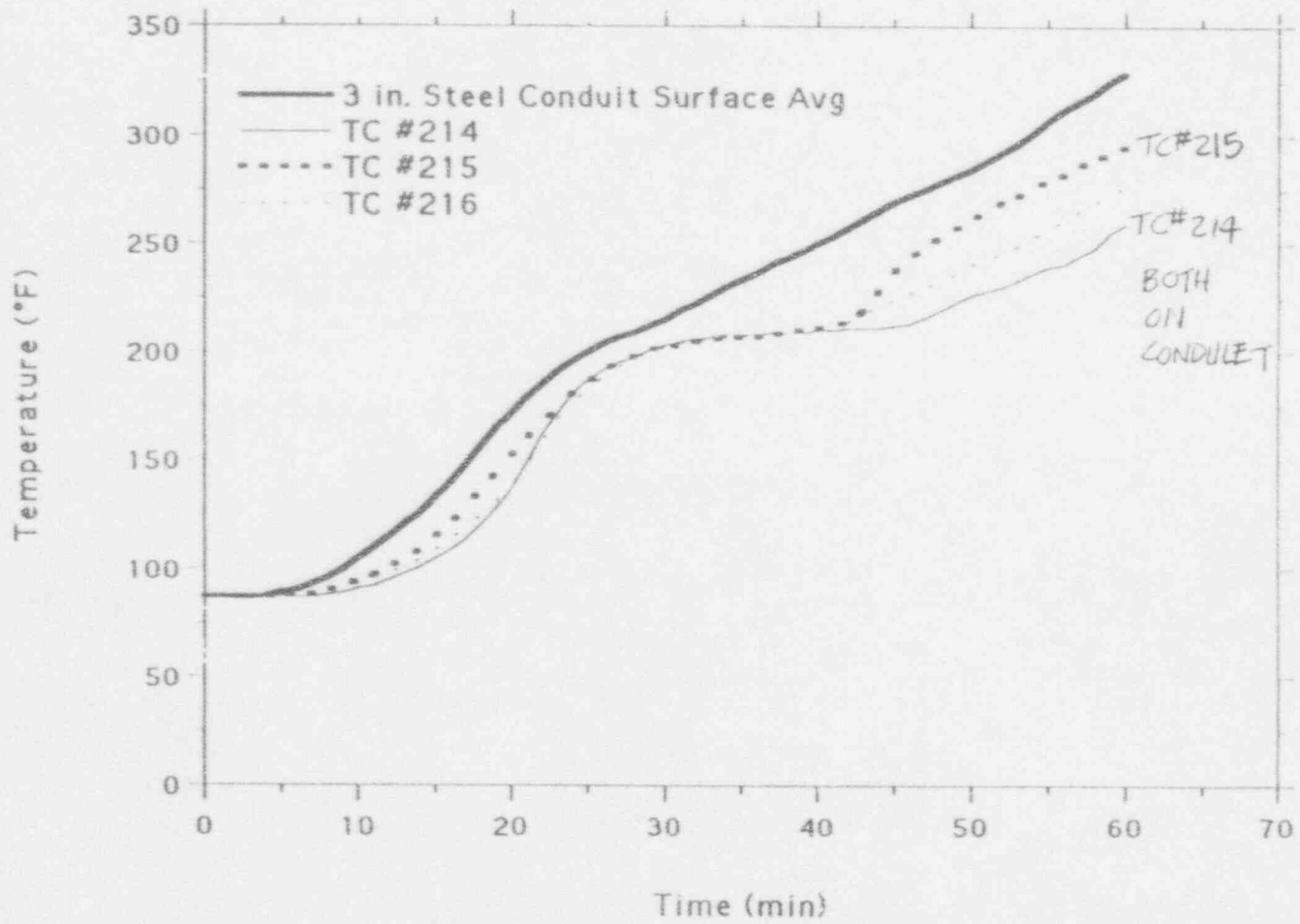
THEREFORE OTHER OPTIONS SHOULD BE CONSIDERED. IE - UPGRADE, FURTHER TESTING, EXEMPTION, PROB. RISK ASSESSMENT, ETC.

OPTION 1 -
BASED ON EASE OF APPLICATION AND MINIMAL IMPACT (HEIGHT, AMPACITY, ETC.)
THE INSTALLED CONDULET BOX WILL BE UPGRADED CONSISTENT WITH THE UPGRADE UTILIZED IN NUMARC TEST 1-6. THIS DESIGN IS THEREFORE BOUNDED BY THE NUMARC 1-6 TESTED CONFIGURATION AND IS EQUIVALENT TO A ONE HOUR RATED ASSEMBLY.

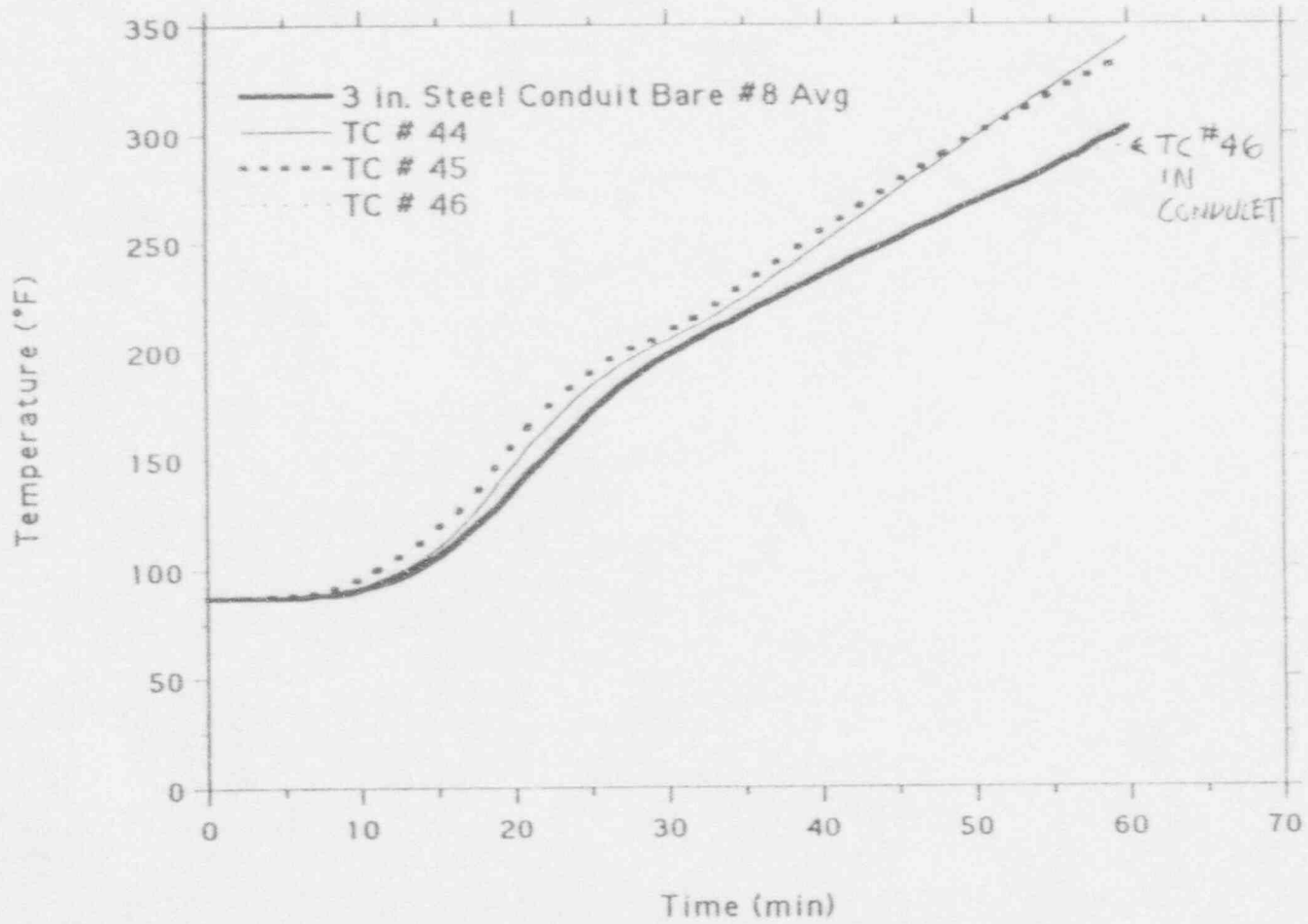


OMEGA POINT LABORATORIES, INC.	
Project No. 13890-95676	
NUMARC	
Fig. 12 Thermocouple View of 3" Steel Conduit Configured for 1 hr Test, Rev. 0	
Drawn by: <i>[Signature]</i>	Date: 8/24/83
Approved by: <i>[Signature]</i>	Date: 8/24/83

NUMARC
Project No. 13890-95676
3 In. Steel Conduit Surface



NUMARC
Project No. 13890-95676
3 In. Steel Conduit Bare #8



NUMARC
Project No. 13890-95676
3 In. Steel Conduit Bare #8

