January 5, 1994

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

THRU: K. Steven West, Chief
Special Project Section
Plant Systems Branch
Division of Systems Safety and Analysis

FROM: Daniele Oudinot, Reactor Systems Engineer
Special Project Section
Plant Systems Branch
Division of Systems Safety and Analysis

SUBJECT: TRIP TO OMEGA POINT LABORATORIES - PHASE 2 OF NUMARC THERMO-LAG FIRE BARRIER TESTING

The enclosed trip report documents my observation of Thermo-Lag fire barrier test specimen construction for the NUMARC fire barrier testing program. This report covers construction activities during the period December 14-17, 1993, at Omega Point Laboratories, Elmendorf, Texas.

Original signed by

Daniele Oudinot, Reactor Systems Engineer
Special Project Section
Plant Systems Branch
Division of Systems Safety and Analysis

Enclosure:
As stated

Distribution
PDR
Central File
SPLB TSI File
AThadani
MVirgilio
CMcCracken
NRC PDR
EPawlik, R:III/OI
GMulley, OIG
WDean
JLyons
GHubbard
DOudinot
ASingh
JHolmes
PMadden
SWest

SPLB:DSSA	SPLB:DSSA	SPLB:DSSA
DOudinot	SWest	CMcCracken
1/5/94	1/5/94	1/5/94

[G:\THERMOLA\ZTRIP.DO]

DFO3 Rev 1/1 D. Oudinot

Enclosure

TRIP REPORT

Facility: Omega Point Laboratories (OPL), Elmendorf, Texas
Industry Group: Nuclear Management and Resources Council (NUMARC)
Activity: Phase 2 of NUMARC Thermo-Lag fire test program
Trip Dates: December 14-17, 1993
Reviewer: D. Oudinot, NRR

INTRODUCTION

During the period December 14-17, 1993, I visited Omega Point Laboratories (OPL), Elmendorf, Texas. The purpose of the visit was to observe the initial construction activities for Phase 2 of NUMARC Thermo-Lag fire test program. The contract personnel contacted during this visit includes: Calvin Banning of ABB Impell; Michael Jordan, QC Inspector for Peak Seal, a subsidiary of Promatec; and Leon Werner and Earl Bray, Installers for Peak Seal. In addition, the following OPL personnel was contacted: Deggary Priest, President; Constance Humphrey, Vice President and Quality Assurance (QA) Manager; Cleda Patton, Assistant to the President and Assistant to the QA Manager; Herb Stansbury, Fire Technologist and Project Engineer; Kerry Hitchcock, Shop Foreman; and Ray Hutchins, Draftsman.

CONSTRUCTION ACTIVITIES

Background

The NUMARC test program for the qualification of Thermo-Lag fire barriers included two testing phases. Phase 1 consisted of six upgraded configurations designed and funded by the vendor, Thermal Science, Inc. Phase 1 testing was completed on October 6, 1993 and the test results were discussed with the staff during a meeting on October 18, 1993.

Phase 2 construction, which commenced on December 14, 1993, includes eleven baseline and upgraded configurations designed and funded by NUMARC. The test specimens were designed to represent a large percentage of the configurations currently installed in the plants. Phase 2 construction and testing is scheduled to be completed by March 1994. NUMARC has not submitted the Phase 2 test plan to the NRC.

Observations

During the period December 14-17, 1993, I observed installer training conducted by Calvin Banning of ABB Impell and initial construction activities for NUMARC Test Program Phase 2. The training of installers was limited to a half-hour review of "Thermo-Lag Installation Notes" attached to the drawings for the test specimen under construction. The installers and the QC inspector asked a few questions for clarification and signed off. This new approach entitled "Drawing Control Program" will replace the installation procedures

used in Phase 1. The training of installers will be done prior to each specimen construction using installation notes included in the drawings for that specimen.

I also audited the following procedures and specifications:

- "NUMARC Phase 2 Test Program, TEST PLAN, Rev.0", prepared by OPL for NUMARC and dated December 13, 1993.

- OPL "Event Log" for the NUMARC Phase 2 Test Program, prepared on December 15, 1993.

- "Procedure for Quality Verification of Fire Resistive Barrier Systems Installed on Electrical Cables and Raceways," prepared by ABB Impell for NUMARC and dated December 14, 1993.

- "Calibration of Delmhorst Moisture Meter as Applied to Thermo-Lag Products," prepared by OPL and dated September 9, 1993.

- "Q/A Personnel Reporting Independence Requirement" prepared by OPL and dated December 9, 1993.

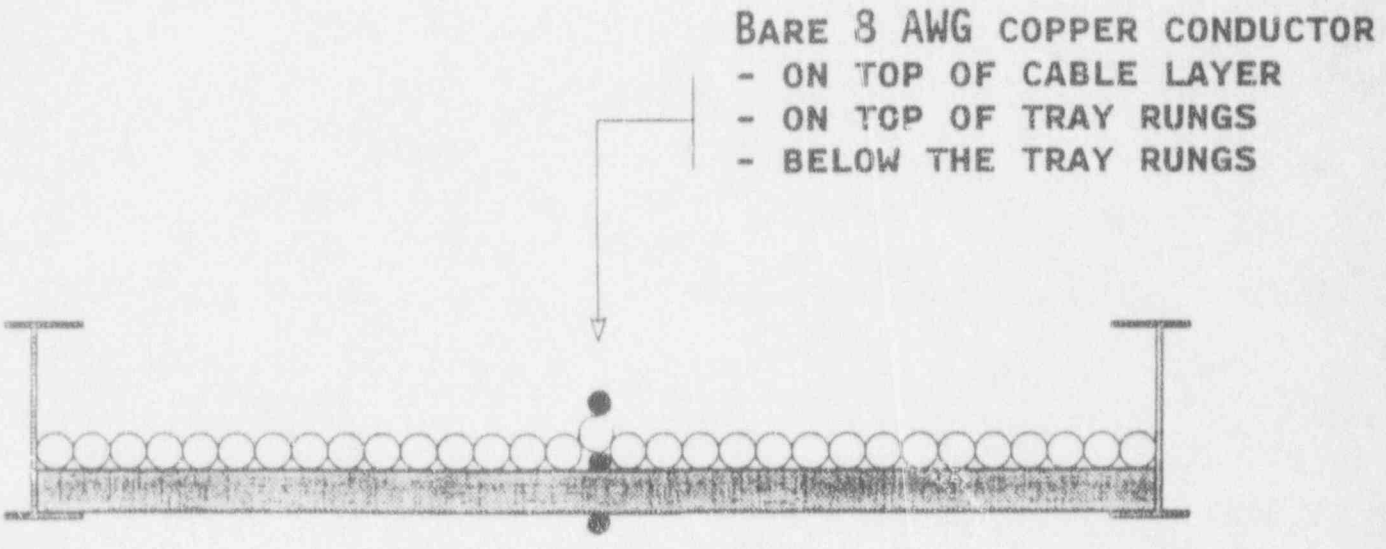
On December 14, 1993, I observed the removal of Thermo-Lag from test specimen 1-2, a 1-hour 36-inch aluminum cable tray which was originally constructed for Phase 1. Fire testing of specimen 1-2 was cancelled by NUMARC due to unsatisfactory results from a previous fire test. After the removal of Thermo-Lag from specimen 1-2, the No. 14 bare copper conductors located on top of the tray rungs and on top of the single cable layer (15% cable fill) were removed and replaced with No. 8 bare copper conductors instrumented with thermocouples every 6 inches. An additional No. 8 bare copper conductor with thermocouples was installed under the cable tray rungs, as recommended by the staff in draft Generic Letter 86-10, Supplement 1. Attachment 1 shows the location of the bare copper conductors. At this point, the cable tray was released by the OPL QA Inspector, renamed test specimen 2-9 and Thermo-Lag fire barrier installation began.

Test specimen 2-9 was a 1-hour 36"x 4" aluminum ladder back cable tray with upgrades. The U-shape cable tray consisted of a straight horizontal run, two radial bends and two vertical runs as shown in Attachment 2. The cable tray sides were designed with flanges as shown on Attachment 1. Of note, all other cable trays used for Phase 2 are designed with flat sides. This different design is preferred since it does not allow for space between the side of the tray and the Thermo-Lag enclosure. An air gap could affect the thermocouple temperature readings in a non-conservative way. The upgrades consisted of internal pre-banding at 24" intervals off center on the horizontal section of the tray to provide Thermo-Lag panel support and stress skin reinforcement of all joints with trowel grade skim coat.

The Thermo-Lag fire barrier material used were 1/2 inch (nominal) panels with ribs and stress skin. On the horizontal and vertical runs, the panels were installed with ribs perpendicular to the rungs. On the radial bends, the ribs were oriented parallel to the rungs. The ribs and stress skin were on the

inside of the Thermo-Lag enclosure. A butt joint was positioned at the nominal center of the horizontal span and 1/2 inch stainless steel banding was installed within 2" of the butt joint at 12" intervals off center. One radial bend was covered with mitered panel sections secured with one or two stainless steel bands within 2" of each butt joint. The other radial bend was covered on top and bottom with scored panels secured with steel bands. Each side was covered with a single panel section. All joints were pre-buttered with Thermo-Lag trowel grade material. After installation, the pre-buttered joints were touched up with trowel grade material to fill up the crevices. By the end of the day on December 17, 1993, the installers were completing the installation of the baseline layer by covering the cable tray supports up to 9" from the outside of the tray envelope. Installation of the stress skin upgrade was scheduled to be completed during the following week. After completion of the barrier installation, moisture readings were to be taken daily with a Delmhorst moisture detector until moisture content reached equilibrium. Fire testing of specimen 2-9 was tentatively scheduled on January 26, 1994.

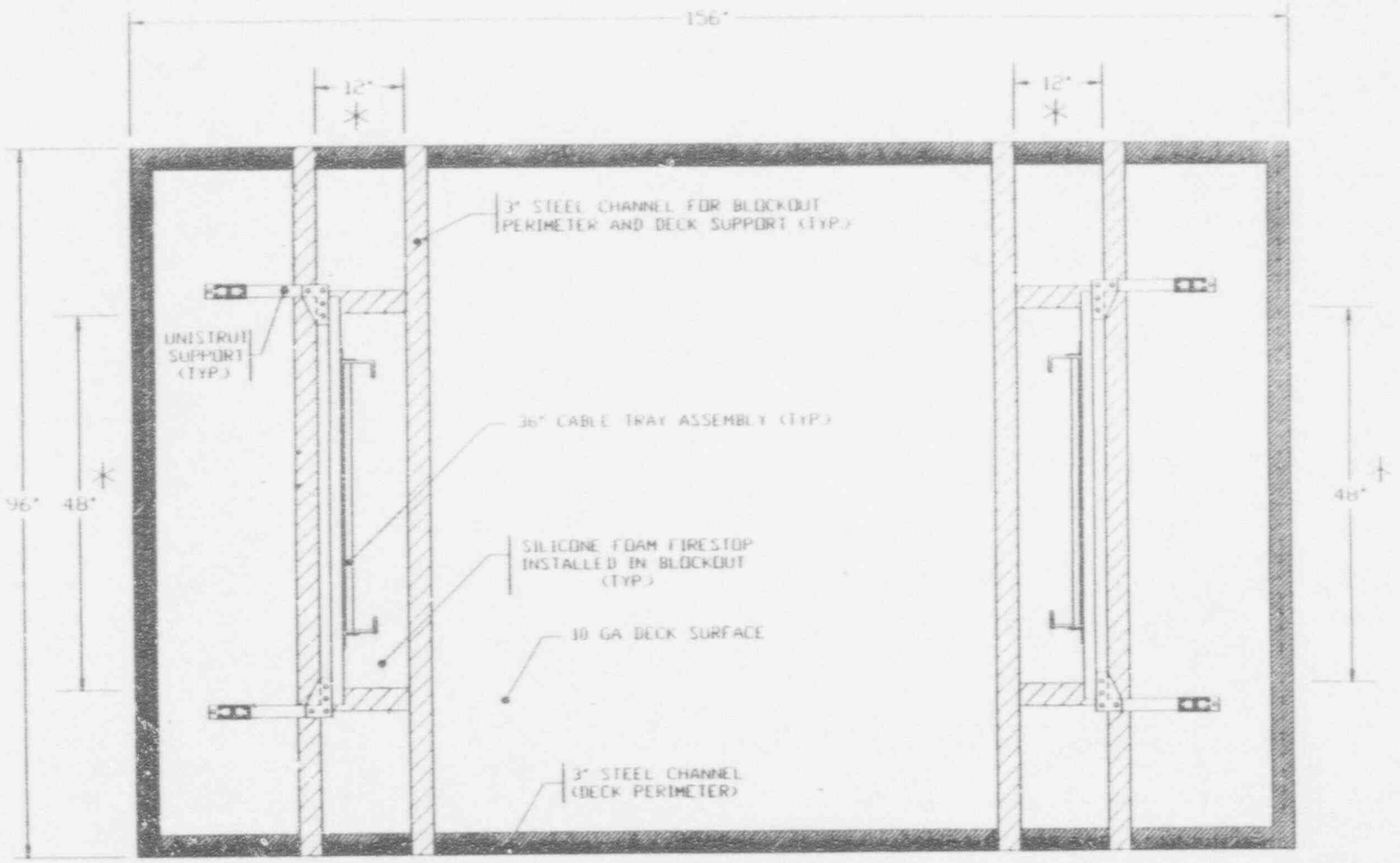
The work performed by the installers was supervised closely by the QC inspector, M. Jordan, and the installation notes showed on Attachment 2 were carefully followed. During the cutting of panels, the stress skin separated from the substrate material on approximately two inches from a corner. The QC inspector noticed this anomaly immediately and discarded the entire panel. The installers had previously installed Thermo-Lag at Comanche Peak for Texas Utilities and this experience showed in the skill they displayed.



NUMARC PHASE 2 TEST 2-9

LOCATION OF BARE COPPER CONDUCTORS

REV	DWN	DRIG	VER	APVD
0	ELT	RCP 11/19/93	RJD 12/13/93	RB 12/14/93



FRONT

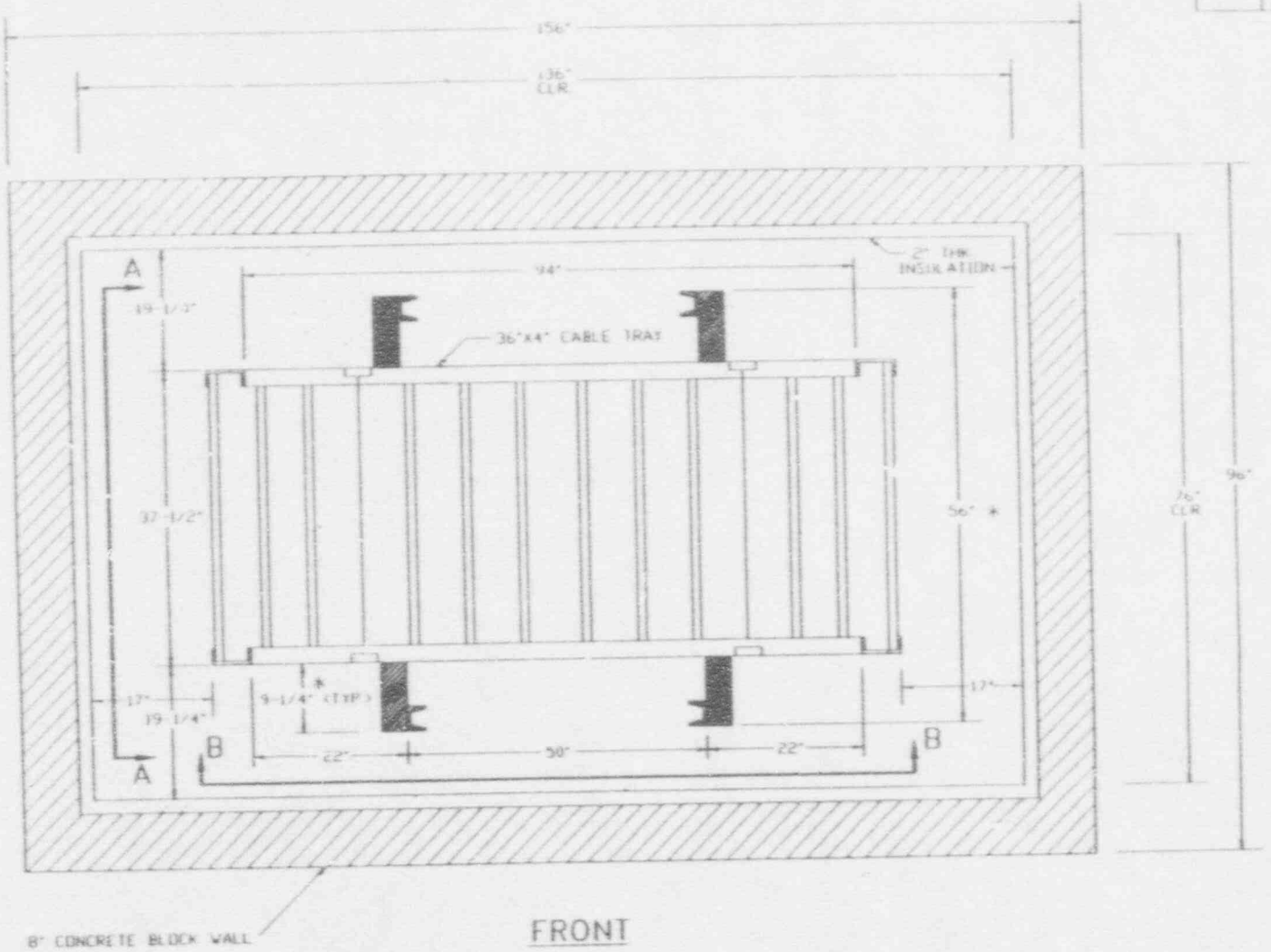
NOTES:

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 +/- 2" UNO.
4. SEE DWG 0784-00001-D-000 FOR REVISION HISTORY, DESIGN CHANGE STATUS AND USE DESIGNATION.
5. REFER TO DWG 0784-00001-D-009 SH.2 FOR TEST INSTRUMENTATION REQUIREMENTS.

ABB IMPELL CORP PROJ NO 0784-00001
NUMARC PHASE 2 TEST PROGRAM
DWG 0784-00001-D-009 SH 1 REV 0
TEST 2-9 (T1-A-36X)
FIG 1 PLAN VIEW - ABOVE DECK

Attachment 2

REV	DWN	DWG	VER	APVD
0	ELT	[illegible]	[illegible]	[illegible]



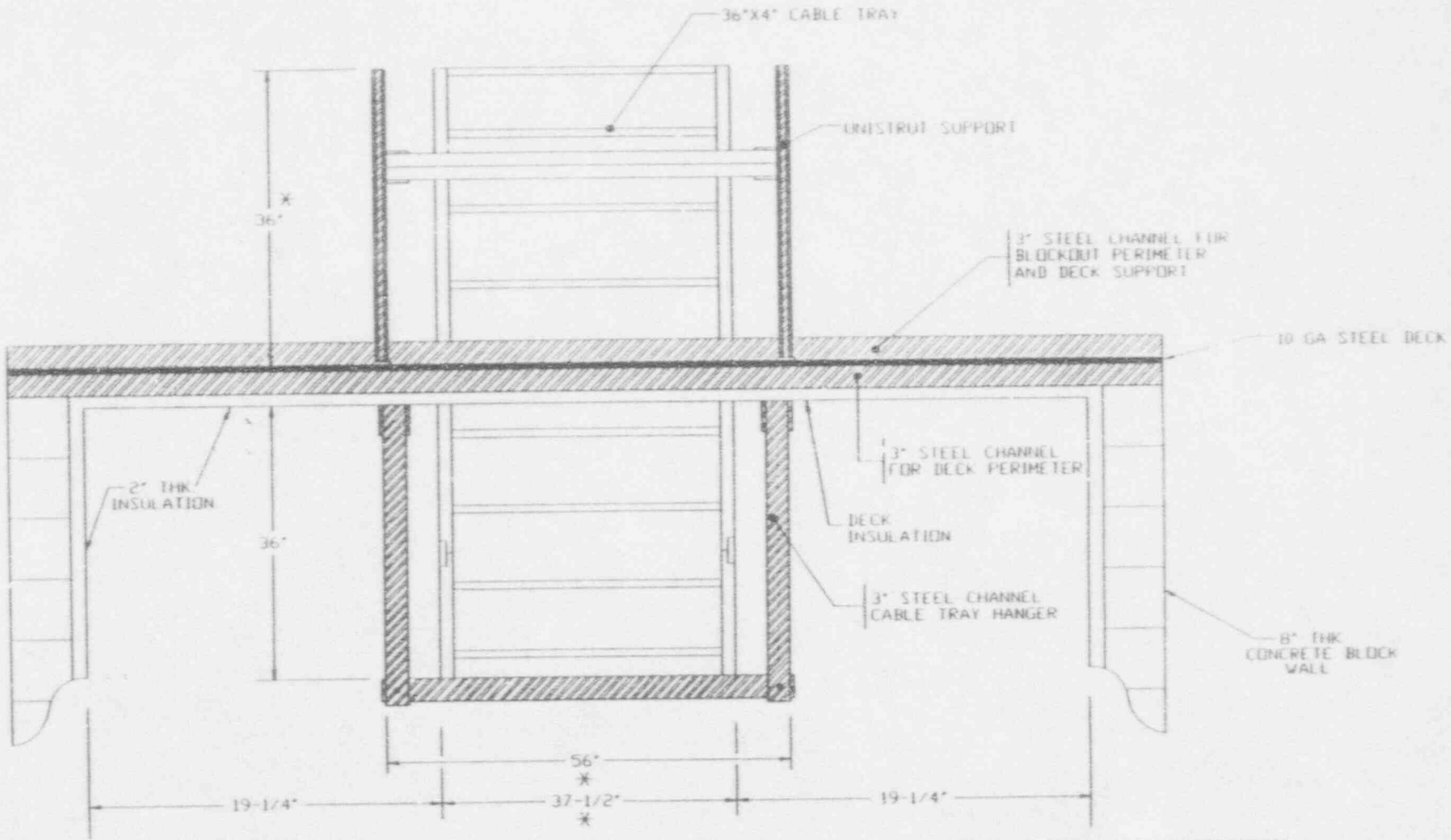
FRONT

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 +/- 2" UNO.
4. SEE DWG. 0784-00001-B-800 FOR REVISION HISTORY, DESIGN CHANGE DATES, AND USE DESIGNATION.
5. IN THERMOCOUPLE REQUIREMENTS - THERMOCOUPLES INSTALLED AT 6' INTERVALS ALONG BOTH TRAY SIDE RAILS. THERMOCOUPLES INSTALLED AT 6' INTERVALS ALONG #8 AWG BARE COPPER CONDUCTORS AS FOLLOWS ONE (1) CONDUCTOR SECURED TO TOP OF TRAY RUNGS, ONE (1) CONDUCTOR POSITIONED ON TOP OF CABLES, ONE (1) CONDUCTOR SECURED TO BOTTOM OF TRAY RUNGS(S) EQUALLY OFFSET FROM CONDUCTOR ON TOP

ABB IMPELL CORP PROJ NO. 0784-00001
NUMARC PHASE 2 TEST PROGRAM
DWG. 0784-00001-B-009 SH 2 REV 0
TEST 2-9 (11-A 3&X)
FIG. 2 PLAN VIEW - BELOW DECK

REV.	DWN.	ORIG.	VER.	APVD.
0	ELT	REP 12/2/93	RLD 12/13/93	[illegible] 12-14-93



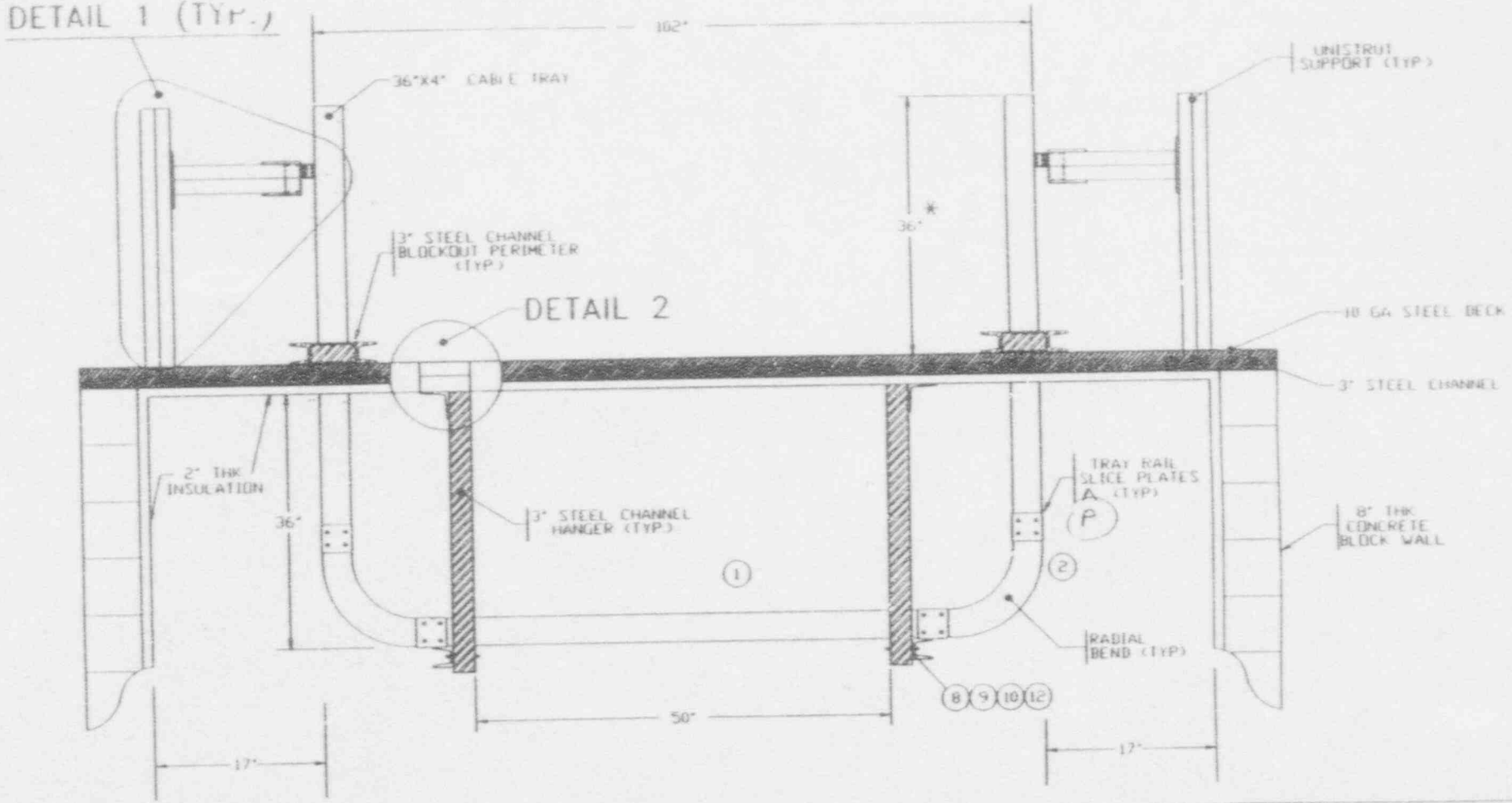
SECTION A–A

NOTES:

1. ( ) DENOTES BILL OF MATERIAL ITEM NO. (SEE SH 7)
2. * DENOTES NOMINAL DIMENSION PROVIDED FOR INFORMATION AND COORDINATION PURPOSES
3. ALL OTHER DIMENSIONS HAVE WORKING TOLERANCE OF +/- 2" UNO
4. SEE DWG. 0784-00001-D-000 FOR REVISION HISTORY, DESIGN CHANGE STATUS AND ITEM DESIGNATION

ABB IMPELL CORP PROJ. NO. 0784-00001
NUMARC PHASE 2 TEST PROGRAM
DWG. 0784-00001-D-009 SH. 3 REV 0
TEST 2-9 (11-A 36X)
FIG. 3 - END VIEW

REV	DWN	DRIG	VER	APVD
0	ELT	RLD 12/13/93	RLD 12-14-93	



SECTION B-B

NOTE:

1. ( ) DENOTES BILL OF MATERIAL ITEM NO (SEE SH 7)
2. * DENOTES NON-CRITICAL DIMENSION PROVIDED FOR INFORMATION AND GENERAL CONFIGURATION PURPOSES
3. ALL OTHER DIMENSIONS HAVE WORKING TOLERANCE OF +/- 2" UNO
4. SEE DWG 0784-00001-B-000 FOR REVISION HISTORY, DESIGN CHANGE

ABB IMPELL CORP.
PROJ. NO. 0784-00001

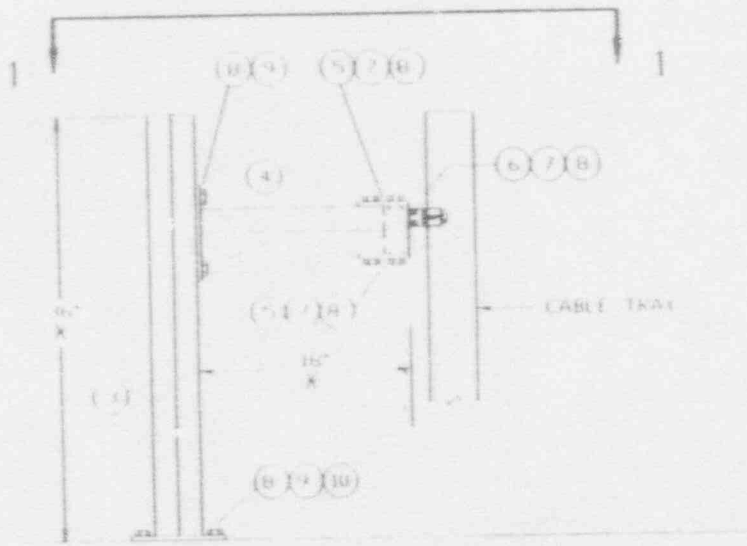
NUMARC PHASE 2 TEST PROGRAM

DWG 0784-00001-B-009 SH 4
REV 0

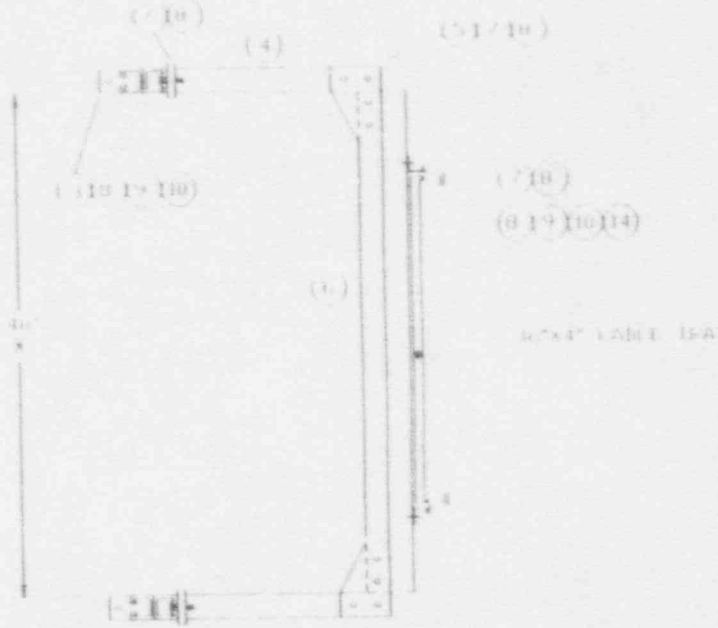
TEST 2-9
(T1-A-36X)

FIG 4 ELEVATION VIEW

REV	DWN	ORIG	VER	APVD
0	[illegible]	RGP 12/13/93	RLO 12/13/93	[illegible] 12/14/93



DETAIL 1 - UNISTRUT SUPPORT



SECTION 1-1

NOTES

[illegible]

ABB IMPELL CORP
PROJ NO 6784 0000

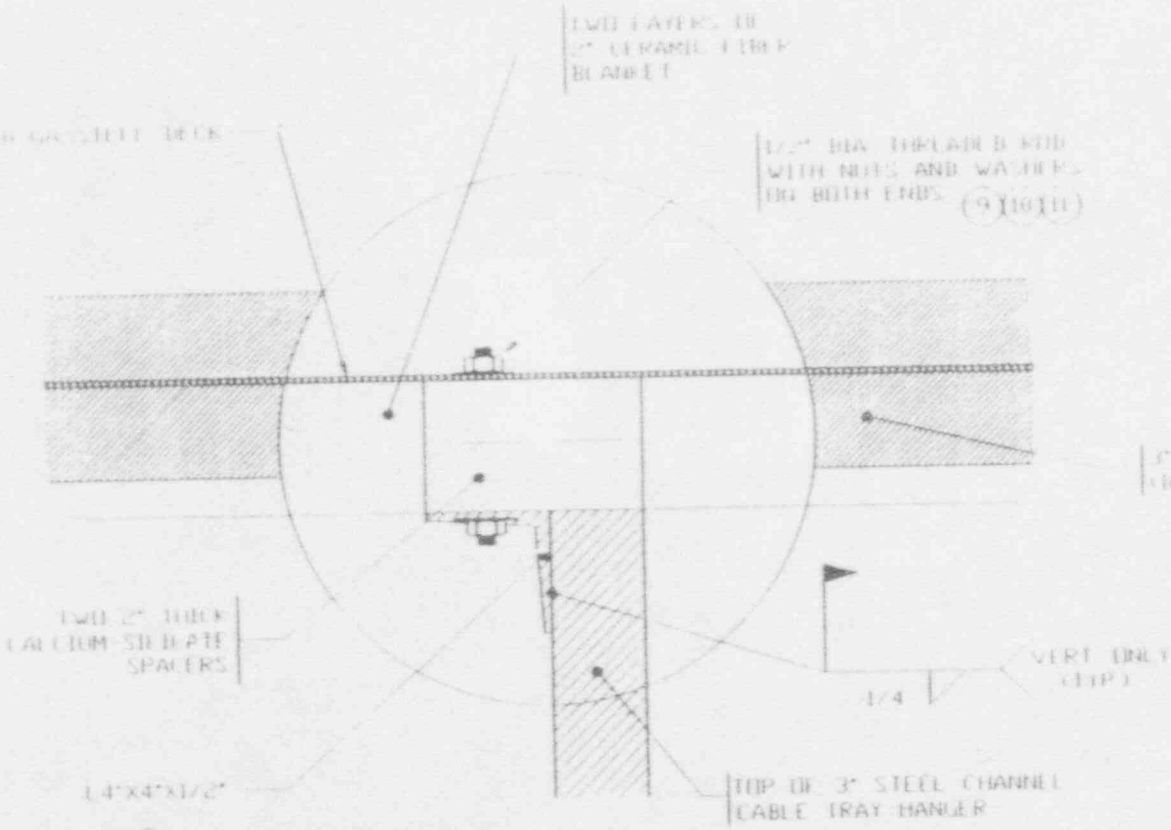
NUMARC PHASE 2 TEST PROGRAM

DWG 0784 0000 D 009 SH 5
REV 0

[illegible]

FIG 5 SUPPORT DETAILS

REV	DWN	DRFG	VER	APVD
0	LLL	REP 12/13/93	RLO 12/13/93	CAB 12-14-93



DETAIL 2

ITEM NO.	DESCRIPTION	QUANTITY
	36"x4" LADDER TYPE CABLE TRAY 6063-T6 ALUMINUM 9" RUNG SPACING (B-LINE 24A09-36-144)	20
2	36"x4" ALUMINUM 90° INSIDE BEND w/ONE PR SPLICE PLATES AND HARDWARE) 6063-T6 ALUMINUM (B-LINE 4A-36-V124)	2
3	UNISTRUT P2546 T-HANGER	4
4	UNISTRUT P2543 T-HANGER	4
5	UNISTRUT P1380 PLATE FITTING	8
6	UNISTRUT P1001C3 CHANNEL	10
7	UNISTRUT P1010 1/2" SPRING NUTS	34
8	1/2"x1-1/4" A307 BOLTS	50
9	1/2" HEX NUTS A563 GR A	24
10	1/2" STEEL FLAT WASHERS	24
11	1/2" ALL THREAD ROD MILD STEEL	2
12	C3x4.1 A36 STEEL CHANNEL	20
13	4"x4"x1/2" A36 STEEL ANGLE	2
14	2"x2"x1/4" A36 STEEL ANGLE	

REV	DWN	ORIG	VER	APVD
0	ELT	REP 12/13/93	RLD 12/13/93	CAB 12-14-93

ABB IMPELL CORP
PROJ NO 0784-00001

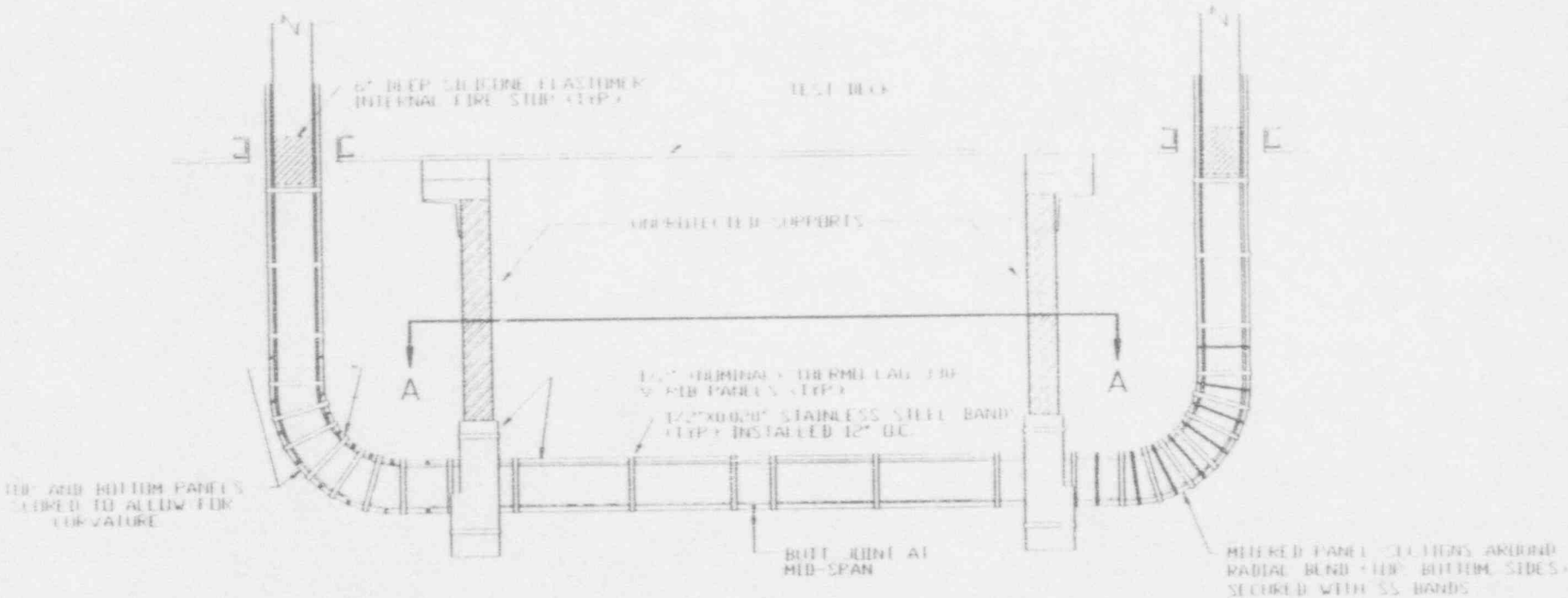
NUMARC PHASE 2 TEST PROGRAM

DWG 0784-00001-D-009 SHT [illegible]
REV 0

TEST 2-[illegible]
(14A-36)

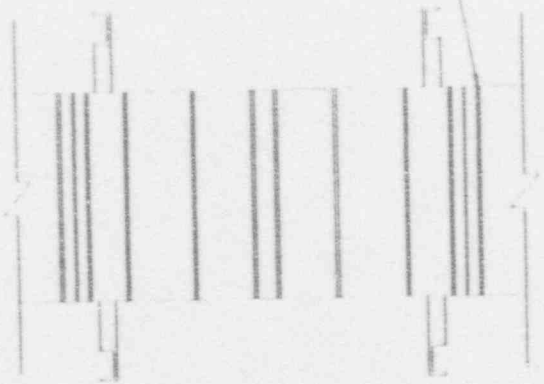
FIG [illegible] - BILL OF MATERIALS

REV	DWN	DRG	VER	APVD
0		REP 12/13/93	RD 12/13/93	FB 12/14/93

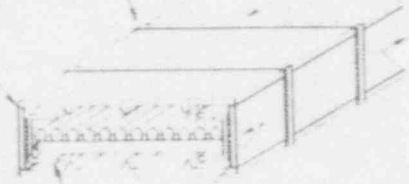


ELEVATION VIEW
36" CABLE TRAY–1 HR. UPGRADE
(WITHOUT STRESS SKIN UPGRADE)

REV	BWN	ORIG	VER	APVD
B	ELI	RSP 12/13/93	JSD 12/13/93	GB 12-14-93

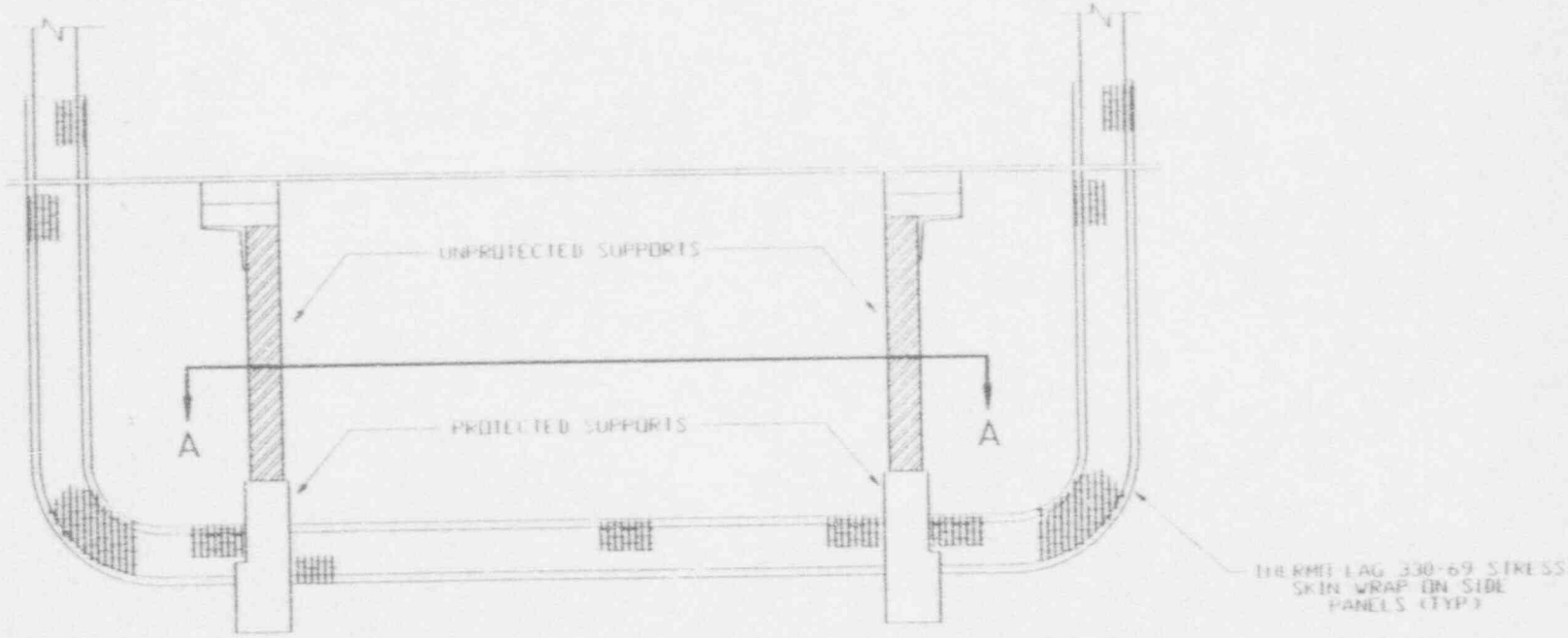


SECTION A–A
(STRESS SKIN UPGRADE NOT SHOWN)



CUTAWAY VIEW
(STRESS SKIN UPGRADE NOT SHOWN)

REV.	DWN.	DES.	VER.	APVD.
0	ELT	REP 12/13/93	RWD 12/13/93	12-14-93



ELEVATION VIEW
36" CABLE TRAY – 1 HR. UPGRADE
(SHOWING STRESS SKIN AT LONGITUDINAL JOINTS)

ABB IMPELL CORP.
PROJ. NO. 0784-0001

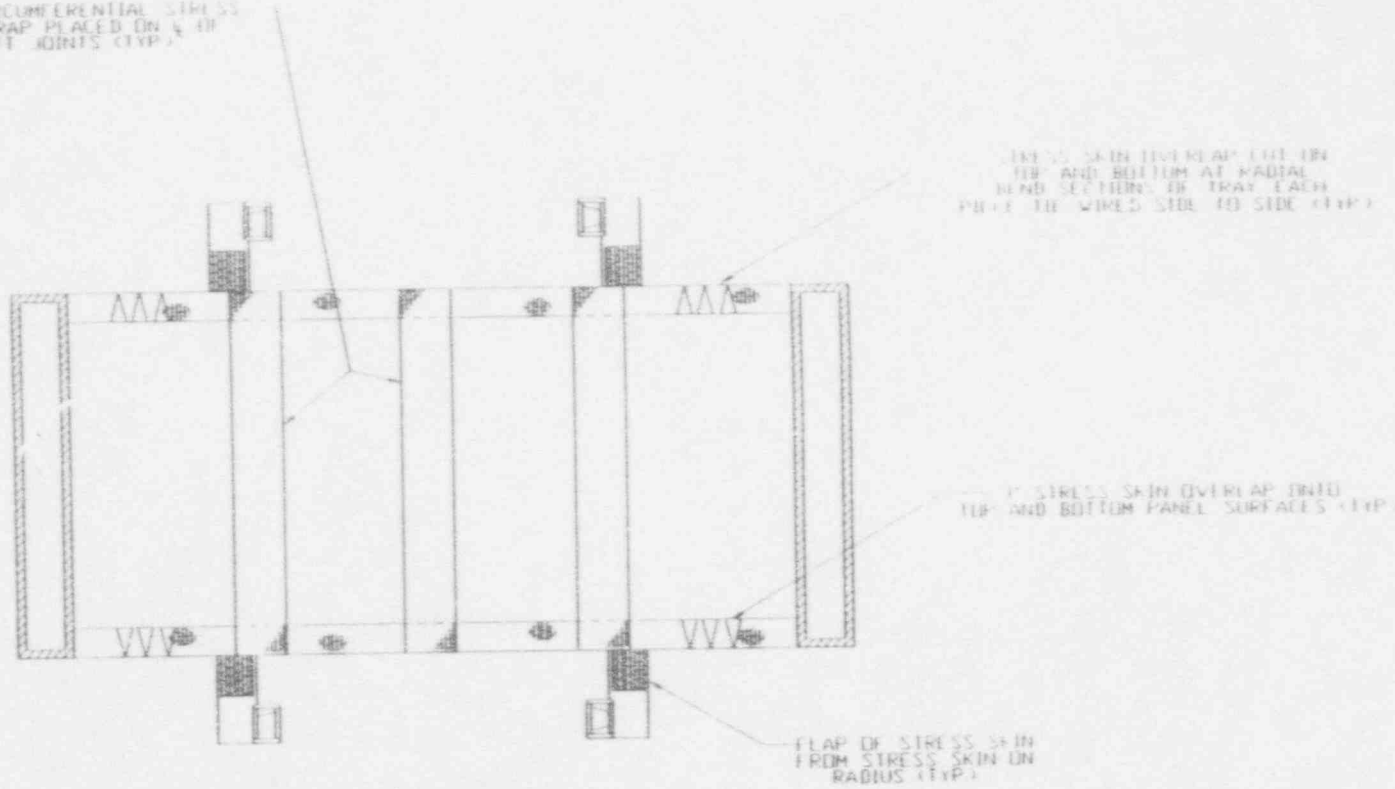
NUMARC PHASE 2 TEST PROGRAM

DWG. 0784-0001-B-009 SH 10
REV 0

TEST # 9
CELL A-6X7

DWG. 10 ELEVATION VIEW — THERMO-LAG DETAILS

REV	DWN	DRIG	VER	APVD
0		RGP 12/9/93	RLD 12/31/93	RB 12/31/93



PLAN VIEW
36" CABLE TRAY – 1 HR. UPGRADE
(SHOWING STRESS SKIN INSTALLATION)

NOTE:

1. AS DWG. 0784-0000 B-089 SH. 11 REVISION HISTORY DESIGN CHANGE DATA AND NOT BE DUPLICATED
2. REFER TO DWG. 0784-0000 B-089 SH.9 AND 10 FOR STRESS SKIN INSTALLATION DETAIL

ABB IMPELL CORP PROJ NO 0784-0000	
NUMARC PHASE 2 TEST PROGRAM	
DWG. 0784-0000 B-089 SH 11 REV 0	
TEST 2.9 (11 A 36")	
FIG. 11	HERMETAL INSTALLATION

THERMO-LAG INSTALLATION NOTES – 1 HR. UPGRADE CABLE TRAY USING 4 SEPARATE PIECE THERMO-LAG DESIGN

1. ALL JOINTS TO BE PRE-BUTTERED WITH THERMO-LAG 330-1 TROWEL GRADE MATERIAL.

2. STAINLESS STEEL BANDING TO BE INSTALLED WITHIN 2" OF BUTT JOINTS AND AT 12" (MAX.) INTERVALS WHERE POSSIBLE. CLOSER BAND SPACING IS PERMISSIBLE WHERE NECESSARY TO RESULT IN A SECURE INSTALLATION (MINIMUM OF 1 BAND PER INDIVIDUAL PIECE).

3. NO EDGE GUARDS SHALL BE USED.

4. RADIAL BEND COVERAGE ON ONE SIDE TO UTILIZE SEPARATE MITERED PIECES. 1 BAND SHOULD BE USED TO SECURE EACH MITRED SECTION UNLESS ADDITIONAL REINFORCEMENT IS REQUIRED (2 BANDS MAX.). RADIAL BEND COVERAGE ON OTHER SIDE TO UTILIZE SCORED PANELS (TOP AND BOTTOM) AND SINGLE PIECES FOR TRAY SIDES.

5. INSTALL MATERIAL ON TRAYS FIRST AND SUPPORT MEMBERS LAST.

6. EXTEND THERMO-LAG COVERAGE ON SUPPORT MEMBERS 9" (MIN.) TO 10" (MAX.) AS MEASURED FROM OUTSIDE OF TRAY ENVELOPE ALONG ANY CONTINUOUS SUPPORT STEEL CONDUCTIVE PATH. ORIENTATION OF V-RIBS FOR PANELS ON SUPPORTS IS NONCRITICAL.

7. EXTEND THERMO-LAG COVERAGE THROUGH TOP OF TEST FURNACE FOR NOMINAL DISTANCE OF 12".

8. INSTALL THERMO-LAG PANELS SUCH THAT SIDE PANEL PIECES ARE PLACED IN COMPRESSION BETWEEN TOP AND BOTTOM PANEL PIECES.

9. ONE (1) BUTT JOINT ON BOTTOM PANEL SHALL BE POSITIONED AT NOMINAL CENTER OF HORIZONTAL SPAN.

10. PANELS TO BE INSTALLED WITH STRESS SKIN SIDE FACING PROTECTED COMMODITY.

11. FOR HORIZONTAL AND VERTICAL TRAY SEGMENTS, INSTALL PANELS WITH V-RIBS ORIENTED PARALLEL TO RUN OF TRAY. PANELS INSTALLED ON SIDE RAILS TO HAVE V-RIBS ORIENTED VERTICALLY ON HORIZONTAL TRAY SEGMENT AND HORIZONTALLY ON VERTICAL TRAY SEGMENT. V-RIB ORIENTATION FOR MITERED PIECES ON RADIAL BEND IS NONCRITICAL (CRAFT PREROGATIVE). V-RIB ORIENTATION FOR SCORED PANELS ON RADIAL BEND TO BE PERPENDICULAR TO RUN OF TRAY.

12. CABLE TRAY SHALL BE PRE-BANDED IN HORIZONTAL SEGMENT. SPACING OF BANDING SHALL BE 24" O.C. (NOMINAL) AND WITHIN 2" (NOMINAL) ON EACH SIDE OF TOP PANEL BUTT JOINTS. PRE-BANDING MAY EXTEND INTO RADIAL BEND AREAS AS REQUIRED TO SUPPORT JOINTS WHERE COVERAGE TRANSITIONS.

13. V-RIBS ON PANELS MAY BE FLATTENED IN AREAS OF TRAY SIDE RAIL FLANGES AS REQUIRED FOR TIGHT JOINT FIT-UP.

14. MAXIMUM JOINT GAP BETWEEN PANELS DURING FIT-UP IS 1/4".

15. AS REQUIRED BY TRAY SPLICE PLATE HARDWARE, SEPARATE SPLICE PLATE COVERS (WITH BANDING) ARE ACCEPTABLE.

16. TOUCH-UP OF PRE-BUTTERED JOINTS AFTER INSTALLATION IS ACCEPTABLE TO COMPENSATE FOR SHRINKAGE OF TROWEL GRADE MATERIAL TO OBTAIN 1/8" (MIN.) TO 5/8" (MAX.) DFT.

17. ALL JOINTS BETWEEN PANELS SHALL BE SQUARE OR BUTT TYPE. IE: PANELS SHALL NOT BE BEVELED AT JOINTS.

18. APPLY SUFFICIENT TROWEL GRADE SKIM COAT TO LAP TOP AND BOTTOM PANEL BUTT JOINTS BY 3" (MIN.).

19. INSTALL CIRCUMFERENTIAL STRESS SKIN WRAP TO LAP EACH SIDE OF BUTT JOINTS BY 3" (MIN.).

20. OVERLAP ENDS OF CIRCUMFERENTIAL STRESS SKIN WRAP BY 3" (MIN.) ON BUTT JOINTS.

REV.	DWN	ORIG	VER	APVD
0	ELT	REP 12/13/93	RLD 12/17/93	12-20-93

ABB IMPELL CORP
PROJ NO 0784-00001

NUMARC PHASE 2 TEST PROGRAM

DWG 0784-00001-D-009 S- 1EA REV 0

TEST 2-9
(T1-A-36X)

FIG 12 - THERMO-LAG INSTALLATION

21. APPLY SUFFICIENT TROWEL GRADE SKIM COAT TO LAP EACH SPLICE PLATE COVER PIECE [illegible] BY 1/2" (MIN.)

22. IN[illegible] STRESS SKIN PIECE OVER SPLICE PLATE COVER (IF REQUIRED) WITH 1/2" (MIN.) OVERLAP

23. SE[illegible] ALL STRESS SKIN WITH 1/2" LONG STAPLES AT 2" INTERVALS APPROXIMATELY 1 1/2" FROM EDGES

24. FOR LONGITUDINAL JOINTS, APPLY SUFFICIENT TROWEL GRADE SKIM COAT FOR 3" (MIN.) DISTANCE (EACH SIDE) AS MEASURED FROM TOP AND BOTTOM CORNERS

25. FOR LONGITUDINAL JOINTS, INSTALL "U" SHAPE STRESS SKIN PIECES ALONG EACH SIDE EXTENDING 3" (MIN.) ONTO TOP AND BOTTOM PANELS (MEASURED FROM CORNERS). OVERLAP SEPARATE PIECES BY 2" (MIN.). APPLY STRESS SKIN UPGRADE AT LONGITUDINAL JOINTS PRIOR TO CIRCUMFERENTIAL WRAPS AT BUTT JOINTS.

26. FOR LONGITUDINAL JOINTS, SECURE TWO STRESS SKIN "U" SECTIONS WITH TIE WIRES ACROSS TOP AND BOTTOM PANELS AT 6" INTERVALS, EXCEPT AT BUTT JOINTS WHERE THEY ARE INSTALLED APPROXIMATELY 2" FROM EACH SIDE OF THE JOINT.

27. APPLY A SUFFICIENT TROWEL GRADE SKIM COAT TO COVER ALL STRESS SKIN AND FASTENERS. TOUCH-UP AS REQUIRED TO COMPENSATE FOR MATERIAL SHRINKAGE.

28. NO UPGRADE OF JOINTS IS REQUIRED FOR SUPPORTS.

29. DURING CUTTING OF PANELS, ENSURE STRESS SKIN DOES NOT DISENGAGE FROM SUBSTRATE MATERIAL.

30. DURING SCORING OF PANELS, ENSURE STRESS SKIN INTEGRITY IS MAINTAINED.

31. LOT NUMBER TRACEABILITY AND INSTALLED LOCATION SHALL BE MAINTAINED FOR ALL THERMO-LAG MATERIALS.

32. THERMO-LAG SHALL NOT BE APPLIED TO TEST ITEM UNTIL RELEASED BY TEST LABORATORY.

33. ALL QUESTIONS PERTAINING TO THERMO-LAG MATERIAL APPLICATION SHALL BE RESOLVED WITH THE ENGINEER PRIOR TO INSTALLATION.

REV	DWN	ORIG	VER	APVD
0	ELT	REP 12/13/93	RLO 12/13/93	12-14-93

ABB IMPELL CORP
PROJ NO 0784-00001

NUMARC PHASE II TEST PROGRAM

DWG 0784-00001-2-019 (I-[illegible])
REV 0

TEST 2-9
(T1-A-36x)

FIG 12 - THERMO-LAG INSTALLATION [illegible]