

PDR

November 5, 1996

MEMORANDUM TO: K. Steven West, Chief
Fire Protection Engineering Section
Plant Systems Branch

FROM: Chris S. Bajwa, *151*
Reactor Systems Engineer
Fire Protection Engineering Section

SUBJECT: TRIP TO OMEGA POINT LABORATORIES - PACIFIC GAS AND ELECTRIC
COMPANY (PG&E) PYROCRETE FIRE ENDURANCE TESTS
(OCTOBER 1-3, 1996) (TAC. NOs. M96540 and 96541)

On October 1 - 3, 1996, I visited Omega Point Laboratories (OPL), San Antonio, Texas to witness 3 fire endurance tests conducted for Pacific Gas and Electric Company (PG&E). Three separate test assemblies were constructed by PG&E using Pyrocrete and delivered to OPL. The test assemblies were constructed to represent configurations currently present at the Diablo Canyon Nuclear Power Plant.

The assemblies included: 1) A 36 x 36 x 36 inch (nominal) box with a 2" thickness of Pyrocrete installed over the frame. A 27-1/2" long, 4" diameter rigid steel conduit was installed in the box 2" from the fireside face of the box; 2) An assembly similar to the first, with the addition of mineral wool insulation 1" thick installed over the Pyrocrete enclosure and covered with two (5/8") layers of Firecode type "c" gypsum wallboard; 3) A 36 x 36 x 36 inch (nominal) junction box enclosure, complete with hatch access doors and access door cover surrounding a simulated 20 gauge junction box.

The fire tests were conducted in accordance with Supplement 1 to Generic Letter 86-10, "Fire Endurance Test Acceptance Criteria for Fire Barrier Systems Used to Separate Redundant Safe Shutdown Trains Within the Same Fire Area." The techniques used to construct the test specimens followed the design details and procedures developed by PG&E, who constructed the specimens. Attached is my trip report which documents the results of these tests.

Attachment: As stated

Contact: Chris Bajwa, NRR
301-415-1237

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TRIP REPORT

Licensee: Pacific Gas and Electric Company (PG&E)
Docket Nos.: 50-275/323
Plant: Diablo Canyon Power Plant, Units 1 and 2

Activity: Test of Pyrocrete Fire Barriers and Junction Box

Trip date: October 1-3, 1996

Reviewer: Chris S. Bajwa, Reactor Systems Engineer,
Fire Protection Engineering Section
SPLB/DSSA/NRR

INTRODUCTION

On October 1 - 3, 1996, C. Bajwa visited Omega Point Laboratories (OPL), San Antonio, Texas to witness 3 fire endurance tests conducted for Pacific Gas and Electric Company (PG&E). Three separate test assemblies were constructed by PG&E using Pyrocrete, a cementitious fire resistant material, and delivered to OPL. The test assemblies were representations of configurations currently present at the Diablo Canyon Nuclear Power Plant.

The objective of the tests was to qualify protective fire barrier systems for redundant essential cables in an Appendix R safe shut down circuit.

The fire tests were conducted in accordance with Supplement 1 to Generic Letter (GL) 86-10, "Fire Endurance Test Acceptance Criteria for Fire Barrier Systems Used to Separate Redundant Safe Shutdown Trains Within the Same Fire Area." The test specimens were constructed by PG&E in accordance with their design details and procedures.

Personnel contacted during this visit: Lou Pons, PG&E, Dave Bidwell, PG&E; Fleur de Peralta, Tri-En Corp.; Herb Stansberry, Cleda Patton, Deggary Priest, and Kerry Hitchcock of OPL.

TEST SUMMARY AND RESULTS

On October 1-3, 1996, OPL performed 3 full-scale fire endurance tests of Pyrocrete fire barriers representative of barriers used at the Diablo Canyon Power Plant. The tests were conducted for PG&E, the licensee, in accordance with Supplement 1 to GL 86-10, "Fire Endurance Test Acceptance Criteria for Fire Barrier Systems Used to Separate Redundant Safe Shutdown Trains Within the Same Fire Area."

The assemblies tested included the following:

- (1) A 36 x 36 x 36 inch (nominal) assembly complete with 3/4" thick galvanized steel furring channels, USG 3.4 galvanized Diamond Mesh metal lath and a 2" thickness of Pyrocrete installed over the frame. A 27-1/2" long, 4" diameter rigid steel conduit was installed in the box 2" from the fireside face of the box. (See Figure 1)

- (2) A 36 x 36 x 36 inch (nominal) assembly similar to the first, with the addition of 1" Z-bars (1" rise, 2" leg, 18 ga galvanized steel) attached to the Pyrocrete enclosure surfaces with 1/4"-20 bolts, 3" long, screwed into Hilti Toggler Bolt hollow wall anchors installed into holes provided in the Pyrocrete. Mineral wool insulation 1" thick with 4 pcf density was installed over the Pyrocrete enclosure and covered with two 5/8" layers of Firecode type "c" gypsum wallboard. Expanded galvanized metal lath corner guards (3" leg) were installed over the gypsum corners. The corner guards and screw heads were covered with joint compound. (See Figure 2)
- (3) A 36 x 36 x 36 inch (nominal) junction box (JB) enclosure, complete with 3/16" steel plate interior, 3/4" thick galvanized steel furring channels, USG 3.4 galvanized Diamond Mesh metal lath and a 2" thickness of Pyrocrete installed over the frame. The assembly included 2 hinged hatch access doors and an access door cover fabricated with 10 gage steel plate, 3.4 galvanized mesh lath, 3/4" furring channels and 2" of Pyrocrete. An instrumented 20 gauge junction box was fabricated by OPL and installed inside the junction box enclosure. (See Figure 3)

All of the specimens were instrumented with 24 GA Chromel-Alumel, electrically welded thermocouples, and mounted on a 70 x 70 x 8 inch concrete test slab. The assemblies were mounted in a test bulkhead (vertical wall) assembly which was mounted to the vertical fire resistance furnace.

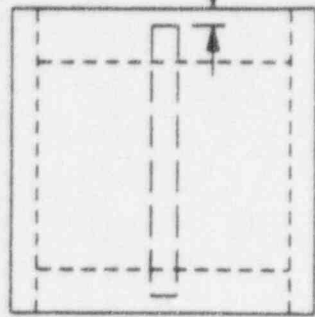
The tests were conducted for a period of 120 minutes for the Pyrocrete box and the junction box enclosure (assemblies 1 and 3), and 180 minutes for the Pyrocrete box with the additional layers of mineral wool and gypsum board (assembly 2). The tests were conducted following the ASTM E-119 standard time-temperature fire. For assemblies 1, 2, and 3, at the onset of the fire exposures, the ambient test temperatures were 67 °F, 72 °F, and 77 °F, respectively. Following the guidance of Supplement 1 to GL 86-10, this ambient temperature established the average temperature rise criterion (as measured on the unexposed side of the fire barrier material) at 317 °F, 322 °F and 327 °F, and the maximum single point temperature criterion at 392 °F, 397 °F, and 402 °F, respectively. Following the fire exposure, the assemblies were exposed to a fog nozzle hose stream test for 5 minutes in accordance with the criteria specified in Supplement 1 to GL 86-10. On the basis of observations during the test, it appeared that test assemblies 1 and 3 met the acceptance criteria specified in Supplement 1 to GL 86-10 for a fire rating of 2 hours, while assembly 2 appeared to meet the acceptance criteria for a 3 hour rating. A final determination of the performance of these barriers will require a review and evaluation of the final test report issued by OPL.

The results of the fire tests are presented in the Table 1 below.

TABLE 1

SUMMARY OF PG&E FIRE ENDURANCE TEST RESULTS FOR TESTING OF PYROCRETE ASSEMBLIES					
TEST SPECIMEN	DURATION OF TEST (MINS)	THERMOCOUPLE (TC) LOCATIONS	AVERAGE TEMPERATURE (°F)	MAXIMUM SINGLE-POINT TEMPERATURE OBSERVED/TC # (°F)	GL 86-10 ALLOWABLE TEMPERATURES: AVG./MAX. (°F)
(1) PYROCRETE BOX W/INTERNAL 4" CONDUIT	120 ¹	TC #'s 1-5 ² , FRONT OF CONDUIT	276	309 (#1)	317/392
		TC #'s 6-11, SIDES OF BOX (ENGINEERING TCs)	N/A ³	481 (#9)	N/A ⁴
		TC #'s 12-15, EXTERNAL SURFACE OF CONCRETE SLAB (ENGINEERING TCs)	N/A	170	N/A
(2) PYROCRETE BOX W/INTERNAL 4" CONDUIT AND ADDITIONAL INSULATION	180	TC #'s 1-5, FRONT OF CONDUIT	211	212 (#2)	322/397
		TC #'s 6-11, SIDES OF BOX (ENGINEERING TCs)	N/A ³	214 (#7 AND 9)	N/A
(3) PYROCRETE JUNCTION BOX ENCLOSURE	120	JUNCTION BOX FACE TEMPERATURES	N/A	306 (FRONT FACE)	327 (MAX)
		JUNCTION BOX TEMPERATURES TC #'s 1-29	N/A	329 (#2)	402 (MAX)
		BACK OF ENCLOSURE DOORS TC #'s 30 - 37 (ENGINEERING TCs)	N/A	493 (#32)	N/A
		BACK OF DOOR COVER TC #'s 38 - 42 (ENGINEERING TCs)	N/A	600 (#39)	N/A
		SIDES/ TOP AND BOTTOM OF JB ENCLOSURE TC #'s 43 - 54 (ENGINEERING TCs)	N/A	318 (#44)	N/A
NOTES:					
1. ALL SPECIMENS APPEARED TO PASS FIRE TESTS FOR THE INDICATED DURATION					
2. SEE APPENDIX 1 FOR THERMOCOUPLE LOCATIONS					
3. AVERAGE TEMPERATURE WAS NOT SEPARATELY CALCULATED DURING THE TEST FOR THESE THERMOCOUPLES					
4. NO MAXIMUM ALLOWABLE TEMPERATURE WAS SPECIFIED FOR ENGINEERING THERMOCOUPLES					

2" CLR TO
PYROCRETE
(TYP)

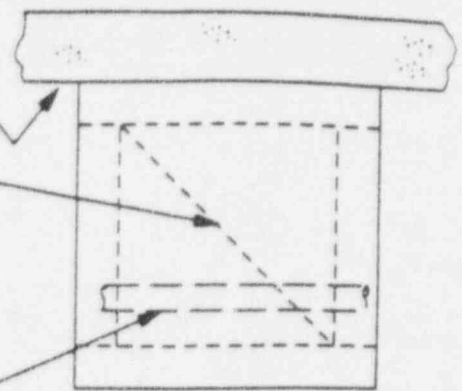


PLAN
 $\frac{1}{2}'' = 1' - 0''$

SURFACE OF
CONC. SLAB

$L 1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}''$

RIGID
STEEL
CONDUIT
4" Ø



SIDE ELEVATION
 $\frac{1}{2}'' = 1' - 0''$

4- $\frac{1}{2}'' \varnothing$
THRU BOLTS
(MIN. OF 4)

8" THICK SLAB

CURRING $\frac{3}{4}''$
16" O.C.
AX.

3' - 0"

$L 1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}''$
@ 3' - 0" OC MAX

2" PYROCRETE
(241)

2" ($+\frac{1}{2}''$, - 0")

USG 3.4 GALV.
DIAMOND MESH
METAL LATH

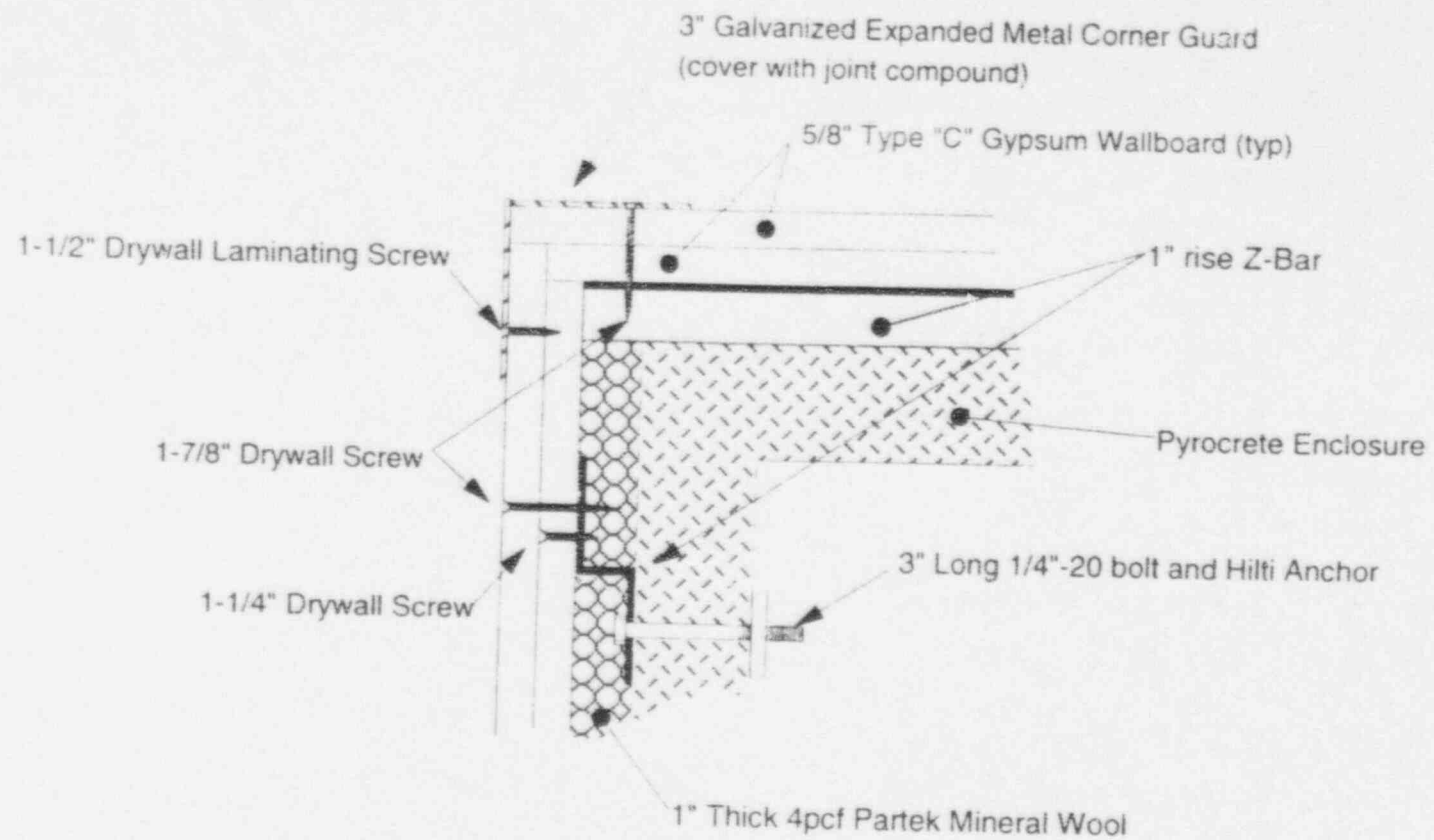
3' - 0"

SECTION

1" = 1' - 0"



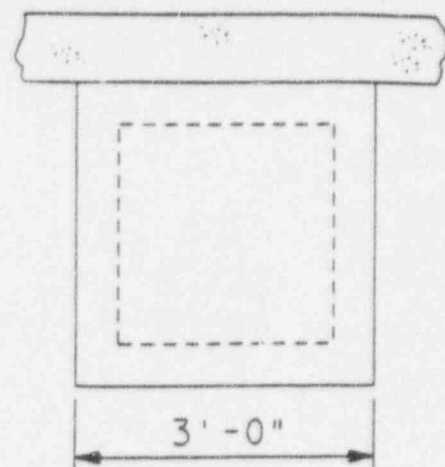
FIGURE 1
FIRE BARRIER WITHOUT
ACCESS OPENING



Pyrocrete Enclosure with Upgraded System

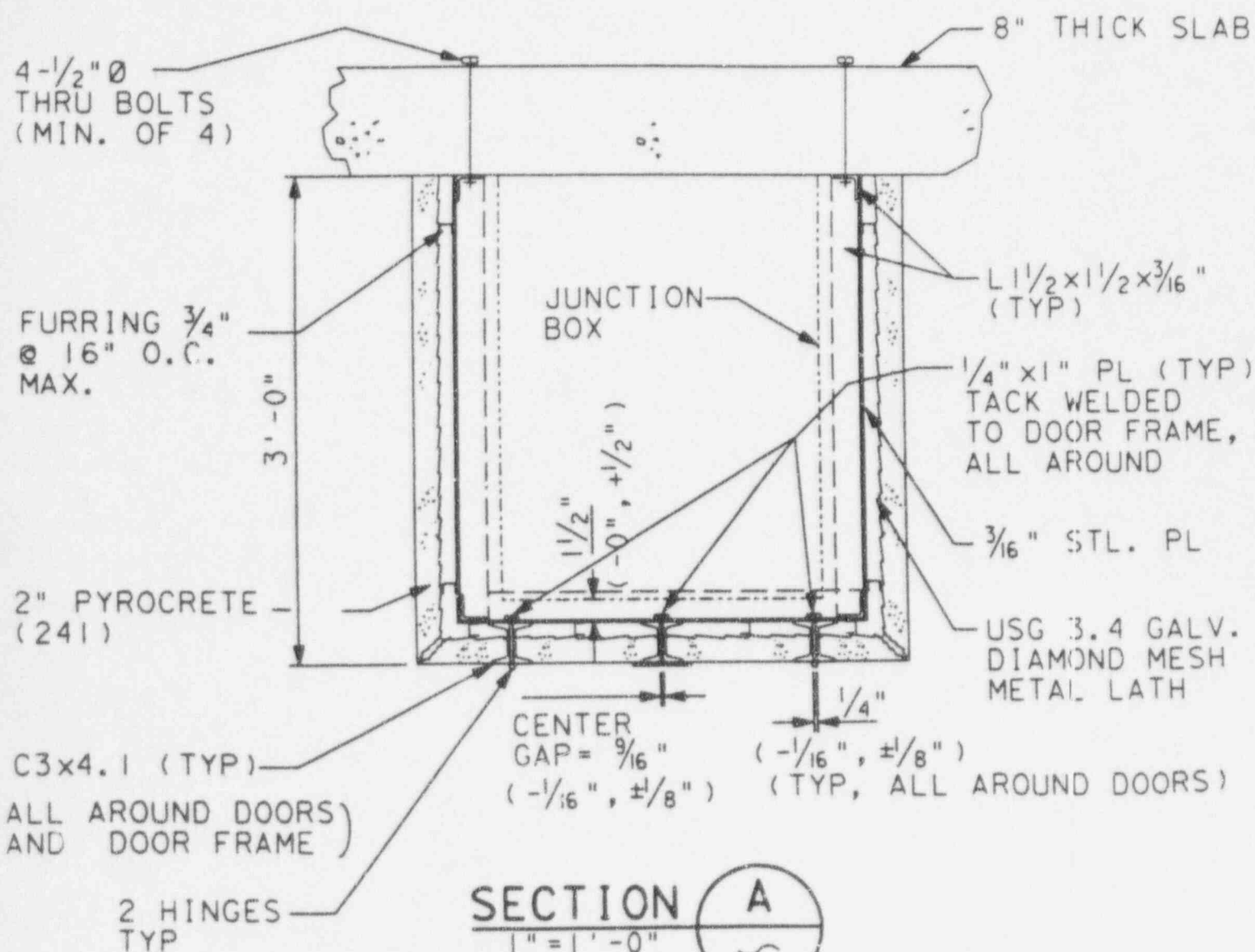
SECTIONAL VIEW

FIGURE 2



PLAN
1/2" = 1' - 0"

SIDE ELEVATION
1/2" = 1' - 0"



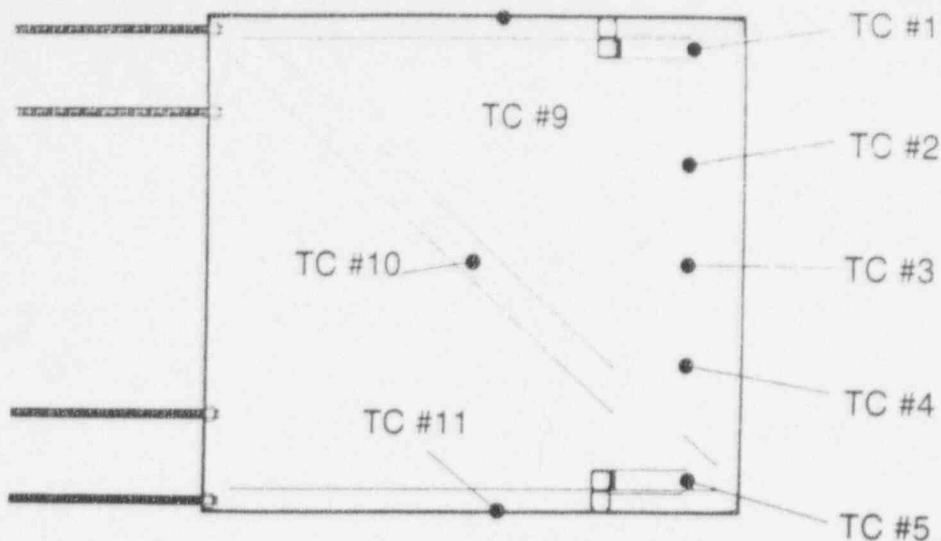
SECTION

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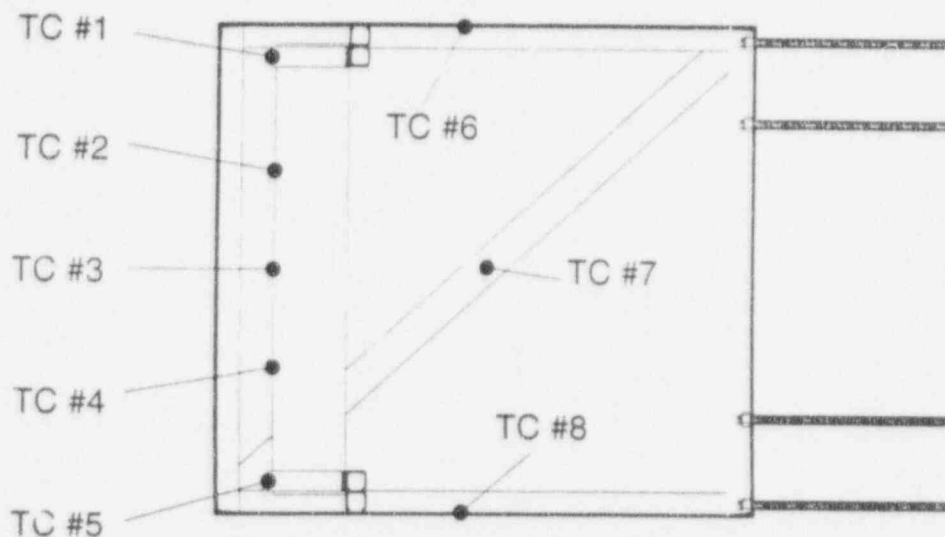
FIGURE 3

FIRE BARRIER

APPENDIX 1



Thermocouple Locations - Left Side
INTERIOR ELEVATION VIEW



Thermocouple Locations - Right Side
INTERIOR ELEVATION VIEW

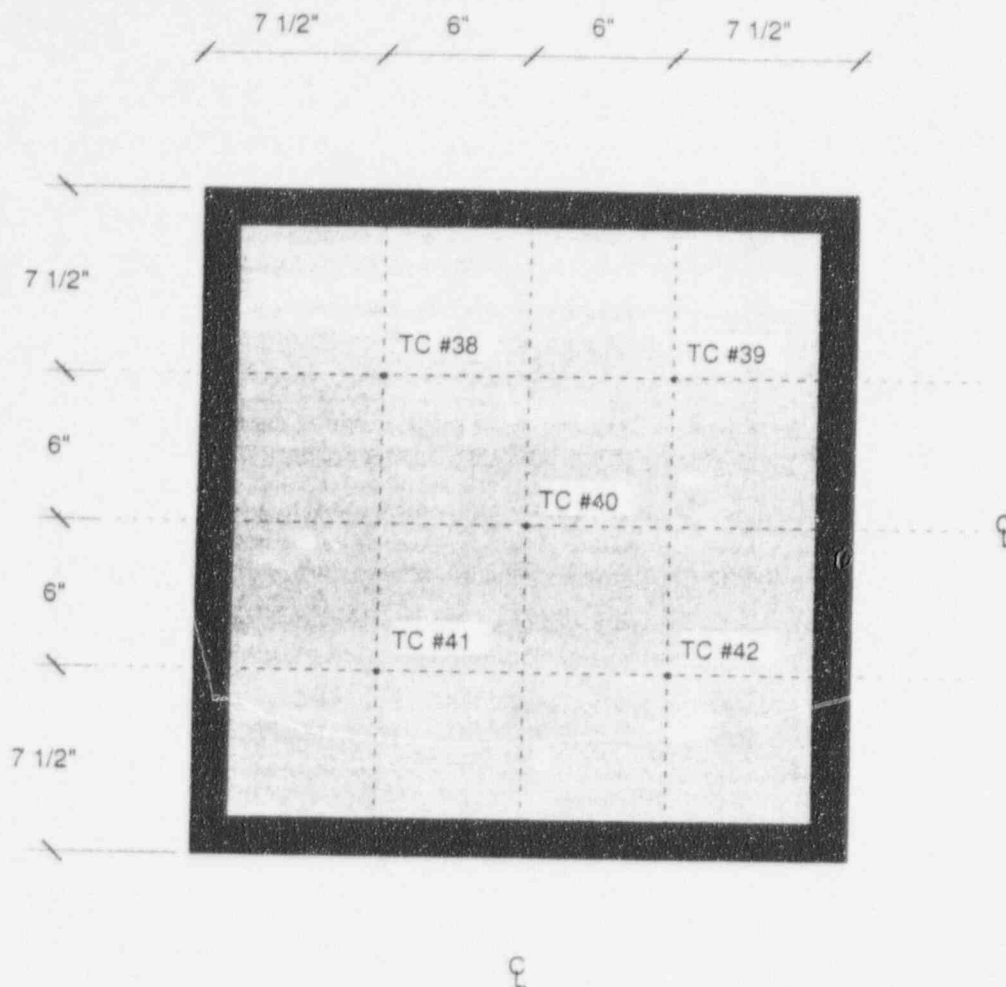
NOTE:

The specimens were instrumented with 24 GA Chromel-Alumel, electrically-welded thermocouples, Special Limits of Error ($\pm 1.1^{\circ}\text{C}$), purchased with lot traceability, fastened to the conduit surface (front) and the steel angle with small machine screws drilled and tapped into the steel. The thermojunctions were clamped between the steel and the heads of these screws.



OMEGA POINT LABORATORIES, INC.	
Project No. 15594-100410	
Pacific Gas And Electric Company	
Thermocouple Placement Details (As-Built)	
Drawn By:	<i>John W. Smith</i> 9/30/96
OPL Approval:	<i>[Signature]</i> 9/30/96
Client Approval:	<i>[Signature]</i>

Scale: 1"=1'



Interior Box Enclosure Details - Front (back of door cover)

INTERIOR ELEVATION VIEW (from interior)

NOTE:

The specimen was instrumented with 24 GA Chromel-Alumel, electrically-welded thermocouples, Special Limits of Error ($\pm 1.1^{\circ}\text{C}$), purchased with lot traceability, fastened to the interior surface of the door cover with small machine screws drilled and tapped into the steel skin. The thermojunctions were clamped between the steel skin and the heads of these screws.

$\pm 1/4$ " tolerance on all dimensions



OMEGA POINT LABORATORIES, INC.
Project No. 15594-100409

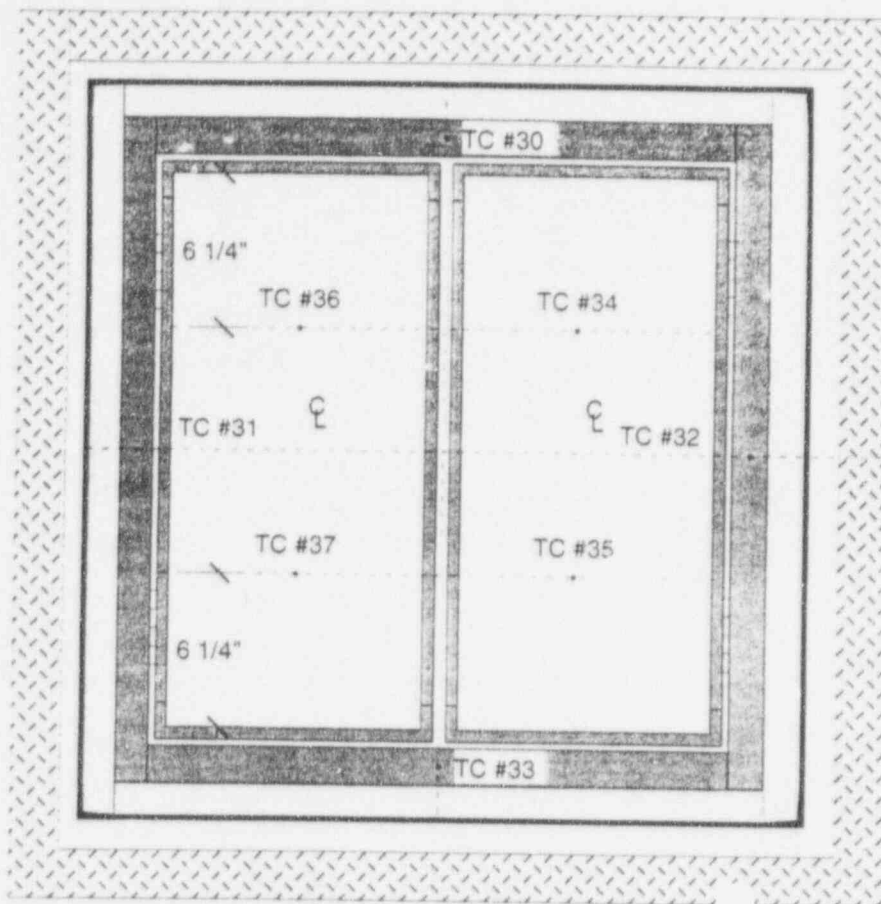
Pacific Gas And Electric Company

Box Thermocouple Locations
(As-Built)

Drawn By: *Habit* 10/17/96
OPL Approval: *[Signature]* 10/17/96

Client Approval: *[Signature]* 10/3/96

Scale: 1-1/2"=1'



Interior Box Enclosure Details - Front (back of doors)

INTERIOR ELEVATION VIEW (from interior)

NOTE:

The specimen was instrumented with 24 GA Chromel-Alumel, electrically-welded thermocouples, Special Limits of Error ($\pm 1.1^{\circ}\text{C}$), purchased with lot traceability, fastened to the interior surface with small machine screws drilled and tapped into the steel skin. The thermojunctions were clamped between the steel skin and the heads of these screws.

$\pm 1/4$ " tolerance on all dimensions



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Project No. 15594-100409

Pacific Gas And Electric Company

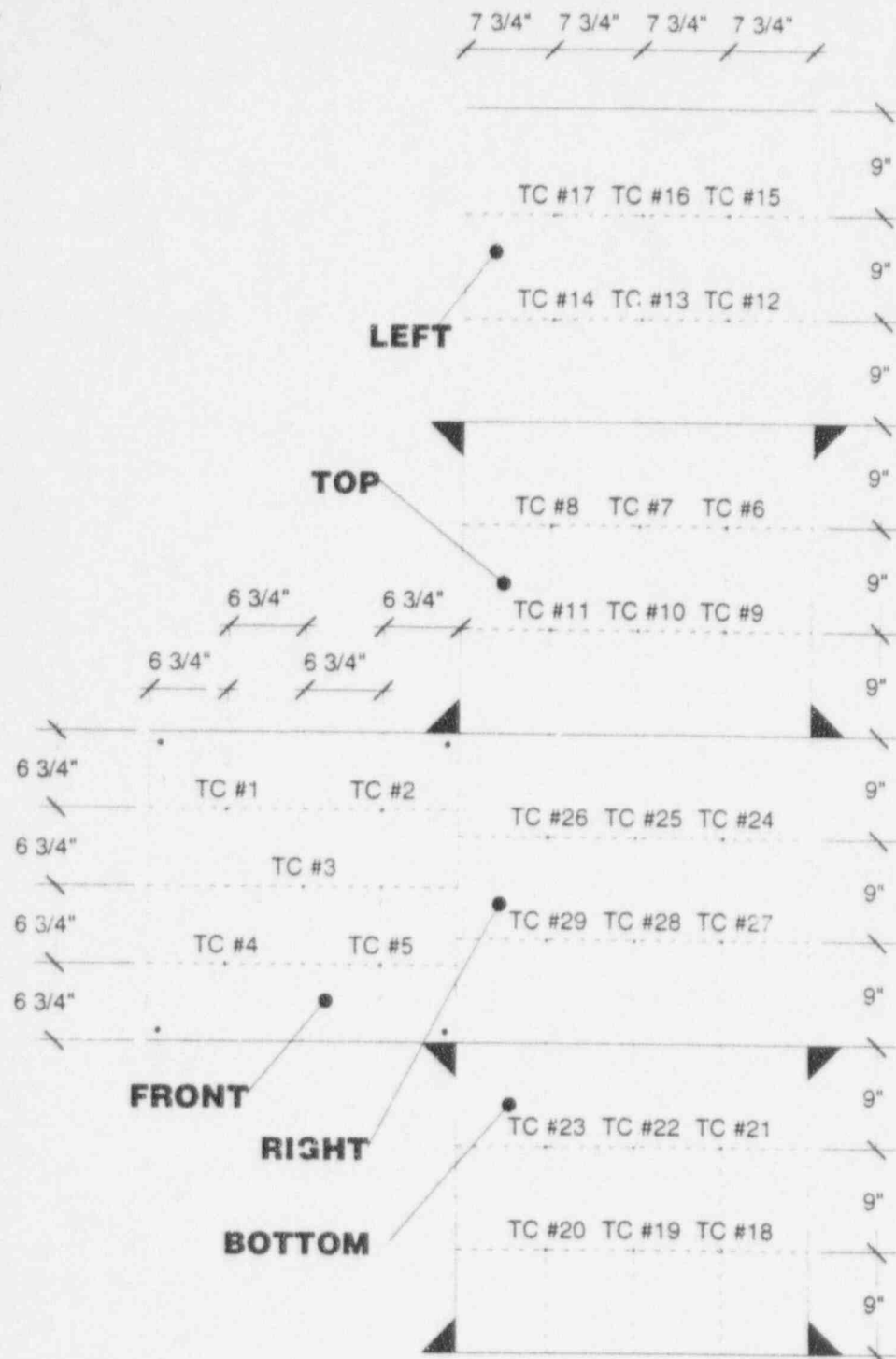
Box Thermocouple Locations
(As-Built)

Drawn By: *Handwritten signature* 10/12/96

OPL Approval: *Handwritten signature* 10/2/96

Client Approval: *Handwritten signature* 10-3-96

Scale: 1-1/2"=1'



Interior Junction Box Thermocouple Details

UNFOLDED ELEVATION VIEW (from front)

NOTE:

The specimen was instrumented with 24 GA Chromel-Alumel, electrically-welded thermocouples, Special Limits of Error ($\pm 1.1^{\circ}\text{C}$), purchased with lot traceability, fastened to the interior junction box surface with small machine screws drilled and tapped into the steel skin. The thermojunctions were clamped between the steel skin and the heads of these screws.

$\pm 1/4"$ tolerance on all dimensions



OMEGA POINT LABORATORIES, INC.
Project No. 15594-100409

Pacific Gas And Electric Company

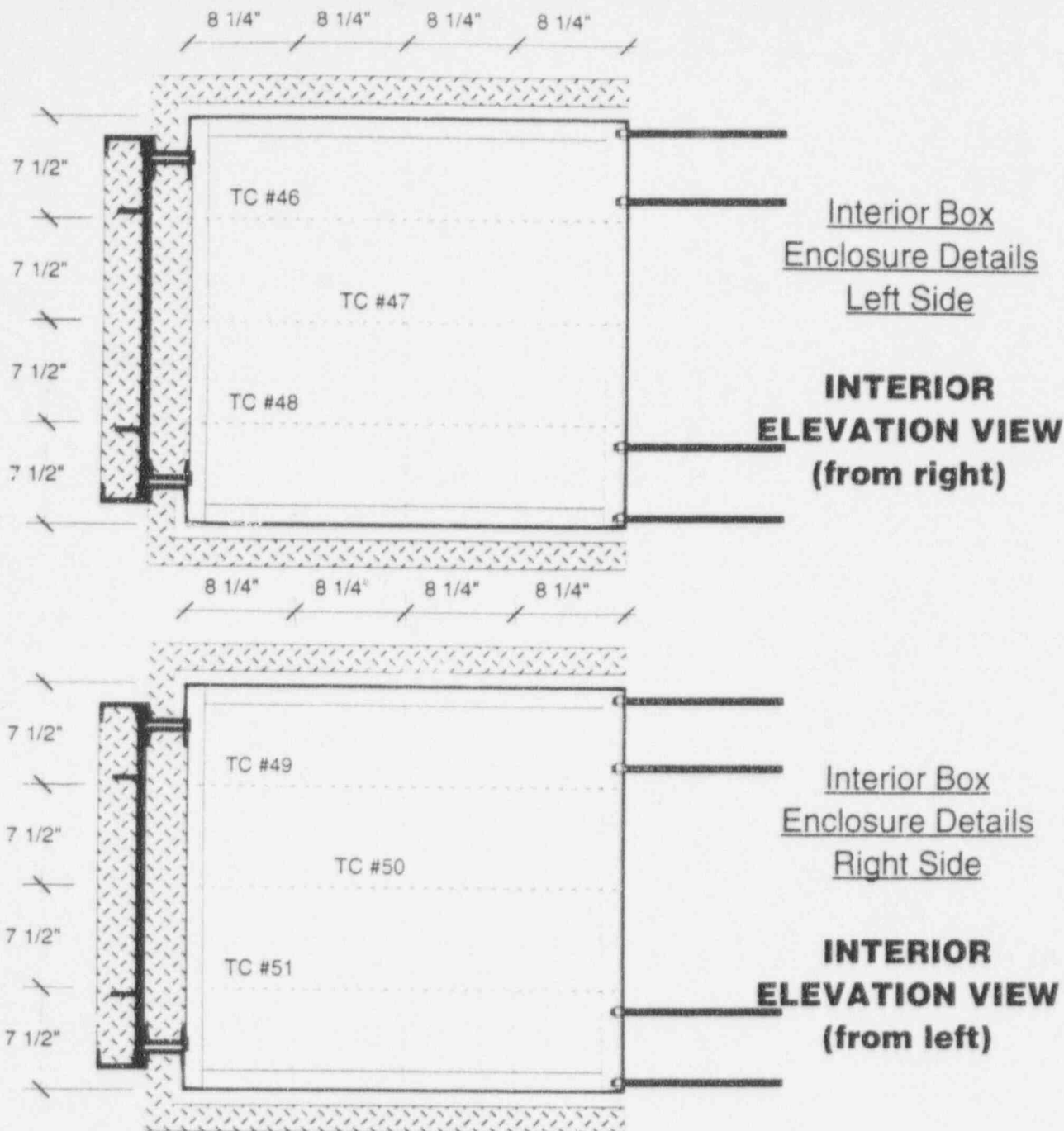
Junction Box Thermocouple Locations
(As-Built)

Drawn By: *Handwritten signature* 10/5/96

OPL Approval: *Handwritten signature* 10/12/96

Client Approval: *Handwritten signature* 10-3-96

Scale: 3/4"=1'



NOTE:

The specimen was instrumented with 24 GA Chromel-Alumel, electrically-welded thermocouples, Special Limits of Error ($\pm 1.1^{\circ}\text{C}$), purchased with lot traceability, fastened to the interior surface with small machine screws drilled and tapped into the steel skin. The thermojunctions were clamped between the steel skin and the heads of these screws.

$\pm 1/4"$ tolerance on all dimensions



OMEGA POINT LABORATORIES, INC.
Project No. 15594-100409

Pacific Gas And Electric Company

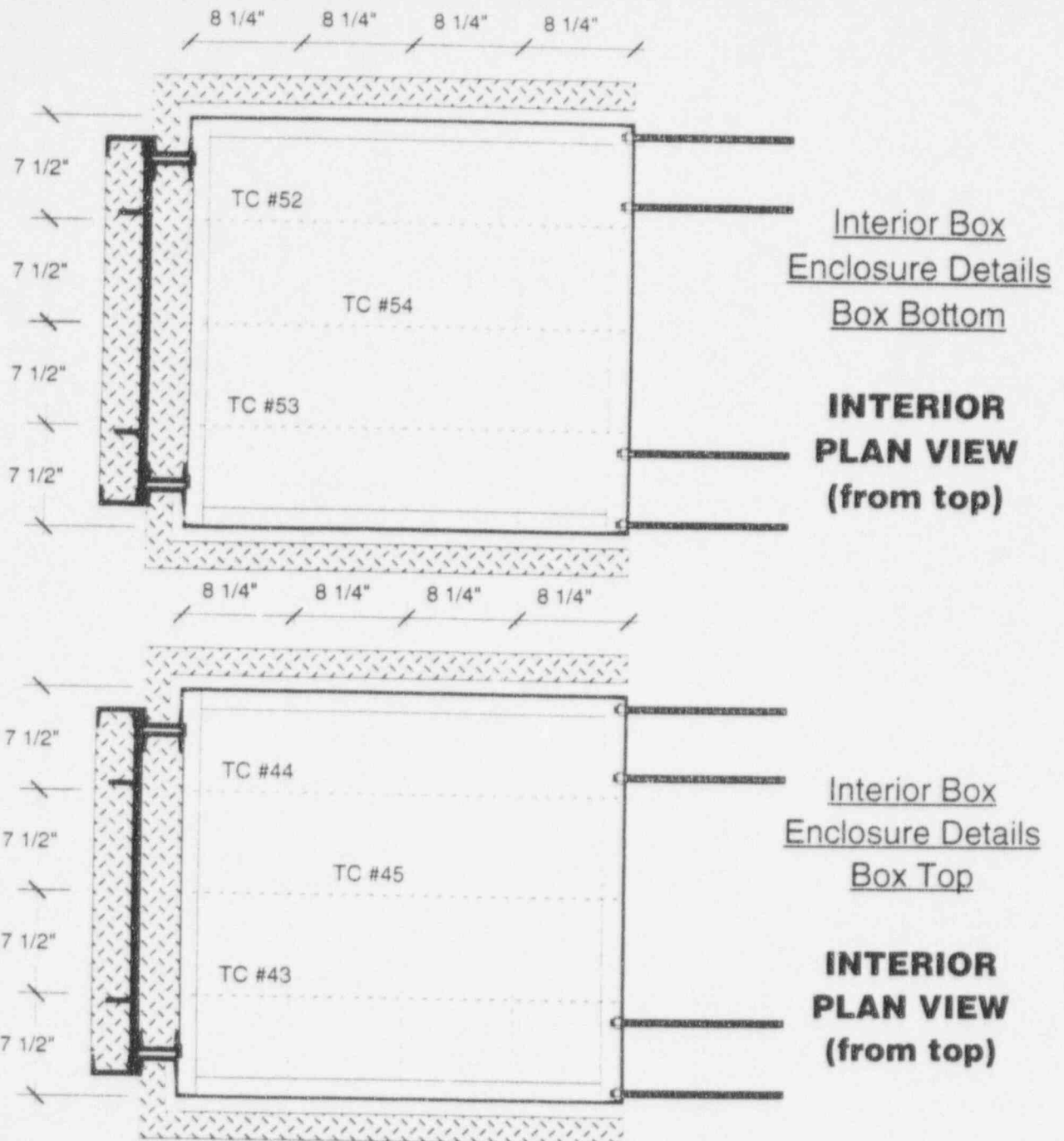
Box Thermocouple Locations
(As-Built)

Drawn By: *H. L. [Signature]* 10/3/96

OPL Approval: *[Signature]* 10/3/96

Client Approval: *L. Davis* 10-3-96

Scale: 1"=1'



NOTE:

The specimen was instrumented with 24 GA Chromel-Alumel, electrically-welded thermocouples, Special Limits of Error ($\pm 1.1^{\circ}\text{C}$), purchased with lot traceability, fastened to the interior surface with small machine screws drilled and tapped into the steel skin. The thermojunctions were clamped between the steel skin and the heads of these screws.

$\pm 1/4"$ tolerance on all dimensions



OMEGA POINT LABORATORIES, INC.
Project No. 15594-100409

Pacific Gas And Electric Company

Box Thermocouple Locations
(As-Built)

Drawn By: *[Signature]* 10/15/96
OPL Approval: *[Signature]* 10/3/96

Client Approval: *[Signature]* 10-3-96

Scale: 1"=1'