SOUTHWEST RESEARCH INSTITUTE

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DEPARTMENT OF FIRE TECHNOLOGY

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August 24, 1982

Mr. Donald J. Kohn
Fire Protection Supervisor
Nuclear Plant Engineering
Pennsylvania Power & Light Company
Two North Ninth Street
Allentown, Pennsylvania 18101

Subject: SwRI Project No. 01-7163 Report No. 2
"Evaluation of Small Conduits"

Dear Mr. Kohn:

This letter constitutes our final report on this portion of Project No. 01-7163. This report includes a description of the test materials, test procedures and test results.

OBJECTIVE

This fire test was conducted in accordance with Section 4.2 of the Pennsylvania Power & Light (PP&L) Company Test Specification. A copy of this specification has been provided in Report No. 1 "Qualification Fire Test of a Protective Envelope System."

EXPERIMENTAL

Test conduits were 1 ft long and capped at one end. A single thermocouple was placed in the center of the cables and emerged through the uncapped end.

Conduits were wrapped by Pennsylvania Power & Light personnel following the PP&L Test Specification.

Cure time and moisture content of the conduits prior to test were:

Conduit No. 1: approximately 29 days; 0-20% moisture
Conduit No. 2: approximately 7 days; 40-60% moisture

On August 19, 1982, the conduits were placed in SwRI's horizontal furnace and tested for one hour according to the time/temperature curve specified in the PP&L specification.

RESULTS

The furnace average temperature obtained during the test is provided in Table I.

The internal temperature of each conduit attained during the test is provided in Table II.

Visual inspection of the conduits after the test showed that the Thermo-Lag 330-1 material had charred and cracked for its full depth. Cables in both conduits showed signs of charred and cracked cable insulation.

If you have any questions or if I can be of further assistance, please do not hesitate to contact me.

Sincerely,

Jesse J. Beitel
Manager
Fire Performance Evaluations
and Fire Protection Systems

Enclosures

JJB/cjm

SwRI Project No. 01-7163
August 24, 1982

TABLE 1. FURNACE AVERAGE

ASTM E119 TIME/TEMPERATURE CURVE
(1 Hour: ± 10%)

TIME	STANDARD CURVE	-10%	ACTUAL	+10%	TIME
0	70	63	81	73	0
1	200	180	105	220	1
2	400	360	237	440	2
3	600	540	475	660	3
4	800	720	765	880	4
5	1000	900	999	1100	5
6	1100	990	1156	1210	6
7	1150	1035	1256	1265	7
8	1200	1080	1305	1320	8
9	1250	1125	1282	1375	9
10	1300	1170	1269	1430	10
11	1320	1188	1288	1452	11
12	1350	1206	1324	1474	12
13	1360	1224	1367	1496	13
14	1380	1242	1388	1518	14
15	1399	1259	1388	1539	15
16	1414	1274	1398	1555	16
17	1429	1286	1417	1572	17
18	1435	1291	1436	1579	18
19	1450	1305	1453	1595	19
20	1462	1316	1465	1608	20
21	1474	1327	1473	1621	21
22	1486	1337	1481	1635	22
23	1498	1348	1494	1648	23
24	1500	1350	1508	1650	24
25	1510	1359	1512	1661	25
26	1520	1368	1507	1672	26
27	1528	1375	1518	1681	27
28	1537	1383	1533	1691	28
29	1541	1387	1547	1695	29
30	1550	1395	1549	1705	30
35	1584	1426	1591	1742	35
40	1613	1452	1607	1774	40
45	1630	1467	1631	1793	45
50	1661	1495	1659	1827	50
55	1681	1513	1688	1849	55
60	1700	1530	1701	1870	60

TABLE II. INTERNAL TEMPERATURES

TIME (Min)	CONDUIT NO. 1 0-20%	CONDUIT NO. 2 40-60%
0:00	68	90
1:00	69	90
2:00	69	90
3:00	70	90
4:00	72	91
5:00	74	92
6:00	77	93
7:00	81	95
8:00	85	97
9:00	89	99
10:00	93	101
11:00	99	104
12:00	104	107
13:00	111	110
14:00	118	114
15:00	127	119
16:00	140	126
17:00	152	132
18:00	164	161
19:00	177	179
20:00	184	230
21:00	182	245
22:00	176	265
23:00	174	293
24:00	173	323
25:00	175	356
26:00	179	382
27:00	211	391
28:00	276	388
29:00	302	387
30:00	327	375
35:00	444	278
40:00	574	291
45:00	651	320
50:00	738	353
55:00	826	500
60:00	892	772

QUALIFICATION FIRE TEST OF A PROTECTIVE

ENVELOPE SYSTEM

FINAL REPORT

SwRI PROJECT NO. 01-7163

APPENDIX E

Pennsylvania Power & Light Company
Test Specification

Prepared for

Pennsylvania Power & Light Company
Two North Ninth Street
Allentown, Pennsylvania 18101

August 1982

SOUTHWEST RESEARCH INSTITUTE
SAN ANTONIO HOUSTON

PP&L	ASME SECTION III OR XI ☐ SAFETY RELATED ☐ OTHER QUALITY ☒ NON QUALITY ☐ DESIGN VERIFICATION YES ☐ NO ☒	SPECIFICATION NO. F1001 FILE NO. 143 PAGE 1 OF 235

TECHNICAL

SPECIFICATION

FOR

CONTROLLED

FIRE QUALIFICATION TEST OF A PROTECTIVE ENVELOPE SYSTEM

SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2
PENNSYLVANIA POWER & LIGHT COMPANY
ALLENTOWN, PENNSYLVANIA

RECEIVED
JUL 19 1982
DEPT. FIRE TECHNOLOGY

RECEIVED
JUL 16 1982
NUCLEAR REC. SYS.

O	7/16/82	Release for use	Donald J. Kohn	N/A	AWMetzger
A	7/13/82	Internal Review	Donald J. Kohn	N/A	
REV.	DATE	DESCRIPTION	PREPARED BY	VER'FD.	APPROVED

INDEX

1.0 SCOPE

This Specification prescribes the methods and guidelines to be utilized for the preparation of test specimen, installation of protective envelope systems, performance of the One Hour Fire Test and documentation of Test Results.

2.0 GENERAL INFORMATION

The objective of this test is to qualify a protective envelope system for redundant essential cables at the Susquehanna Steam Electric Station. It will provide documented evidence that the envelope will satisfactorily withstand an American Society for Testing Materials (ASTM) E-119 (80) fire exposure and provide a one hour effective barrier per American Nuclear Insurers/Mutual Atomic Energy Reinsurance Pool acceptance rating by maintaining circuit integrity, and continuity.

3.0 REFERENCES

The work to be performed under this Specification shall conform to the applicable provisions of the latest revisions of the following documents.

a. American Society for Testing Materials (ASTM) E119.
b. American Nuclear Insurers/Mutual Atomic Energy Reinsurance pool (ANI/MAERP) "Standard Fire Endurance Test Method to Qualify A Protective Envelope For Class 1E Electrical Circuits"
c. 10 CFR 50 Appendix R
d. PP&L Specification F1000
e. Texas Utilities Services, Inc. "Test Procedure to Qualify a protective Envelope System For CPSES" Rev. 0 dated 9-9-81 [Appendix A]
f. Bechtel Specification 8856-E-61 Rev. 1 [Appendix B]
g. Bechtel Field Change Request E6347 [Appendix C]
h. Bechtel Special Detailed instructions for Installation of thermo lag 330-1 [Appendix D]
i. PP&L Operational Policy Statement (OPS-1)

If a conflict exists between any of these documents and this Specification, the Specification shall govern.

4.0 TECHNICAL REQUIREMENTS

4.1 FIRE TEST

The Fire Test shall be done in accordance with Texas Utilities Services, Inc. "Test Procedure to Qualify A Protective Envelope System for CPSES" (Rev. 0) [Appendix A] with the following exceptions.

a. Delete References 4.3.5, 4.3.6, 4.3.8, 4.3.9, 4.3.10, 4.3.11, 4.3.12, 4.3.13 and 4.3.14.

b. Change section 5.1 and 5.2 to Pennsylvania Power and Light

c. Delete 5.5, 5.6, and 5.7

d. Section 7.1, change Comanche Peak Steam Electric Station to Susquehanna Steam Electric Station and change Comanche Peak Project Engineering to Pennsylvania Power & Light

e. Section 7.2 is optional

f. Section 7.4 change 40% density to 30% density for cable trays

g. Delete Section 7.8

h. Section 11.0 change CPPE to Pennsylvania Power and Light

i. Appendix 1 Replace with PP&L Appendix E to this Specification

j. Appendix 2 should be generally followed except

   1) Cable Tray Support shall be per Figure 4.1 and 4.2 of this Specification

   2) Change 40% fill to 30% fill for cable trays.

   3) Drawing FDSG-D7 and FDSG D8 should be followed except the supports shall be per figure 4.1 and 4.2 of this Specification

   4) Appendix 4 and Tables FDSG - T1, T2, T3, and T4 shall be deleted and replaced with Appendix E to this Specification.

   5) Delete Appendix 6 Section 3 and replace with Appendix B and Appendix C of this Specification. Preformed panels maybe be used for a maximum of 50% of the enclosure. It is desirable to have at least one section preformed. Preforming guidance shall obtained from Appendix 6 Section 3, but the actual installation of Thermo-Lag shall be per Appendix B and C of this specification.

4.2 FIRE TEST OCCURRING LESS THAN 30 DAYS AFTER APPLICATION OF THERMO-LAG

If the fire test will occur less than 30 days after application of Thermo-lag, on the main test set up, then the following shall be done in addition to section 4.1:

a. Two test conduits shall be provided. Each 1 foot long with both ends capped, the interior shall be filled with cables.

b. One conduit shall be enclosed per Appendix B & C 30 days prior to the fire test.

c. The other conduit shall be enclosed per Appendix B & C at the time the test conduits and cable tray are enclosed.

d. Both conduits shall be provided with a thermocouple located at the center of interior of the conduits.

e. Both conduits shall be attached to the fire test set-up at approximately the same position and the temperatures recorded.

f. The temperature data shall be compared to determine the possible effect of less than a 30 day curing time.

4.3 DOCUMENTATION

All records generated as a result of this specification shall be included in the appropriate Quality Assurance Records File and SSES Records Management System File.

5.0 TESTING AND INSPECTION

This section is not applicable for this Specification

6.0 PREPARATION FOR DELIVERY

This section is not applicable for this Specification

7.0 QUALITY ASSURANCE PROGRAM REQUIREMENTS

7.1 INTERNAL USE

For PP&L internal use of this Specification, the Quality Assurance Program Requirements shall be as required by the Scope of Operational Policy Statement-1.

7.2 EXTERNAL USE

For use external to PP&L, the Quality Assurance Program Requirements shall be as required in the purchase documents or contracts and specifications for the materials/services.

7.3 SOUTHWEST RESEARCH INSTITUTE QUALITY

The Southwest Research Institute Quality Program, which has been approved by PP&L, shall apply to all activities conducted at the test facility to include:

a) The tests be shall performed per the procedures indicated. All instruments and devices shall be calibrated in accordance with SRI QA program requirements. Records of calibration shall be maintained by SRI and shall identify the calibration standards use. The personnel performing the tests shall be qualified in accordance with SRI QA program requirements.

b) Testing shall be performed under SRI QA program which meets 10CFR50 Appendix B. Access to witness testing shall be provided for PP&L personnel and any representatives of organizations designated by PP&L.

c) SRI Quality Control shall perform the necessary Quality Control for the installation of the TSI protective envelope according to Bechtel's "Special Detailed instructions for Installation of thermo-lag 330-1" [Appendix D] and PP&l Specification F1000.

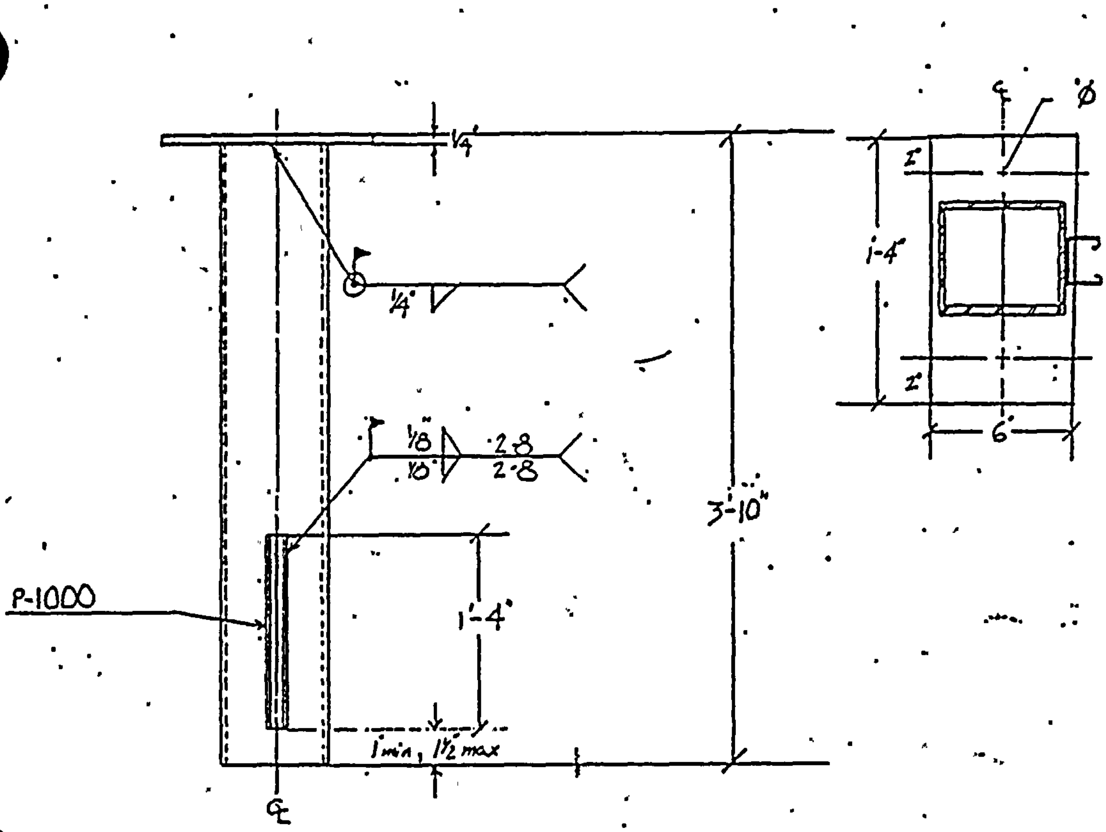


Figure 4.1

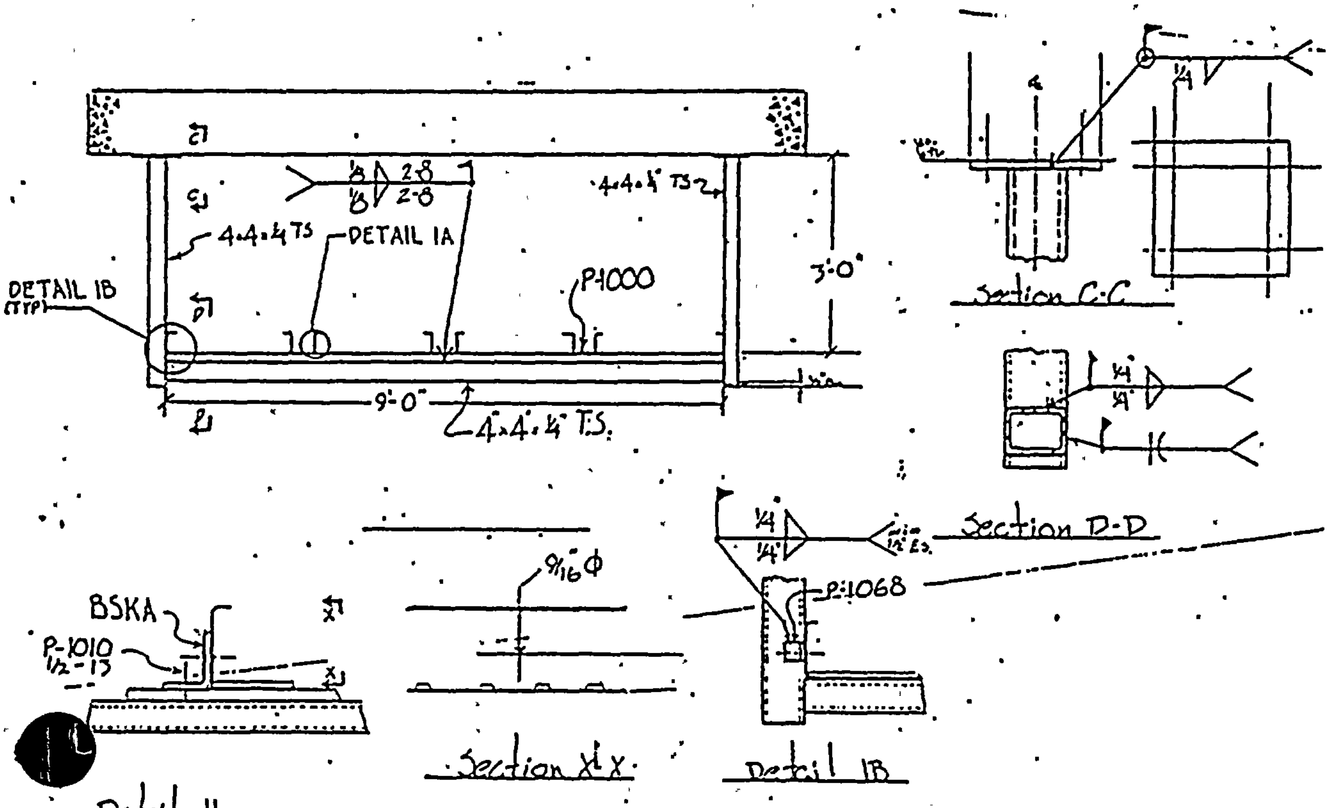


Figure 4.2

TEST PROCEDURE TO QUALIFY A PROTECTIVE ENVELOPE SYSTEM

TEXAS UTILITIES SERVICES, INC.				
COMANCHE PEAK STEAM ELECTRIC STATION GLEN ROSE, TEXAS				
TEST PROCEDURE TO QUALIFY A PROTECTIVE ENVELOPE SYSTEM FOR CPSES				
REV. 0	DATE 9-9-81	PREP. KNK	CHKD [illegible]	APP'D [illegible]

TABLE OF CONTENTS

1.0 SCOPE

This procedure prescribes the methods and guidelines to be utilized for the preparation of test specimens, installation of protective envelope systems, performance of the One Hour Fire Test and documentation of Test Results.

2.0 TEST OBJECTIVE

The objective of this test is to qualify a protective envelope system for redundant essential cables at the Comanche Peak Steam Electric Station. It will provide documented evidence that the envelope will satisfactorily withstand an ASTME-119-(80) fire exposure and provide a one hour effective barrier per American Nuclear Insurers acceptance rating by maintaining circuit integrity, and continuity. This test satisfies the requirements for fire testing the cable raceway fire barriers as detailed in Technical Specification 2323-MS-38H.

3.0 ACCEPTANCE CRITERIA

3.1 Acceptance will be based on American Nuclear Insurer's criteria for successful passage of the ASTM-E-119-(80) Fire and Hose Stream Test as outlined in Section 8.0 of this procedure.

3.2 Criteria for successful passage of these tests are defined by Reference 4.3.2.

4.0 REFERENCES

4.1 DRAWINGS

4.1.1 American Nuclear Insurers Bulletin #5 (79)
Suggested Test Layout Drawing

4.1.2 Gibbs & Hill Drawing 2323-E1-1701

4.1.3 Pictorial Drawing of Cable Tray #SK-012979-0

4.1.4 Pictorial Drawing of 90° Cable Tray Riser #GF-0691-R-CP

4.2 VENDOR MANUALS

4.3 DOCUMENTS

4.3.1 Federal Register/Volume 45, No. 225/Wednesday, November 19, 1980. Fire Protection Program for Operating Nuclear Power Plants 10CFR Part 50, Appendix R.

4.3.2 ANI Bulletin #5 (79) July 1979, ANI/MAERP STANDARD Fire Endurance Test Method to Qualify a Protective Envelope for Class 1E Electrical Circuits.

4.3.3 ASTM-E-119-80 Standard Methods of Fire Tests of Building Construction and Materials.

4.3.4 Appendix A to BTP-9.5-1, NRC Supplemental Guidance-Nuclear Plant Fire Protection Functional Responsibilities, Administrative Controls and Quality Assurance.

4.3.5 Texas Utilities Generating Company Quality Assurance Plan.

4.3.6 TSI, Inc. Nuclear Quality Assurance program manual and Quality Control operating procedures manual.

4.3.7 Standards and Practices for Instrumentation; 5th Edition, 1977.

4.3.8 Construction Procedure for Cable Installation; Brown & Root #35-1195-331-7.

4.3.9 Construction Procedure for Installation of "Hilti" Drilled in Bolts; Brown & Root #35-1195-CEI-20.

4.3.10 Construction Procedure for Cable Tray and Hanger Fabrication and Installation; Brown & Root #35-1195-ECP-10.

4.3.11 Construction Procedure for Exposed Conduit and Conduit Hanger Fabrication and Installation; Brown & Root #35-1195-ECP-10.

4.3.12 Gibbs & Hill Specification 2323-ES-100; Electrical Erection Specification.

4.3.13 Gibbs & Hill Specification 2323-ES-19; Cable Tray Specification.

4.3.14 Unistrut - General Engineering Catalog - No. 9; @ 1980.

4.3.15 Steel Construction Manual (AISC) 8th Edition.

5.0 <u>RESPONSIBILITIES</u>

5.1 COMANCHE PEAK PROJECT ENGINEERING STAFF

5.1.1 Establish the criteria, guidelines, drawings, recommendations, etc. to govern the installation of the test specimen and application of the protective envelope.

5.1.2 Approve the specific application procedures.

5.1.3 Provide materials representative of site installations per the bill of materials, Appendix 1.

5.2 VENDOR

5.2.1 Provide envelope system materials and application equipment, and specific application procedures.

5.2.2 Provide scheduling of personnel, equipment and material necessary to perform the application of envelope system utilizing the appropriate procedu[res]

5.2.3 Coordinate all phases of the Fire Test preparation with the testing organization.

5.3 APPLICATOR

5.3.1 Apply protective envelope system on test assemblies and their supports per approved vendor procedures.

5.4 TESTING ORGANIZATION

5.4.1 Prepare the test slab in accordance with approved drawings and applicable procedures.

5.4.2 Conduct the fire test in accordance with references 4.3.2 and 4.3.3.

5.4.3 Document the test parameters and results.

5.5 TEXAS UTILITIES GENERATING COMPANY QUALITY ASSURANCE

5.5.1 Provide assurance that the Vendor, Applicator and Testing Organization have QA/QC programs that are in accordance with the applicable QA requirements of reference 4.3.4 as prescribed in reference 4.3.5.

5.6 VENDOR QUALITY ASSURANCE/QUALITY CONTROL

5.6.1 Provide documentation to assure compliance with the applicable requirements of reference 4.3.4 for the manufacture of the product.

5.6.2 Will assure necessary inspection points are included in the application procedure.

5.6.3 Maintain material quality and application inspection documentation of the envelope installation in accordance with the applicable QA requirements of reference 4.3.4, and verify that approved procedures are utilized in the application of the envelope system.

5.6.4 Perform as a liason with the testing organization and provide the testing organization with all applicable procedures, documentation of applicable acceptances and any other necessary items.

5.7 APPLICATOR QUALITY ASSURANCE/QUALITY CONTROL

5.7.1 The applicator shall operate within the quality assurance and quality control programs of the vendor.

5.8 TESTING ORGANIZATION QUALITY ASSURANCE/QUALITY CONTROL

5.8.1 Inspect and document the construction of the test specimen.

5.8.2 Assure the test monitoring instrumentation is properly calibrated.

6.0 <u>SPECIAL PRECAUTIONS</u>

6.1 PRECAUTIONS FOR APPLICATION OF PRODUCTS

While spraying products, avoid repeated inhalation due to potential

of lung injuries from components of coatings. Avoid prolonged contact of products with skin. Do not take products internally. Observe special precuations as recommended by product manufacturer.

6.2 PRECAUTIONS FOR CONDUCT OF FIRE TEST

Fire Endurance tests, as outlined in Section 8.1, have potential for producing smoke, combustion products, fumes and toxic vapors. Proper safety precaution shall be exercised to preclude personnel hazard from breathing the above.

7.0 PRE-REQUISITES

7.1 GENERAL TEST CONFIGURATION REQUIREMENTS

Cable tray, conduit, and instrument sensing line construction, support, installation and loading shall be representative of the configurations installed at the Comanche Peak Steam Electric Station, where applicable. Deviations from representative configurations and procedures shall be approved by Comanche Peak Project Engineering.

7.2 TRACIBILITY REQUIREMENTS

To insure that the materials used in this test are representative of those used in the plant, the materials leaving the site shall be marked with a material identification tag. Prior to shipping the test materials to the testing laboratory, they shall be tagged, and logged for tracibility purposes.

7.3 TEST CONFIGURATION

7.3.1 GENERAL

All test assemblies shall be sufficiently secured to the top of the test slab by the testing laboratory.

7.3.2 CABLE TRAY TEST ASSEMBLIES

Two types of cable trays shall be utilized in the test assembly.

(a) Solid bottom

(b) Ladder bottom

One typical cable tray support shall be installed in each cable tray test assembly. Refer to drawings FDSG-02, and FDSG-03 contained in Appendix 2 (Support Installation), for support type and locations. Supports shall be installed in accordance with Appendix 2.

Cable tray test assemblies shall be fabricated and installed in accordance with Appendix 3. Refer to drawings FDSG-08 and FDSG-09, contained in Appendix 3, for details of fabrication and installation.

7.3.3 CONDUIT TEST ASSEMBLY

One five (5) inch conduit shall be used in the test assembly.

The typical conduit support shall be installed in the test assembly. Refer to drawing FDSG-02 and FDSG-04, contained in Appendix 2, showing support type and location.

The conduit test configuration shall be assembled and installed in accordance with Appendix 3. Refer to drawings FDSG-010 and FDSG-011, contained in Appendix 3 for details.

7.3.4 AIR DROP CABLE TEST ASSEMBLIES

Cables representative of an air drop shall be incorporated into the test assembly. Cables to be air dropped shall be identified in Table FDSG-T4, contained in Appendix 4.

These cables shall drop freely through the slab penetrations (singularly, or in groups) and into a cable tray assembly. Four different configurations shall be tested. They are defined as follows:

(1) A 5" conduit shall be sealed in the slab. This conduit shall be flush with the slab on the fire exposed side. Cables shall drop through this penetration and crossover to the adjacent tray (tray #3 - ladder bottom, 40% fill). Refer to drawing FDSG-012, contained in Appendix 3, for details of this configuration.

(2) A 5" conduit shall be sealed in the slab. This conduit shall extend down from the bottom of the slab, then bend to the horizontal plane. Cables shall drop through this penetration and into the tray (tray #1, ladder bottom, single layer fill). Refer to drawing FDSG-012, contained in Appendix 3, for details of this configuration.

(3) A 5" conduit shall be sealed in the slab. This conduit shall be flush with the slab on the fire exposed side. A single cable shall drop into the adjacent tray (tray #4 - solid bottom, single layer fill) that has been coated and cured. This arrangement simulates a repair in the coating system, or the addition of a cable to the already coated system. Refer to drawing FDSG-012, contained in Appendix 3, for details of this configuration.

(4) A 5" conduit shall be sealed in the slab. This conduit shall enter a junction box mounted on the fire exposed side of the slab. A 5" conduit shall drop out of the junction box. Cables shall drop through junction box and conduit assembly and into the tray (tray #2 - solid bottom, 40% fill). Refer to drawing FDSG-012, contained in Appendix 3, for details of this configuration.

The conduit assemblies as described above shall be installed in accordance with Appendix 3, of this procedure.

The cables shall be installed in accordance with Appendix 4 of this procedure.

7.4 CABLE LOADING REQUIREMENTS

Cable loading requirements shall be as specified in the American Nuclear Insurers Bulletin #5 (79). The distribution of cables in the cable tray and conduit test assemblies shall be as follows:

33 1/3% Power Cables
33 1/3% Instrumentation Cables
33 1/3% Control Cables

Test configurations shall be as follows:

(a) Ladder Bottom Tray
 (i) 100% Design (40% density)*
 (ii) Lightly loaded (one layer)

(b) Solid Bottom Tray
 (i) 100% Design (40% density)*
 (ii) Lightly loaded (one layer)

(c) Conduit
 (i) 40% Density*

* Tray and conduit cable densities filled by cross-sectional area.

7.5 CABLE INSTALLATION

An itemized listing of cable types and quantities to be routed in the test assemblies is provided in tables FDSG-T1, through FDSG-T4, contained in Appendix 4.

To attach cables to solid back trays, holes shall be drilled in the trays. Specifications for spacing of holes, and intervals for tying cable to the trays are contained in Appendix 4. Cables shall be installed in accordance with Appendix 4. Cable location within tray shall be documented and included with data to be evaluated by the testing laboratory.

7.6 THERMOCOUPLE INSTALLATION

Thermocouples shall be located in test assemblies in accordance with reference 4.3.2.

Refer to drawing FDSG-014, contained in Appendix 5, for locations of thermocouples in test assemblies.

7.7 COATING OF TEST ASSEMBLY

Test assemblies shall be coated with the fire retardant material in accordance with approved procedures contained in Appendix 6 (application of product). There shall be no differences in the application procedures for the test and the actual installation without prior approval.

7.8 FIRE SEAL INSTALLATION

Upon completion of the fabrication, installation and coating of the test configuration, penetrations shall be sealed with an American Nuclear Insurers approved seal.

The conduit openings, where cables drop out, shall be sealed with an American Nuclear Insurers approved seal.

As stated in reference 4.3.2, section 3.4.4.6, failure of the fire seal shall not necessarily constitute a failure of the protective envelope. The type of fire seal used shall be at the discretion of the testing laboratory.

7.9 CIRCUIT INTEGRITY MONITORING

Sufficient cables shall be energized to monitor circuit integrity. They shall be energized as required to check for a circuit failure. Circuit failure is defined as circuit to circuit (conductor to conductor short circuits); circuit to system (conductor continuity); and circuit to ground (short circuits, conductors to ground). Monitoring all of the conductors in every cable or even part of the conductors in each cable will be an impossible task, therefore selected cables in each cable tray will be instrumented for each of the three parameters.

a. Two cables in each cable tray will be connected to a short circuit detection circuit as shown in Figure FDSG-F2, contained in Appendix 4.

b. Two cables will be connected to a continuity monitoring circuit as shown in Figure FDSG-F2, contained in Appendix 4.

c. Two cables will be connected to a ground short circuit detection circuit as shown in Figure FDSG-F2, contained in Appendix 4. This is a total of six instrumented cables per cable tray.

d. In addition to the six cables per tray, each air dropped cable will be monitored for one of the three parameters. (Continuity, ground short circuit, short circuit.)

e. Two cables in the conduit will be connected to a short circuit detection circuit as shown in Figure FDSG-F2, contained in Appendix 4.

f. Two cables in the conduit will be connected to a continuity monitoring circuit as shown in Figure FDSG-F2, contained in Appendix 4.

g. Two cables in the conduit will be connected to a ground short circuit detection circuit as shown in Figure FDSG-F2, contained in Appendix 4.

Monitored cables shall be the bottom layer of cables in test assemblies, where applicable.

The monitored cables shall be scanned once each minute. Monitored cables shall be energized until the hose stream test is completed. Refer to reference 4.3.2 for acceptance criteria.

7.10 PRE-BURN INSPECTION

Prior to commencement of the fire endurance test, a thorough check of the entire test assembly and associated equipment (including data recording equipment) shall be performed and documented, by the testing laboratory. Refer to Appendix 7 of this procedure for details.

8.0 PROCEDURE

8.1 FIRE ENDURANCE TEST

8.1.1 The protective envelope shall be exposed to the standard time-temperature curve, found in ASTM-E-119 (80), for one hour.

Refer to Appendix 8, contained in this procedure, for detailed test instructions.

8.1.2 The third party testing organization shall strive to adapt their testing procedures to assure the fire test shall comply with the requirements established in reference 4.3.2 standards. Any changes, revisions or deviations required to comply with this requirement shall be documented and properly justified and included as a part of the final test report.

8.1.3 Acceptance criteria are contained in reference 4.3.2.

8.2 HOSE STREAM TEST

8.2.1 Immediately following the fire endurance test, accessible surfaces of the protective envelope shall be subjected to the American Nuclear Insurers preferred Hose Stream Test, as specified in reference 4.3.2. The Hose Stream shall be applied for a minimum of two and one-half (2½) minutes, without de-energizing the circuit. Proper safety precautions shall be exercised.

8.2.2 Refer to Appendix 9, contained in the procedure, for detailed test instructions.

8.2.3 Acceptance criteria are contained in Reference 4.3.2.

9.0 DATA SYSTEM

9.1 During the fire exposed period, the thermocouples will be scanned at the rate of twenty channels per second, at one-minute intervals.

9.2 The monitored cables shall be scanned once each minute. Monitored cables shall be energized until the Hose Stream Test is completed.

10.0 QUALITY CONTROL DOCUMENTATION

10.1 The Vendor/Applicator's Quality Control Inspection shall verify fabrication and application and document accordingly to assure concurrence with drawings, the Bill of Materials, and the appropriate application procedures.

11.0 FIRE TEST REPORT

11.1 Testing laboratory will submit report on results of test and thermocouple data sheets to CPPE.

11.2 The testing laboratory will assemble the laboratory report, data and required QC documentation into a final report for submittal to CPPE.

11.3 The test report shall be prepared in sufficient detail to summarize the total test activity. The report shall identify the date, location, procedure, and personnel performing, witnessing, or supervising the activity. The inclusion of actual test data is not mandatory, however, the location of such data should be designated for future reference as required. Test results should state the testing activity was performed in compliance with the test requirements and that the documentation is complete and accurate. Measures shall be taken to assure permanent retention of the test report such as transmittal to ARMS.

APPENDIX 1

BILL OF MATERIALS

APPENDIX 1

BILL OF MATERIALS

ITEM	QUANTITY	DESCRIPTION	MAT'L SPEC
A.	4	18" width x 4" depth x 65" length Solid Bottom Cable Tray	ES-19
B.	4	18" width x 4" high 90^o inside Riser El. 12" Rad., Solid Bottom Cable Tray	ES-19
C.	4	18" width x 4" depth x 65" length Ladder Bottom Cable Tray	ES-19
D.	4	18" width x 4" high x 90^o inside Riser El. 12" Rad., Ladder Bottom Cable Tray	ES-19
E.	2	18" width x 4" depth x 40" length Solid Bottom Cable Tray (Middly Section)	ES-19
F.	2	18" width x 4" depth x 34" length Ladder Bottom Cable Tray (Middle Section)	ES-19
G.	1	5" Ø Rigid Steel Conduit x 29½" length (threaded on both ends)	ES-23A
H.	1	5" Ø Rigid Steel Conduit x 58" length (threaded on both ends)	ES-23A
I.	2	5" Ø Rigid Steel Conduit x 50 3/4" length (threaded on both ends)	ES-23A
J.	3	5" Ø Rigid Steel Conduit El. 24" Rad. (threaded on both ends)	ES-23A
K.	1	5" Ø Rigid Steel Conduit x 38 3/4" length (threaded on both ends)	ES-23A
L.	5	5" Ø Rigid Steel Conduit Couplings	ES-23A
M.	2	5" Ø Rigid Steel Conduit x 24" length (threaded on both ends)	ES-23A
N.	2	Carbon Steel Plate 3/8" x 3" x 3" Lg.	ASTM A36
O.	2	C6 x 8.2 x 44" Lg. (channel)	ASTM A36
P.	1	C6 x 13 x 108" Lg. (channel)	ASTM A36
Q.	2	L6 x 6 3/4 x 1'-6" Lg. (angle)	ASTM A36
R.	6	1" Ø x 12" Lg. Bolts (Hilti Kwik)	
S.	1	Conduit Clamp (Unistrut - P2558-50)	
T.	1	Carbon Steel Plate ½" x 6" x 6" Lg.	ASTM A36

APPENDIX 1

BILL OF MATERIALS

ITEM	QUANTITY	DESCRIPTION	MAT'L SPEC
U.	1	C4 x 7.25 x 3'-8" Lg. (channel)	ASTM A36
V.	2	½" x 2 1/8" x 6" Lg. Filler Plate, Carbon Steel	ASTM A36
W.	6	Carbon Steel Plate 3/16" x 2" x 4" Lg.	ASTM A36
X.	6	5/8" Ø Bolts x 2½" Lg. w/nut & std. Hardened Washer	A-325
Y.	12	½" Ø RD. HD. Bolts w/Hex. nut & std. washer x 2" Lg.	A-325
Z.	6	Bevel Washers for 5/8" Ø Bolts Carbon Steel	A-325
A.A.	1	Junction Box 24" x 10" x 10", Nema Four w/mounting lugs	ES-23A
B.B.	2	Channel Combinations 28" Long (Unistrut-P1001)	
C.C.	6	3/8" Ø x 1" Lg. Bolts (Unistrut)	
D.D.	4	3/8" Ø x 5" Lg. Bolts (Hilti Kwik)	
E.E.	2	½" Ø x 1½ Lg. Hex HD. Bolts w/Hex nut & Bevel Washers	A-325
F.F.	1	5" Ø Rigid Steel Conduit x 8" Length (threaded on both ends)	ES-23A
G.G.	256	3/8" - 16 x 34" Lg. Spline Bolt w/Oval Type Phillips Slotted Heads w/Nuts and Locking Devices	A-307
H.H.	As Required	Cables (Refer to following page for itemized listing) IEEE-383 qualfied	ES-13
I.I.	As Required	Cable Ties	
J.J.	32	Splice Plates	ES-19
K.K.	6	L 3½" x 2½" x 5/16" x 4" Long	ASTM A36
L.L.	1	Carbon Steel Plate ½" x 6" x 1'-4"	ASTM A36

APPENDIX 1

BILL OF MATERIALS

TOTAL CABLES REQUIRED

CABLE FUNCTION	CABLE TYPE	CABLE SIZE	QUANTITY	LENGTH
Power	W-008	1/C 750 MCM	3	20 Ft.
Power	W-709	1/C 500 MCM	1	20 Ft.
Power	W-710	1/C 350 MCM	4	20 Ft.
Power	W-211	1/C 4/0 AWG	2	20 Ft.
Power	W-012	4/0 Triplex	2	20 Ft.
Power	W-713	2/0 Triplex	2	20 Ft.
Power	W-715	# 2 Triplex	2	20 Ft.
Power	W-116	2/C # 2 AWG	4	20 Ft.
Power	W-017	3/C # 4 AWG	2	20 Ft.
Power	W-220	3/C # 6 AWG	2	20 Ft.
Power	W-221	2/C # 6 AWG	2	20 Ft.
Power	W-123	3/C # 8 AWG	4	20 Ft.
Power	W-124	2/C # 8 AWG	3	20 Ft.
Control	W-141	4/C #10 AWG	8	20 Ft.
Control	W-045	12/C#12 AWG	15	20 Ft.
Control	W-046	9/C #12 AWG	12	20 Ft.
Control	W-047	7/C #12 AWG	13	20 Ft.
Control	W-048	5/C #12 AWG	13	20 Ft.
Control	W-850	3/C #12 AWG	14	20 Ft.
Instrumentation	W-061	12 Shielded twisted pairs # 16 AWG	4	20 Ft.
Instrumentation	W-062	6 Shielded twisted pairs #16 AWG	2	20 Ft.
Instrumentation	W-263	4 Shielded twisted pairs #16 AWG	5	20 Ft.
Instrumentation	W-264	2 Shielded twisted pairs #16 AWG	4	20 Ft.
Instrumentation	W-069	22/C#16 AWG with overall shield	4	20 Ft.
Instrumentation	W-071	5/C #16 AWG with overall shield	2	20 Ft.
Instrumentation	W-076	6 Twisted pair #16; 1 twisted pair #14; 2 # 16 drain wire	4	20 Ft.
Instrumentation	W-081	7 Shielded triads	6	20 Ft.
Instrumentation	W-372	1TQ #16 Shield	3	20 Ft.
Instrumentation	W-058	RG-11U Triaxial	3	20 Ft.
Instrumentation	W-067	48/C #16 Shield	3	20 Ft.

Note: All vendors supplying IEEE 383 qualified cables shall be represented in the fire test.

APPENDIX 2

SUPPORT INSTALLATION

APPENDIX 2

SUPPORT INSTALLATION

1.0 CABLE TRAY SUPPORTS

1) Attach cable tray supports to the underside of the slab as shown in drawings FDSG-02 and FDSG-03, contained in this Appendix.

2.0 CONDUIT SUPPORTS

1) Attach conduit support to the underside of the slab as shown in drawing FDSG-02 and FDSG-04 contained in this Appendix.

3.0 JUNCTION BOX SUPPORT

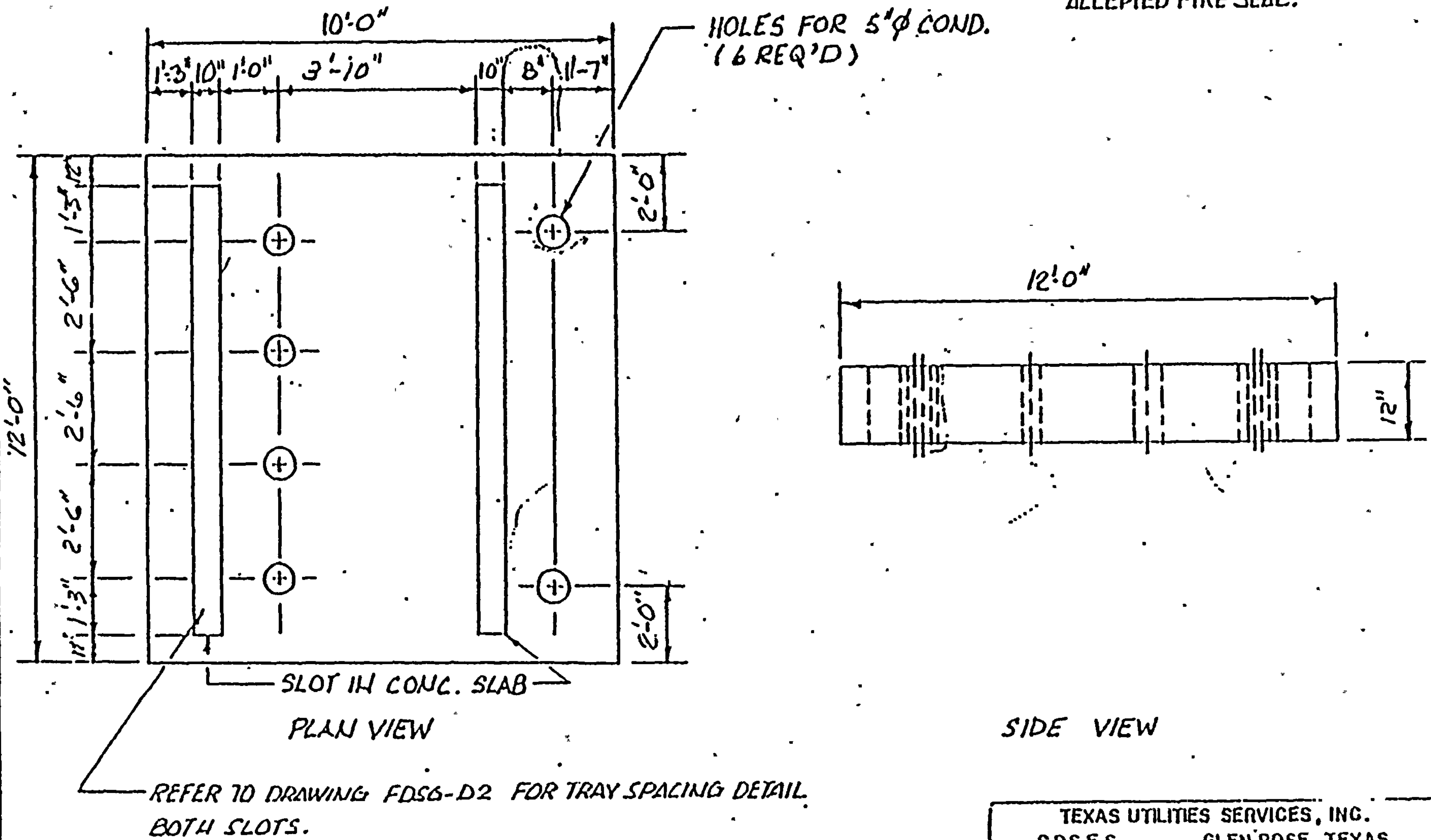
1) Attach junction box support to the underside of the slab as shown in drawing FDSG-05, contained in this Appendix.

4.0 FIRE PROTECTIVE ENVELOPE FOR ALL SUPPORT SYSTEMS

1) All cable tray supports, conduit supports, instrument sensing line supports and junction box supports shall be thermally protected with the protective envelope system.

NOTE: Procedure for installation of Hilti Bolts in Brown & Root Construction Procedure # CEI-20.

NOTE:
ALL SLAB PENETRATIONS SHALL BE SEALED WITH AN ANI ACCEPTED FIRE SEAL.



TEXAS UTILITIES SERVICES, INC.					
C.P.S.E.S. GLEN ROSE, TEXAS					
FIRE PROTECTION TEST FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS					
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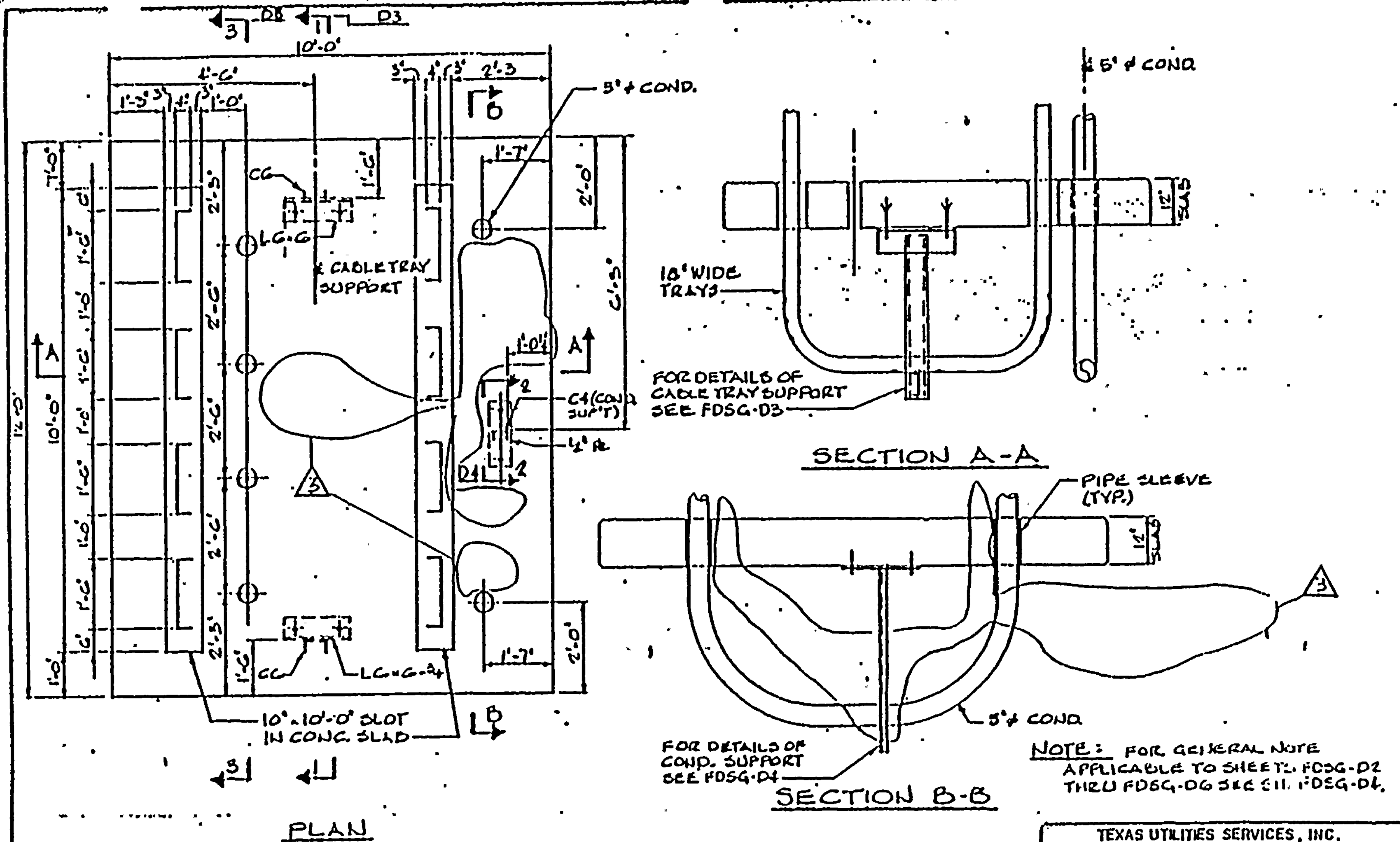
DATE: 9-11-81	DWN: RAD	CKD:	APP'D:	ISSUED FOR CONSTRUCTION	DWG NO. FDSG-D1



TEXAS UTILITIES SERVICES, INC.

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FIRE PROTECTION TEST FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS

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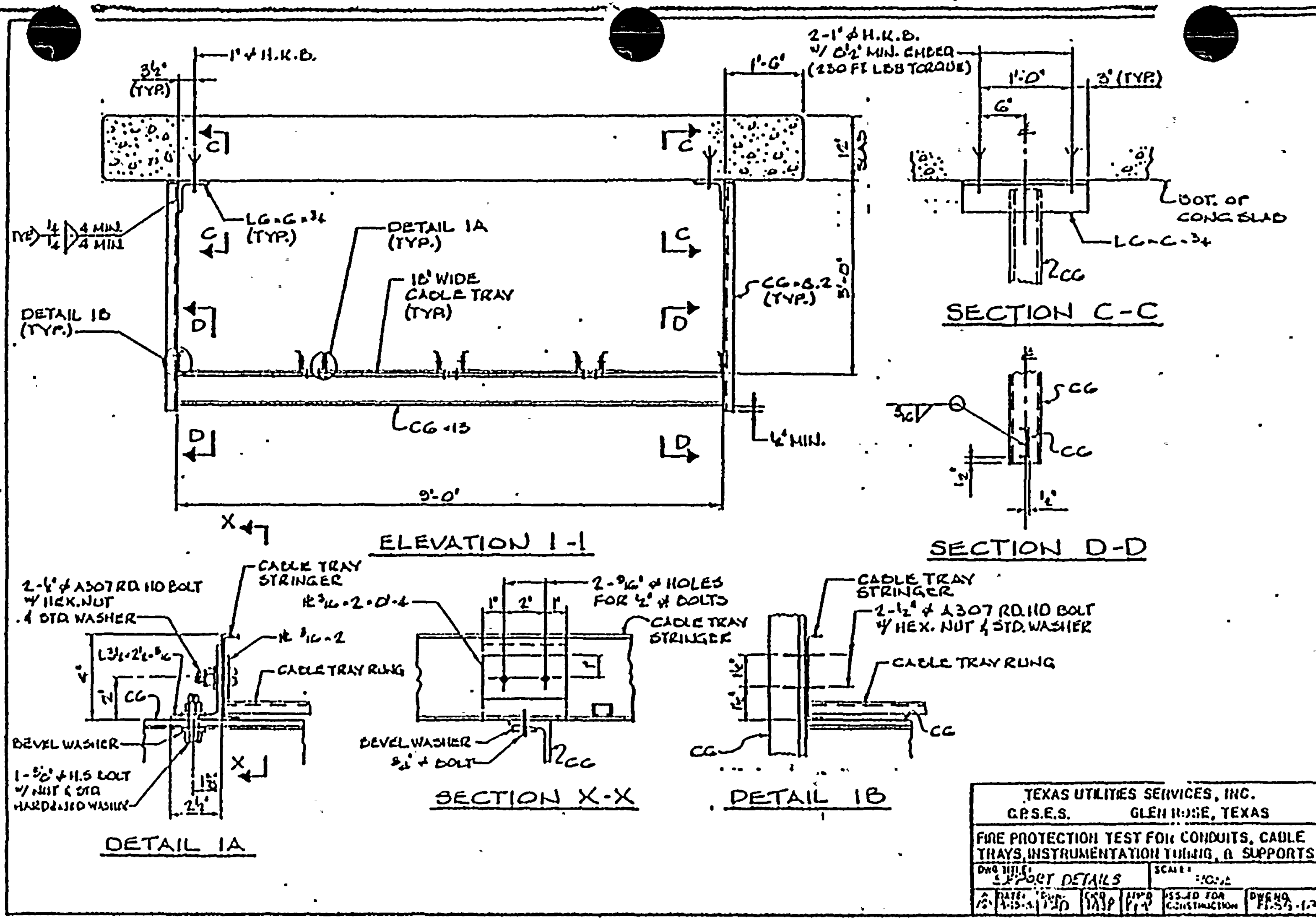
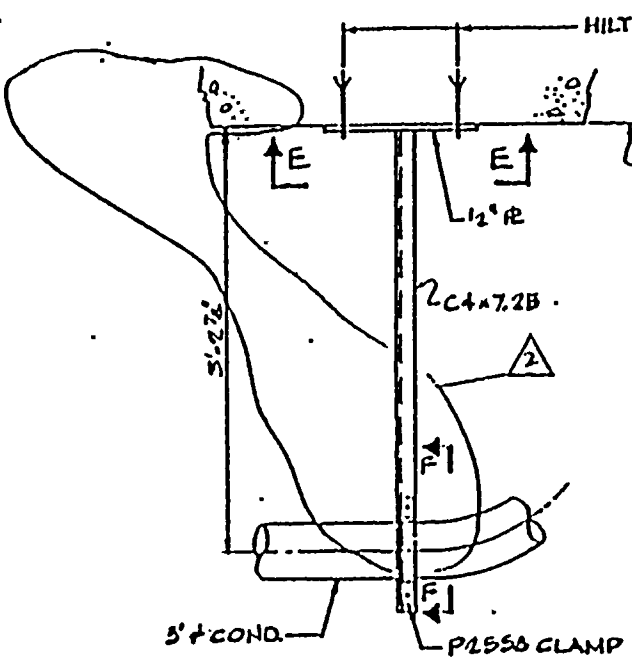
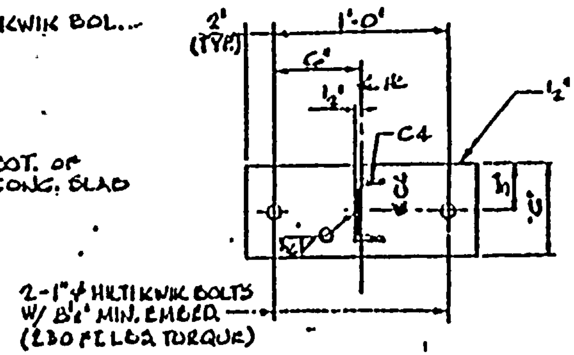

ELEVATION 1-1
SECTION C-C
SECTION D-D
SECTION X-X
DETAIL 1A
DETAIL 1B
DETAIL 1A (TYP.)
DETAIL 1B (TYP.)
18" WIDE CABLE TRAY (TYP.)
CABLE TRAY STRINGER
CABLE TRAY RUNG
BEVEL WASHER
BOT. OF CONC SLAB
9'-0"
TEXAS UTILITIES SERVICES, INC.
C.P.S.E.S. GLEN ROSE, TEXAS
FIRE PROTECTION TEST FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS
SUPPORT DETAILS

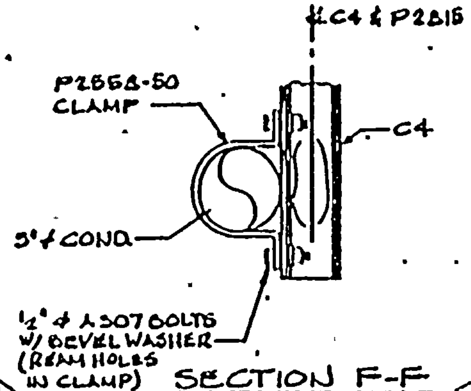
I-29



ELEVATION 2-2



SECTION E-E



SECTION F-F

2

GENERAL NOTES:

1. CABLE TRAYS ARE TO BE AS MANUFACTURED BY T.J. COPE &/OR BURNDY & HUSKY.
2. ALL STRUCTURAL STEEL MEMBERS SHALL CONFORM TO ASTM A36.
3. FOR ITEMS REFERRED TO IN THESE DRAWINGS WITH A PREFIX "P" (FOR EXAMPLE: P1001C3) SEE "UNISTRUT GENERAL CATALOG N° 9A". THESE ITEMS, AS WELL AS UNISTRUT BOLTS, SHALL BE AS MANUFACTURED BY UNISTRUT CORP, AND FURNISHED HOT DIPPED GALVANIZED. THREADED PARTS SHALL BE ELECTRO-GALVANIZED.
4. ALL WELDING SHALL CONFORM TO THE REQUIREMENTS OF THE AMERICAN WELDING SOCIETY. WELDING ELECTRODES SHALL BE ASTM A233, CLASS E70.
5. FABRIC. ` AND ERECTION OF ALL STRUCTURAL STEEL SHALL CONFORM TO THE A.I.S.C. "MANUAL OF STEEL CONSTRUCTION", SEVENTH EDITION.

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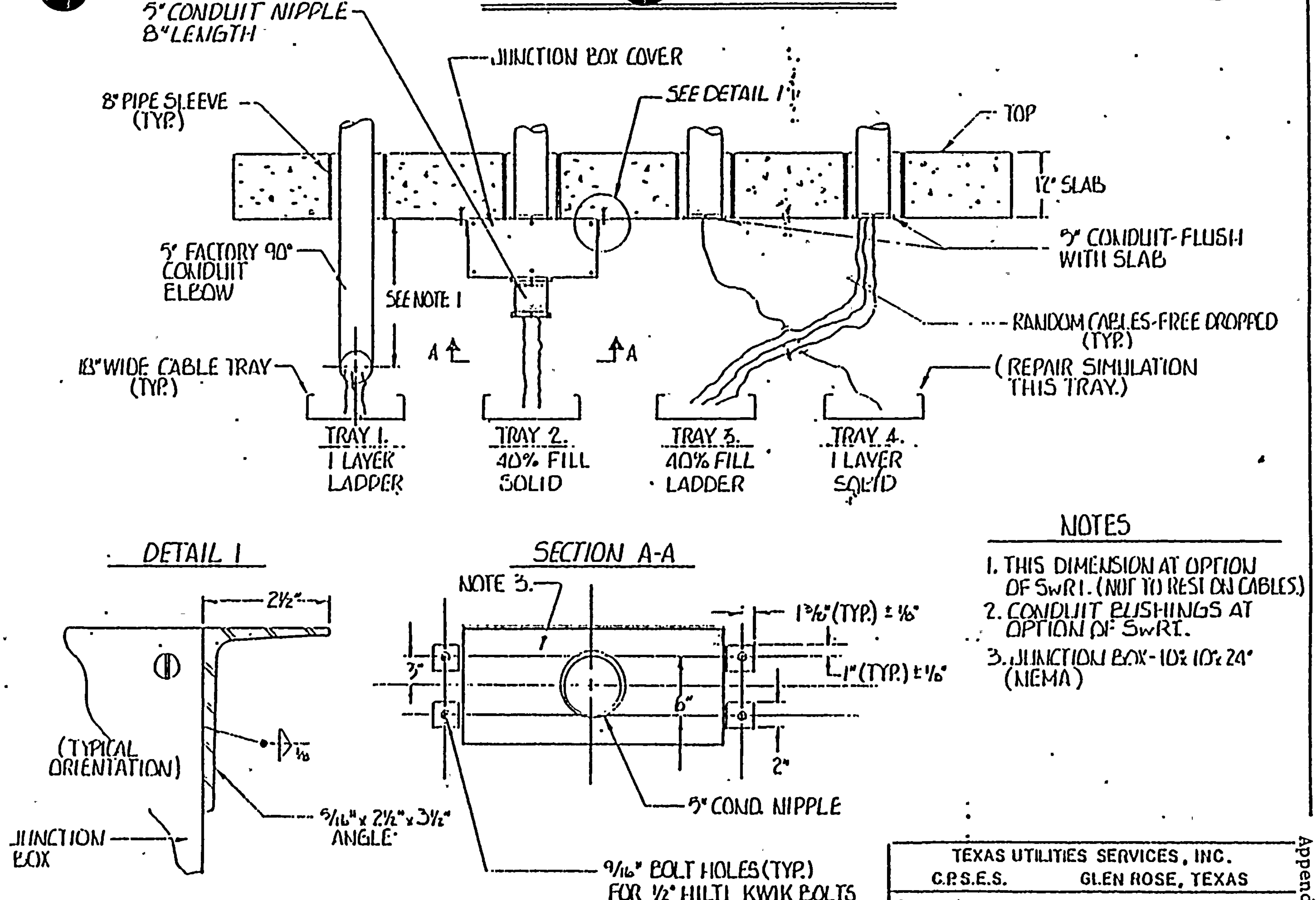
FIRE PROTECTION TEST FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS					
DWG TITLE: SUPPORT DETAILS	SCALE: NONE				
DATE: 9-3-81	DWN: KAD	CKD:	APPD:	ISSUED FOR CONSTRUCTION	DWG NO. FP-2-04

AIR DROP CAB[illegible] RACEWAY ASSEMBLY



NOTES

1. THIS DIMENSION AT OPTION OF SwRI. (NOT TO REST ON CABLES.)
2. CONDUIT BUSHINGS AT OPTION OF SwRI.
3. JUNCTION BOX - 10" x 10" x 24" (NEMA)

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FIRE PROTECTION TEST FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS

DWG TITLE: SUPPORT DETAILS				SCALE: NONE		
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Appendix A

APPENDIX 3

TEST CONFIGURATION INSTALLATION

APPENDIX 3

TEST CONFIGURATION INSTALLATION

1.0 INSTALLATION OF CABLE TRAY SEGMENTS

1) Fabricate cable tray test assemblies as shown in drawings FDSG-08 and FDSG-09 contained in this Appendix.

2) Secure assemblies with typical cable tray support as shown in drawings FDSG-02 and FDSG-03 contained in Appendix 2.

2.0 INSTALLATION OF CONDUIT

1) Fabricate conduit assembly as shown in drawings FDSG-010 and FDSG-011, contained in this Appendix.

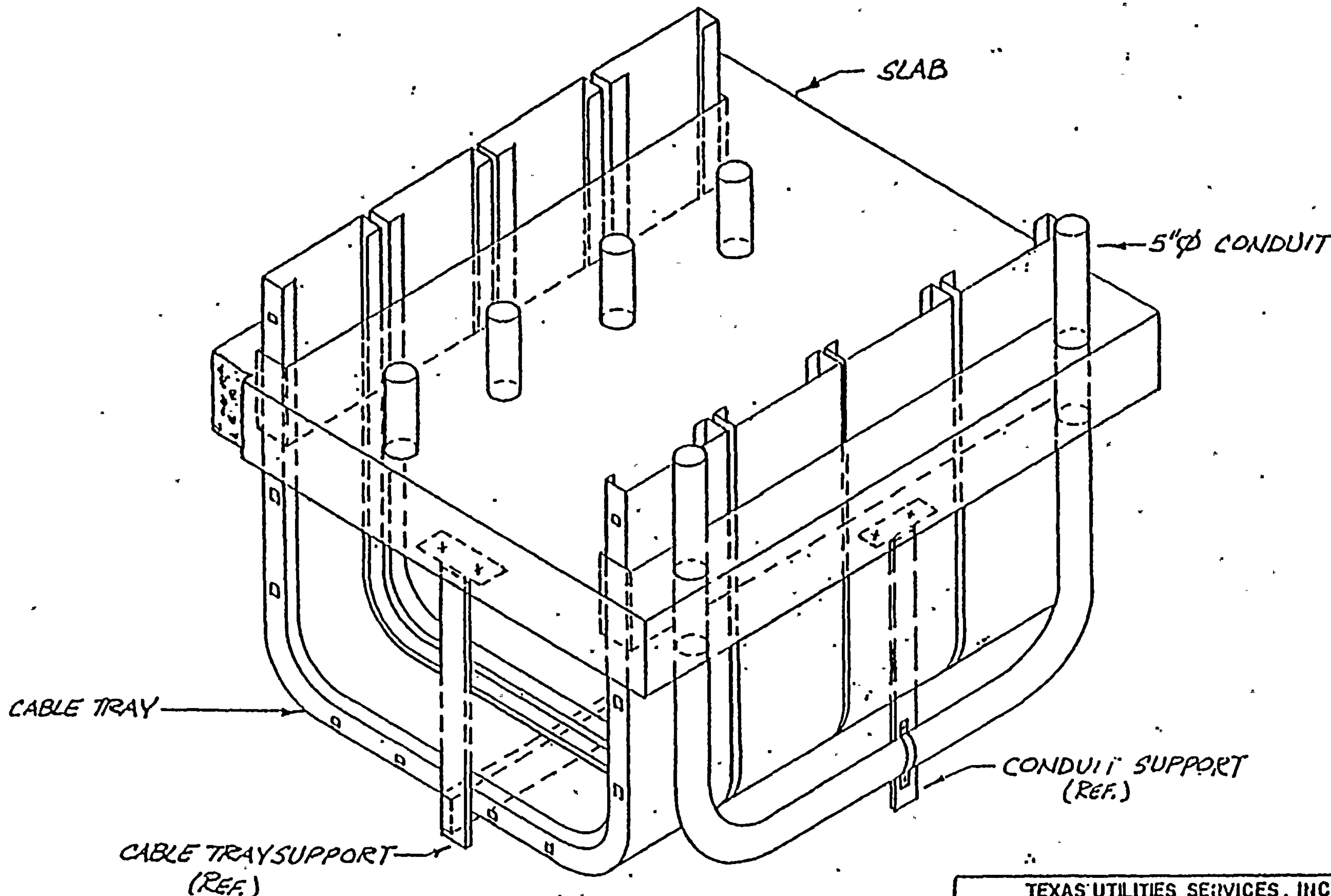
2) Secure assembly with typical conduit support as shown in drawings FDSG-02 and FDSG-04 contained in Appendix 2.

3.0 INSTALLATION OF JUNCTION BOX ASSEMBLY

1) Install junction box and conduit assembly as shown on drawing FDSG-012 contained in this Appendix.

4.0 Test assembly shall be sufficiently secured to the top of the slab. The system used for this shall be at ~~the~~ the discretion of the testing laboratory.

5.0 Upon installation of cables and thermocouples, all assemblies installed herein for test and support purposes shall have the protective envelope system applied as delineated in Appendix 6.



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FIRE PROTECTION TEST FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS

DWG TITLE: TEST ASSEMBLY					SCALE: NONE	
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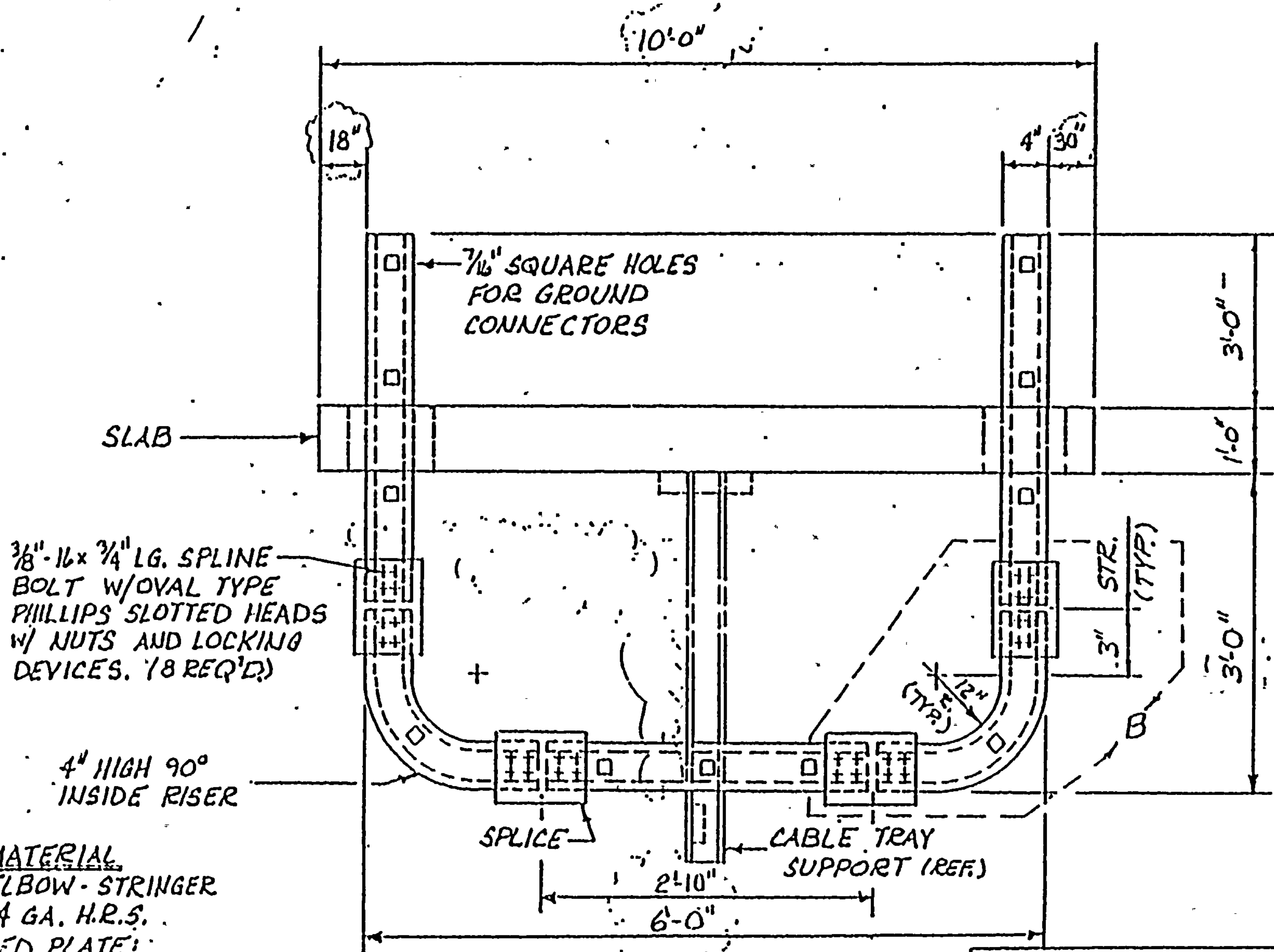
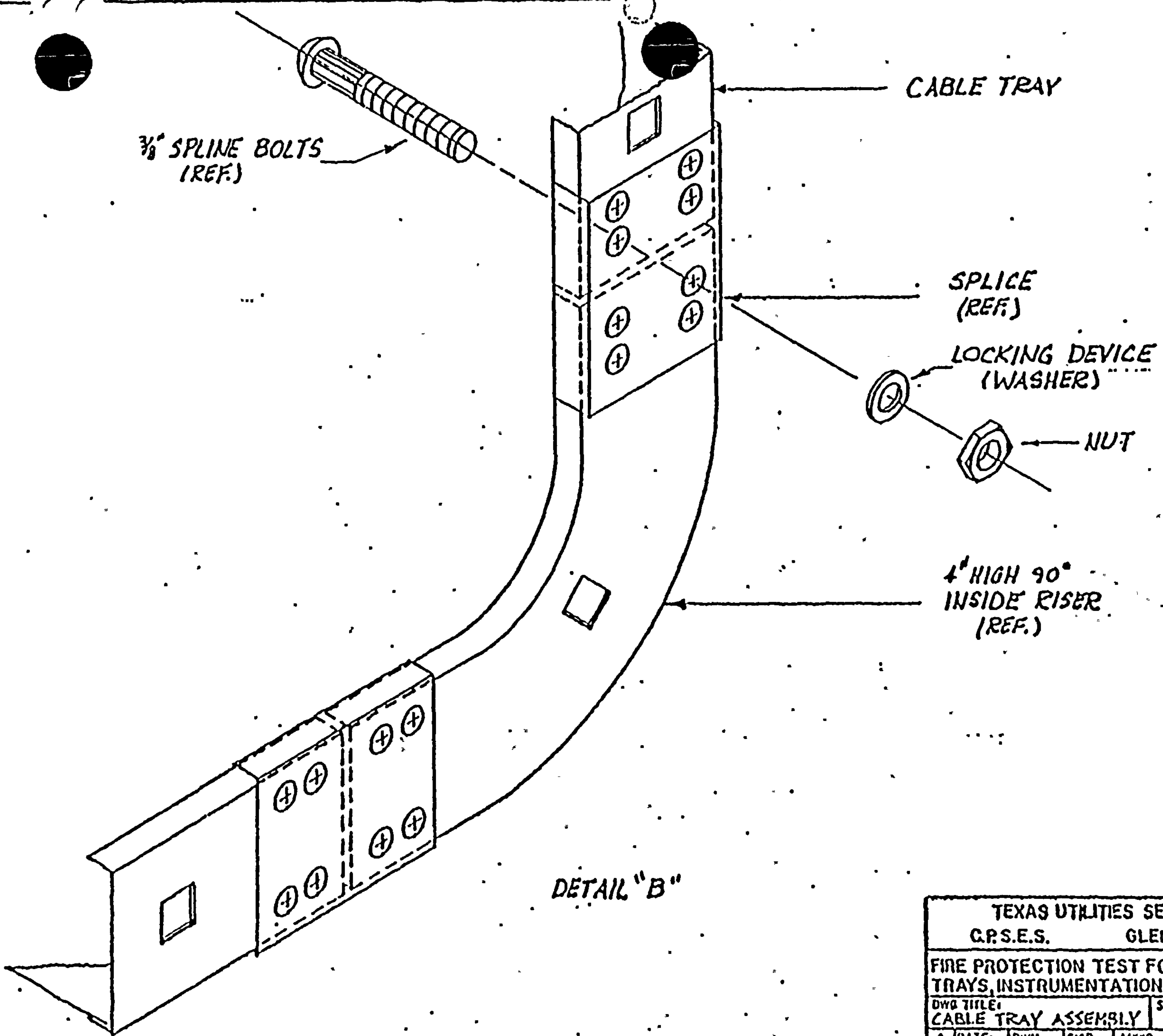


MATERIAL

ELBOW - STRINGER
#14 GA. H.R.S.
BED PLATE:
18 CR #22 GA.
STRAIGHT LENGTH:
STRINGER #16 GA. CRS.
BEDPL[illegible] #22 GA. CRS.

TEXAS UTILITIES SERVICES, INC. C.P.S.E.S. GLEN ROSE, TEXAS	
FIRE PROTECTION TEST FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS	
DWG TITLE: CABLE TRAY ASSEMBLY	SCALE: NONE
DATE: 8-25-81 · DWN: RAD · CK'D: MJP · APP'D: [illegible] · ISSUED FOR CONSTRUCTION	DWG: F1[illegible] 08



TEXAS UTILITIES SERVICES, INC.
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FIRE PROTECTION TEST FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS

DWG TITLE: CABLE TRAY ASSEMBLY
SCALE: NONE

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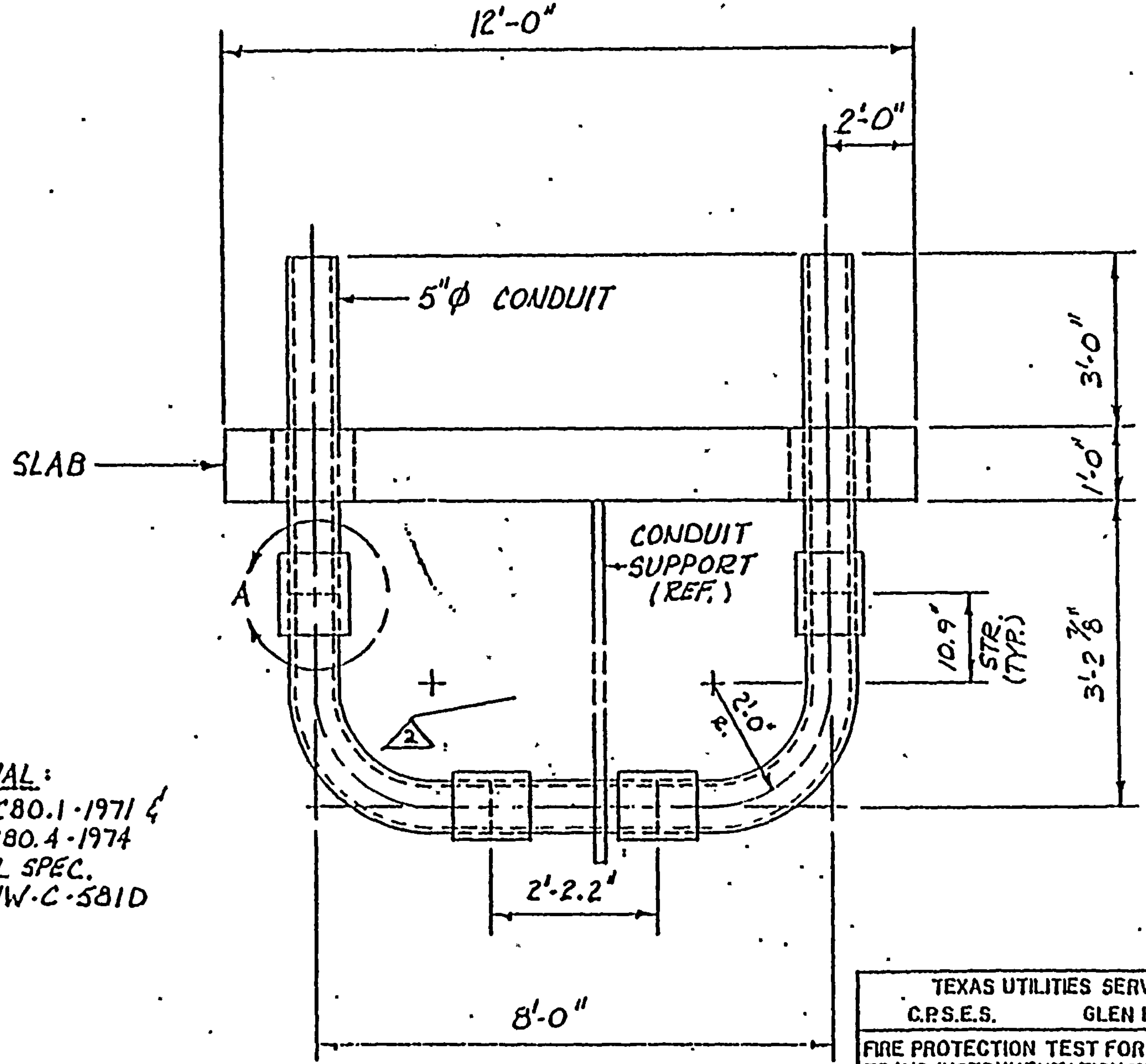
5-26-81	RAD	MJP	[illegible]	ISSUED FOR CONSTRUCTION	FDSO-D



<u>MATERIAL</u>:

1. ANSI C80.1-1971 &
 C80.4-1974
2. FEDERAL SPEC.
 WW-C-581D

TEXAS UTILITIES SERVICES, INC.					
C.P.S.E.S. GLEN ROSE, TEXAS					
FIRE PROTECTION TEST FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS					
DWG TITLE: CONDUIT+CPL'ING ASSEMB.			SCALE: NONE		
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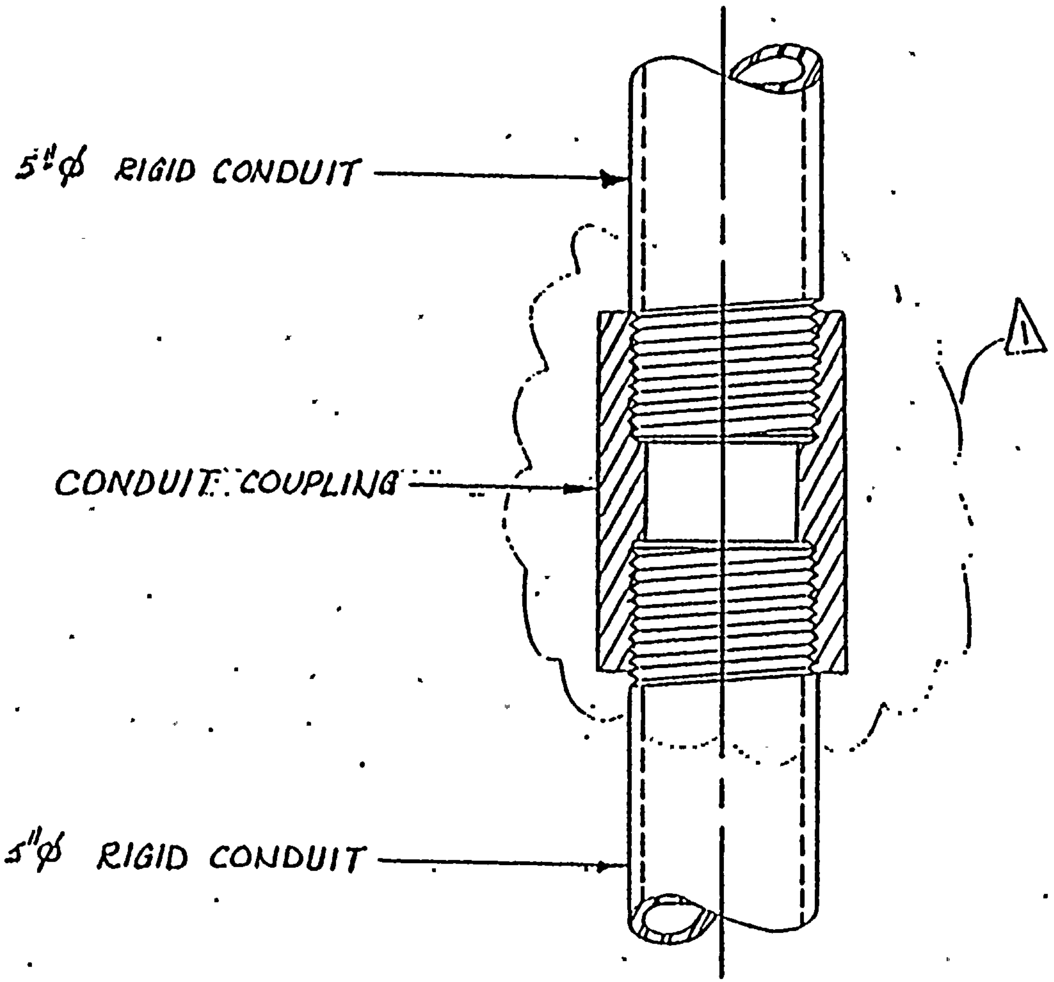


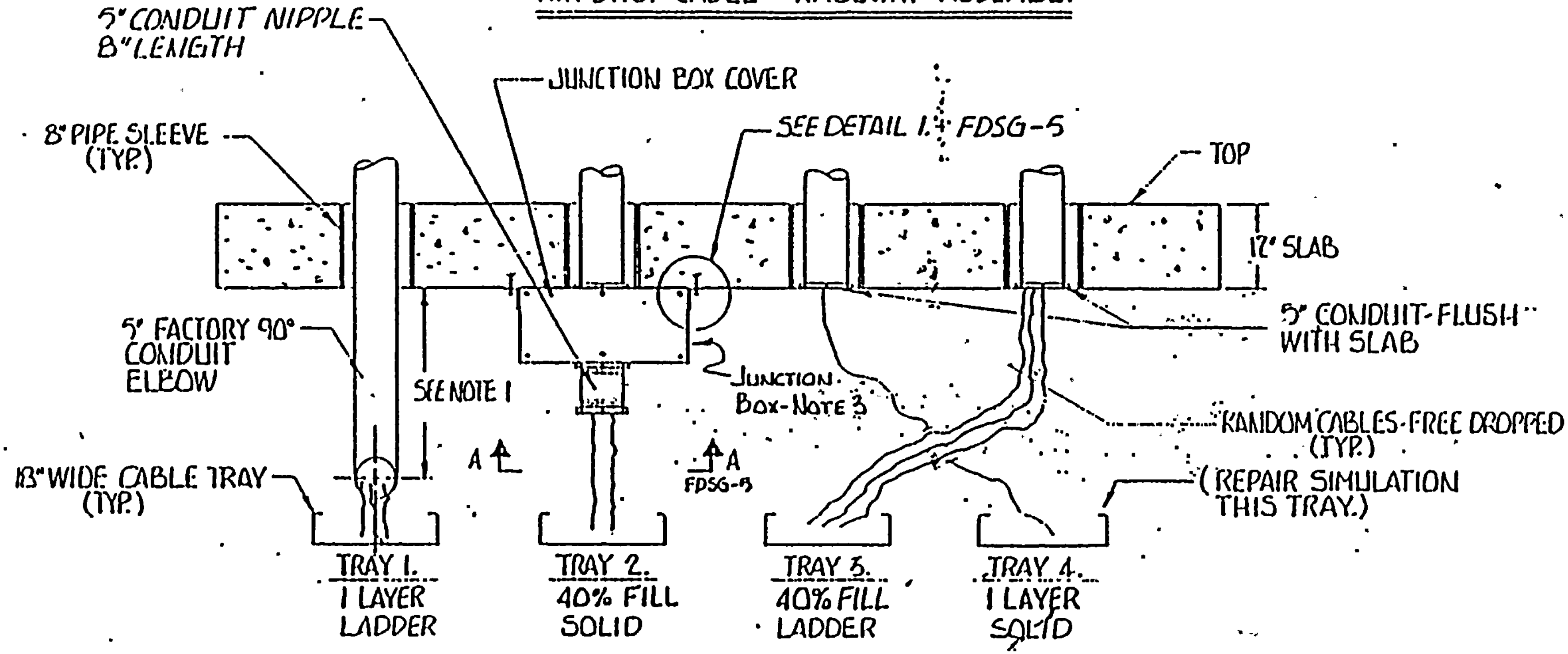
DETAIL "A"

TEXAS UTILITIES SERVICES, INC.
C.P.S.E.S. GLEN ROSE, TEXAS

FIRE PROTECTION TEST FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS

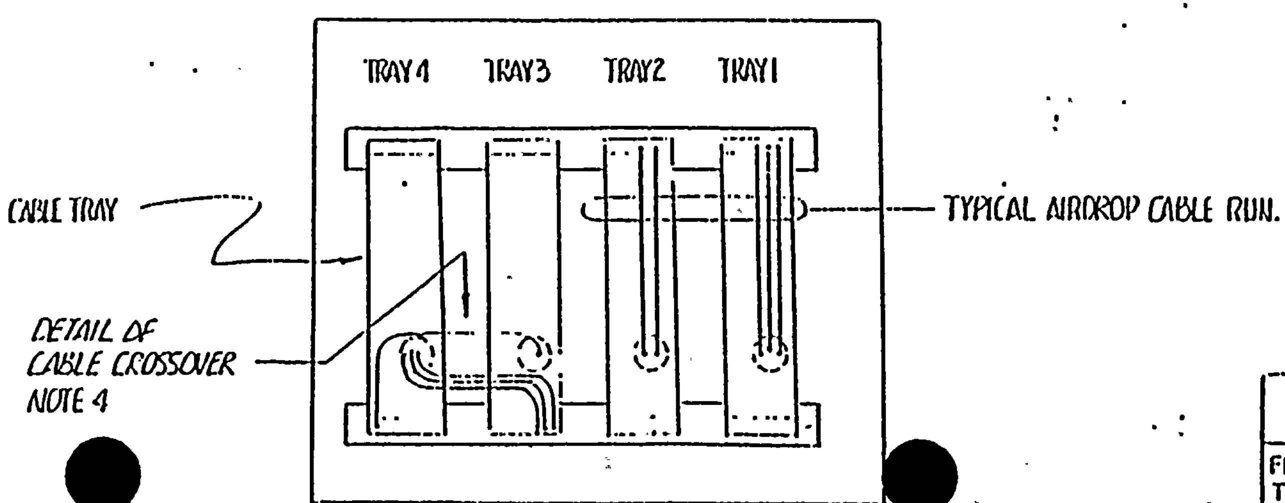
DWG TITLE: CONDUIT + CPL'G ASSEMBLY				SCALE: NONE	
DATE: 5.26.81	DWN: KAD	CKD: M.I.P	APP'D: [illegible]	ISSUED FOR CONSTRUCTION	DWG NO. FP52-D11

AIR DROP CABLE & RACEWAY ASSEMBLY



NOTES

1. THIS DIMENSION AT OPTION OF SwRI. (NOT TO REST ON CABLES.)
2. CONDUIT BUSHINGS AT OPTION OF SwRI.
3. JUNCTION BOX-10"x 10"x 24" (NEMA)
4. EXACT ROUTING OF CABLES AT OPTION OF SwRI.



UNDERSIDE VIEW OF SLAB

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Appendix A

TEXAS UTILITIES SERVICES, INC.	
C.P.S.E.S.	GLEN ROSE, TEXAS
FIRE PROTECTION TEST FOR COND CABLE TRAYS, INSTRUMENTATION TUBING UPPORTS	
DWG TITLE: AIR DROP CABLE ASSEMBLY	SCALE: NONE

APPENDIX 4

CABLE INSTALLATION

APPENDIX 4
CABLE INSTALLATION

1.0 PRECAUTIONS FOR CABLE INSTALLATION

(a) Cables shall be handled with care during installation and protected from abrasion or other damage due to pulling over rough surfaces or obstruction with sharp edges.

(b) Select proper cable type and quantity as specified in Tables FDSG-T1 thru FDSG-T4, contained in this appendix.

(c) Quality Control Personnel shall be present for cable installation.

(d) Raceway shall be free of debris, oil and sharp edges.

(e) Raceway shall be adequately supported for cable pulling activity.

1.1 CABLE INSTALLATION PROCEDURES

1) Refer to Tables FDSG-T1 through FDSG-T4 contained in this Appendix, for types and quantities of cable to be routed.

2) Drill holes in solid bottom cable tray segments to permit securing cables to tray. Drill holes subject to the following limitations:

   (a) Holes shall be ¼" diameter.
   (b) Holes shall be at a minimum spacing of 2".
   (c) Holes drilled shall be minimized.

   Drill holes at the following intervals:

   Six to eight foot intervals in horizontal trays not more than four feet in vertical trays.

3) Cables shall be tied in convenient sized bundles, randomly placed in cable trays and secured at the above specified intervals. Cable ties shall be nylon ties, representative of those used at CPSES.

4) Pull cables through conduit assembly in bundles of convenient size. Cables shall be pulled through conduit randomly.

5) Air drop cables to be tested shall be pulled through slab penetration, and enter the horizontal tray segment, as detailed on drawing FDSG-012, contained in Appendix 3.

6) Document locations of all cables within test configurations to be included with data to be evaluated by testing laboratory.

NOTE: Monitored cables shall be the bottom layer of cables in test assemblies, where applicable.

APPENDIX 4
TABLE FDSG-T1
CABLE DISTRIBUTION FOR 40% FILL OF
A CABLE TRAY (18")

CABLE FUNCTION	CABLE TYPE	CABLE SIZE	QUANTITY	LENGTH
Power	W-008	1/C 750 MCM	1	20 Ft.
Power	W-710	1/C 350 MCM	1	20 Ft.
Power	W-211	1/C 4/0 AWG	1	20 Ft.
Power	W-713	2/0 Triplex	1	20 Ft.
Power	W-715	# 2 Triplex	1	20 Ft.
Power	W-116	2/C # 2 AWG	1	20 Ft.
Power	W-017	3/C # 4 AWG	1	20 Ft.
Power	W-220	3/C # 6 AWG	1	20 Ft.
Power	W-221	2/C # 6 AWG	1	20 Ft.
Power	W-123	3/C # 8 AWG	1	20 Ft.
Power	W-124	2/C # 8 AWG	1	20 Ft.
Control	W-141	4/C #10 AWG	4	20 Ft.
Control	W-045	12/C#12 AWG	5	20 Ft.
Control	W-046	9/C #12 AWG	4	20 Ft.
Control	W-047	7/C #12 AWG	5	20 Ft.
Control	W-048	5/C #12 AWG	5	20 Ft.
Control	W-850	3/C #12 AWG	6	20 Ft.
Instrumentation	W-061	12 Shielded twisted pairs #16 AWG	2	20 Ft.
Instrumentation	W-062	6 Shielded twisted pairs #16 AWG	1	20 Ft.
Instrumentation	W-263	4 Shielded twisted pairs #16 AWG	1	20 Ft.
Instrumentation	W-264	2 Shielded twisted pairs #16 AWG	1	20 Ft.
Instrumentation	W-069	22/C#16 AWG with over-all shield	1	20 Ft.
Instrumentation	W-071	5/C #16 AWG with over-all shield	1	20 Ft.
Instrumentation	W-076	6 Twisted pair #16; 1 Twisted pair #14; 2 #16 drain wire	2	20 Ft.
Instrumentation	W-081	7 Shielded twisted triads	2	20 Ft.
Instrumentation	W-372	1TQ #16 Shield	1	20 Ft.

APPENDIX 4
TABLE FDSG-T2
CABLE DISTRIBUTION FOR A LIGHTLY LOADED
(SINGLE LAYER) CABLE TRAY (18")

CABLE FUNCTION	CABLE TYPE	CABLE SIZE	QUANTITY	LENGTH
Power	W-710	1/C 350 MCM	1	20 Ft.
Power	W-012	4/0 Triplex	1	20 Ft.
Power	W-116	2/C # 2 AWG	1	20 Ft.
Power	W-123	3/C # 8 AWG	1	20 Ft.
Control	W-045	12/C #12 AWG	1	20 Ft.
Control	W-046	9/C #12 AWG	1	20 Ft.
Control	W-047	7/C #12 AWG	1	20 Ft.
Control	W-048	5/C #12 AWG	1	20 Ft.
Control	W-850	3/C #12 AWG	1	20 Ft.
	W-372	1TQ #16 Shield		
Instrumentation	~~W-058~~	~~RG-11U Triaxial~~	1	20 Ft.
Instrumentation	W-067	48/C #16 Shield	1	20 Ft.
Instrumentation	W-263	4 Shielded twisted pairs #16 AWG	1	20 Ft.
Instrumentation	W-264	2 Shielded twisted pairs #16 AWG	1	20 Ft.
Instrumentation	W-069	22/C #16 AWG with over-all shield	1	20 Ft.
Instrumentation	W-081	7 Shielded twisted triads	1	20 Ft.

APPENDIX 4
FDSG-T3
CABLE DISTRIBUTION FOR 40% FILL OF A 5" CONDUIT

CABLE FUNCTION	CABLE TYPE	CABLE SIZE	QUANTITY	LENGTH
Power	W-008	1/C 750 MCM	1	20 Ft.
Power	W-709	1/C 500 MCM	1	20 Ft.
Power	W-124	2/C # 8 AWG	1	20 Ft.
Control	W-045	12/C #12 AWG	3	20 Ft.
Control	W-046	9/C #12 AWG	2	20 Ft.
Control	W-047	7/C #12 AWG	1	20 Ft.
Control	W-048	5/C #12 AWG	1	20 Ft.
Instrumentation	W-263	4 Shielded Twisted pairs # 16 AWG	1	20 Ft.
Instrumentation	W-058	RG-11U Triaxial	1	20 Ft.
Instrumentation	W-067	48/C #16 Shield	1	20 Ft.
Instrumentation	W-372	1TQ #16 Shield	1	20 Ft.

APPENDIX 4
TABLE FDSG-T4
CABLES TO BE AIR DROPPED*

A) CABLES TO BE AIR DROPPED INTO 40% FILL LADDER BOTTOM TRAY

CABLE FUNCTION	CABLE TYPE	CABLE SIZE	QUANTITY
Power	W-715	#2 Triplex	1
Control	W-046	9/C # 12 AWG	1

B) CABLES TO BE AIR DROPPED INTO 40% FILL SOLID BOTTOM TRAY

CABLE FUNCTION	CABLE TYPE	CABLE SIZE	QUANTITY
Power	W-123	3/C # 8 AWG	1
Control	W-045	12/C # 12 AWG	1
Instrumentation	W-061	12 Shielded twisted pairs, # 16 AWG	1

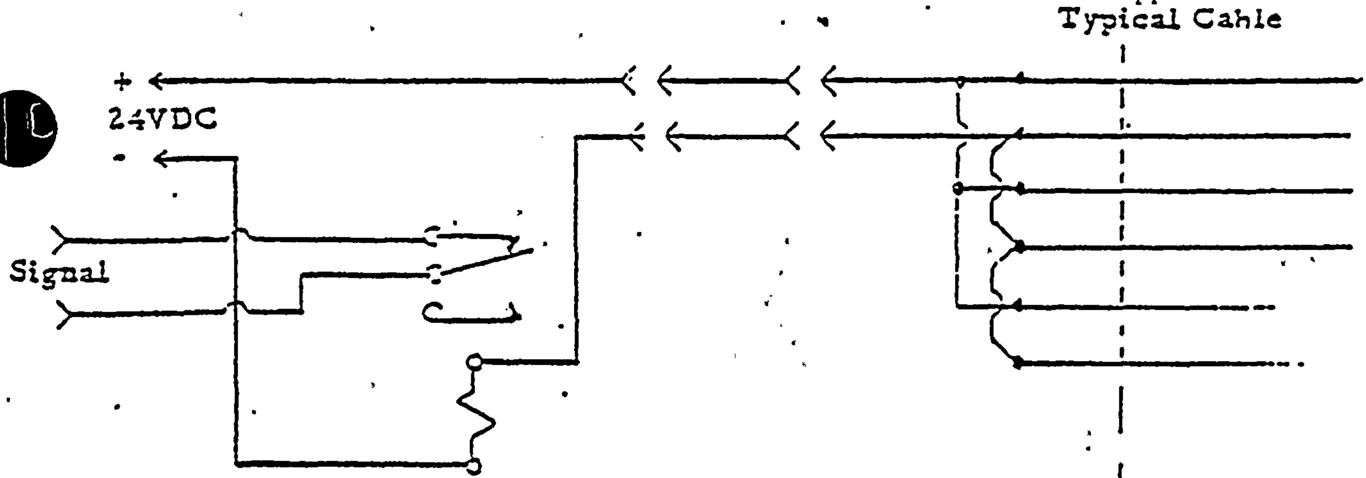
C) CABLES TO BE AIR DROPPED INTO LIGHTLY LOADED LADDER BOTTOM TRAY

CABLE FUNCTION	CABLE TYPE	CABLE SIZE	QUANTITY
Power	W-116	2/C # 2 AWG	1
Control	W-850	3/C # 12 AWG	1
Instrumentation	W-081	Shielded twisted triads	1

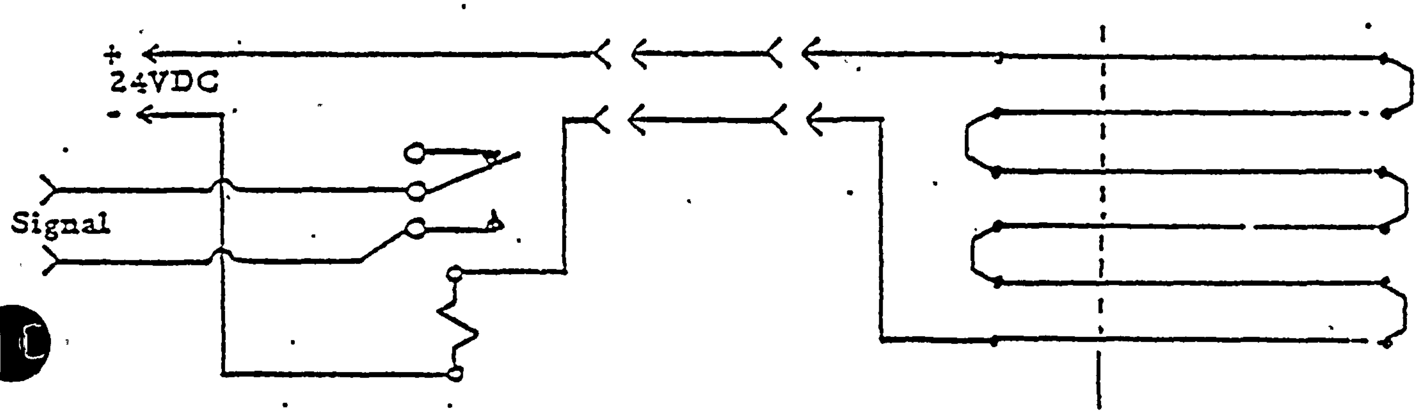
D) CABLES TO BE AIR DROPPED INTO LIGHTLY LOADED SOLID BOTTOM TRAY

CABLE FUNCTION	CABLE TYPE	CABLE SIZE	QUANTITY
Power	W-116 ~~W-123~~	2/C 12 AWG ~~3/C # 8 AWG~~	1

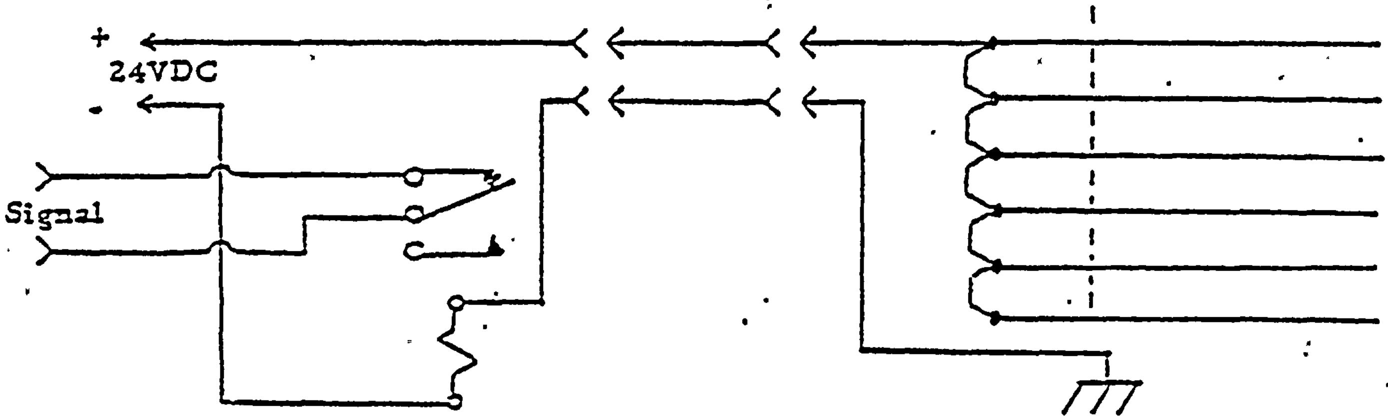
* THESE CABLES SHALL DROP THROUGH THE SLAB PENETRATION AND ENTER THE HORIZONTAL SECTION OF TRAY. THESE CABLES ARE NOT IN ADDITION TO CABLES IDENTIFIED IN TABLES FDSG-T1 and T2. THESE CABLES ARE A PART OF THE REQUIRED FILL FOR THE CABLE TRAYS.



A - Typical Circuit to Circuit Monitoring Channel



B - Typical Circuit to System Monitoring Channel



C - Typical Circuit to Ground Monitoring Channel

Figure FDSG-F2 Cable Integrity Monitoring Circuits

APPENDIX 5

THERMOCOUPLE INSTALLATION

APPENDIX 5
THERMOCOUPLE INSTALLATION

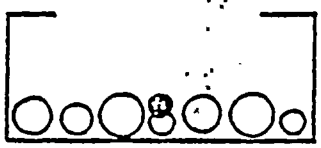
1.0 THERMOCOUPLE INSTALLATION

1.1 GENERAL

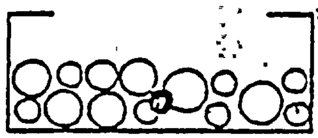
Prior to seal and coating installation, thermocouples will be embedded into the cable bundles and coatings to provide the test engineer with an identification of the conditions during the fire exposure test.

1.2 TEST ASSEMBLIES

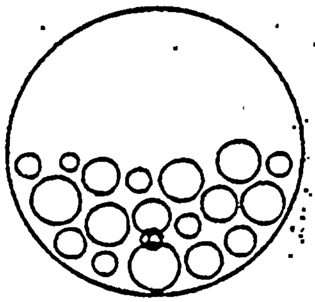
All test assemblies will contain one string of thermocouples located inside the assembly, among the cables at twelve (12) inch intervals.
Refer to drawing FDSG-014 contained in this appendix for a pictorial representation of thermocouple locations.



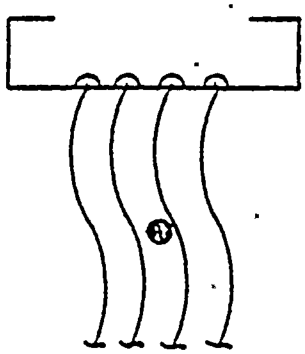
THERMOCOUPLE LOCATION
FOR LIGHTLY LOADED TRAY



THERMOCOUPLE LOCATION
FOR 40% TRAY FILL.



THERMOCOUPLE LOCATION
FOR CONDUIT



THERMOCOUPLE LOCATION
FOR FREE DROP CABLE

NOTE:
THERMOCOUPLES SHALL BE
INSTALLED AT ONE FOOT
INTERVALS.

TEXAS UTILITIES SERVICES, INC. C.P.S.E.S. GLEN ROSE, TEXAS						
FIRE PROTECTION TEST FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS						
DWG TITLE: THERMOCOUPLE LOCATIONS				SCALE: NONE		
3	DATE: [illegible]	DWN: ZSD	CKD: MJP	APP'D: [illegible]	ISSUED FOR CONSTRUCTION	DWG NO. [illegible]

APPENDIX 6
PRODUCT TECHNICAL INFORMATION
AND
PRODUCT APPLICATION AND REPAIR PROCEDURES

SECTION 1: PRODUCT DATA SHEETS

SECTION 2: ASTM-E84 TEST DOCUMENTATION

SECTION 3: PRODUCT APPLICATION AND REPAIR PROCEDURES

SECTION 1: PRODUCT DATA SHEETS

APPENDIX 6

TECHNICAL INFORMATION

THERMO-LAG STRESS SKIN TYPE 330-69 DATA SHEET

PRODUCT DESCRIPTION:

THERMO-LAG Stress Skin type 330-69 is comprised of an open weave, self stiffened steel mesh used to provide an enclosure over conduits, cable trays, and air dropped cables and provide an easily accessible refurbishment of surfaces which possess adequate characteristics to receive the THERMO-LAG 330-1 Subliming Material System.

THERMO-LAG Stress Skin Type 330-69 is inherently resistant to differential thermal expansion, thermal stress, flutter, vibration and other type of loading - potentially resultant from earthquake conditions.

PHYSICAL PROPERTIES:

THERMO-LAG Stress Skin Type 330-69 shall be comprised of an open weave, self stiffened steel mesh to meet the following characteristics:

Strand Diameter:	0.019 inches minimum
Mesh Size:	64 Holes/sq. in. minimum
Weight/Sq Yd:	1.75 pounds/Sq. Yd. minimur

Type "V" Stiffeners dimensions:

Height:	.29 $\pm$ 0.04 inches
Base:	.29 $\mp$ 0.04 inches
Distance Between:	6 $\mp$ 1 inches

CHEMICAL PROPERTIES:

THERMO-LAG Stress Skin Type 330-69 is chemically treated to provide reliable long lasting corrosion inhibiting environment.

APPENDIX 6
TECHNICAL INFORMATION

THERMO-LAG STRESS SKIN TYPE 330-69

DATA SHEET CONTINUED

BASIC USE: THERMO-LAG Stress Skin Type 330-69 shall be installed in such a manner as to provide a complete and continuous wrap over all areas to receive the THERMO-LAG 330-1 Subliming Material System, with the exception of junction boxes and structural support entities.

SURFACE PREPARATION: Prior to use, the substrate should be clean, free of loose dirt, grease and other contaminants. No special surface preparation is required.

METHOD OF APPLICATION: Best results are obtained if each individual length of each individual section does not exceed 10 feet. Each section should overlap each preceding section by at least 6 inches or fastened to the preceding and following section by a flange facsimile having a 1 inch lip, minimum. Circumferentially, two sections are preferred. The skin shall be tight and all flanges and butt joints properly fastened. The sections should be secured to each other by using a stapler plier equipped with a reverse clinch. The stapler wire must have a minimum thickness of 0.019 inches and a width of 0.050 inches. The maximum distance between staples should be 6 inches.

APPENDIX 6

TECHNICAL INFORMATION

THERMO-LAG 351-2 WATER BASED PRIMER
DATA SHEET

PRODUCT DESCRIPTION:	THERMO-LAG 351-2 primer is specifically provided for use in conjuction with THERMO-LAG 330-1 subliming coating. It provides the strong mechanical base required for field application of the subliming material to a steel substrate.
COLOR:	Red
FINISH:	Matte
TEMPERATURE:	This product should be applied in conformance with good painting practices. The surface shall be dry, above 40 degrees F and above the dew point.
PHYSICAL PROPERTIES:	
PIGMENTS:	Anti-Corrosion
SOLVENTS:	Water
SOLIDS by VOLUMES:	44 ± 1 Percent
NET WEIGHT PER GALLON:	11.5 ± 1.0 lbs.
SHELF LIFE:	Six Months
PACKAGED:	5 Gallon Pails
STORAGE:	Keep container tightely sealed when not in use. Store off the ground, above 32 degrees F and below 100 degrees F.
SPREAD RATE:	200 Sq. ft. per gallon on smooth surfaces. Allow for loss due to overspray and surface irregularities.
APPLICATION:	May be applied by airless or conventional spray brush or roller.
MIXING:	Mix thoroughly before starting application.
THINNING:	Water

APPENDIX 6
TECHNICAL INFORMATION

THERMO-LAG 351-2 WATER BASED PRIMER
DATA SHEET CONTINUED

The ideal surface for application of THERMO-LAG 330-1 subliming mastic is over a steel substrate which is clean and primed with THERMO-LAG 351-2 primer.

Before applying the primer be sure the surface is clean, dry, free of grease, oil, rust, scale dirt and other contaminants.

If applying over previously painted surfaces, verify adhesion by the cross hatch adhesion test as per federal method 141. Zinc or other metal based coatings and any other non-compatible coatings should be coated with THERMO-LAG 351-2 as a barrier/tie coating. Any decision to "short cut" the recommended surface preparation shall be at the applicator's own risk. While other primers may provide satisfactory, TSI can accept no responsibility for use of products which have not been fire tested with THERMO-LAG 330-1.

AIRLESS SPRAY EQUIPMENT:

GUN	TIP ORIFICE	FLUID INBOUND PRESSURE	AIR HOSE ID	MATERIAL HOSE ID	PUMP RATIO
NORDSON VERSA					27:1
GRACO HYDRA SPRAY					28:1
DEVIBISS JGA 5026	0.015" TO 0.020"	50 TO 70 psi	3/8"	1/4"	

CLEAN UP: WATER

SAFETY PRECAUTIONS: Proper Air masks or respirators for spray personnël and proper ventilation should be provided.

APPENDIX 6
TECHNICAL INFORMATION

THERMO-LAG 330-1 SUBLIMING COMPOUND

DATA SHEET

PRODUCT DESCRIPTION: THERMO-LAG 330-1 is a water based, fire-proofing, thermally activated, subliming and insulative coating. When exposed to flame, the material volatizes at fixed temperatures; exhibits a small volume increase through formation of a mult-cellular matrix; absorbs and blocks heat to protect the substrate material.

TYPE: THERMO-LAG 330-1 Subliming Compound

COLOR: Antique White

Textured

OUTSTANDING FEATURES:

- Ease of Application
- Excellent exterior and interior durability
- No flash point or fire hazard
- Chemical Resistance
- No asbestos
- Rugged

COMPOSITION AND PHYSICAL PROPERTIES:

Solvent	Water
Net Weight/gallon lbs/gal	10.5 ± 0.5
Non volatile	66 Min.
Flash Point	None
Consistency	Semi-solid, paste-like
Warranted Shelf Life	6 Months
Storage Conditions	Above 32°F and Below 100°F

APPENDIX 6
TECHNICAL INFORMATION

THERMO-LAG 330-1 SUBLIMING COMPOUND

DATA SHEET CONTINUED

BASIC USE:	THERMO-LAG 330-1 is applied to cable trays, cable drop and junction box assemblies, structural steel, support structures, containment vessels, tank cars, and other similar entities. THERMO-LAG 330-1 is applied to protect the substrate against loss of structural strength and accessing temperatures during exposure to fire. One and multiple hour fire ratings can be provided as determined by test utilizing the ASTM E-119 time - temperature environment, hydrocarbon or chemical fire environments. THERMO-LAG 330-1 Subliming Compound has also been tested per ASTM E84 Standards by an independent testing laboratory and will have a: Flame Spread 5 Fuel Contributed 0 Smoke Developed 15
COATING THICKNESS:	The coating thickness is a function of the specific weight of the steel to be protected. The heavier the steel, the thinner the coating required for a given fire endurance rating. (Specific film thicknesses are recommended by the architect or owner.)
PACKAGED:	55-gallon drums approximately 500 net lbs. THERMO-LAG 330-1 Subliming Compound is supplied in containers bearing Underwriters Laboratories labels.
STORAGE CONDITIONS:	Store above 32^{o}F and below 100^{o}F.

APPENDIX 6
TECHNICAL INFORMATION

THERMO-LAG 330-1 SUBLIMING COMPOUND

DATA SHEET CONTINUED

SURFACE PREPARATION:	1. Surface must be clean, dry and free from contaminants including oil, grease and scale prior to application.
	2. THERMO-LAG 351 Primer should be used as and where required.
MIXING:	Material should be stirred to a homogeneous consistency prior to application.
TEMPERATURE/HUMIDITY:	THERMO-LAG 330-1 Subliming Compound shall be applied in conformance with good painting practices. The surface shall be dry, above 40°F and above the dew point.
METHOD OF APPLICATION:	May be applied by airless spray or by troweling.
RECOMMENDED SPRAY EQUIPMENT:	For spray application direct from the shipping container, air-ram (45:1 compression ratio) extrusion pump, airless spray equipment should be used.
CLEAN UP:	Water

APPENDIX 6
TECHNICAL INFORMATION

THERMO-LAG 330-70 CONFORMABLE CERAMIC INSULATOR

DATA SHEET

PRODUCT DESCRIPTION:

THERMO-LAG 330-70 Conformable Ceramic Insulator is a strong light weight, flexible ceramic blanket. It is manufactured from long ceramic fibers. There are no binders added to the THERMO-LAG 330-70 Conformable Ceramic Insulator. It is a highly efficient material having low specific heat, excellent resistance to thermal and mechanical shock.

HYSICAL PROPERTIES:

Color:	White
*Continuous Use Limit:	1260°C(2300°F)
Melting Point:	1760°C(3200°F)
Fiber Diameter:	2-3 microns(mean)
Specific Heat at 1093°C(2000°F):	1130 J/kg°C(.27 Btu/lb/°F)
Specific Gravity:	2.73 g/cm3

*The Continuous Use Limit is determined by irreversible linear change criteria not product melting point.

APPENDIX 6
TECHNICAL INFORMATION

THERMO-LAG 330-70 CONFORMABLE CERAMIC INSULATOR

DATA SHEET CONTINUED

CHEMICAL PROPERTIES:

Aluminum Oxide:	48.0%	Silicone Dioxide:	51.8%
Iron Oxide:	0:04%	Titanium Dioxide:	0.002%
Magnesium Oxide:	0.01%	Calcium Oxide:	0.02%
Sodium Oxide:	0.1%		
Leachable Chlorides:	Less Than 10 ppm		

BASIC USE: THERMO-LAG 330-70 Conformable Ceramic Insulator is used for insulation enhancement of temperature sensitive components and is designed to provide equal compatibility, efficiency and greater heat resistance when used in concert with THERMO-LAG 330-1 Subliming Material System.

SURFACE PREPARATION: No special surface preparation is required.

METHOD OF APPLICATION: THERMO-LAG 330-70 Conformable Ceramic Insulator shall be wrapped in such a manner as to be complete and continuous with no gaps or holes. When the application of the THERMO-LAG Stress Skin Type 330-69 and THERMO-LAG 330-70 Conformable Ceramic Insulator is complete, a "cacoon" effect should be present.

STORAGE: THERMO-LAG 330-70 Conformable Ceramic Insulator should be kept in its containers sealed when not in use. Store off the ground.

THERMO-LAG 330-71 FIBERGLASS ARMORING

DATA SHEET

PRODUCT DESCRIPTION:	The Fiberglass Armoring is a light weight, electrical glass armoring fabric for use with the THERMO-LAG 330-1 Subliming Material System.
PHYSICAL PROPERTIES:	
Color:	White
Finish:	Matte
Type:	"E" Type Fiberglass Fabric
Ounce/Sq. Yd.	1.9 ± 0.2
Thickness (Inches):	0.005 ± 0.001
*Tensile Strength (Lbs/In):	Warp: 75 Fill: 60
Yarn:	Warp: 150-1/0 Fill: 150-1/0
Knit:	Weave Type
Temperature of Decomposition:	circa 1600°F

*Minimum average breaking strength, pounds per inch (ASTM Method 579-49).

BASIC USE:	The Fibergalss Armoring is specially provided for use in connection with the THERMO-LAG 330-1 Subliming Material System. It provides a strong mechanical base or armoring as required for field application for the intended use.

APPENDIX 6
TECHNICAL INFORMATION

THERMO-LAG 350

TWO PART WATER BASED SPILL RESISTANT TOPCOAT

DATA SHEET

PRODUCT DESCRIPTION: THERMO-LAG 350 Water Based Spill Resistant Topcoat is a two component formulation designed to provide chemical and corrosion resistance to protect against abrasion, moisture, corrosive fumes and chemical contact.

PHYSICAL PROPERTIES:

Color:	White
Finish:	Gloss
Solids by Volume:	34.0 ± 1.0% Mixed
Theoretical Coverage:	50 Sq. Ft Per Gallon
Mixing Ratio By Volume:	Part A - 4 To Part B - 1
Net Weight Per Gallon:	10.93 ± 0.20 lbs (Mixed)
Storage Temperature:	Minimum - 35°F Maximum - 120°F Protect from freezing. In cold weather, store materials inside above 60°F until use.
Shelf Life:	6 Months at recommended storage temperatures.
Flash Point (Seta):	Part A - above 200°F Part B - above 135°F
Pot Life:	10 hours at 60°F 8 hours at 77°F 4 hours at 100°F
Surface Temperature:	Minimum - 60°F Maximum - 120°F
Thinning:	Use clean water. For air spray thin up to 10%; airless spray, brush or roller, up to 5%.

APPENDIX 6
TECHNICAL INFORMATION

THERMO-LAG 350

TWO PART WATER BASED SPILL RESISTANT TOPCOAT

DATA SHEET CONTINUED

CHEMICAL RESISTANCE:

FREQUENT CONTACT	OCCASIONAL CONTACT	
Alkali Solutions	Fresh Water	Organic Acids
Alcohols	Waste Water	Mineral Acids
Aliphatic Hydrocarbons	Mineral Oils	Oxidizing Agents
Aromatic Hydrocarbons	Vegetable Oils	Ketones
Salt Solutions		

BASIC USE:

Especially formulated to provide compatibility when used in the THERMO-LAG 330-1 Subliming Material System. THERMO-LAG 350 Two Part Water Based Spill Resistant Topcoat provides excellent protection against water flow, climatic variations, chemical attack and physical abuse. This material has been tested in accord with ASTM E84 Standards by an independent testing laboratory and will provide a:

Flame Spread: 5
Fuel Contributed: 0
Smoke Developed: 0

PACKAGED:

5 Gallon Kits consisting of one short filled 5 gallon pail of Part A and a one gallon can of Part B.

APPENDIX 6
TECHNICAL INFORMATION

THERMO-LAG 350

TWO PART WATER BASED SPILLED RESISTANT TOPCOAT

DATA SHEET CONTINUED

SURFACE PREPARATION: The surface should be clean, free of loose and foreign contaminants and dry: at least 5°F above the dew point. Coating will not cure below minimum surface temperature.

Moisture meter readings, using a Delmhorst Meter, Model DP must be taken and readings of 20 or less must be obtained prior to the topcoat being applied.

MIXING: Stir contents of Part A, making sure no pigment remains on the bottom of the pail. Add Part B (1 gallon container) to Part A (5 gallon pail). Mix with a power mixer until the two components are thoroughly blended. Do not use mixed material beyond potlife limits.

METHOD OF APPLICATION: Application can be made by spray, roller or brushing. A criss/cross application technique is recommended to help achieve pin-hole free coverage.

APPLICATION EQUIPMENT:

Brush: Use Nylon or synthetic bristle brushes.

Rollers: Use short nap synthetic rollers for smooth surfaces.
Use long nap synthetic rollers for rough surfaces.

APPENDIX 6
TECHNICAL INFORMATION

THERMO-LAG 350

TWO PART WATER BASED SPILL RESISTANT TOPCOAT

DATA SHEET CONTINUED

APPLICATION EQUIPMENT:

For Air Spray:

Gun	Fluid Tip	Air Cap	Air Hose ID	Mat'l Hose ID	Atomizing Pressure	Pot Pressure
DeVilbiss MBC or JGA or equal	E	2 or 78	5/16" or 3/8"	3/8" or 1/2"	75-100 psi	10-20 psi

NOTE: Low ambient temperature applications or longer hoses require higher pot pressure.

For Airless Spray:

Tip Orifice	Atomizing Pressure	Material Hose ID	Manifold Filter
0.015" to 0.019"	2700-3000 psi	1/4" or 3/8"	60 mesh

NOTE: Use appropriate tip and atomizing pressure for equipment, applicator technique and weather conditions.

DRYING TIME AT 75°F: THERMO-LAG 350 Two Part Water Based Spill Resistant Topcoat dries to touch in approximately 1 hour; to handle in approximately 5 hours. Allow to dry for at least seven days before exposure to immersion service. Drying time will vary on ambient temperatures and relative humidity.

CLEAN UP: Clean all equipment immediately after use with water, followed by a final washing with xylol or No. 8 Thinner.

SECTION 2: ASTM-E84 TEST DOCUMENTATION

ASTM-E-84 TEST DOCUMENTATION

<u>THERMO-LAG 330-69 STRESS SKIN</u>

TESTED BY INDUSTRIAL TEST LABORATORIES
of St. Louis, Missouri September 9, 1981

FLAME SPREAD	0
FUEL CONTRIBUTED	0
SMOKE DEVELOPED	5

ASTM-E-84 TEST DOCUMENTATION

THERMO-LAG 351-2 WATER BASED PRIMER

TESTED BY INDUSTRIAL TEST LABORATORIES
of St. Louis, Missouri September 9, 1981

FLAME SPREAD	0
FUEL CONTRIBUTED	0
SMOKE DEVELOPED	5

ASTM-E-84 TEST DOCUMENTATION

THERMO LAG 330-1 SUBLIMING COMPOUND

UL TESTED AND LISTED JUNE 16, 1981

UL FILE NO. R6076

PROJECT NO. 81NK3238

FLAME SPREAD	5
FUEL CONTRIBUTED	0
SMOKE DEVELOPED	15

ASTM-E-84 TEST DOCUMENTATION

THERMO-LAG 330-70 CONFORMABLE CERAMIC INSULATOR

UL TESTED AND LISTED SEPT. 1979

UL FILE NO. R8418

PROJECT NO. 79NK1036

FLAME SPREAD 0
FUEL CONTRIBUTED 0
SMOKE DEVELOPED 0

ASTM-E-84 TEST DOCUMENTATION

THERMO-LAG 330-71 FIBERGLASS ARMORING

TESTED BY INDUSTRIAL TEST LABORATORIES
of St. Louis, Missouri September 9, 1981

FLAME SPREAD	0
FUEL CONTRIBUTED	0
SMOKE DEVELOPED	0

ASTM-E-84 TEST DOCUMENTATION

THERMO-LAG 350 TOPCOAT

UL TESTED AND LISTED APRIL 28, 1970

UL FILE NO. R6076B

PROJECT NO. 69NK4859

FLAME SPREAD	5
FUEL CONTRIBUTED	0
SMOKE DEVELOPED	0

SECTION 3: PRODUCT APPLICATION AND REPAIR PROCEDURES

TSI TECHNICAL NOTE 80181

THERMO-LAG 330-1

SUBLIMING COATING ENVELOPE SYSTEM

APPLICATION PROCEDURES

8/81

REVISION I

TSI TECHNICAL NOTE 80181

REVISION II

9/81

PREPARED BY:

Wilbur Paddock
Manager of Production

REVIEWED BY:

R. A. Lohman
Manager, Quality Assurance

APPROVED BY:

R. Feldman
President

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LIST OF FIGURES

TSI TECHNICAL NOTE 80181

THERMO-LAG 330-1

SUBLIMING COATING ENVELOPE SYSTEM

APPLICATION PROCEDURES

1.0 INTRODUCTION

This procedure sets forth the sequential steps involved in applying THERMO-LAG 330-1 Subliming Coating Envelope System to cable trays, cable drops, conduit, junction box assemblies, and structural steel.

The THERMO-LAG 330-1 Subliming Envelope System consists of THERMO-LAG Stress Skin Type 330-69, THERMO-LAG 330-1 Subliming Coating, Fiberglass Armoring, and where required, THERMO-LAG 330-70 Conformable Ceramic Blanket and THERMO-LAG 350 Two Part Spill Resistant Topcoat.

2.0 PRE-APPLICATION PRACTICES

2.1 Qualifications of Contractor

The application shall be performed by a qualified contractor who has had prior training in applying the material and who has the equipment required to perform the application.

2.2 Safety Precautions

The contractor shall follow standard industrial safety practices established for the handling of chemical coatings and shall conform to applicable OSHA and owner safety rules in all respects.

2.3 Delivery

The coating materials shall be delivered to the job site in original, unopened containers which show the product name, batch number, color, name of the manufacturer, the expiration date, and where applicable, an Underwriters' Laboratories label.

2.4 Storage

The coating materials shall be stored off the ground when not in use in an area provided for that purpose. The materials in storage shall be protected against freezing and from temperatures above 100°F.

2.5 Temperature and Precipitation

The coating materials shall be applied only to dry surfaces. The temperature of the coating material and surfaces to be coated shall be above 40°F during the material application and curing periods. The contractor shall furnish and install any protective covers required to protect the newly applied coating from rainfall or hard freeze during its initial curing period.

2.6 Protection of Adjacent Surfaces

The contractor shall mask off or otherwise protect all adjacent areas and in place equipment from receiving any material overspray during the coating application. Any spilled material and overspray shall be removed promptly using water, wet rags or sponges before the material has dried.

3.0 FABRICATION OF STRESS SKIN ENVELOPE

3.1 Cable Trays (Figures 1.0.1, 1.0.2, & 1.0.3)

3.1.1 Cut a piece of material large enough to form the bottom section from a roll of Stress Skin. The width of the bottom section shall be equal to the sum of the base (W) and both sides (H) of the cable tray plus 3½ inches, as shown in Figure 1.0.1 . The length of the bottom piece of material shall not exceed 10 feet since longer sections are unwieldy and are difficult to install.

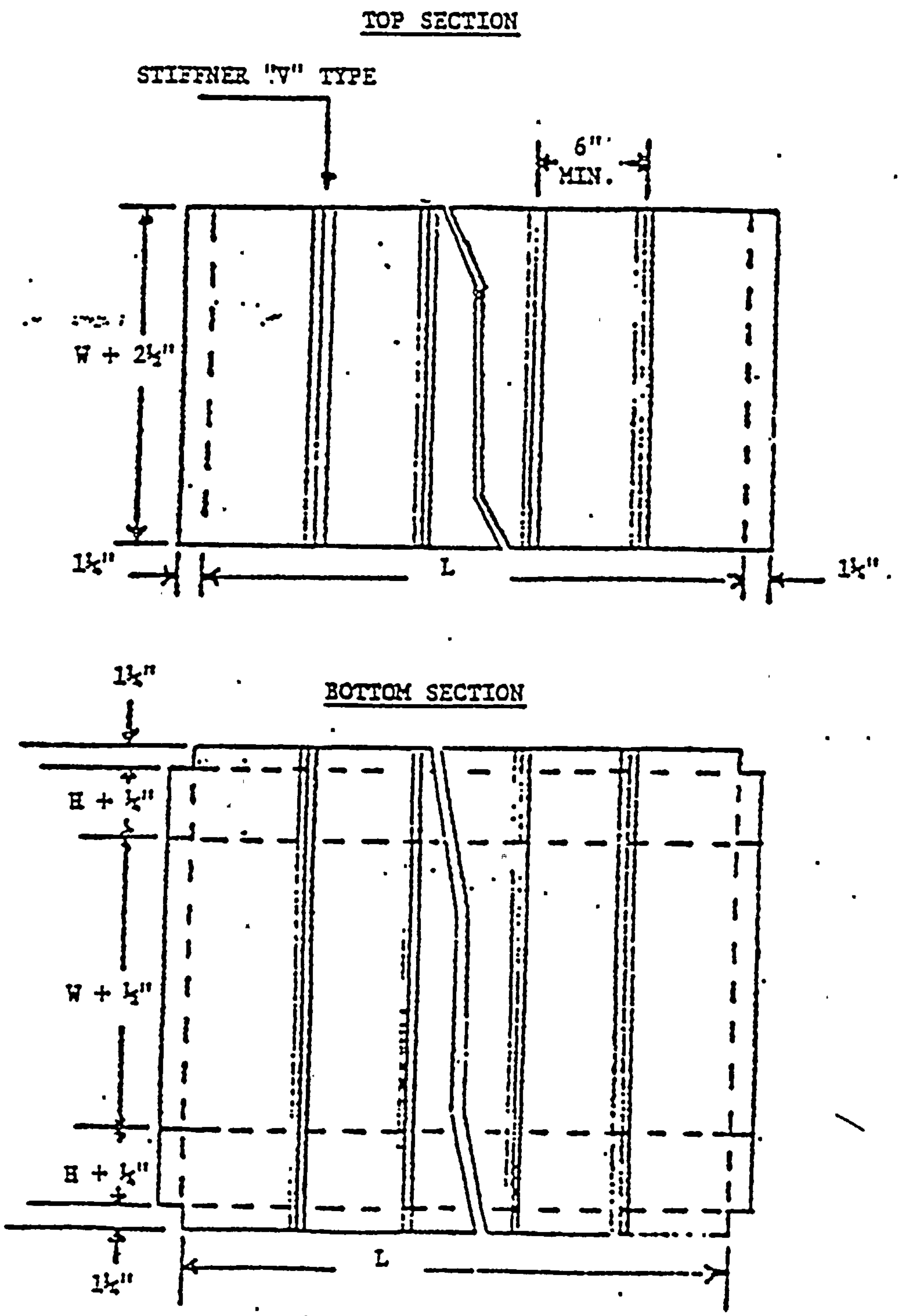
3.1.2 Cut a square 1½ inch piece from each corner of the bottom section of the Stress Skin.

3.1.3 Form a "U" shaped section by making two 90° bends along the dotted lines which are located at each end of the W + ½" dimension line shown in Figure 1.0.1.

FIGURE 1.0.1

THERMO-LAG STRESS SKIN TYPE 330-69

TYPICAL LAYOUT FOR CABLE TRAY SECTIONS



3.1.4 Form a 1½" flange on each side of the bottom section by making a 90° bend along the dotted lines as shown in Figure 1.0.1.

3.1.5 Cut a piece of material large enough to form the top section from a roll of Stress Skin. The width of the top section shall be equal to the base (W) of the cable plus 2½".

3.1.6 Form a 1½" flange at each end of the top section by making 90° bends along the dotted lines shown in Figure 1.0.1.

3.1.7 Drill holes for fastening the bottom and top sections together as required in the flanges of both sections as shown in Figure 1.0.2.

3.1.8 Mount the bottom and top sections of Stress Skin on the cable tray and fasten the two sections together at a maximum of six inch intervals using mechanical fasteners, staples or 18 ga. galvanized tie wire.

3.1.9 Attach additional bottom and top sections of Stress Skin to a previously installed section by fastening them together at the end flanges using mechanical fasteners, staples or 18 ga. galvanized tie wire.

3.1.10 Coat the bottom and top sections of Stress Skin with THERMO-LAG 330-1 Subliming Coating as shown in Figure 1.0.3. The coating shall be applied with Fiberglass Armoring in accordance with the instructions given in Section 4.0 of this procedure.

OR WHEN COATING PRIOR TO MOUNTING

3.1.11 Coat the bottom and top sections of Stress Skin with THERMO-LAG 330-1 Subliming Coating prior to mounting on the cable tray. The coating shall be applied with Fiberglass Armoring in accordance with instructions given in Section 4.0 of this procedure.

3.1.12 Drill holes for fastening the bottom and top sections together as required in the flanges of both sections as shown in Figure 1.0.2.

FIGURE 1.0.2

THERMO-LAG STRESS SKIN TYPE 330-69

INSTALLATION SCHEMATIC PRIOR TO

THERMO-LAG 330-1 SUBLIMING COATING APPLICATION

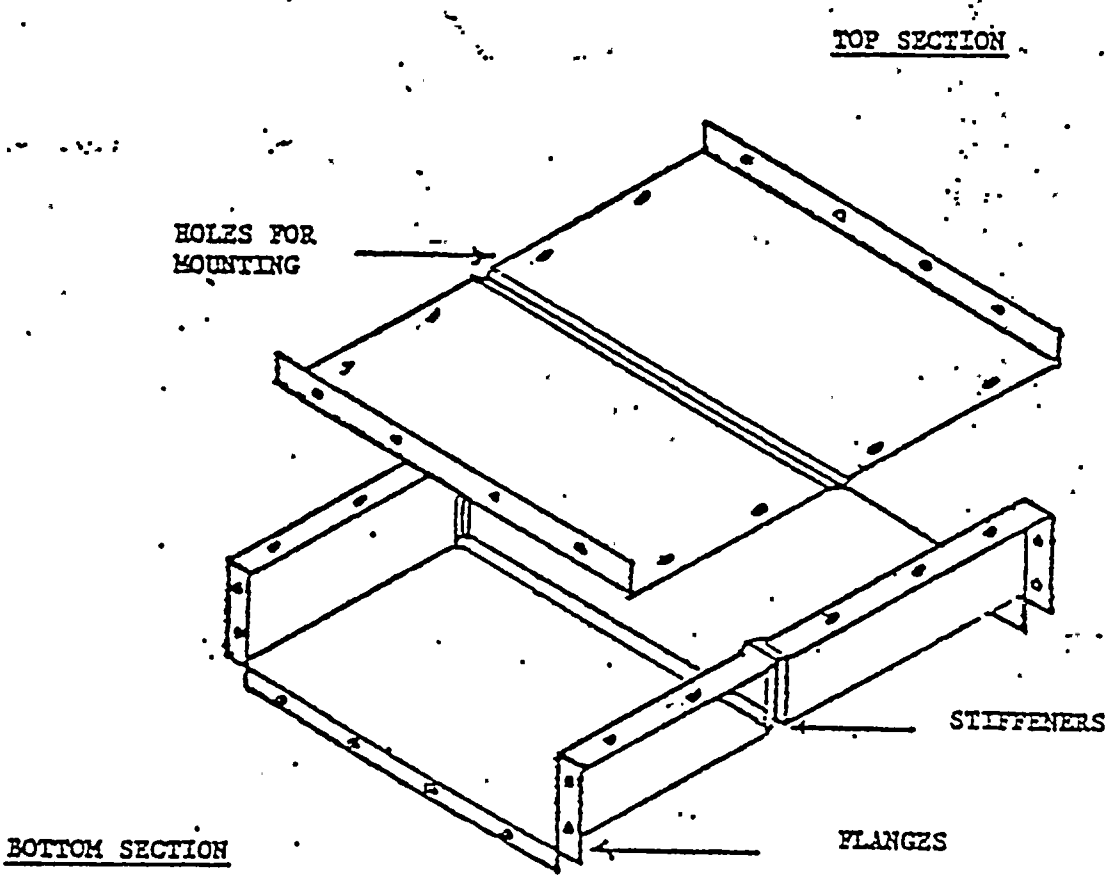
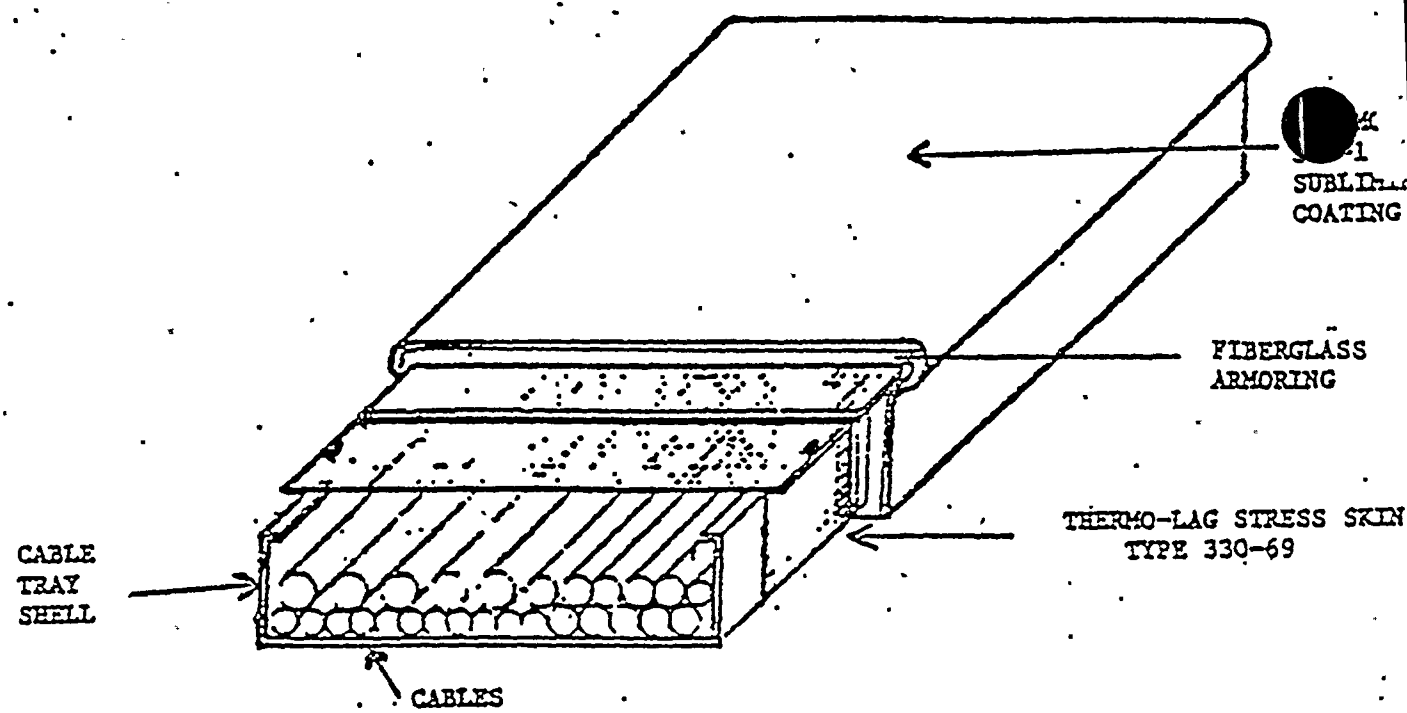


FIGURE 1.0.3

CROSS SECTIONAL VIEW OF

THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM

APPLIED TO A TYPICAL CABLE TRAY



3.1.13 Mount the bottom and top sections of the precoated Stress Skin on the cable tray and fasten the two sections together at a maximum of six inch intervals using mechanical fasteners, staples or 18 ga. galvanized tie wire.

3.1.14 Attach additional precoated bottom and top sections of Stress Skin to a previously installed section by fastening them together at the end flanges using mechanical fasteners, staples or 18 ga. galvanized tie wire.

3.1.15 Apply a coating of THERMO-LAG 330-1 Subliming Coating in the specified wet film thickness to the edges and joints of the precoated sections of Stress Skin using a trowel or stiff bristle brush to fill in any gaps or fastening holes.

3.2 Conduit (Figure 1.0.4)

3.2.1 Cut two pieces of Stress Skin large enough to form a top and a bottom section for the conduit. The width of each piece shall be equal to [illegible] [illegible] of the circumference of the conduit plus 1". The length of the piece of Stress Skin shall not exceed 10 feet since longer sections are unwieldy and more difficult to install.

3.2.2 Form a semi-circular section with edge flanges from each of the two pieces by making two 90° bends at a distance of 1/2 inches from each edge of the width dimensions as shown in Figure 1.0.4a.

[illegible] For sharp radius bends, the procedure delineated in Section 3.0 for the fabrication of Stress Skin Envelope utilizing a design as shown in Figure 1.0.2 shall apply for conduit when sharp radius bends must be coated.

For conduit: [illegible] is different. [illegible] to [illegible]

3.2.3 Form a ½" flange on the length edges of each of the two pieces, where required, by making 90° bends.

3.2.4 Drill holes for fastening the bottom and top sections together at a maximum of six inch intervals in the flanges of both sections when required.

3.2.5 Mount the bottom and top sections of Stress Skin on the conduit and fasten the two sections together at a maximum of six inch intervals using mechanical fasteners, staples or 18 ga. galvanized tie wire.

3.2.6 Attach additional bottom and top sections of Stress Skin to a previously installed bottom and top sections as shown in Figure 1.0.4b.

a) Overlapping the bottom and top sections by a maximum of 2", or

b) Fastening them together at the end flanges using mechanical fasteners, staples or 18. ga. galvanized tie wire.

3.2.7 Coat the bottom and top sections of Stress Skin with THERMO-LAG 330-1 Subliming Coating. The coating shall be applied with Fiberglass Armoring in accordance with instructions given in Section 4.0 of this procedure.

OR WHEN COATING PRIOR TO MOUNTING

3.2.8 Coat the bottom and top sections of Stress Skin with THERMO-LAG 330-1 Subliming Coating prior to mounting on the conduit. The coating shall be applied with Fiberglass Armoring in accordance with instructions given in Section 4.0 of this procedure.

3.2.9 Drill holes for fastening the bottom and top sections together as required in the flanges of both sections.

3.2.10 Mount the bottom and tops sections of the precoated Stress Skin on the conduit and fasten the two sections together at a maximum of six inch intervals using mechanical fasteners, staples or 18 ga. galvanized tie wire.

3.2.11 Attach additional precoated bottom and top sections of Stress Skin to a previously installed section by fastening them together at the end flanges using mechanical fasteners, staples or 18 ga. galvanized tie wire as shown in Figure 1.0.4b.

3.2.12 Apply a coating of THERMO-LAG 330-1 Subliming Coating in the specified wet film thickness to the edges and joints of the precoated sections of Stress Skin using a trowel or stiff bristle brush to fill in any gaps or fastening holes.

FIGURE 1.0.4a

THERMO-LAG STRESS SKIN TYPE 330-69

INSTALLATION SCHEMATIC PRIOR TO

THERMO-LAG 330-1 SUBLIMING COATING APPLICATION

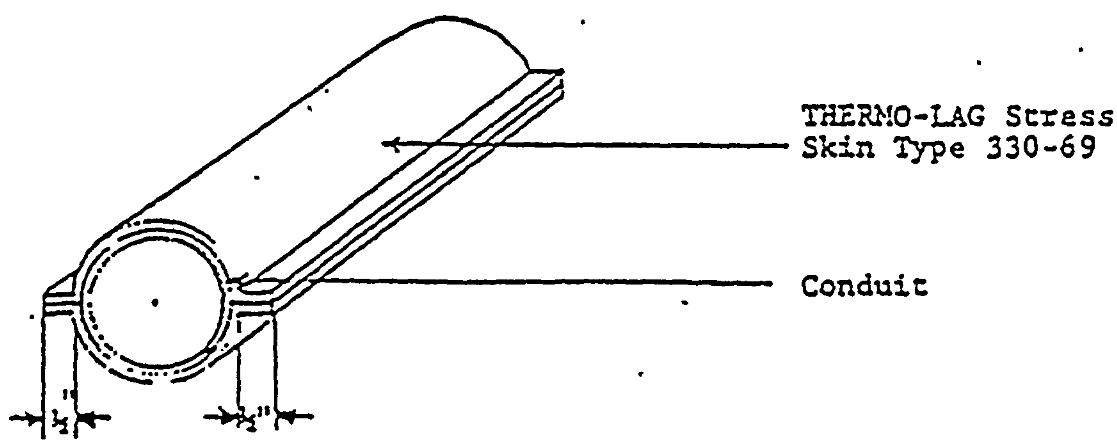
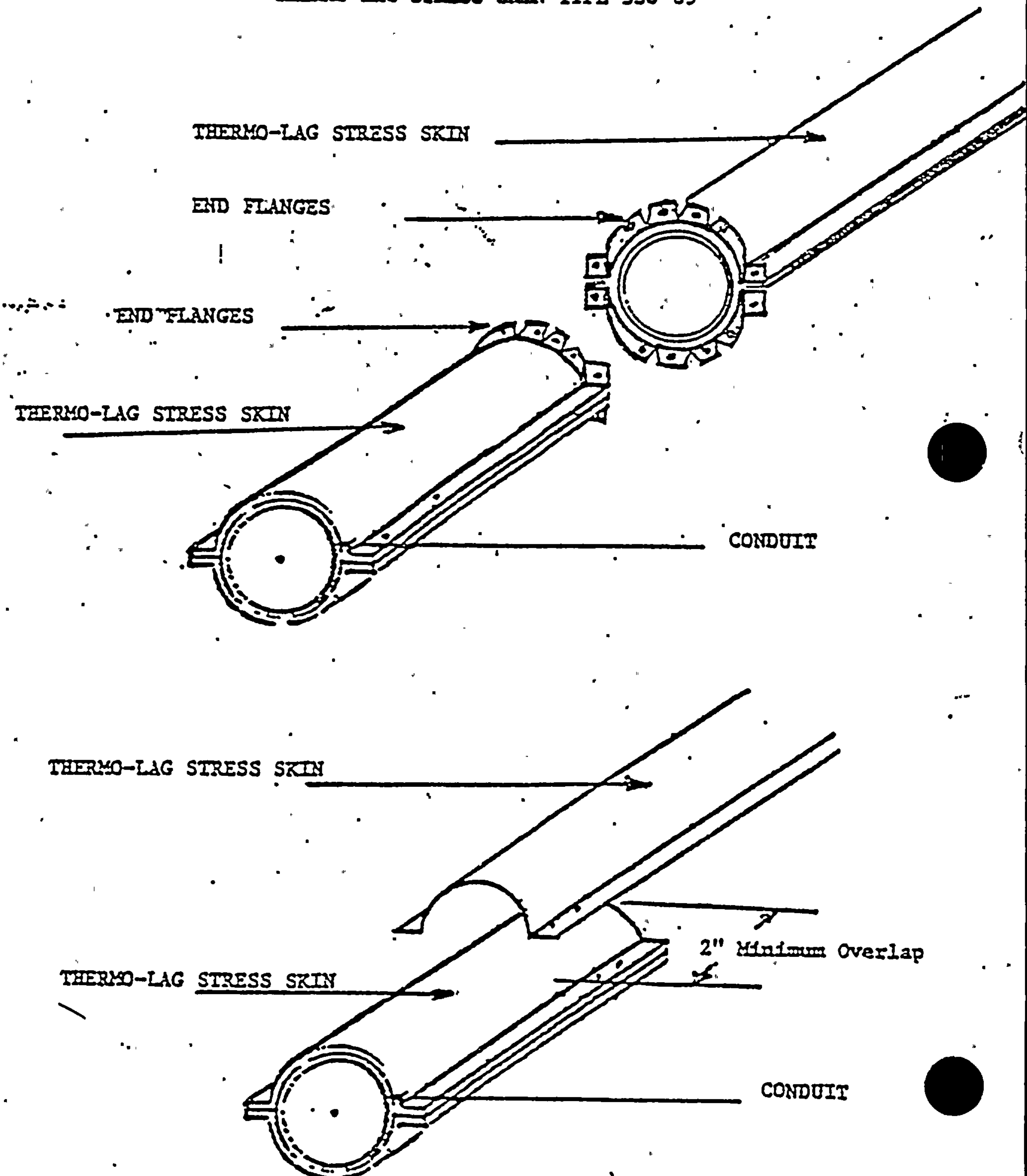


FIGURE 1.0.4b

INSTALLATION SCHEMATICS FOR ATTACHING ADDITIONAL SECTIONS OF THERMO-LAG STRESS SKIN TYPE 330-69 TO PREVIOUSLY INSTALLED THERMO-LAG STRESS SKIN TYPE 330-69



3.3 Cable Drops (Figure 1.0.5a)

3.3.1 Cut a piece of Stress Skin large enough to wrap around the circumference of a single or multiple number of cable drops. The width of the piece should be equal to the circumference of the single or group of cable drops plus an additional 3/4" minimum to provide for the overlap. The length of the piece of material shall not exceed 10 feet since longer sections are unwieldy and more difficut to handle.

3.3.2 Wrap the piece of Stress Skin around the single or group of cable drops and secure at a maximum of six inch intervals with 18 ga. galvanized tie wire. Attach additional pieces of Stress Skin to a previously wrapped piece by overlapping by a minimum of six inches and secure with 18 ga. galvanized tie wire.

3.3.3 Cut a piece of THERMO-LAG 330-70 Conformable Ceramic Blanket large enough to wrap around the circumference of the installed Stress Skin. The width of the piece should be equal to the circumference of the installed Stress Skin plus ½" minimum to provide for a tight abutment of the edges. The length of the piece of material shall not exceed 10 feet in order to minimize the handling problems during installation.

3.3.4 Wrap the piece of Conformable Ceramic Blanket around the installed piece of Stress Skin and secure at a maximum of six inch intervals with 18 ga. galvanized tie wire. Attach additional pieces as required of the Conformable Ceramic Blanket to a previously installed piece by tightly abutting the pieces together. Care should be exercised to ensure that the wrapping of the Conformable Ceramic Blanket is continuous with no gaps or holes in the material surfaces.

3.3.5 Cut two pieces of Stress Skin large enough to form a top and a bottom section. The width of each piece shall be equal to one half of the circumference of the installed Conformable Ceramic Blanket plus 2½" minimum. The length of the piece of material shall not exceed 10 feet since longer sections are unwieldy and more difficult to handle.

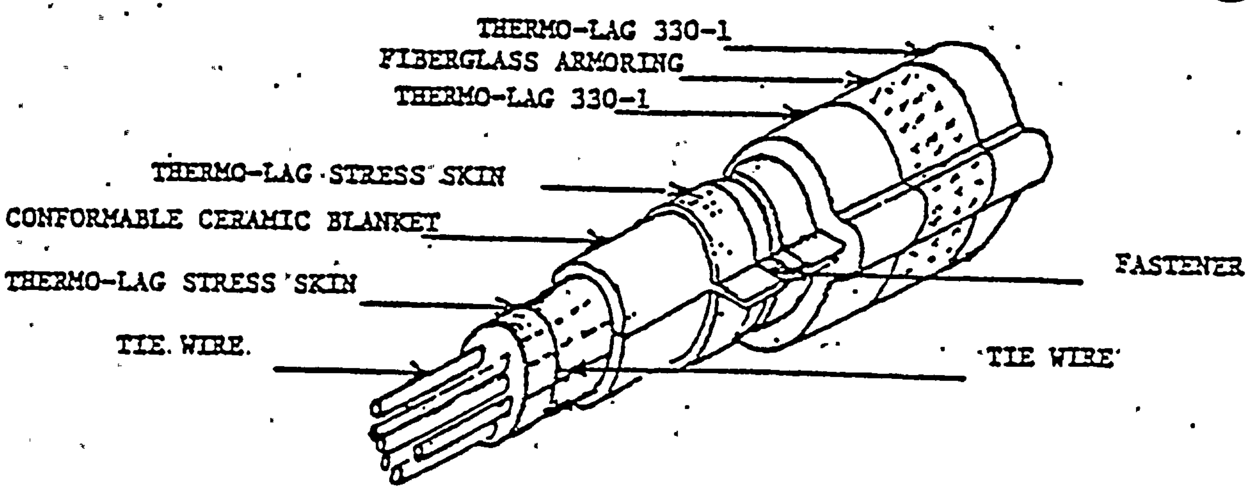
3.3.6 Form a semi-circular section with edge flanges from each of the top pieces by making two 90° bends at a distance of 1¼" minimum from each edge of the width dimension.

FIGURE 1.0.5a

CROSS SECTIONAL VIEW OF

THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM

APPLIED TO CABLE DROPS



3.3.7 Form a 1¼" flange on the length edges of each of the two pieces, when required, by making 90° bends.

3.3.8 Cut holes for fastening the bottom and top sections together at a maximum of six inch intervals in the flanges of both sections.

3.3.9 Mount the bottom and top sections of Stress Skin on the Conformable Ceramic Blanket and fasten the two sections together at a maximum of six inch intervals using mechanical fasteners, stapes or 18 ga. galvanized tie wire.

3.3.10 Attach additional bottom and top sections of Stress Skin to a previously installed bottom and top section by fastening them together at the end flanges using mechanical fasteners, staples or 18 ga. galvanized tie wire.

3.3.11 Coat the bottom and top sections of Stress Skin with THERMO-LAG 330-1 Subliming Coating as shown in Figure 1.0.5a. The coating shall be applied with Fiberglass Armoring in accordance with the instructions given in Section 4.0 of this procedure.

3.3.12 Cable Drops (Figure 1.0.5b)

3.3.12.1 Cut a piece of Stress Skin large enough to wrap around the circumference of a single or multiple number of cables. The width of the piece should be equal to the circumference of the single or group of cable drops plus an additional 3/4" minimum to provide for the overlap. The length of the piece shall not exceed 10 feet since longer sections are unwieldy and more difficult to handle.

3.3.12.2 Wrap the piece of Stress Skin around the single or group of cable drops and secure at a maximum of six inch intervals with 18 ga. galvanized tie wire. Attach additional pieces of Stress Skin to a previously wrapped piece by overlapping by a minimum of six inches and secura with 18 ga. galvanized tie wire.

3.3.12.3 Coat the section of Stress Skin with THERMO-LAG 330-1 Subliming Coating as shown in Figure 1.0.5b. The coating shall be applied with Fiberglass Armoring in accordance with instructions given in Section 4.0 of this procedure.

3.3.12.4 Cut a piece of THERMO-LAG 330-70 Conformable Ceramic Blanket large enough to wrap around the circumference of the installed Stress Skin. The width of the piece should be equal to the circumference of the installed Stress Skin plus ½" minimum to provide for a tight abutment of the edges. The length of the piece of material shall not exceed 10 feet in order to minimize the handling problems during installation.

3.3.12.5 Wrap the piece of Conformable Ceramic Blanket around the installed piece of Stress Skin and secure at a maximum of six inch intervals with 18 ga. galvanized tie wire. Attach additional pieces as required of the Conformable Ceramic Blanket to a previously installed piece by tightly abutting the pieces together. Care should be exercised to ensure that the wrapping of the Conformable Ceramic Blanket is continuous with no gaps or holes in the material surfaces.

3.3.12.6 Cut two pieces of Stress Skin large enough to form a top and a bottom section. The width of each piece shall be equal to one half of the circumference of the installed Conformable Ceramic Blanket plus 2½" minimum. The length of the piece of material shall not exceed 10 feet since longer sections are unwieldy and more difficult to handle.

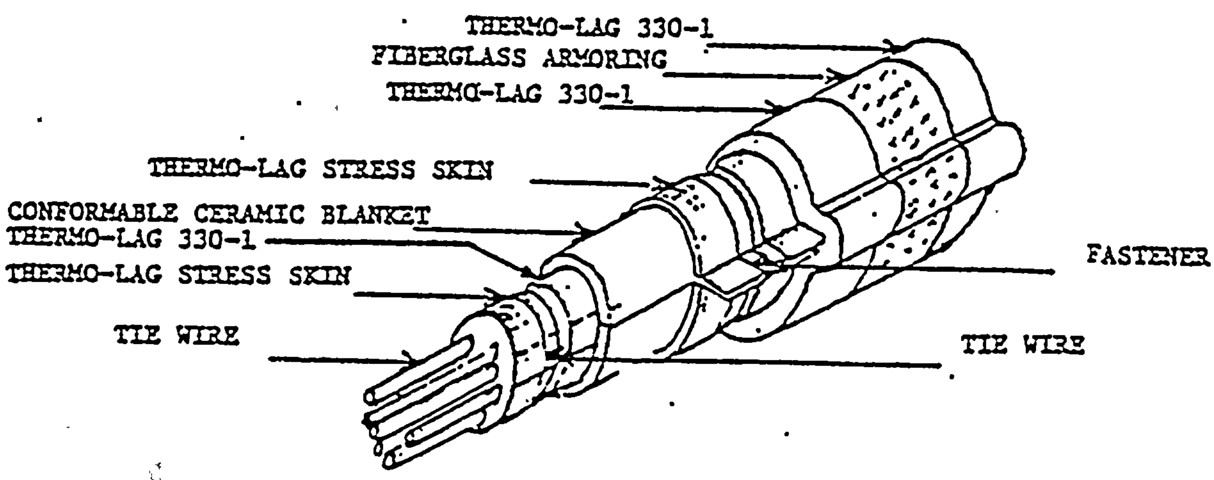
3.3.12.7 Form a semi-circular section with edge flanges from each of the top pieces by making two 90° bends at a distance of 1½" minimum from each edge of the width dimension.

FIGURE 1.0.5b

CROSS SECTIONAL VIEW OF

THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM

APPLIED TO CABLE DROPS



3.3.12.8 Form a 1½" flange on the length edges of each of the two pieces, when required, by making 90° bends.

3.3.12.9 Cut holes for fastening the bottom and top sections together at a maximum of six inch intervals in the flanges of both sections.

3.3.12.10 Mount the bottom and top sections of Stress Skin on the Conformable Ceramic Blanket and fasten the two sections together at a maximum of six inch intervals using mechanical fasteners, stapes or 18 ga. galvanized tie wire.

3.3.12.11 Attach additional bottom and top sections of Stress Skin to a previously installed bottom and top section by fastening them together at the end flanges using mechanical fasteners, staples or 18 ga. galvanized tie wire.

3.3.12.12 Coat the bottom and top sections of Stress Skin with THERMO-LAG 330-1 Subliming Coating as shown in Figure 1.0.5b. The coating shall be applied with Fiberglass Armoring in accordance with the instructions given in Section 4.0 of this procedure.

3.4 <u>Conduit and Cable Drop Junction (Figure 1.0.6)</u>

3.4.1 Apply the THERMO-LAG 330-1 Subliming Coating Envelope System to the conduit and the single or multiple cable drops following the instructions given in Section 3.2 or 3.3 of this procedure.

3.4.2 Cut a piece of Stress Skin of sufficient size to wrap around the circumference of the conduit. The width of the piece should be equal to the outside circumference of the conduit plus an additional 3/4 inch to provide for an overlap. The length of the piece shall be 12 inches minimum.

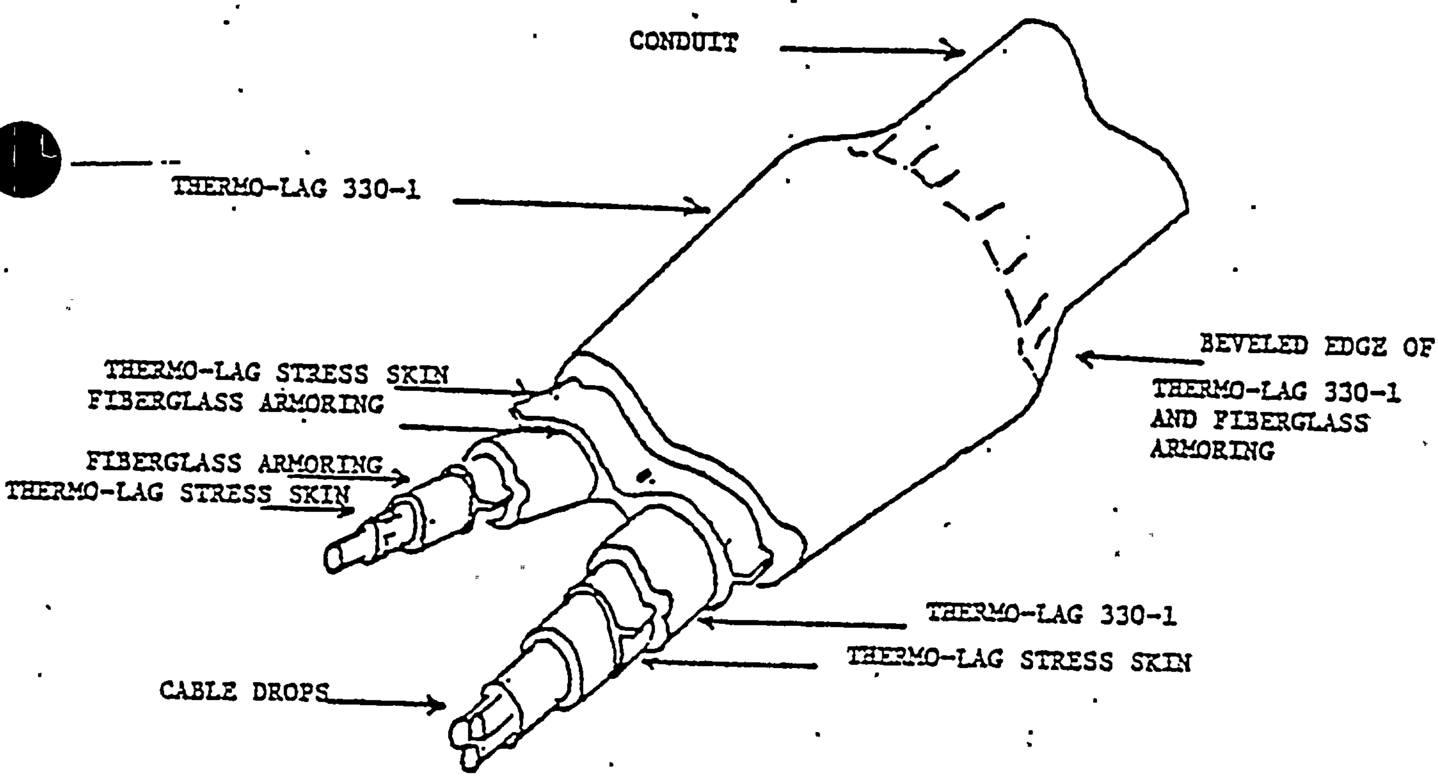
3.4.3 Wrap the piece of Stress Skin around the outside circumference of the conduit in such a manner that it covers six inches of the conduit. Secure the piece of Stress Skin to the conduit with two 18 ga. galvanized tie wires mounted approximately 5 inches apart.

FIGURE 1.0.6a

CROSS SECTIONAL VIEW OF

THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM

APPLIED TO CONDUIT AND CABLE DROP



3.4.4 Cut a required number of small pieces of THERMO-LAG 330-70 Conformable Ceramic Blanket from a roll of this material.

3.4.5 Insert the small pieces of Conformable Ceramic Blanket inside the open end of the installed piece of Stress Skin and around and between the cable drops in such a manner that the open end is relatively sealed. Then secure the piece of Stress Skin to the cable drops with 18 ga. galvanized tie wires.

3.4.6 Coat the installed piece of Stress Skin with THERMO-LAG 330-1 Subliming Coating as shown in Figure 1.0.6. The coating shall be applied with Fiberglass Armoring in accordance with the instructions given in Section 4.0 of this procedure.

3.5 <u>Cable Tray and Cable Drop Junction at Open End of Cable Tray</u>

3.5.1 Apply the THERMO-LAG 330-1 Subliming Coating Envelope System to the cable tray at the single or multiple cable drops following the instructions given in Sections 3.1 and 3.3 of this procedure.

3.5.2 Cut a piece of Stress Skin of sufficient size to wrap around the outside parameters perimeter of the cable tray. The width of the piece should be equal to the outside parameter of the cable tray plus an additional 3/4" to provide for an overlap. The length of the piece shall be 24 inches minimum.

3.5.3 Wrap the piece of Stress Skin around the parameter perimeter of the cable tray in such a manner that it covers six inches of the conduit. Secure the piece of Stress Skin to the conduit with two 18 ga. galvanized tie wires mounted approximately 5 inches apart.

3.5.4 Cut a required number of small pieces of the THERMO-LAG 330-70 Conformable Ceramic Blanket from a roll of this material.

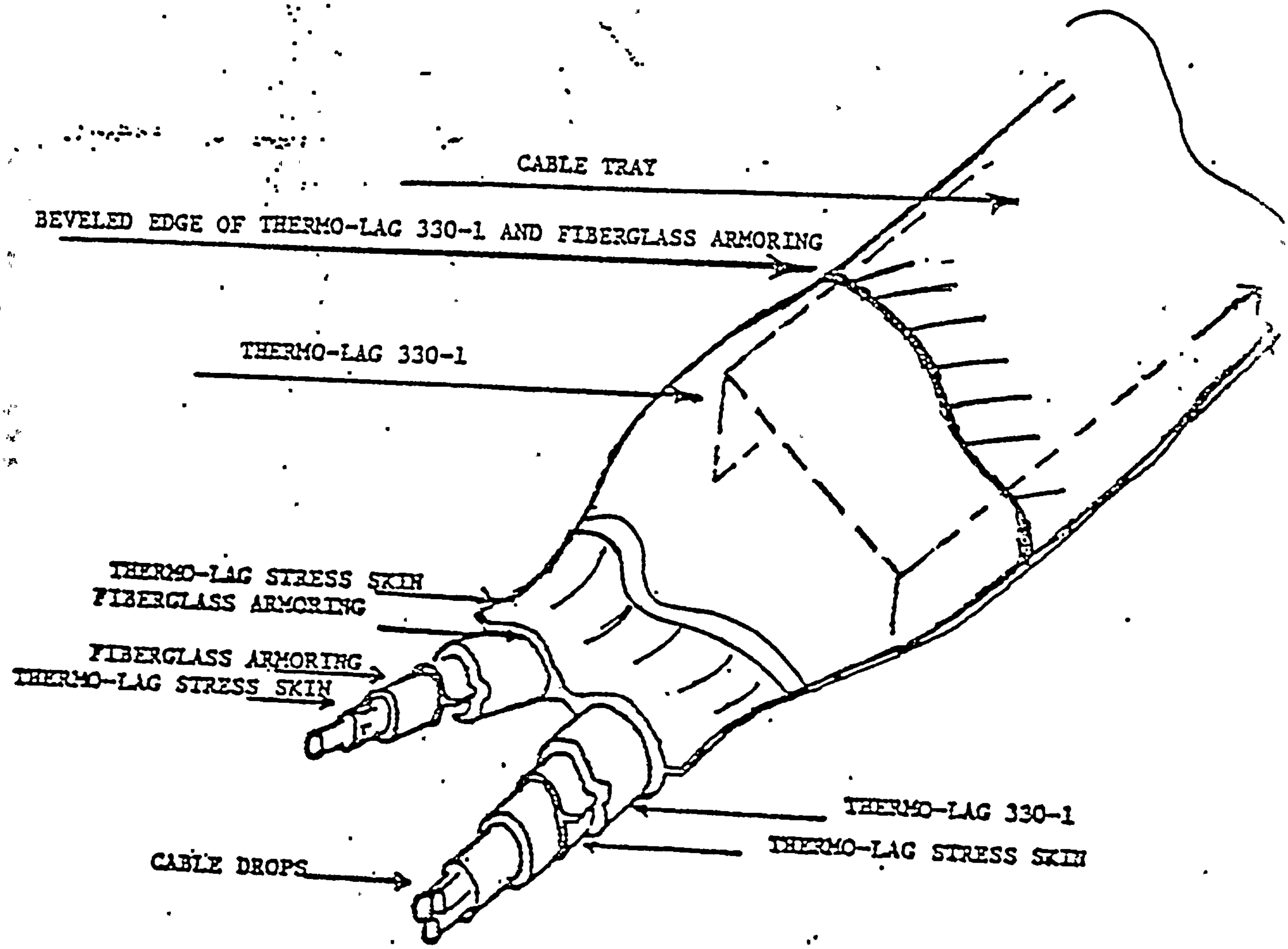
3.5.5 Cut slots approximately 12 inches in length at each corner of the open end of the piece of Stress Skin.

FIGURE 1.0.6b

CROSS SECTIONAL VIEW OF

THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM

APPLIED TO CABLE TRAY AND CABLE DROP



3.5.6 Insert the small pieces of Conformable Ceramic Blanket inside the installed piece of Stress Skin and around and between the cable drops in such a manner that when the slit open end of the piece of Stress Skin is tightened around the cable drops, the open end is effectively sealed. Then secure the piece of Stress Skin to the cable drops with 18 ga. galvanized tie wires.

3.5.7 Coat the installed piece of Stress Skin with THERMO-LAG 330-1 Subliming Coating in the required thickness. The coating shall be applied with Fiberglass Armoring in accordance with the instructions given in Section 4.0 of this procedure.

3.6 <u>Cable Tray and Cable Drop Junction at Top or Bottom of Cable Tray</u>

3.6.1 Apply the THERMO-LAG 330-1 Subliming Coating Envelope System to the cable tray and the single or multiple cable drops following the instructions given in Section 3.1 and 3.3.

3.6.2 Cut a piece of Stress Skin of sufficient size to form a truncated cone shape which has one end that is equal to the circumference of the cable drops plus 3/4 inch to provide for overlaps. The other end should be approximately four times the circumference of the cable drops plus 3/4 inch to provide for overlaps. The length of the piece should be 6 inches minimum.
Shall

3.6.3 Form a 1" flange at the large end of the piece of Stress Skin by making a 90° bend along a line which is 1" up and parallel to the large end. Drill holes for fastening the flange to the cable tray as required in the flange.

3.6.4 Cut a required number of small pieces of THERMO-LAG 330-70 Conformable Ceramic Blanket from a roll of this material.

3.6.5 Form a cone out of the piece of Stress Skin taking care to overlap the sides by 3/4 inch.

3.6.6 Insert the small pieces of Conformable Ceramic Blanket inside the small end of the cone in such a manner that the small end is sealed when it is wrapped around the cable drops. Then secure the small end of the piece of Stress Skin to the cable drops with 18 ga. galvanized tie wires.

3.6.7 Secure the flanged end of the piece of Stress Skin to the cable tray using mechanical fasteners, staples or 18 ga. galvanized tie wires.

3.6.8 Coat the installed piece of Stress Skin with THERMO-LAG 330-1 Subliming Coating. The coating shall be applied with Fiberglass Armoring in accordance with the instructions given in Section 4.0 of this procedure.

3.7 <u>Cable Tray or Conduit Junction With Fire Wall</u>

3.7.1 Attach the Stress Skin Envelope of the cable tray or conduit at each junction with a fire wall by fastening the butt flange of the Stress Skin to the fire wall using mechanical fasteners.

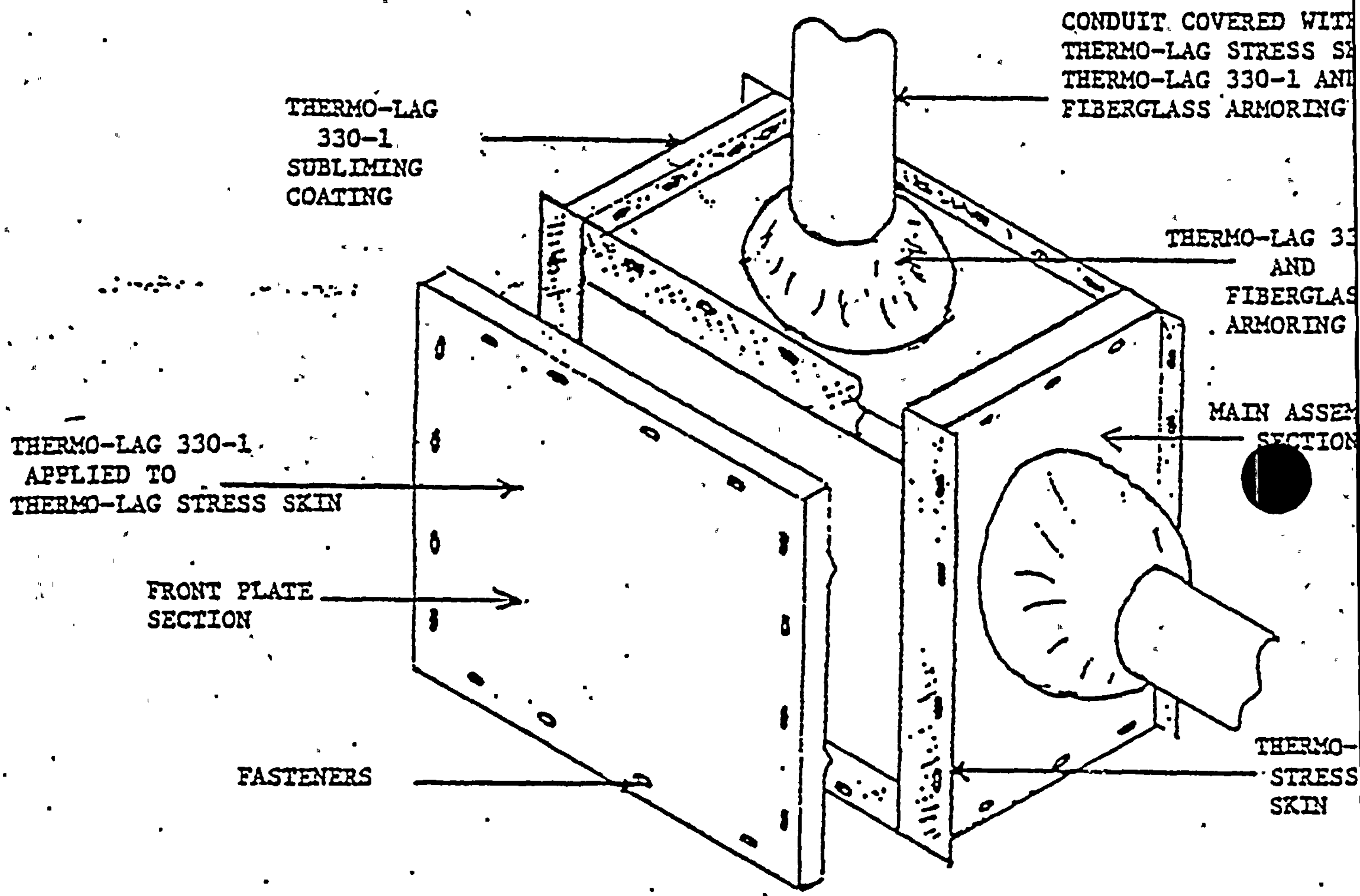
3.7.2 Apply the THERMO-LAG 330-1 Subliming Coating to the butt flanges, overlapping the flange joints with the coating by a minimum of 3 inches. The coating shall be applied with Fiberglass Armoring in accordance with the instructions given in Section 4.0 of this procedure.

3.8 <u>Junction Box Assembly (Figure 1.0.7)</u>

3.8.1 Cut two pieces of Stress Skin large enough to form the top and bottom sections of the main assembly section of the junction box assembly as shown in Figure 1.0.7. The width of each piece of material shall be equal to the width of the junction box plus 5 inches and the length of each piece shall be equal to the depth of the junction box plus 3 inches. The additional 5 inches provides for 1½" flanges and 1½" clearance from the side edges of the junction box. The additional 3 inches provides for 1½" flanges and ~~1½"~~ 1/4" clearance along the sides of the junction box.

FIGURE 1.0.7

CROSS SECTIONAL VIEW OF
THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM
APPLIED TO A JUNCTION BOX ASSEMBLY



3.8.2 Cut any required holes for cable drops in the top and bottom sections.

3.8.3 Form a 1½" flange on each of the four sides of the top and bottom section of Stress Skin by making the required number of 90° bends.

3.8.4 Drill holes for fastening the top and bottom sections at a maximum of 6 inch intervals in the flanges as shown in Figure 1.0.7.

3.8.5 Cut two pieces of Stress Skin large enough to form the two side sections of the main assembly section. The width of each piece of Stress Skin shall be equal to the height of the junction box plus 5 inches and the length of each piece shall be equal to the depth of the junction box plus 3 inches. The additional 5 inches provides for 1½" flanges and 1½" clearance from the top and bottom edges of the junction box. The additional 3 inches provides for 1½" flanges and ½" clearance along the sides of the junction box.

3.8.6 Drill any required holes for cable drops in the two side sections.

3.8.7 Form a 1½" flange on each of the four sides of the two side sections of Stress Skin by making the required number of 90° bends.

3.8.8 Drill holes for fastening the two side sections at a maximum of 6 inch intervals in the flanges as shown in Figure 1.0.7.

3.8.9 Cut a piece of Stress Skin large enough to form the front plate section. The width of the front plate section shall be equal to the width of the top and bottom sections plus 2½" required to cover the flanges. The length of the front plate section shall be equal to the height of the side sections plus 2½" required to cover the flanges.

3.8.10 Drill holes for fastening the front plate section to the main assembly section as shown in Figure 1.0.7.

3.8.11 Mount the main assembly section around the junction box by connecting the top and bottom sections to the two side sections and attaching the main assembly section to the wall on which the junction box is mounted using mechanical fasteners, staples or 18 ga. galvanized tie wires.

3.8.12 Mount the front plate section on the main assembly section using mechanical fasteners, staples or 18 ga. galvanized tie wire.

3.8.13 Coat the assembled front plate and main assembly sections of Stress Skin with THERMO-LAG 330-1 Subliming Coating. The coating shall be applied with Fiberglass Armoring in accordance with the instructions given in Section 4.0 of this procedure.

3.9 Structural Steel Supports

3.9.1 See Appendix C of this procedure for application instructions.

4.0 COATING APPLICATION TECHNIQUES

4.1 Spray Application

4.1.1 Apply the THERMO-LAG 330-1 Subliming Coating over a properly prepared surface. Make sure that the surface to be coated is clean, dry, above 40°F and free from scale, rust or other contaminants.

4.1.2 Apply the material in as many passes as required to provide the required film build of coating thickness, taking care to avoid slumping or sagging of the coating. Normally, a required 0.500 inch dry coating thickness is accomplished by applying three wet coats of 0.225 inches. However, the thickness which can be safely applied in a single pass will depend on the temperature, humidity, and other factors that are best determined on the job site.

4.1.3 Apply the material in smooth even passes, taking care to keep the spray gun fan pattern at a 90° angle whenever possible. Reaching with a spray gun will cause the spray pattern to vary from the 90° angle and will result in a rougher surface than normal.

4.1.4 Take frequent wet thickness measurements during the application using a penetration measuring device such as those shown in Appendix A to ensure that the coating is being applied uniformly and at the required wet film thickness. These wet thickness checks shall be made every five square feet or every two running feet of coated surface area. (Note: When taking measurements allow for a shrinkage rate of 25% between the wet and the desired dry ~~film~~ coating thickness.

4.1.5 Remove excess build up of coating material at edges and joints by brushing or rolling the surface with a damp sponge roller.

4.1.6 Spray edges of the substrate from each side to cause the material to wrap around the edge. If the edge coating is not completely closed, use a wet roller or trowel to seal the edge surface.

4.1.7 Apply Fiberglass Armoring to the wet surface after the final pass and use a roller to flatten out any wrinkles and to embed the fiberglass securely. Then apply sufficient material to cover the embedded fiberglass.

4.1.8 Remove all runs, sags, drips or other surface imperfections before the material cures using wet sponge rollers, brushes or hand trowels.

4.2 Hand Applications

4.2.1 Trowel the material to a uniform thickness using moderate pressure and avoid overworking the material. The trowel should be wetted with water when a smooth finish is required.

4.2.2 Glove the material to cables and small pipe using standard work gloves. Work small areas and keep the gloves wet to insure a relatively uniform thickness.

Coating

4.3 Dry Film Thickness Measurements

Coating

4.3.1 Take dry film thickness measurements after the applied material has cured. Measurements shall be made using electrical, penetrating or magnetic measuring instruments.

4.4 Repair Procedure - Damage

4.4.1 Remove damaged and loose material using a knife and scrapper. Cut back until sound adhering material is reached.

4.4.2 The edge should be undercut to form a beveled edge as in plaster repair.

4.4.3 Remove all foreign matter from the substrate using a wire brush.

4.4.4 Spray or trowel THERMO-LAG 330-1 onto patch area. Several coats of the material can be applied to achieve the desired ~~film~~ thickness. Coating

4.5 Cable Replacement - Repair

4.5.1 Locate and define that section of the material system where the electrical repair procedure such as cable replacement or addition is to be instituted.

4.5.2 By use of the cutting tool such as a knife, mechanical scribe, or similiar device, cut along the boundaries located and defined in 4.5.1 to isolate the section of the material systems to be removed.

4.5.3 Remove the material section by cutting away the partially exposed stress skin along the defined boundaries. Continuous care must be exercised not to damage the cable or other sensitive items beneath. The use of such hand operated tools such as cutting shears or snips is authorized.

4.5.4 If larger sections have to be removed, accomplish this by cutting away material at the side and butt flanges.

4.5.5 Remove fasteners from flanges and carefully remove coated sections.

4.5.6 After work is completed, reattach envelope system using mechanical fasteners, staples or # 18 gage galvanized tie wires.

4.5.7 Apply a coating of THERMO-LAG 330-1 subliming coating in the specified wet thickness where required, including the edges and joints of the reinstalled sections. Use a trowel or caulking gun or stiff bristle brush to fill in any uncoated areas.

5.0 TOPCOAT APPLICATION

5.1 Spray Application

5.1.1 Pour Part B into Part A and thoroughly mix using a mechanical mixer. Mix a minimum of 5 minutes and allow a "sweat in" period of 20 minutes before commencing the application.

5.1.2 Insure that the area to be topcoated is free from loose and foreign matter.

5.1.3 Take moisture meter readings of the applied subliming coated surface using a Delmhorst Moisture Meter (Model DP) or equivalent. Obtain a reading of 20 or less before applying the topcoat.

5.1.4 Place mixed material into spray rig.

5.1.5 Apply topcoat in a smooth even pattern, making sure to criss-cross the area in a continuous film.

5.2 Hand Application

5.2.1 Apply a full smooth coat of topcoating using a long nap mohair roller. Avoid excessive buildup of topcoat in corners and always work to a wet edge of applied topcoat.

6.0 POST APPLICATION PRACTICES

6.1 A clean and orderly condition shall be maintained in the application area. Following the application, all overspray, debris and equipment shall be removed and the area left in a condition acceptable to the owner.

7.0 EQUIPMENT SUGGESTIONS

7.1 The most economical and satisfactory method of applying THERMO-LAG 330-1 Subliming Coating is by either airles or air type spray equipment.

7.1.1 Air type spray equipment is recommended for use in spraying cable drops and conduit in order to minimize overspray.

7.1.2 Airless spray equipment is recommended for use in spraying larger sections such as cable trays and large I beams.

7.1.3 Suggested complement of spray equipment for both types are shown in Appendix B.

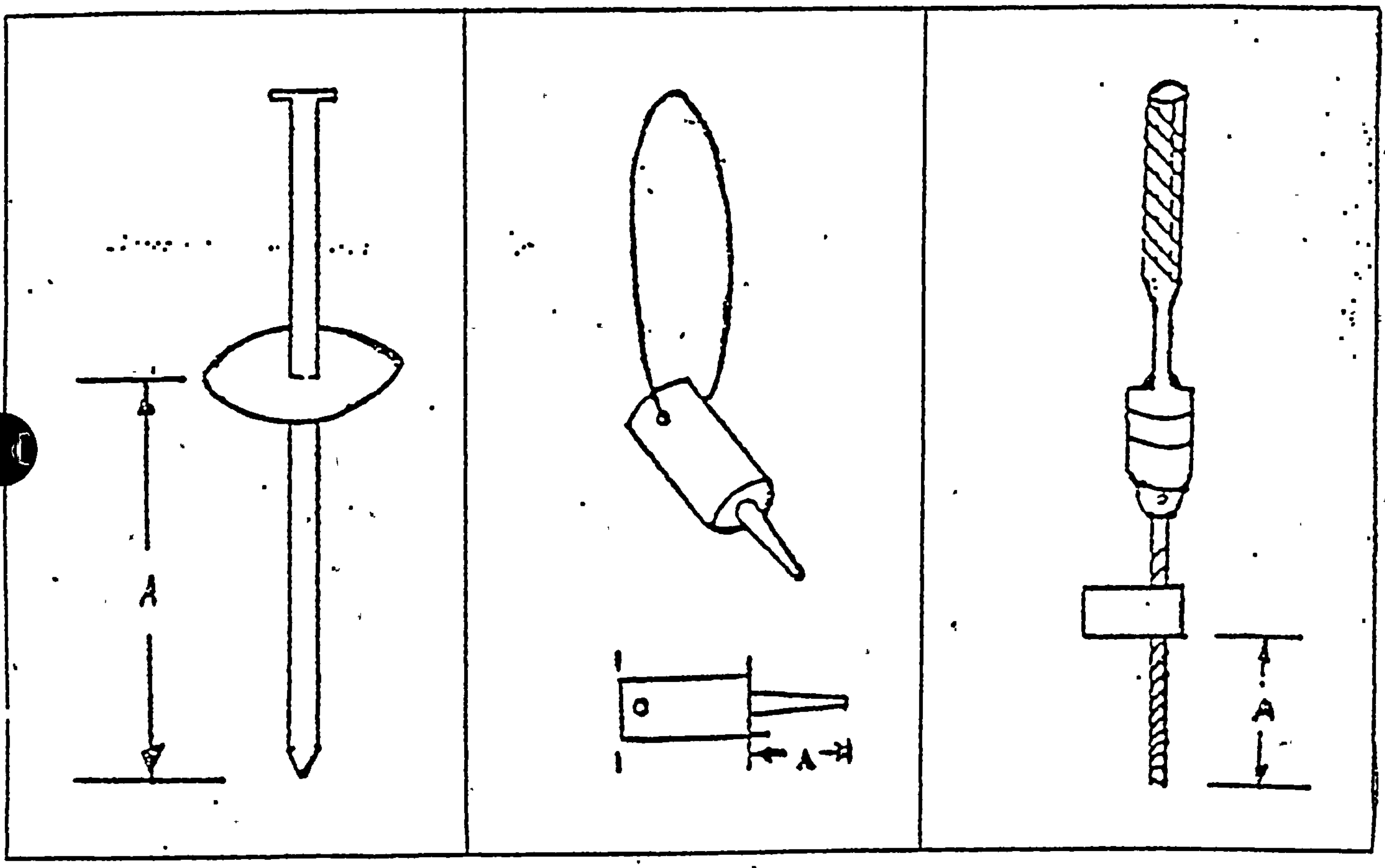
APPENDIX A

SCHEMATIC OF SUGGESTED PENETRATING MEASURING DEVICES

APPENDIX A

SCHEMATIC OF SUGGESTED PENETRATING

MEASURING DEVICES



"A" is equal to the desired thickness of the coating.

On measurement - the pin portion of the gauge must sink completely into the layer of the applied coating. Take several readings for each thickness. Fill the hole created by the gauge after measurement is completed.

APPENDIX B

SUGGESTED COMPLEMENT OF REQUIRED SPRAY EQUIPMENT FOR THERMO-LAG 330-1 SUBLIMING COATING APPLICATION

APPENDIX B

SUGGESTED COMPLEMENT OF REQUIRED SPRAY EQUIPMENT FOR THERMO-LAG 330-1 SUBLIMING COATING APPLICATION

AIRLESS SPRAY EQUIPMENT

QUANTITY	DESCRIPTION OF EQUIPMENT		
1 Each	Hydra Spray Pump 45:1		
1 Each	Air Powered Ram		
1 Each	Hydra Mastic Spray Gun		
1 Each	Special Dump Valve		
2 Each	RAC III with 0.55 Tips		
1 Each	Air Agitator		
1 Each	Air Regulator Kit		
1 Each	Air Regulator Only with Gauge		
1 Each	Air Line Filter		
1 Each	Air Line Lubricator		
5 Each	Pump Repair Parts Kits		
6 Each	Extra Tips with Seals		
100 Feet	1 Inch	I.D.	Hi Pressure Fluid Hose
75 Feet	1/2 Inch	I.D.	Hi Pressure Fluid Hose
25 Feet	3/8 Inch	I.D.	Hi Pressure Fluid Hose

APPENDIX B

(CONTINUED)

AIR TYPE SPRAY EQUIPMENT

QUANTITY	DESCRIPTION OF EQUIPMENT
1 Each	10:1 President Spray Pump
1 Each	Air Powered Ram
1 Each	Heavy Mastic Spray Gun
1 Each	Special Dump Valve
2 Each	1/4 Inch or 1/4 Inch "E" Spray Tip
1 Each	Air Agitator
1 Each	Air Regulator Kit
1 Each	Air Regulator Only with Gauge
1 Each	Air Line Lubricator
1 Each	Air Line Filter
5 Each	Pump Repair Parts Kits
75 Feet	1/2 Inch I.D. Hi-Pressure Fluid Hose
25 Feet	3/8 Inch I.D. Hi-Pressure Fluid Hose

APPENDIX C

APPLICATION PROCEDURES

STRUCTURAL STEEL ENTITIES

APPENDIX C

APPLICATION PROCEDURES

STRUCTURAL STEEL ENTITIES

1.0 INTRODUCTION

This procedure sets for the sequential steps involved in applying THERMO-LAG 330-1 Subliming Coating System to structural steel entities and steel storage tanks.

The THERMO-LAG 330-1 Subliming Coating System consists of THERMO-LAG Primer, THERMO-LAG 330-1 Subliming Coating, and where applicable, THERMO-LAG Topcoat.

2.0 SURFACE PREPARATION

2.1 All surfaces to be coated are to be clean, dry, above 40°F, and free from scale, rust and other contaminants.

2.2 Prepare non-compatible surfaces for coating by applying a barrier coat of THERMO-LAG 351 or THERMO-LAG 351-2 Primer. Never apply the primer directly over a surface previously primed with a zinc based primer without installing a barrier coat. Never apply the primer directly over any hard or glossy paint without roughening the surface in accordance with standard, good painting, practice procedures and make sure that the cleaned substrate is compatible with the THERMO-LAG 330-1 Subliming Coating by making cross hatch adhesion tests.

2.3 Blast clean doubtful surfaces to an SSPC-SP6 finish and reprime immediately.

3.0 PRIMER APPLICATION.

3.1 Apply the primer to a properly prepared steel surface in one continous coat using spray equipment or a roller. The minimum acceptable dry primer thickness should be 0.002 inches which is normally achieved by applying at a rate of 200 square feet per gallon.

3.2 Measure primer thickness using an approved magnetic direct reading gauge.

3.3 Make cross hatch adhesion tests, as per Federal Standard 141A, on the primed surface to assure proper adhesion between the primer and the steel substrate prior to proceeding with the application of the THERMO-LAG 330-1 Subliming Coating.

3.4 Make at least one cross hatch adhesion test every twenty (20) square feet of primed surface area. Any primed surface area which fails the cross hatch adhesion test shall be sandblasted to an SSPC-SPC6 commercial blast finish and then shall be reprimed with THERMO-LAG 351 or THERMO-LAG 351-2 Primer.

4.0 THERMO-LAG 330-1 SUBLIMING COATING

4.1 Apply the material in as many passes as required to provide the required film build or thickness, taking care to avoid slumping or sagging of the coating. The thickness which can be safely applied in a single pass will depend upon the temperature, humidity, application technique, and other factors and should be determined at the job site.

4.2 Apply the material in smooth even passes, taking care to keep the spray gun fan pattern at a 90° angle whenever possible. Reaching with a spray gun will cause the spray pattern to vary from the 90° angle and will result in a rougher surface than normal.

4.3 Take frequent wet thickness measurements during the application using a penetration measuring device such as those shown in Appendix A to ensure that the coating is being applied uniformly and at the required wet film thickness. These wet thickness checks shall be made very five square feet or every two running feet of coated surface area. (Note: When taking measurements allow for a shrinkage rate of 25% between the wet and the desired dry film coating thickness.

4.4 Remove excess build up of coating material at edges and joints by brushing or rolling the surface with a damp sponge roller.

4.5 Spray edges of the substrate from each side to cause the material to wrap around the edge. If the edge coating is not completely closed, use a wet roller or trowel to seal the edge surface.

4.6 Apply Fiberglass Armoring, where required, to the wet surface after the final pass and use a roller to flatten out any wrinkles and to embed the fiberglass securely. Then apply sufficient coating material to cover the embedded fiberglass.

4.7 Remove all runs, sags, drips or other surface imperfections before the material cures using wet sponge rollers, brushes or hand trowels.

4.8 Take dry film thickness measurements after the applied material has cured. Measurements shall be made using electrical, penetrating or magnetic measuring instruments.

5.0 TOPCOAT APPLICATION

5.1 Insure that the area to be topcoated is free from loose and foreign matter.

5.2 Take moisture meter readings of the applied subliming coated surface using a Delmhorst Moisture Meter (Model DP) or equivalent. Obtain a reading of 20 or less before applying the topcoat.

5.3 Place mixed material into spray rig.

5.4 Apply topcoat in two continuous coats at a minimum spread rate of 50 square feet per gallon in a smooth even pattern, making sure to criss-cross the area in a continuous film.

6.0 <u>CLEAN UP</u>

6.1 A clean and orderly condition shall be maintained in the application area. Following the application, all overspray, debris and equipment shall be removed and the area left in a condition acceptable to the owner.

APPENDIX D

TYPICAL APPLICATION DETAILS

APPENDIX D

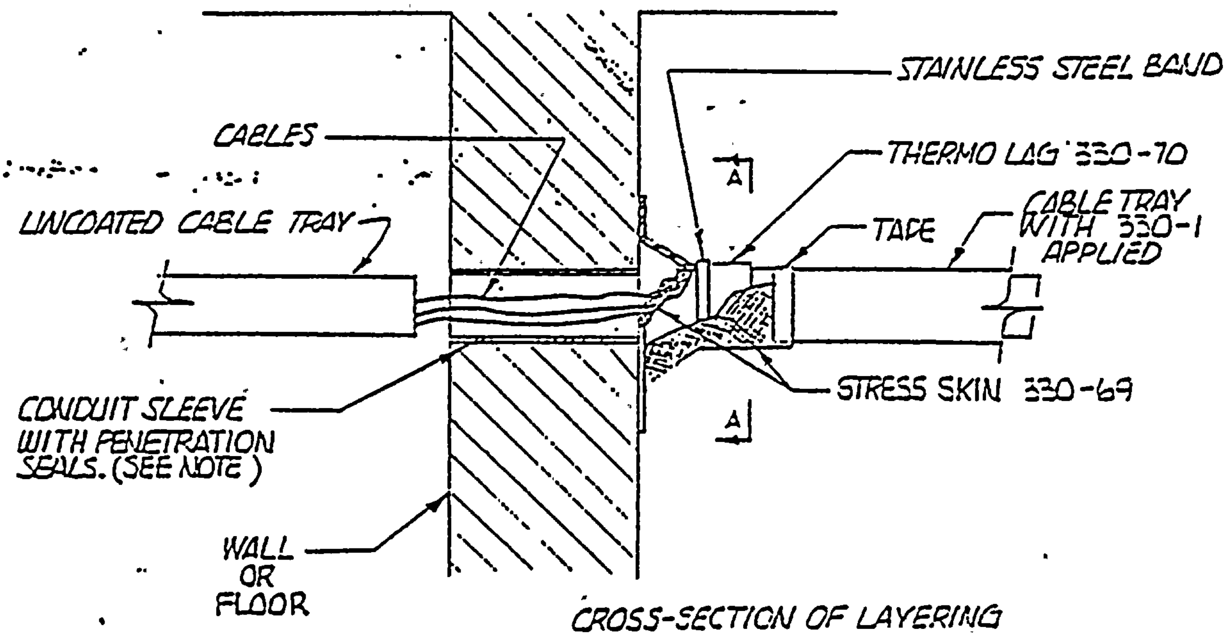
TYPICAL APPLICATION DETAILS

TABLE OF CONTENTS

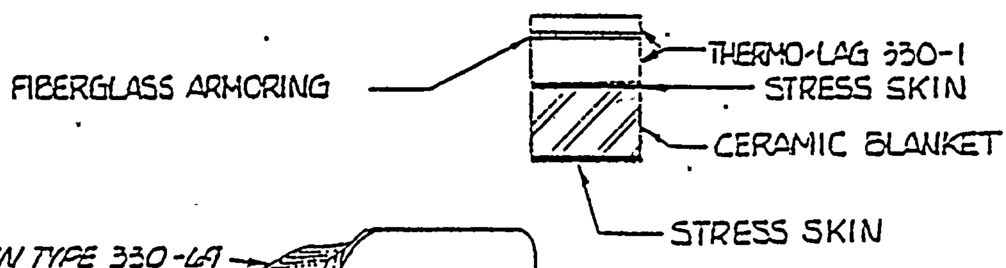
TEXAS UTILITIES SERVICES, INC. C.P.S.E.S. GLEN ROSE, TEXAS					
FIRE PROTECTION DWG. FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS					
DWG TITLE: TYPICAL APPLICATION DETAILS				SCALE: NONE	
DATE: 8/18/81	DWN: KLA	CK'D KUK	APP'D	ISSUED FOR CONSTRUCTION	DWG NO. 1 of 1

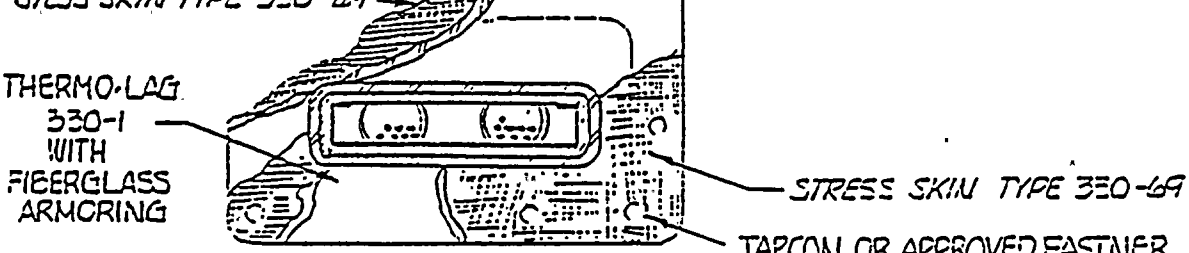
CABLE AIR DROP FROM TRAY INTO WALL OR FLOOR SLEEVE

SCALE: NONE



CROSS-SECTION OF LAYERING



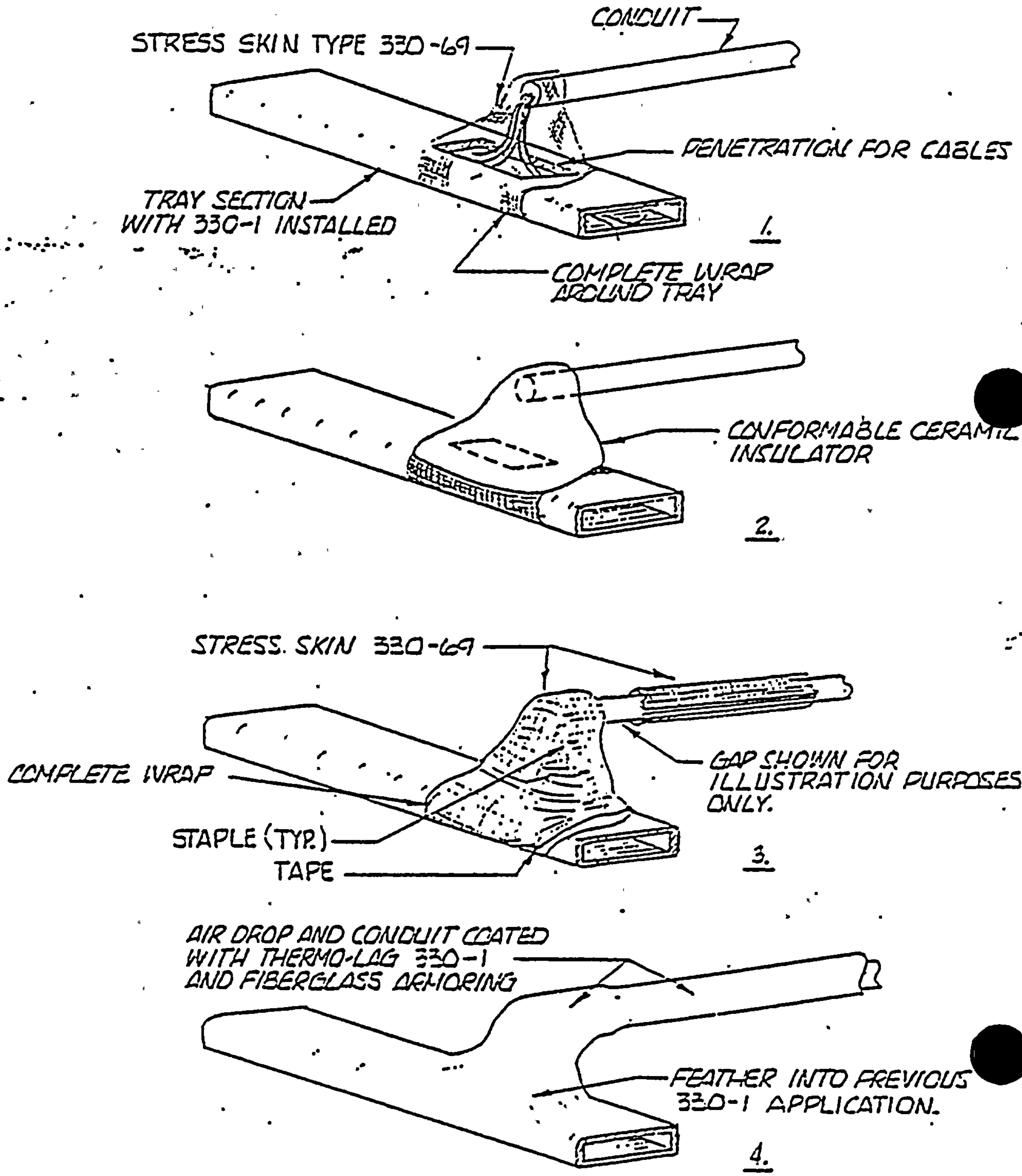


SECTION A-A

NOTE: PENETRATION SEALS BY OTHERS.

TEXAS UTILITIES SERVICES, INC. C.P.S.E.S. · GLEN ROSE, TEXAS					
FIRE PROTECTION DWG. FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING & SUPPORTS					
DWG TITLE: TYPICAL APPLICATION DETAILS			SCALE: NONE		
DATE: 3/18/81	DWN: KLA	CK'D KNK	APP'D	ISSUED FOR CONSTRUCTION	DWG NO. 1 of 1. 2

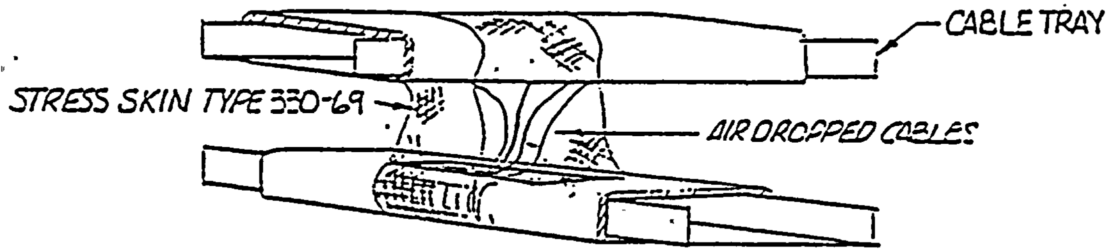
CABLE AIR DROP BETWEEN CONDUIT & TRAY



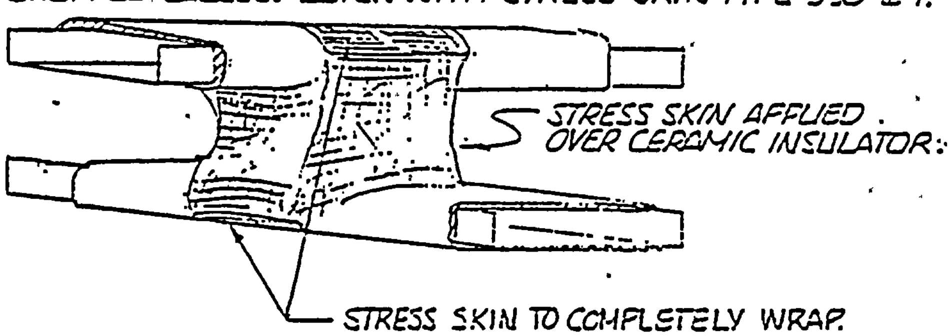
TEXAS UTILITIES SERVICES, INC. C.P.S.E.S. GLEN ROSE, TEXAS					
FIRE PROTECTION DWG. FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS					
DWG TITLE: TYPICAL APPLICATION DETAILS			SCALE: NONE		
DATE: 3/11/81	DWN: KLA	CK'D KNK	APP'D	ISSUED FOR CONSTRUCTION	DWG NO. 3 1 of 1

CABLE AIRDROP BETWEEN TRAYS

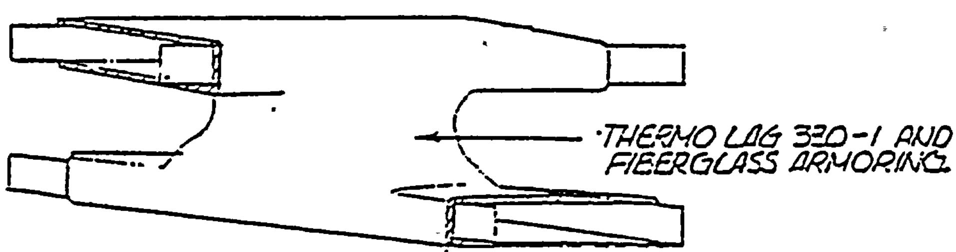
1. PREPARE ADJACENT TRAY SECTIONS LEAVING OPENING FOR AIR DROP CABLES. WRAP COMPLETELY WITH STRESS SKIN TYPE 330-69.



2. ATTACH THERMO-LAG CONFORMABLE CERAMIC INSULATOR BETWEEN THE TRAY SECTIONS COMPLETELY ENCLOSING THE AIR DROPPED CABLES. COVER WITH STRESS-SKIN TYPE 330-69.



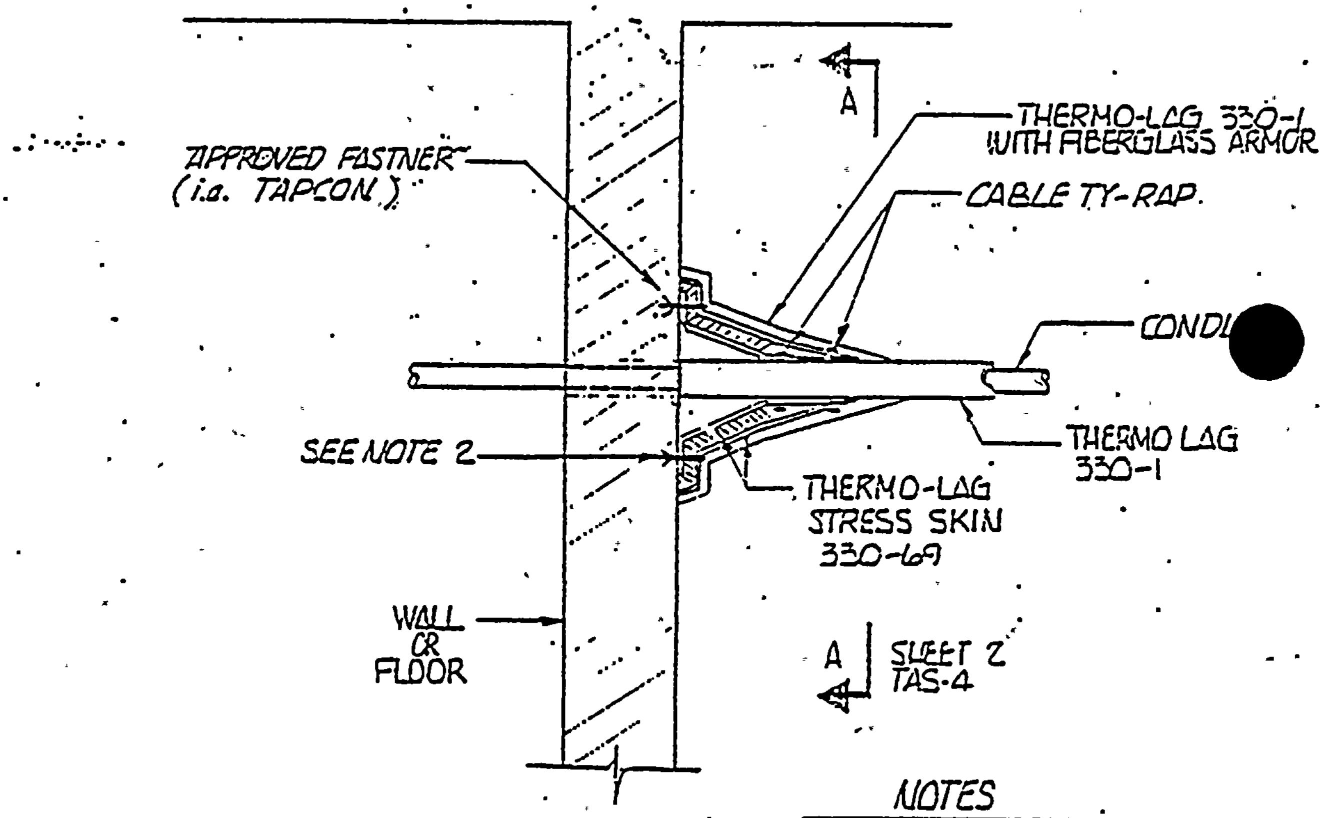
3 COAT WITH T-LAG 330-1 AND HAND FINISH TO MATE WITH PREVIOUS 330-1 APPLICATION.



4. COVER WITH THERMO-LAG 350 TOPCOAT.

TEXAS UTILITIES SERVICES, INC. C.P.S.E.S. GLEN ROSE, TEXAS					
FIRE PROTECTION DWG. FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS					
DWG TITLE: TYPICAL APPLICATION DETAIL			SCALE: NONE		
DATE: 3/11/81	DWN: KLA	CK'D KNK	APP'D	ISSUED FOR CONSTRUCTION	DWG NO. 4 1 of 2

CONDUIT EMBEDDED INTO WALL OR FLOOR



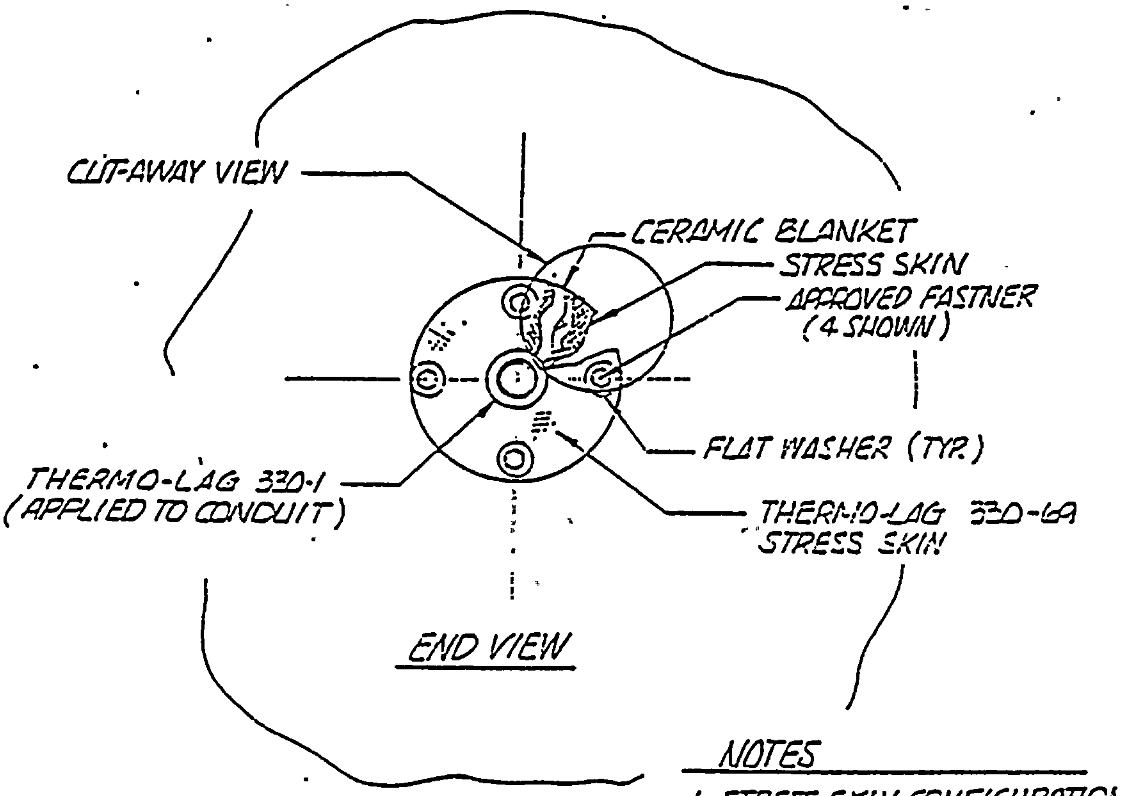
NOTES

1. TYPE OF FASTNER AT APPLICATORS OPTION SUBJECT TO ACCEPTANCE BY TUSI ENGINEERING.

2. FASTNER PLACEMENT:
   1"-1 3/4" EMBEDMENT } TYP.
   1½" MIN. EDGE DISTANCE

TEXAS UTILITIES SERVICES, INC. C.P.S.E.S. GLEN ROSE, TEXAS					
FIRE PROTECTION DWG. FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS					
DWG TITLE: TYPICAL APPLICATION DETAIL			SCALE: NONE		
DATE: 3/11/81	DWN: KLA	CK'D	APP'D	ISSUED FOR CONSTRUCTION	DWG NO. 4 2 of 2

SECTION A-A
FIGURE TAS-4 (PG. 1)
(PRIOR TO THERMO-LAG 330-1 COAT.)

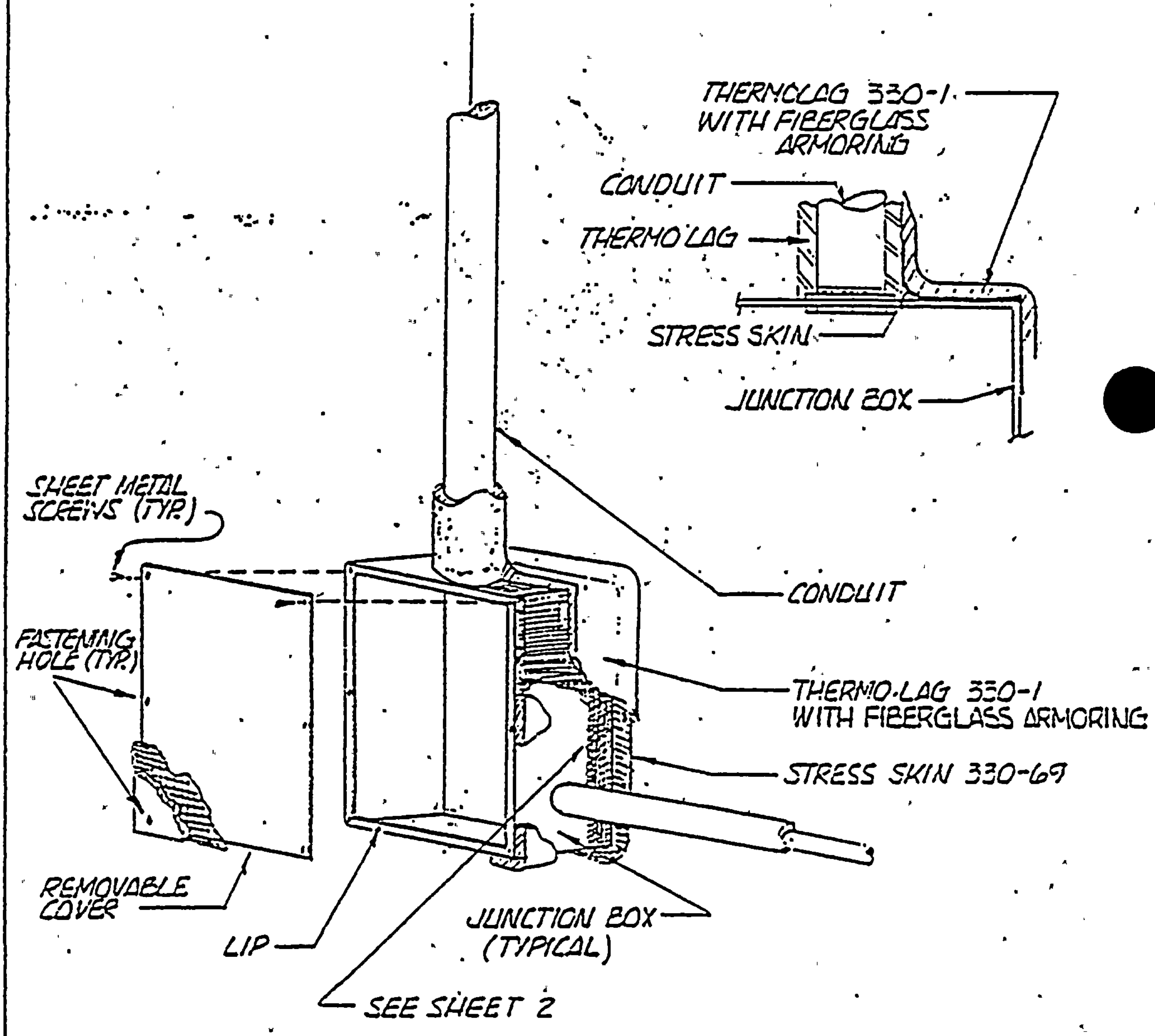


END VIEW

NOTES
1. STRESS SKIN CONFIGURATION AGAINST WALL NEED NOT BE ROUND AS DRAWN
2. FASTNER PLACEMENT: 1" – 1 3/4" EMBEDMENT 1 1/2"

TEXAS UTILITIES SERVICES, INC. C.P.S.E.S. GLEN ROSE, TEXAS						
FIRE PROTECTION DWG. FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS						
DWG TITLE: TYPICAL APPLICATION DETAIL				SCALE: NONE		
DATE: 8/5/81	DWN: KLA	CK'D KWK	APP'D	ISSUED FOR CONSTRUCTION	DWG NO. 1 of 2	5

JUNCTION BOXES



TEXAS UTILITIES SERVICES, INC.
C.P.S.E.S. GLEN ROSE, TEXAS

FIRE PROTECTION DWG. FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS

DWG TITLE: TYPICAL APPLICATION DETAIL			SCALE: NONE		
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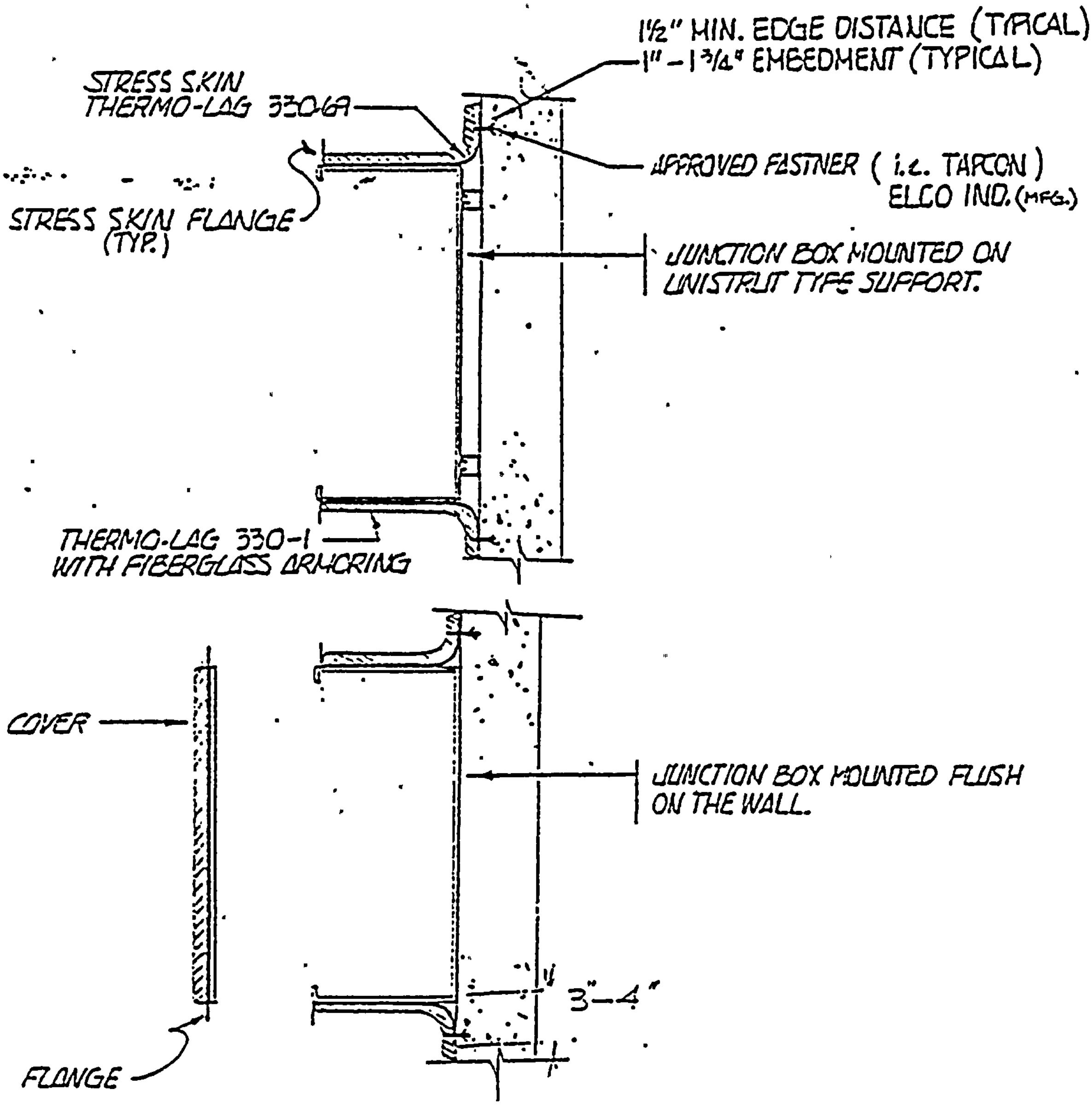
JUNCTION BOXES



APPENDIX E

FIRE PROOFING COATING THICKNESSES REQUIRED FOR VARIOUS STRUCTURAL STEEL MEMBERS

ENGINEERING REPORT

ON

THE THERMO-LAG 330-1 FIREPROOFING COATING THICKNESSES

REQUIRED FOR

1 AND 2 HOUR FIRE RATINGS FOR VARIOUS STRUCTURAL STEEL

MEMBERS USED BY TEXAS UTILITIES SERVICES, INC.

Prepared

for

TSI, INC.

3260 Brannon Avenue

St. Louis, MO 63139

By

Wesson and Associates, Inc.
P. O. Box 1082
Norman, Oklahoma 73070

ENGINEERING REPORT

ON

THE THERMO-LAG 330-1 FIREPROOFING COATING THICKNESSES

REQUIRED FOR

1 AND 3 HOUR FIRE RATINGS FOR VARIOUS STRUCTURAL STEEL

MEMBERS USED BY TEXAS UTILITIES SERVICES, INC.

I. INTRODUCTION

The purpose of this report is to present and summarize the calculated Thermo-Lag 330-1 Fireproofing Coating thicknesses for the various structural steel members that are used by Taxas Utilities Services, Inc.

The fireproofing coating thicknesses have been calculated for two fire exposure times; a one (1) hour fire exposure and a three (3) hour fire exposure period. As discussed in detail in Section III of this report, the fire exposure is the commonly accepted ASTM - E - 119 Test Method. Using this Test Method, the integrated average Incident Heat Flux for a one (1) hour fire exposure is equal to 24,500 BTU/hr-ft^2, and the three (3) hour Incident Heat Flux is equal to 42,000 BTU/hr-ft^2.

In the Thermo-Lag 330-1 Fireproofing Coating thicknesses presented herein, the following structural steel member sizes and shapes, as well as the noted structural steel temperature limits were considered in the applicable heat transfer analses:

STRUCTURAL MEMBER	MAXIMUM SURFACE TEMPERATURE - °F
Square Structural Tubing	1000
Rectangular Structural Tubing	1000
Angles	1000
Channels	1000
Wide Flanges	1000
Unistrut Sections-All Types	1000

It should be recognized that the thickness of a given structural steel member significantly affects the required fireproofing coating thickness, regardless of the type of fireproofing coating used, for a given incident heat flux and fire exposure period. Hence, the thicknesses required for a Three (3) Hour Fire Rating are substantially greater than those required for a One (1) Hour Fire Rating.

The calculated fireproofing coating thicknesses reported herein are derived from Basic Engineering Data Correlations that we have developed for the Thermo-Lag 330-1 Fireproofing Coating. The experimental data sources include the results of fire testing conducted by the Underwriters' Laboratories, Factory Mutual Research, US Department of Transportation/Federal Railroad Administration, Mobil Oil Corporation, British Gas Corporation, British Petroleum Company, Shell International, and ourselves.

II. FIREPROOFING COATING MATERIAL TEST DATA CORRELATIONS-STRUCTURAL STEEL MEMBERS

The thermal performance characteristics of fireproofing materials such as Thermo-Lag 330-1, Thermo-Lag 290, Chartek 59, Korotherm and Pyrocrete 102 have been found to correlate as:

$$t = \text{A Function of } (T, \Delta T, W, \text{ and } F) \qquad (1)$$

where t = fire/flames exposure time, minutes

T = fireproofing material thickness, inches

ΔT = allowable maximum temperature rise of the protected substrate, degrees "F"

W = effective heat capacity of the protected substrate, lbs per square foot of protected surface area

F = total incident heat flux (radiative plus convective), thousands of $BTU/HR\text{-}FT^2$.

Experimental engineering test data expressing the fire/flames exposure time as a function of the fireproofing material coating thickness, the temperature rise of the thermally protected substrate, the weight of the protected substrate and the total incident heat flux have been developed for the Thermo-Lag 330-1 Subliming Compound Fireproofing Material applied to conventional concrete, pre-stressed concrete, flat steel plates, large diameter steel plates, pipes and structural I-Beams and Angles. The range of total incident heat fluxes in these testing programs has varied from a low of 10,000 $BTU/HR\text{-}FT^2$ to a high of 100,000 $BTU/HR\text{-}FT^2$. The Thermo-Lag 330-1 dry film thicknesses have varied from a low of 0.125 inches to a high of 1.250 inches.

In this Engineering Report we are concerned only with the requirements for the fireproofing coating materials that are applied to structural steel members. The fire testing data accumulated on the Thermo-Lag 330-1 fireproofing materials applied to structural I-Beams is presented in Figure 1 in the form of,

$$t = \text{A Function of } (T)\ (\Delta T)\ (W)^{\frac{1}{2}} / (F), \qquad (2)$$

As also shown by Figure 1, the Equation for the prediction of the required fireproofing material thickness applied to structural I-Beams is given as,

$$t = 1.514 \left[(T)\ (\Delta T)\ (W)^{\frac{1}{2}} / (F)\right]^{1.172} \qquad (3)$$

where (W) is expressed in pounds per foot of length of the protected I-Beam.

A similar engineering test data correlation for the Thermo-Lag 330-1 fireproofing material applied to steel flat plates and pipes is presented in Figure 2. The equation for the prediction of the required fireproofing material thickness is given as,

$$t = 23.002 \left[(T)\ (\Delta T)^{0.7}\ (W)^{0.5} / (F)\right]^{1.3356} \qquad (4)$$

where (W) is expressed in pounds per sq-ft for the flat plates. As noted on Figure

FIGURE 1: CORRELATION OF THE THERMAL PERFORMANCE CHARACTERISTICS OF THE THERMO-LAG 330-1 FIREPROOFING COATING APPLIED TO STRUCTURAL STEEL COLUMNS

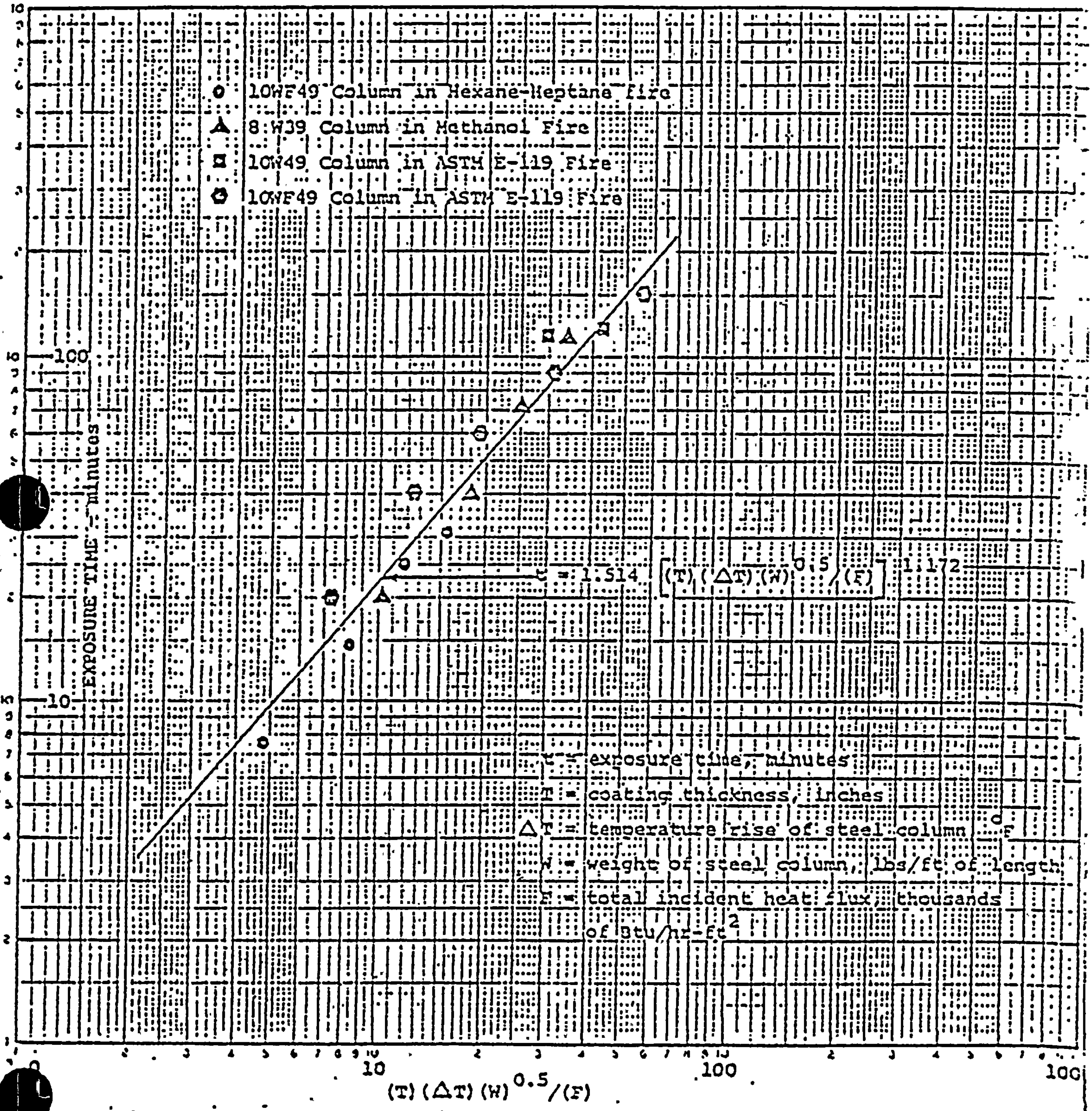
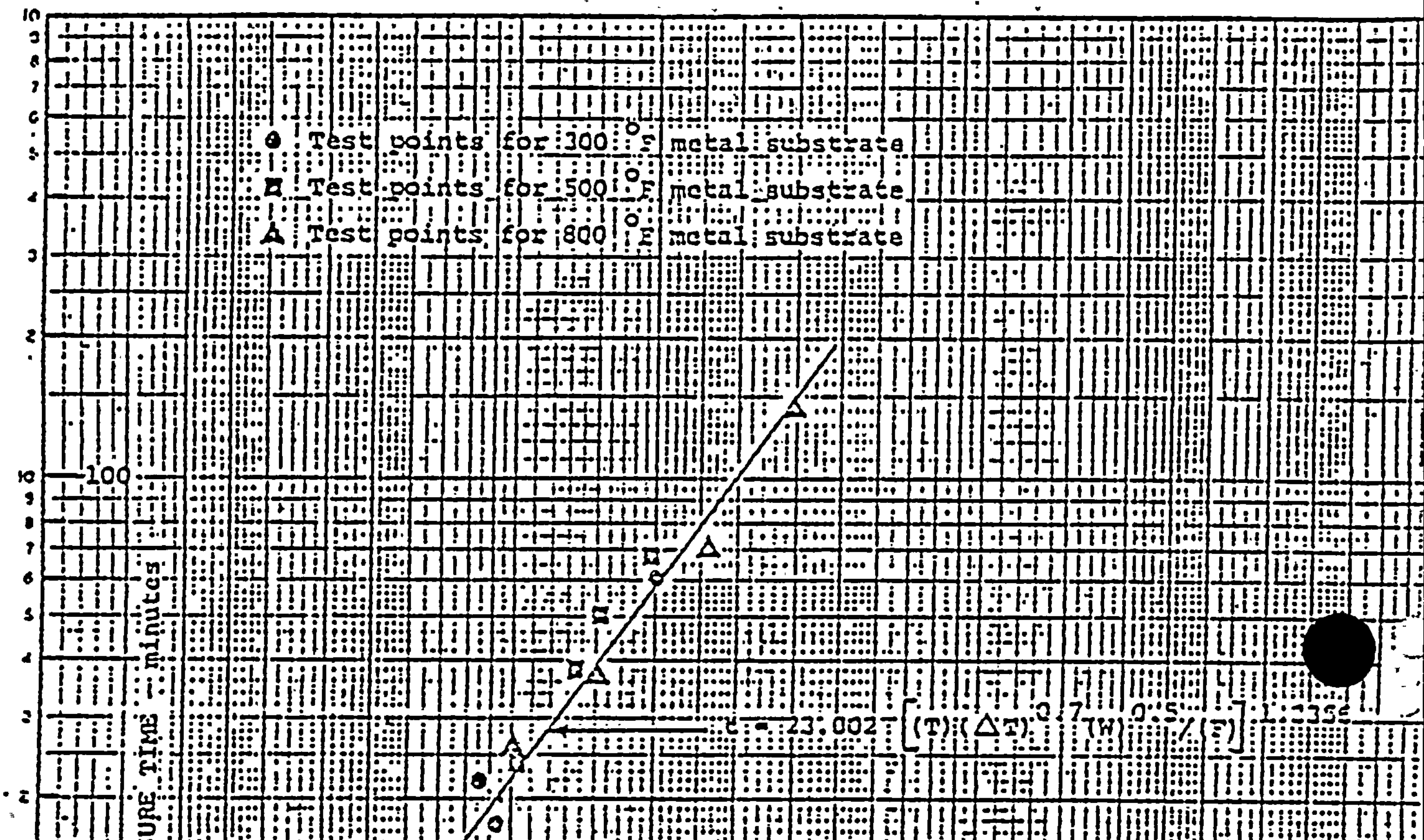


FIGURE 2: CORRELATION OF THE THERMAL PERFORMANCE CHARACTERISTICS OF THE THERMO-LAG 330-1 FIREPROOFING COATING APPLIED TO CARBON STEEL PLATES AND PIPES



for the fireproofing thickness requirements for various structural steel Channels, Angles, Flat Plates and Unistruts, as currently utilized by the Texas Utilities Services, Inc., that are exposed to heating conditions on 'Both Sides', the factor (W) is expressed in terms of pounds per square foot of surface area using one-half the plate, section thickness, or angle thickness for calculation of the member weight per squate foot per linear foot of length.

The report reader is cautioned that the Thermo-Lag 330-1 fireproofing coating thicknesses reported herein are probably the 'minimum' fireproofing coating thicknesses that are available from the 'passive thermal coatings' which have been commercially approved. Hence, if the coating thicknesses reported herein are used, they 'will not' be applicable to other types of fireproofing coating materials. If other materials are considered, the required thickness could vary from moderate increases over the thicknesses presented herein to very large thickness increases, depending upon the specific material being considered.

III. DETERMINATION OF THE REQUIRED FIREPROOFING COATING THICKNESS AS A FUNCTION OF THE FIRE EXPOSURE TIME PERIOD

As discussed in the INTRODUCTION to this report, both the ASTM - E - 119 Test Method and the total incident heat fluxes resulting from actual flammable liquid spill fires are widely used for the determination of the required fireproofing coating thicknesses for various structural steel members. Each of these two methods are discussed separately below.

A. ASTM - E - 119 Test Method

NOTE: For ease of reference, Appendix (E) presents a copy of the ASTM - E - 119 Test Method.

The ASTM - E - 119 Test Method utilizes a specific Time-Temperature Relationship for testing of the fire resistive capabilities of the various fireproofing coating materials. This Time-Temperature Relationship is presented in Figure 3. As shown, the Test Set-up Internal Air Temperature starts at the prevailing ambient air temperature, reaches a temperature of 1700 ^oF at the end of the first hour of exposure, a temperature of 1850 ^oF at the end of the second hour of exposure and a temperature of about 1950 ^oF at the end of the third hour of exposure. As such, this Time-Temperature History DOES NOT fairly represent the Time-Temperature Relationship for a typical flammable liquid hydrocarbon spill fire wherein the temperature within the flames zone may very quickly (within a few SECONDS) reach a value of 2200 ^oF or more depending on the specific fuel. Thus, as such the ASTM - E - 119 Test Method does not provide a uniform target incident heat flux, as would a typical hydrocarbon spill fire. For this reason many Insurance Underwriters' require a long term (up to three hours) Fire Rating when applying the ASTM - E - 119 Test Method to hydrocarbon Processing Facilities.

However, using accepted engineering practices, the Figure 1 Time-Temperature Relationship can be converted to a Heat Flux-Time Relationship. Such a relationship for the ASTM - E - 119 Test Method is presented in Figure 4. As shown, the Time Averaged Heat Flux for the first hour of exposure is equal to 24,500 BTU/HR-FT^2, the Time Averaged Incident Heat Flux for the first two hours of fire exposure is equal to 34,500 BTU/HR-FT^2 and the Time Averaged Total Incident Heat Flux for the first three hours of fire exposure is equal to about 42,000 BTU/HR-FT^2. Using this basis of Time Averaged Incident Heat Flux, the fire resistive capabilities of a given fireproofing material to an equivalent hydrocarbon spill fire can be obtained.

B. Hydrocarbon Pool Fire Total Heat Fluxes:

It MUST be emphasized that all hydrocarbon liquid spill fires DO NOT liberate the same total heating effects. As shown by Table I, different liquid hydrocarbon spill fires have very different heating effects. For example, a spill fire involving Methanol will only yield a total incident heat flux of about 12,000 BTU/HR-FT^2, while a spill fire involving LPG could yield up to 40,000 BTU/HR-FT^2 for large diameter spill fires (fire diameters in excess of 10 meters).

Since the Total Heat Flux, "F" appears as a linear term in Equations (3) and (4), it is very important to know the type of flammable liquid hydrocarbon spill fire for the determination of the required fireproofing material thickness.

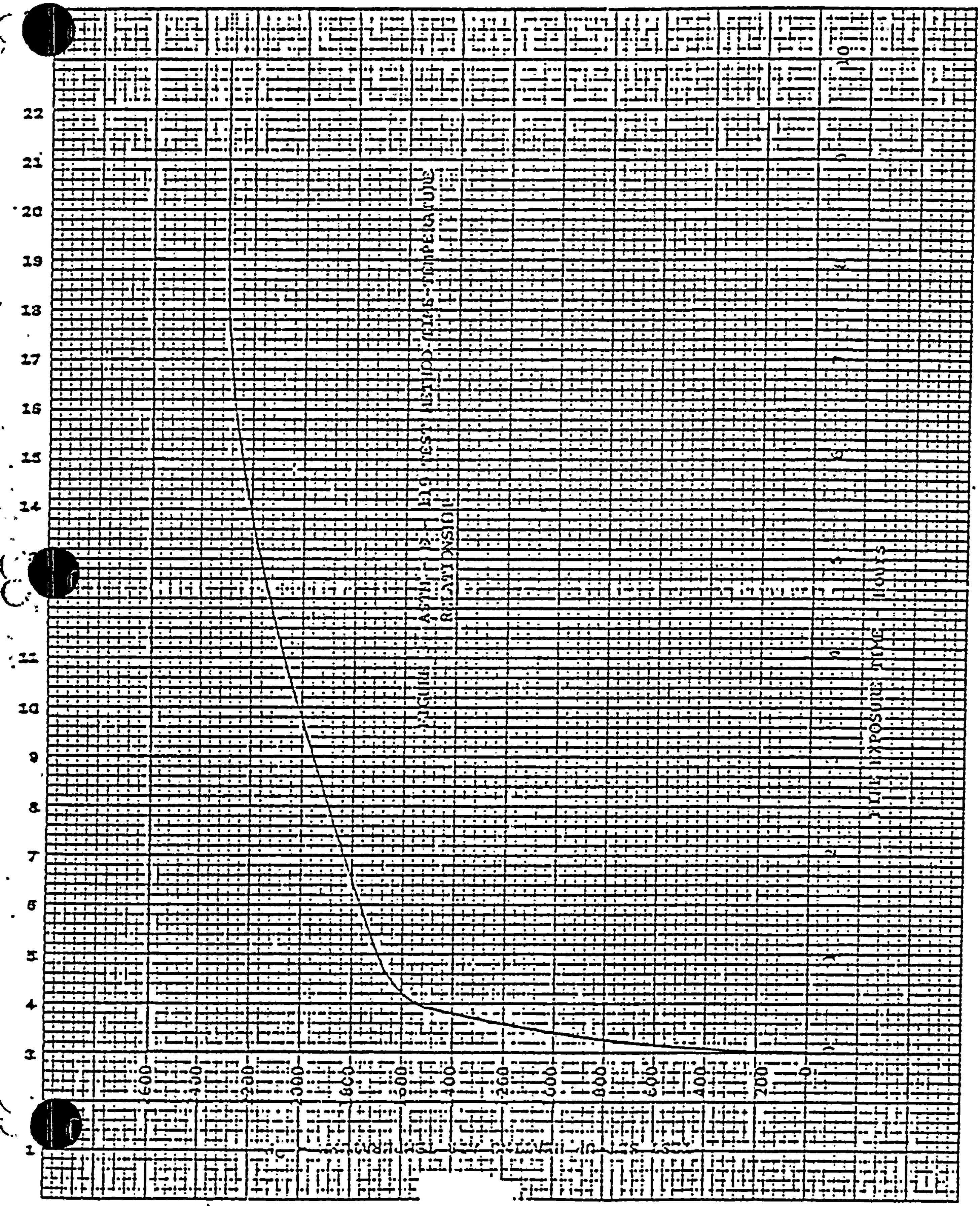


FIGURE 4: ASTM -E -119 TEST METHOD FIRE TEST SET-UP INCIDENT HEAT FLUX LEVEL AS A FUNCTION OF FIRE DURATION/EXPOSURE TIME

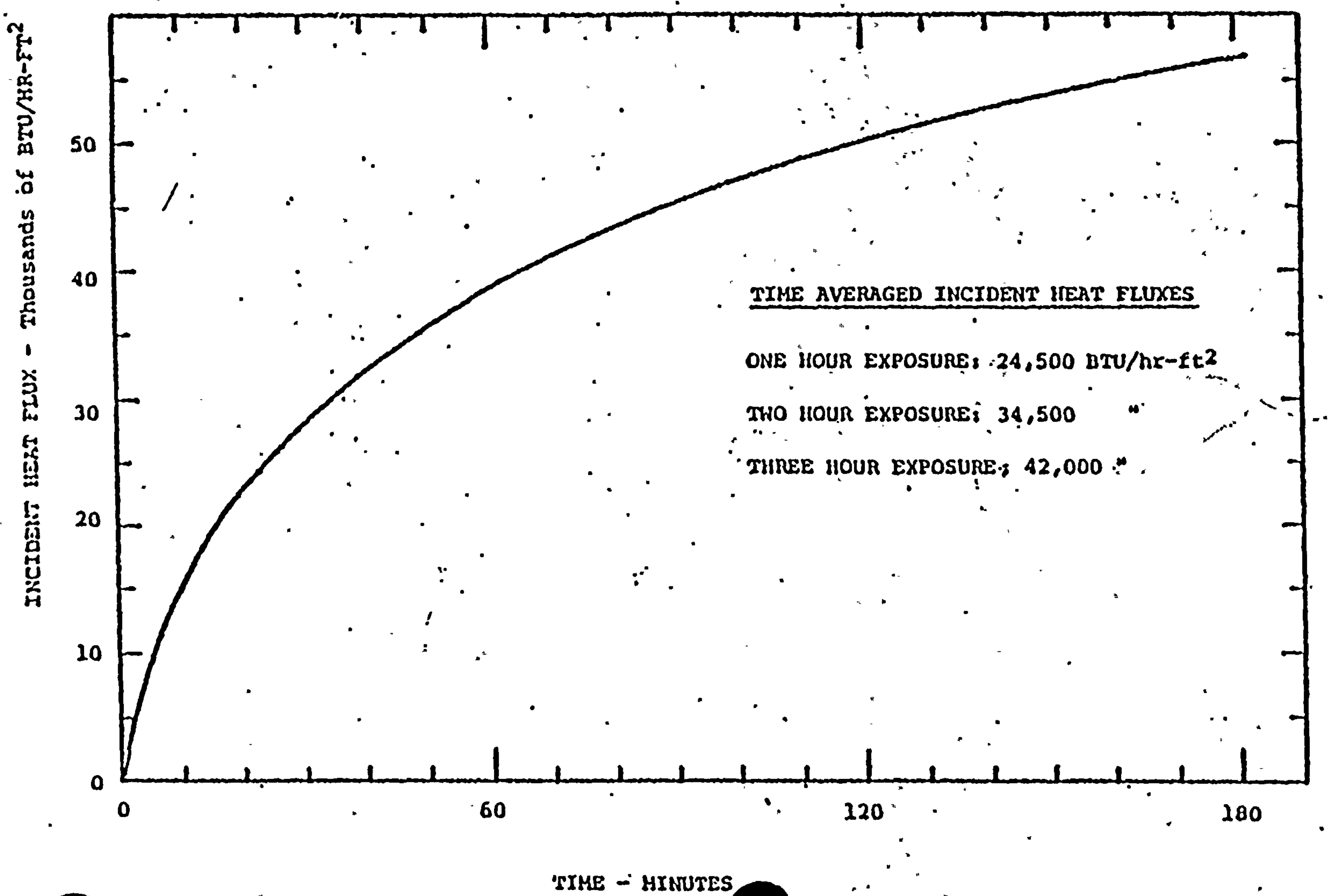


TABLE I

SUMMARY OF TOTAL CONTACT HEAT FLUXES FOR VARIOUS TYPE HYDROCARBON FLAMES

TYPE OF FUEL	MAXIMUM HEAT TRANSFER TO A COLD TARGET (BTU/HR SQ-FT)		
	RADIANT	CONVECTIVE	TOTAL
Methanol	5,000	7,000	12,000
Acetone	10,000	7,000	17,000
Hexane	22,500	7,000	29,500
Cyclohexane	31,000	7,000	38,000
JP-4:Small Fires	23,700	7,000	30,700
JP-4:Large Fires	31,000	10,000	41,000
Benzol	39,000	7,000	46,000
LPG:Impinging Type Fires	------	------	Avg. 64,850
LPG:Small Spills	25,500	7,000	32,500

REFERENCES:

1. Atallah, S. and Allen, D.S., "Safe Separation Distances from Liquid Fuel Fires", Fire Technology, 1, 47 (1971).
2. Law, M., "Structural Fire Protection in the Process Industry", Building, 86-90 (18 July 1969).
3. Neill, D.T., Welker, J.M., and Sliepcevich, C.M., "Direct Contact Heat Transfer from Buoyant Diffusion Flames", J. Fire & Flammability, 1, 289 (1970).
4. Rasbash, D.J., Rogowski, Z.E., and Stark, G.W.V. "Properties of Fires and Liquids", Fuel, 35, (1956).
5. Bader, B.E., "Heat Transfer in Liquid Hydrocarbon Fuel Fires", Proceedings, International Symposium for Packaging and Transportation of Radioactive Materials, Sandia Corporation and U.S. Atomic Energy Commission, SC-RR-65-98, Albuquerque, NM (12-15 January 1965).
6. Anderson, C., Townsend, W., Markland, R., and Zook, J., "Comparison of Various Thermal Systems for the Protection of Rail Cars Tested at the FRA/BRL Torching Facility", BRL Interim Memorandum Report No. 459 (December 1975), Funded under Federal Railroad Administration, DCN AR 30026/Req. 731231

C. Incident Heat Fluxes For Texas Utilities Services, Inc.:

In accordance with the directions from TSI, Inc., we have used the following Incident Heat Fluxes for the fireproofing coating thickness requirements as reported herein:

- One (1) Hour Fire Rating: The One (1) Hour Fire Rating has been based upon the Incident Heat Flux Level associated with a one (1) hour exposure to the ASTM-E-119 Test Method, as shown by Figure 1. As shown, the integrated incident heat flux for one (1) hour's exposure to the ASTM-E-119 Test Method equates to 24,500 BTU/hr-ft^2.

- Three (3) Hour Fire Rating: The Three (3) Hour Fire Rating has also been based upon the Incident Heat Flux Level associated with a three (3) hour exposure to the ASTM-E-119 Test Method, as also shown in Figure 1. As shown, the integrated incident heat flux for three (3) hour's exposure to the ASTM-E-119 Test Method equates to 42,000 BTU/hr-ft^2.

IV. STRUCTURAL STEEL MEMBER REQUIRED FIREPROOFING COATING THICKNESSES.

A complete listing of the calculated Thermo-Lag 330-1 fireproofing coating thicknesses for each of the structural steel members as specified in the letter from Texas Utilities Services, Inc. to TSI, Inc., dated 9 July 1981, is presented in Appendix (A) to this report.

One (1) and Three (3) Hour Fire Rating thicknesses for Square Structural Tubing, Rectangular Structural Tubing, Angles, Channels, Wide Flange Beams and a wide variety of Unistruts are presented. The physical properties for the Unistrut Members was taken directly from "UNISTRUT, General Engineering Catalog, No. 9" forwarded to TSI, Inc. by Texas Utilities Services, Inc., and reforwarded to us by TSI, Inc.

It should be emphasized that the Appendix (A) calculated Thermo-Lag 330-1 fireproofing coating material thicknesses do NOT include a 10 percent aging and weathering allowance in accordance with the long term Environmental Test Programs conducted by Underwriters' Laboratories, U.S. Army Ballistics Research Laboratories and commercial users in the Hydrocarbon (Oil and Gas) Processing Industries. To provide aging and weather allowance, coating thicknesses of Appendix (A) should be increased by 10 percent.

Prepared By:

H. R. Wesson

Dr. H. R. Wesson, PE
President
Wesson & Associates, Inc.

APPENDIX (A)

CALCULATED THERMO-LAG 330-1 FIREPROOFING COATING THICKNESSES FOR TSI/TUSI STRUCTURAL STEEL MEMBERS

1 Hr. & 3 Hr. ASTM 119 Fireratings for Structural Steel

1 Hr. exposure: $F = 24{,}500$ Btu/hrft^2 (time-averaged)
3 Hr. exposure: $F = 42{,}000$ Btu/hrft^2 (time-averaged)

APPLICABLE CORRELATIONS FOR COATING THICKNESS:

1. Structural Beams:

$$T = \frac{F}{(\Delta T)(W)^{0.5}} \left[\frac{t}{1.514}\right]^{1/1.72}$$

2. Pipe, Tubing, Plate:

$$T = \frac{F}{(\Delta T)^{0.7}(W)^{0.5}} \left[\frac{t}{23.002}\right]^{1/1.3356}$$

I. SQUARE STRUCTURAL TUBING: $\Delta T = 1000 - 70 = 930°F$

Size	lb/ft	ft^2/ft	W(lb/ft)	Coating thickness (in.) 1-hour	3-hour
2x2x3/16	4.31	0.66	6.47	0.165	0.642
x1/4	5.40	0.66	8.10	0.147	0.574
3x3x3/16	6.86	1.00	6.86	0.160	0.623
x1/4	8.80	1.00	8.80	0.141	0.551
4x4x3/16	9.31	1.33	6.98	0.158	0.618
x1/4	12.02	1.33	9.02	0.139	0.544
x3/8	16.84	1.33	12.63	0.117	0.460
6x6x1/4	18.82	2.00	9.41	0.136	0.533
x5/16	23.02	2.00	11.51	0.123	0.481
x3/8	27.04	2.00	13.52	0.114	0.445
8x8x3/8	36.83	2.66	13.81	0.113	0.440
x1/2	47.35	2.66	17.76	0.100	0.388
10x10x1/2	60.95	3.33	18.29	0.098	0.382
x5/8	79.26	3.33	23.78	0.086	0.335

II. RECTANGULAR STRUCTURAL TUBING: $\Delta T = 1000 - 70 = 930°F$

Size	lb/ft	ft^2/ft	W(lb/ft)	Coating thickness (in.) 1-hour	3-hour
8x4x5/16	23.02	2.00	11.51	0.123	0.482
x3/8	27.04	2.00	13.52	0.114	0.444
6x4x3/8	21.94	1.66	13.16	0.115	0.450
x1/2	27.68	1.66	16.61	0.103	0.400

III. ANGLES: $\Delta T = 1000 - 70 = 930°F$

Note: exposure to both surfaces assumed

Size	pl thk (in.) (50% leg)	W(lb/ft^2)	Coating thickness (in.) ΔT = 930°F 1-hour	3-hour
3x3x3/8	3/16	7.65	0.151	0.590
3½x3½x3/8	3/16	7.65	0.151	0.590
x1/2	1/4	10.20	0.131	0.511
4x4x3/8	3/16	7.65	0.151	0.590
x1/2	1/4	10.20	0.131	0.511
5x5x3/4	3/8	15.30	0.107	0.417
x 1	1/2	20.40	0.092	0.361
6x6x3/4	3/8	15.30	0.131	0.417
x 1	1/2	20.40	0.092	0.361
8x6x1/2	1/4	10.20	0.131	0.511
x 1	1/2	20.40	0.092	0.361
6x4x3/8	3/16	7.65	0.151	0.590
x1/2	1/4	10.20	0.131	0.511
x 1	1/2	20.40	0.092	0.361

IV. CHANNELS

Size	web thk (in.)	W(lb/ft^2) (50% web thk)	Coating thickness (in.) ΔT = 930°F 1-hour	3-hour
MC 3x7.1	0.321	6.548	0.164	0.638
C 3x4.1	0.170	3.468	0.225	0.817
C 4x5.4	0.180	3.672	0.218	0.852
x7.25	0.320	6.528	0.164	0.639
C 6x8.2	0.200	4.080	0.207	0.808
x10.5	0.314	6.406	0.165	0.646
C 8x11.5	0.220	4.488	0.197	0.771
C10x15.3	0.240	4.896	0.189	0.738

V. WIDE FLANGES: $\Delta T = 1000 - 70 = 930°F$

Size	W(lb/ft)	Coating thickness (in.) 1-hour	3-hour
W 4x13	13	0.169	0.739
W 5x16	16	0.152	0.666
x18.5	18.5	0.141	0.619
W 6x8.5	8.5	0.209	0.913
x15.5	15.5	0.155	0.676
W 8x10	10	0.192	0.842
x13	13	0.169	0.739
x15	15	0.157	0.688
x24	24	0.124	0.544
x28	28	0.115	0.503
W 10x11.5	11.5	0.179	0.785
x15	15	0.157	0.688
x29	29	0.113	0.495

VI. UNISTRUT SECTION: $\Delta T = 1000 - 70 = 930°F$

Size	pl thk	W(lb/ft^2) (50% pl thk)	Coating thickness (in.) ΔT = 930°F 1-hour	3-hour
P 1000	0.105	0.288	0.283	1.104
1001	0.105	0.288	0.283	1.104
1001 C3	0.105	0.288	0.283	1.104
1004 A	0.105	0.288	0.283	1.104
P 3000	0.105	0.288	0.283	1.104
3001	0.105	0.288	0.283	1.104
P 5000	0.105	0.288	0.283	1.104
5001	0.105	0.288	0.283	1.104

APPENDIX 7

PRE-BURN INSPECTION

APPENDIX 7
PRE-BURN INSPECTION

1.0 FURNACE PREPARATION

1.1 Day before test date:

a. The furnace interior will be cleaned of any residual materials from previous tests. The furnace lining will be checked for cracks, etc.

b. The calibration status of the furnace temperature thermocouples (thermowells) will be checked and recalibrated if the calibration period has expired. This check will include verification of individual continuity and assuring that they are all connected in parallel for recording the furnace average temperature.

c. The burners are always checked to insure that all air regulators are free and unobstructed and that the gas supply and igniters are in order.

1.2 Test date:

a. A final check is made of the burners, gas supply and igniters.

b. The Test Engineer is advised of furnace ready status.

2.0 TEST SLAB SET UP

2.1 Day before test date:

a. The test slab will be moved from the laboratory and placed on top of the furnace. The furnace/slab interface will be sealed with ceramic fiber blanket such as Kaowool.

b. If differential pressure is to be applied, the vacuum enclosure will be installed over the test slab and slab/enclosure interface sealed. The vacuum blower system procedures will then be followed.

c. If differential pressure is not to be applied, the windbreak protective housing will be placed over the test slab and furnace.

d. The snubber stack will then be attached to the furnace flue.

2.2 Test date (Vacuum system only)

a. The blower is started and the required pressure differential is eatablished and indicated on the manometers.

b. A final check for leaks is made from both inside and outside the furnace.

c. The Test Engineer is advised of the vacuum system ready status.

APPENDIX 7

3.0. DATA SYSTEM SET UP

3.1 Day before test date:

a. The thermocouple leads from the furnace average thermocouples and the test slab and the cable integrity monitoring leads are connected to the data system input panel.

b. The fire exposure data acquisition program loading will be verified.

c. The calibrated thermocouple simulator will be set to 400°F (or any temperature calibration point as required by the sponsor)and the compensation and linearization program verified.

d. At least one scan of all data channels will be performed to verify proper functioning of all channels.

3.2 Test Date:

a. Steps 3.1b, c, and d above are repeated.

b. The data system clock will be reset and the Test Engineer advised of the data system ready status.

c. Data system will be placed on auto scan upon ignition of the burners and start signal from the Test Engineer.

APPENDIX 8

FIRE ENDURANCE TEST PROCEDURE

APPENDIX 8
FIRE ENDURANCE TEST

1.0 REQUIREMENTS.

Fire endurance tests shall be performed in compliance with the following standards and guidelines:

1) ASTM E-119(80)
2) American Nuclear Insurers Bulletin #5 (79)

2.0 GENERAL

The fire exposure will be conducted under the supervision of a Senior Research Engineer designated as the Test Engineer. Once he has been advised of the ready status of the furnace and the data system, he will make a final check of the test slab and furnace prior to directing the furnace and data system technicians to ignite the burners and initiate the data acquisition.

3.0 TEMPERATURE CONTROL

Furnace temperature is normally controlled by manually adjusting the gas flow to the burners. The furnace temperature will be monitored continuously to insure tracking of the ASTM E119(80) time/temperature curve.

4.0 OBSERVATIONS

The unexposed surface of the test slab will be observed for penetration by flame or hot gases and the data, which is updated at one minute intervals will be monitored to keep abreast of the condition of the penetration seals, coatings and cables.

5.0 DOCUMENTATION

In addition to the thermocouple and cable integrity data recorded by the data system, the Test Engineer's observations and record of events as they occur will be documented with the use of a miniature tape recorder which the Test Engineer carries throughout the fire exposure period.

APPENDIX 9

HOSE STREAM TEST PROCEDURE

APPENDIX 9
HOSE STREAM TEST

1.0 REQUIREMENTS

Hose stream test shall be performed in compliance with the following standards of guidelines:

1) ASTM E-119-80
2) American Nuclear Insurers Bulletin #5 (79)

2.0 PRE-REQUISITES

1) The cables shall remain energized, and circuits shall continue to be monitored for the duration of the Hose Stream Test.
2) Acceptance criteria per reference 4.3.2 (maintain circuit integrity and continuity) apply to Hose Stream Test.

3.0 EQUIPMENT

Actual fire fighting equipment will be used to perform the hose stream tests. An International/Howe 500 gpm pumper provides a controlled water stream. A Bourdon tube type pressure gage, installed at the base of the nozzle, is used to set the nozzle pressure and a Rockwell Type SR utilities type flowmeter is used to monitor the stream flow rate.

4.0 PROCEDURE

I. Immediately prior to applying the hose stream to the test assembly, the water stream will be adjusted for the required nozzle pressure and flow rate. It will then be directed to the exposed side of the test assembly which has just been removed from the test furnace. The hose stream is normally directed first at the center of the test assembly, then gradually working outwards to uniformly cover the entire test assembly. Hose stream application time shall be 2½ minutes. One of the following stream configurations shall be used.

(1) The stream shall be delivered through a two and one-half (2½) inch national standard playpipe, equipped with one and one-eighth (1 1/8) inch tip, nozzle pressure of thirty (30) pounds per square inch, located twenty (20) feet from the system.

(2) The stream shall be delivered through a one and one-half (1½) inch nozzle, set at a discharge angle of thirty (30) degrees, with a nozzle pressure of seventy-five (75) pounds per square inch, and a minimum discharge of seventy-five (75) gallons per minute with the tip of the nozzle a maximum of five (5) feet from the system.

(3) The stream shall be delivered through a one and one-half (1½) inch nozzle set at a discharge angle of fifteen (15)

(3) (Con't)
degrees with a nozzle pressure of seventy-five (75) gallons per square inch, and a minimum discharge of seventy-five (75) gallons per minute with the tip of the nozzle a maximum of ten (10) feet from the system.

NOTE: #(1) is the preferred test per ANI Bulletin #5 (79)

APPENDIX 10

DATA SYSTEM

APPENDIX 10
DATA SYSTEM

1.0 SYSTEM COMPONENTS

1) A 200 channel microcomputer controlled digital data acquisition system as shown in the block diagram FDSG-F1, contained in this Appendix will be used to record the thermocouple data from the test penetrations, the furnace temperature, and the cable integrity.

   This system is comprised of a B&F Instruments Model SY256 Data Logger integrated with a Cromenco System III Microcomputer, a TEC Model 1440 Terminal, and a Cromenco Model HDD Disc Memory with a 10 megabyte capacity. Redundant data storage is provided by a memodyne Model 3738 Cassette Recorder.

2) A Doric Model 403 A407E Thermocouple Simulator/Calibrator shall be used to insure accuracy of the data and provide data system calibration traceable to NBS. The calibration unit is connected to the thermocouple input panel and serves to provide a reference temperature of 400°F to the microcomputer can then correct for any drift of the data logger as it processes the data for storage.

2.0 DATA ACQUISITION

1) During the fire exposure period, the thermocouples will be scanned at the rate of 20 channels per second at one minute intervals. The millivolt signals from the SY256 will be linearized and compensated by the microcomputer, displayed on the terminal's CRT, and recorded in disc memory and the cassette recorder for subsequent analysis and plotting.

3.0 DATA PROCESSING

1) Upon completion of testing, the data will be transmitted via a hardwire line to the Testing Laboratory Central Computer Facility where a CDC Cyber 171 will process the data and place it on a CDC 844-41 mass storage hard disc for permanent storage. The data will then be retrieved and transmitted to a Tektronix Model 4054 Graphic Computing System where it will be converted to graphic formatting commands and output to a Tektronix Model 4662 digital X-Y Plotter which will produce an individual graph for each of the test penetrations.

2) The Cyber 171 will also format the data for tabular print listings and transmit it to the Division remote batch facility for printout on a CDC Model 1827-30 line printer. These graphs and tubular data will then be included in the test reports.

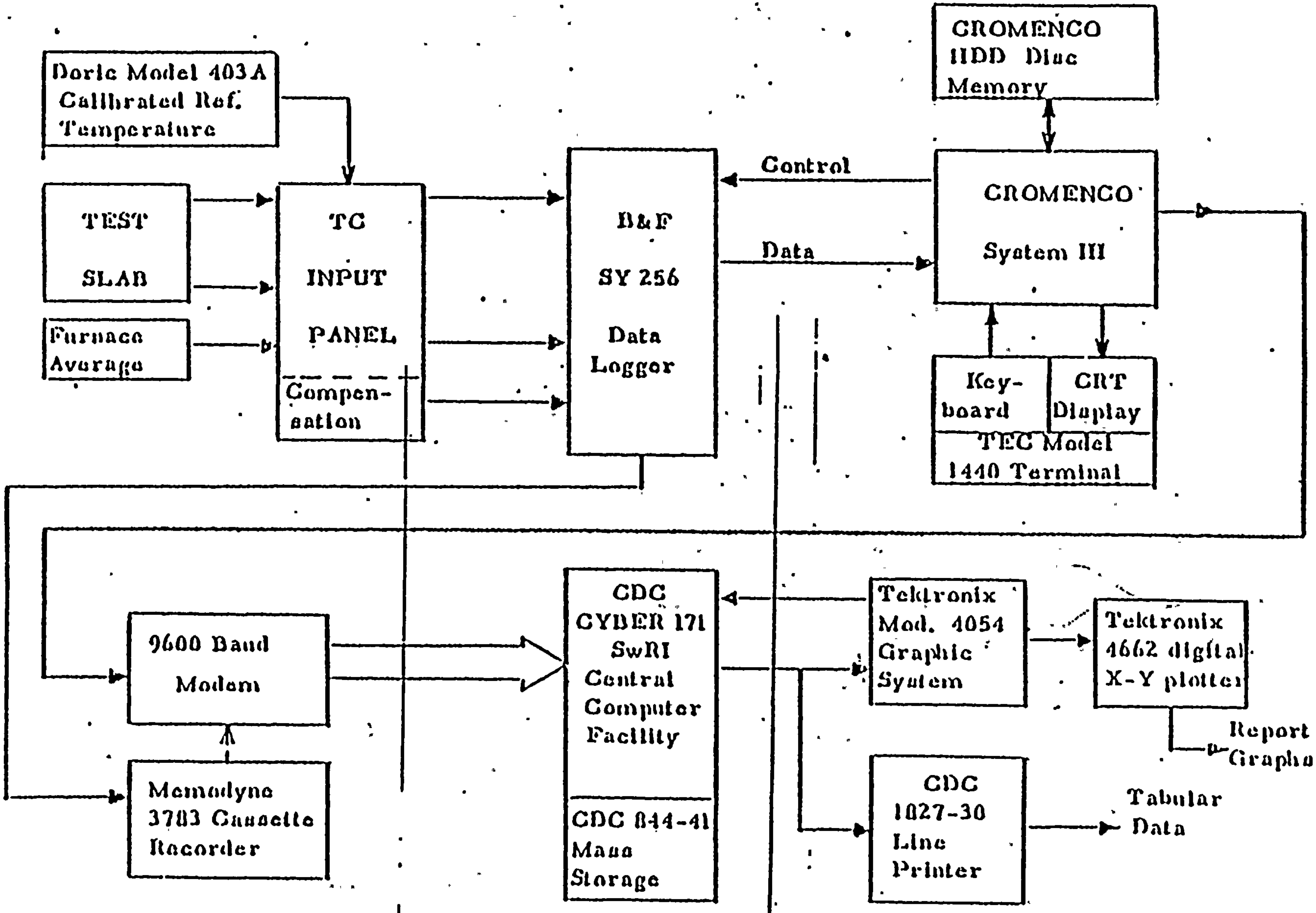


Figure FDSG-F1 Data System

APPENDIX 11
QUALITY CONTROL
QUALITY ASSURANCE

PROCEDURES FOR PRODUCT MANUFACTURE
AND PRODUCT APPLICATION FURNISHED
FOR REVIEW UPON REQUEST

G K Wolfe

F 1001
Revision D
Page 190
Appendix A

RECEIVED
SWRI SECURITY
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&
COMMUNICATIONS

SOWEST RI SNT
TSI INC STL

SOUTHWEST RESEARCH INSTITUTE

FOR THE ATTENTION OF

MR GEORGE WOLFE AND MR JESS BITEL

THE FOLLOWING IS A COPY OF OUR TLX TO MR WM BORNHOEFT
OF ANI

AMERICAN NUCLEAR INSURERS
ATTENTION: MR. WM BORNHOEFT
CC: MR GEORGE WOLFE - SOUTHWEST RESEARCH INSTITUTE
MR JESS BITEL - SOUTHWEST RESEARCH INSTITUTE
MR. R. A. BABB - TEXAS UTILITIES SERVICES CO.
MR. R. FELDMAN - TSI, INC

THE FOLLOWING ARE THE ITEMS AGREED UPON DURING LAST WEEK'S TELECON BETWEEN W. BORNHOEFT, ANI - G. WOLFE, SWRI - R. BABB, TUSI - AND R. FELDMAN, TSI.

1. A RETAINING METAL SCREEN WILL BE PLACED FLUSH WITH THE FACE OF THE FURNACE SLAB FACING THE FIRE SIDE. ITS PURPOSE IS TO MINIMIZE THE POTENTIAL EFFECT OF SPALLED CONCRETE FRAGMENTS FROM THE SLAB IMPACTING ON THE TEST ARTICLES DURING THE FIRE TEST. ALL THE PREREQUISITE PENETRATIONS PRESENTLY IN THE SLAB WILL BE MATCHED ON THE SCREEN.

2. THE TWO (CIRCA 3 FOOT LONG SEGMENTS OF THE AIR DROP EXITING FROM TWO OF THE FOUR CABLE TRAYS WILL BE RE-ROUTED.) IN THE FURNACE. THIS WILL BE ACCOMPLISHED AS FOLLOWS:

A. THE TWO CABLE TRAYS FROM WHICH THE LONG AIR DROP SEGMENTS ARE EXITING WILL BE PLACED ADJACENT TO ONE ANOTHER.

B. THE RESPECTIVE AIR CABLE DROPS FROM EACH OF THESE CABLE TRAYS WILL EXIT THE SLAB THROUGH THE PENETRATIONS PROVIDED FOR THEIR NEIGHBOR. AIR CABLE DROPS FROM CABLE TRAY A WILL THUS EXIT THROUGH PENETRATION PROVIDED AT ABOVE CABLE TRAY B AND VICE-VERSA.

C. THIS REARRANGEMENT WILL ROUTE THE CABLE AIR DROPS DIAGONALLY THROUGH THE UNOBSTRUCTED SPACE IN BETWEEN THE CABLE TRAYS THUS EXPOSING A GREATER SECTION OF THE CABLE AIR DROP TO THE THERMAL ENVIRONMENT OF THE FURNACE AND A GREATER PORTION THEREOF TO THE FULL IMPACT OF THE INCIDENT THERMAL RADIATION.

D. ALL FURNACE THERMOCOUPLES WILL BE PLACED IN TWO HORIZONTAL PLANES. ONE - 12 INCHES BELOW THE BOTTOM PLANE OF THE HORIZONTAL CABLE TRAY SECTION. THE SECOND - 12 INCHES ABOVE THE TOP PLANE OF THE HORIZONTAL RUN OF THE CABLE TRAY SECTION.

REGARDS,
RUBIN FELDMAN
PRESIDENT
TSI, INC
TLX NO 44-2384
MESSAGE NO 901-1
1 SEPTEMBER 1987

"HILTI" BOLT PROCEDURES

BROWN & ROOT, INC. CPSES	INSTRUCTION NUMBER	REVISION	EFFECTIVE DATE	PAGE
JOB 35-1195	CEI-20	7	DATE: 2/11/81	1 of 9

TITLE: INSTALLATION OF "HILTI" DRILLED-IN BOLTS	ORIGINATOR: Richard M. Kissinger	2-10-81 DATE
	REVIEWED BY: JR [illegible] B&R QA	2/4/81 DATE
	RDM Siegfried R. Ali TUGCO QA	2/11/81 DATE
	APPROVED BY: Charles [illegible] CONSTRUCTION PROJECT MANAGER	2-11-81 DATE

0.i TABLE OF CONTENTS

0.ii ATTACHMENTS

1.0 REFERENCES

1.1 B&R Construction Procedure 35-1195-CCP-12, Concrete Patching, Finishing and Preparation of Construction Joints"

1.2 IM-13966, "Hilti Kwik-Bolt Testing Program".

1.3 TUF-4593, (May 22, 1978)

1.4 B&R Quality Assurance Procedure CP-QAP-16.1, "Control of Nonconforming Items".

BROWN & ROOT, INC. CPSES JOB 35-1195	INSTRUCTION NUMBER	REVISION	EFFECTIVE DATE	PAGE
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1.5 TUSI Procedure No. CPP-EP-1, "Procedure for Preparation of Design Changes".

1.6 35-1195-IEI-13, B&R Instruction "Calibration of Micrometer Torque Wrenches".

1.7 CP-QP-11.2, TUGCO Procedure, "Surveillance and Inspection of Concrete Anchor Bolt Installations".

1.8 QI-QP-11.2-1, TUGCO Instruction, "Concrete Anchor Bolt Installation."

1.9 QI-QP-11.2-3, TUGCO Instruction, "Torquing of Concrete Anchor Bolts".

1.10 QI-QP-11.2-4, TUGCO Instruction, "Inspection of 'Hilti" Super Kwik Bolts".

2.0 GENERAL

2.1 PURPOSE

2.1.1 The purpose of this instruction is to describe the methods to be followed in the field installation of Hilti drilled-in expansion anchors.

2.2 SCOPE

2.2.1 This instruction covers the location and preparation of expansion bolt holes, installation of the expansion bolts, and the permanent marking of bolts for identification both prior to and after their installation. The provisions of this instruction apply to both Hilti Kwik-Bolts and Hilti Super Kwik-Bolts that are used for installation of safety-related equipment, and for the installation of non-safety-related equipment located in safety-related structures. Deviations from this instruction are permitted provided they are properly approved by the Engineer.

2.3 RESPONSIBILITY

2.3.1 Establishment of control points and lines for use in layout of bolt locations shall be the responsibility of the B&R Field Engineering Superintendent. Determination and marking of bolt hole location shall be performed by the craft which prepares the holes and installs the bolts; and the superintendent of that craft shall be responsible for this layout work and for preparation of holes and bolt installation.

2.4 DEFINITIONS

2.4.1 "Drilled-in Expansion Bolts" are bolts having expansion wedges so arranged that, when placed in a drilled hole and the nut tightened, the wedges are expanded and the bolt is securely anchored, all as manufactured by Hilti Fastening Systems, Inc.

2.4.2 "Hilti" is Hilti Fastening Systems, Inc., supplier of the expansion bolts.

2.4.3 "Bolt Length" is the total overall length of the bolt. This is the length dimension shown in the Bill of Material on the appropriate drawings.

2.4.4 "Setting" a bolt means positioning the bolt and tightening the nut to the extent required to complete the expansion of the wedges.

2.4.5 "Embedment Length" is the length of bolt extending below the surface of the 4000 psi (28-day strength) structural concrete prior to setting (tightening). Where not shown on the pipe/instrument support design drawings, the minimum embedment length shall be as follows:

BOLT DIAMETER	MINIMUM EMBEDMENT Kwik-Bolts	MINIMUM EMBEDMENT Super Kwik Bolts
1/4	1 1/8	—
3/8	1 5/8	—
1/2	2 1/4	3 1/4
5/8	2 3/4	—
3/4	3 1/4	—
1	4 1/2	6 1/2
1 1/4	5 1/2	8 1/8

Dimensions are in inches, they are according to recommendations by Hilti and correspond to the minimums shown in Abbot A. Hanks, Inc. Test Report No. 8783R on Kwik-Bolts and Test Report No. 8786 on Super Kwik-Bolts, as published in Hilti "Architects and Engineers Anchor and Fastener Design Manual.

The above minimum embedment lengths are into structural concrete. On floors where 2-inch thick concrete topping (and thicker on roof slabs built up to slope to drain) has been placed separately, bolts shall be of sufficient length to provide embedment length or overall length at least equal to the thickness of the topping in addition to the length shown on the drawings. For floor mounted pipe supports only, the engineer shall evaluate the support for sufficient embedment length on a case-by-case basis. The areas where this topping occurs are shown on the following drawings:

Drawing No.	Sheet No.	Building
FSC-00421	1	Fuel
FSC-00421	2	Fuel
FSC-00422	1	Reactor #1
FSC-00422	2	Reactor #1
FSC-00422	3	Reactor #1
FSC-00422	4	Reactor #1
FSC-00422	5	Reactor #1
FSC-00423	1	Auxiliary
FSC-00423	2	Auxiliary
FSC-00423	3	Auxiliary
FSC-00423	4	Auxiliary
FSC-00423	5	Auxiliary
FSC-00423	6	Auxiliary
FSC-00423	7	Auxiliary
FSC-00423	8	Auxiliary
FSC-00423	9	Auxiliary
FSC-00424	1	Safeguard #1
FSC-00424	2	Safeguard #1
FSC-00424	3	Safeguard #1
FSC-00424	4	Safeguard #1
FSC-00424	5	Safeguard #1
FSC-00424	6	Safeguard #1
FSC-00426	1	Service Water Intake
FSC-00425	1	Safeguard #2
FSC-00425	2	Safeguard #2
FSC-00425	3	Safeguard #2

3.0 PROCEDURE

3.1 INSTALLATION

3.1.1 Locating Bolts

3.1.1.1 Bolt locations shall be determined by the installing craftsmen using the control points and lines established by the Field Engineering Department; and, as an aid in locations where reinforcing steel integrity is considered to be critical, utiliza-

tion of reinforcing steel placement drawings and suitable reinforcement detection equipment may be used. The minimum spacing and/or clearance for expansion bolts shall be provided as indicated in Attachments 1, 2 and 3 unless specifically approved otherwise by the Engineer using appropriate design documents.

3.1.2 Drilling Holes

3.1.2.1 Expansion bolt holes shall not be drilled into structural reinforcing steel unless approved by the design engineer or his representative. Holes for the expansion bolts shall be drilled into concrete by the use of suitable power drills using "hilti" carbide masonary bits of the same nominal size as the bolt and which are designed and recommended by the Hilti Corp. specifically for this purpose, or an approved equal. The holes shall be drilled to depths at least one-half inch greater than the embedment length of the bolt. This is in order that any unusable bolts can be cut off and driven deeper into the hole and the top covered with grout or other suitable filler to close the hole.

3.1.2.2 Holes shall normally be drilled as near the perpendicular to the concrete surface as feasible. In no case shall the long axis of installed bolts be more than 6 degrees from this perpendicular direction. Excess dust should be cleaned from the hole after drilling.

3.1.2.3 Where cutting of structural reinforcing steel is permitted by the Engineer, Drillco water cooled carbide/diamond bits or equal shall be used. Once the structural reinforcing steel is cut, the remainder of the hole shall be drilled with a "Hilti" carbide masonary bit per 3.1.2.1. Bolt bits shall be of the same nominal diameter as the bolt to be installed.

3.1.2.4 In limited access areas it may be difficult to drill holes for expansion bolts using equipment as required by 3.1.2.1. For this situation, a flexible drive drill with drill press/vacuum base and Drillco water cooled carbide/diamond bit or approved equal may be used. Caution shall be used when drilling to avoid the cutting of structural reinforcing steel. In no case shall structural reinforcing steel be cut without prior approval of the Engineer.

3.1.3 Marking Bolts

3.1.3.1 The threaded end of bolts shall bear permanent markings which indicate the bolt length.

3.1.3.2 These markings shall be made by the manufacturer by die-stamping a letter or a number on the top end of the bolt. This stamping shall indicate the bolt length in accordance with the "Length Identification System" (Attachment 4). Bolts may also be marked on-site by the same system if verified and documented by B&R QC.

3.1.3.3 Hilti Super Kwik Bolts shall be additionally marked with a "star" on the end which will remain exposed upon installation. This marking will be performed by the craft in a manner which does not obliterate the length marking. The stamp shall be controlled by the cognizant QC Inspector.

3.1.4 Setting Bolts

3.1.4.1 In no case shall bolts be set in concrete having strength less than the 28-day old design strength. Inserting bolts may be accomplished either by use of a mandrel or double nuts. In using double nuts, they shall be placed on the bolt so as to protect the bolt end and threads. The bolt shall be driven into the hole the embedment length by blows on the mandrel or nut. Projection of the bolt should be such that, after final tightening, the end of the bolt is not lower than flush with the top of the nut. Its projection above the top of the nut is not limited although its change in projection during tightening shall be within the limit specified below. The mandrel, if used, is then replaced by a nut, or the top double nut is removed and the bolt is "set". The setting will be accomplished by tightening the nut against the fixture being installed. At that time, the nut will be drawn down and the bolt pulled to set the wedges by the use of a torque wrench, attaining at least the respective final values shown in the following table unless otherwise shown on the drawings. During tightening the nut, the change in bolt projection shall not exceed one nut height unless otherwise approved by the engineer. Where 5/8" diameter bolts are used in erecting Uni-Strut members in such a way that the bearing surface under the nut, used with a flat washer, bears against the open side of the Uni-Strut, the nut shall be tightened to 80-foot-pounds torque.

BOLT SIZE	TORQUE (Ft.-Lbs)	
1/4	8	
3/8	17	
1/2	70	70#.FT
5/8	120	
3/4	150	
1	230	230#.FT —
1 1/4	400	Torque with

Snap-on model TE-60ZL
Serial 5705

These values were determined by field tests conducted by Hilti at the CPSES site which yielded ultimate pull-out strengths equal to or greater than those originally suggested by Gibbs & Hill, Inc. The complete report on those tests is filed in the B&R QC Department. (Ref. CPPA-7240 or B&R IM-13966).

Bolts which cannot be torqued to the above minimum values shall be cut off, driven deeper into the hole, and patched per Reference 1.1. Torque wrenches used in this operation shall be calibrated and periodically recalibrated in accordance with Engineering Instruction 35-1195-IEI-13, "Calibration of Micrometer Torque Wrenches", Reference 1.6.

3.1.4.2 For Hilti expansion bolts that slip, loosen or pull out, the bolt shall be removed and replaced with a bolt that has an embedment depth increased by at least 4½ bolt diameter for Hilti Kwik-Bolts and 6½ bolt diameter for Hilti Super Kwik-Bolts unless otherwise directed by the Engineer. QC shall be notified prior to commencing work.

3.1.5 Repair of Broken Concrete and Abandoned Holes

3.1.5.1 Structural concrete that is broken or spalled as a result of bolt installation but is structurally sound shall be cleaned up and may be cosmetically repaired either in accordance with Construction Procedure CCP-12, or by the use of "NUTEC" #11S as manufactured by and according to the recommendations of Southern Imperial Coating, Inc. Spalling of structural concrete to depths greater than those listed below shall be cause for rejection of the hole and redrilling will be necessary.

Hole Size	Max. Acceptable Spall Depth
5/8" and under	1/2"
3/4" to 1 1/4" (Incl.)	3/4"

Spalling of the 2" topping in areas described in Section 2.4.5 shall be cleaned up and repaired in accordance with Construction Procedure CCP-12 using material described in Section 4.1.2.7 of CCP-12. Maximum spall depth is not to exceed depth of topping.

3.1.5.2 Abandoned holes shall be filled and patched prior to coating the concrete. This repair shall be in accordance with provisions of B&R Construction Procedure 35-1195-CCP-12 for filling "Tie Holes" by the use of patching mortar prepared as described in paragraph 4.1.1.2 of that procedure. However, abandoned OVERHEAD holes, originally drilled for Hilti expansion bolts, which will be completely covered by the base plates or angles of attached fixtures

and which are farther than four bolt diameters (center to center) from an active Hilti bolt, may be filled with "Silpruf" waterproofing sealant or "GE 1300", both as manufactured by General Electric, Inc. Holes located at a distance of four bolt diameters and closer, measured center-to-center, from Hilti bolts shall be filled and patched according to Procedure 35-1195-CCP-12 described above prior to torquing.

3.1.5.3 Unused Richmond Screw Anchors which have been plugged by Richmond screw-in plugs may be used for permanent anchorage only after specific approval by the G&H Engineer or his designee.

3.1.6 Modification

3.1.6.1 When it is necessary, as the result of reinforcing steel interference or on-site unavailability of correct length bolts or for other reason, Hilti bolts may be modified, with proper QC witnessing, on-site by shortening, rethreading, and stamping the new length designation. This shall be done only on a case-by-case basis upon approval of the design engineer responsible for the fixture or item involved and upon completion of a Component Modification Card (CMC) or by revising the FSE. Final bolt length shall be sufficient to satisfy the design requirement.

3.1.6.2 Substitution of a Hilti bolt of the next larger size is acceptable, provided all spacing and embedment requirements are met or exceeded for size Hilti bolt substituted.

3.1.7 Rework of Bolts in 2-inch Concrete Topping Areas

3.1.7.1 For areas in which the requirements of Section 2.4.5 cannot be met, the following action shall be taken:

3.1.7.1.1 Expansion bolts which after setting have less than the below indicated embedment length into the structural concrete shall be reworked as follows:

Bolt Type	Embedment After Setting
Kwik-Bolt	3½ bolt diameters
Super Kwik-Bolt	5½ bolt diameters

a. Existing location

1. Bolt Removal - The removal of in-place expansion bolts shall be completed with care so as not to damge the concrete, thereby impairing its integrity. A hollow core hydraulic ram placed directly over an appropriately sized baseplate which is centered on the bolt may be used to apply direct tension to pull the bolt through the expansion wedges. The baseplate should be a ½ inch thick square plate of a minimum of 16 expansion bolt diameters in width, bearing directly against the concrete surface.

2. Once the bolt is removed, use a high speed drill and bit to drill through the wedges remaining in the side of the hole. Remove any loose wedges in the hole.

3. Using appropriate equipment, re-drill existing expansion bolt hole so that the new embedment depth is a minimum of 4½ bolt diameters for Hilti Kwik-Bolt or 6½ bolt diameters for Hilti Super-Kwik Bolt greater than the previous existing embedment depth, whichever is greater unless otherwise directed by the Engineer by appropriate design documents.

4. Reinstall the appropriate sized expansion anchor to meet the required embedment depth.

b. Relocation - Abandon existing expansion anchor bolts and relocate support structure. Abandoned bolts shall be cut off, driven deeper into the hole, and patched per Reference 1.1.

3.1.7.1.2 Expansion bolts which have less than the specified designed embedment depth into structural concrete but greater than the values indicated above in 3.1.7.1.1 shall be evaulated by the responsible design engineer. If found to be acceptable "as-is", appropriate design change documents shall be issued. If found to be unacceptable, the expansion bolt shall be reworked in accordance with 3.1.7.1.1 a or b.

3.2 INSPECTION

3.2.1 Inspection of Hilti bolt installation shall be performed in accordance with References 1.6, 1.7, 1.8, 1.9 and 1.10 and other applicable QA/QC procedures and instructions.

BROWN & ROOT, INC. CPSES JOB 35-1195	INSTRUCTION NUMBER	REVISION	EFFECTIVE DATE	PAGE
	CEI-20	7	2/11/81	1 of 1

ATTACHMENT 1

* MINIMUM SPACING BETWEEN HILTI EXPANSION BOLTS

Hilti Bolt Size	CENTER TO CENTER SPACING TO: 1/4"Hilti	3/8"Hilti	1/2"Hilti	5/8"Hilti	3/4"Hilti	1"Hilti	1 1/4"Hilti
1/4	2 1/2	3 1/8	3 3/4	4 3/8	5	6 1/4	7 1/2
5/16	2 13/16	3 7/16	4 1/16	4 11/16	5 5/16	6 9/16	7 13/16
3/8	3 1/8	3 3/4	4 3/8	5	5 5/8	6 7/8	8 1/8
1/2	3 3/4	4 3/8	5	5 5/8	6 1/4	7 1/2	8 3/4
5/8	4 3/8	5	5 5/8	6 1/4	6 7/8	8 1/8	9 3/8
3/4	5	5 5/8	6 1/4	6 7/8	7 1/2	8 3/4	10
7/8	5 5/8	6 1/4	6 7/8	7 1/2	8 1/8	9 3/8	10 5/8
1	6 1/4	6 7/8	7 1/2	8 1/8	8 3/4	10	11 1/4
1 1/4	7 1/2	8 1/8	8 3/4	9 3/8	10	11 1/4	12 1/2

Dimension in inches.

* The minimum spacing outlined in the above chart applies to Hilti bolts detailed on separate adjacent fixtures. Violation of minimum spacing by the installation of two separate adjacent fixtures will be approved only by issuance of design change documents by the CPPE design groups.

Hilti bolts detailed on an individual fixture drawing may have less than the minimum spacing tabulated above. Such fixtures have been derated by engineering justification and are the responsibility of the organization issuing the respective fixture drawing. Installation in this case shall proceed in accordance with the fixture drawing.

BROWN & ROOT, INC. CPSES JOB 35-1195	INSTRUCTION NUMBER	REVISION	EFFECTIVE DATE	PAGE
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ATTACHMENT 2

MINIMUM BOLT CLEARANCES *
(INCHES)

Hilti Bolt Size	MINIMUM DISTANCE TO Richmond Screw Anchors* 1-inch	Richmond Screw Anchors* 1½-inch	Concrete Edge*	Abandoned Hilti Bolts or Holes and Embedded Anchor Bolts that are Cut Off**
1/4	7 5/8	12 1/4	1 1/4	1/2
3/8	8 1/4	12 7/8	1 7/8	3/4
1/2	8 7/8	13 1/2	2 1/2	1
5/8	9 1/2	14 1/8	3 1/8	1 1/4
3/4	10 1/8	14 3/4	3 3/4	1 1/2
1	11 3/8	16	5	2
1 1/4	12 5/8	17 1/4	6 1/4	2 1/2

* Measured Center to Center of bolts and bolt center to edge of concrete in inches.

** Minimum spacing between holes covered by this column shall be measured center-to-center and based on size of hole being drilled. (e.g. Pilot hole spacing is based on pilot bit size.)

Locations nearer than the above distances shall be used only upon approval of the design engineer or his representative.

Hilti Bolts may be installed as close as practical to unused Richmond Screw Anchors which have been plugged (i.e., grouted or occupied by Richmond screw-in plugs).

Unused Richmond Screw Anchors located nearer to Hilti Bolts than the respective distances shown above may be used temporarily for construction purposes when the applied load is:

(a) For 1" Richmond Anchors, less than 8,000 pounds minus the actual load supported by the Hilti Bolt; or

(b) For 1½" Richmond Anchors, less than 20,000 pounds minus the actual load supported by the Hilti Bolt.

BROWN & ROOT, INC. CPSES JOB 35-1195	INSTRUCTION NUMBER	REVISION	EFFECTIVE DATE	PAGE
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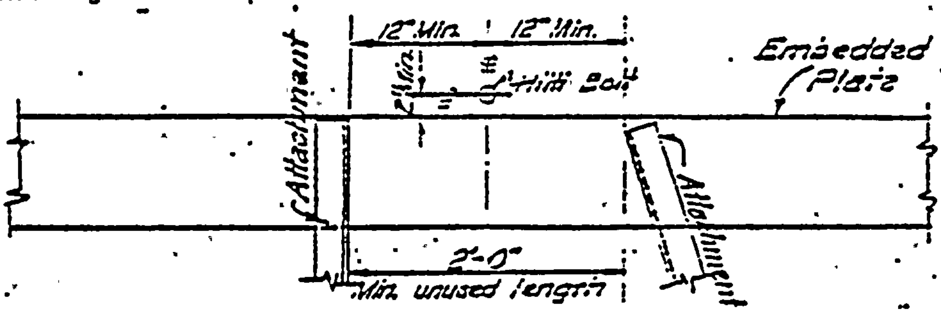
ATTACHMENT 3

MINIMUM CLEARANCES TO EMBEDDED PLATES

1. Where embedded steel plates are unoccupied by attachments for a minimum distance of 12 inches on both sides of a proposed Hilti Bolt location as shown below, the center of the bolt may be a minimum of 2 inches from the edge of the plate



2. Where the embedded steel plates are occupied by attachments within minimum distances shown above, the minimum clearance to Hilti Anchors shall be as follows:

Hilti Anchor Size	Nelson Stud to Hilti Anchor	Edge of plate to Hilti Anchor
1/4	5 1/4	3 3/4
3/8	5 7/8	4 3/8
1/2	6 1/2	5
5/8	7 1/8	5 5/8
3/4	7 3/4	6 1/4
1	9	7 1/2
1 1/4	10 1/4	8 3/4

Dimensions are in inches.
Distance measured with reference to center of bolts and studs..

Where location of the nearest Nelson Stud can be determined from the "S" stamps on the embedded steel plate, the minimum center-to-center clearance to the Hilti Anchor as shown above shall govern. Where location of the nearest Nelson Stud cannot be so determined, the minimum clearance to Edge of Plate" as shown above shall govern.

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ATTACHMENT 4

LENGTH IDENTIFICATION SYSTEM

Stamp On Anchor	Length of Anchor (Inches) From	Up to (Not including)
A	1 1/2	2
B	2	2 1/2
C	2 1/2	3
D	3	3 1/2
E	3 1/2	4
F	4	4 1/2
G	4 1/2	5
H	5	5 1/2
I	5 1/2	6
J	6	6 1/2
K	6 1/2	7
L	7	7 1/2
M	7 1/2	8
N	8	8 1/2
O	8 1/2	9
P	9	9 1/2
Q	9 1/2	10
R	10	11
S	11	12
T	12	13
U	13	14
V	14	15
W	15	16
X	16	17
Y	17	18
Z	18	19

NOTE: 1. Stamped letters shall be on top (threaded) end of bolt.

2. Bolts of 19-inch length and greater shall be stamped with numbers corresponding to the bolt length in inches in the same manner but instead of the stamped letters as listed above.

APPENDIX B

9

TECHNICAL SPECIFICATION

FOR

ELECTRICAL RACEWAY

FIRE INSULATION BARRIER

MATERIALS

FOR THE

SUSQUEHANNA STEAM ELECTRIC STATION

UNITS 1 AND 2

OF THE

PENNSYLVANIA POWER & LIGHT COMPANY

ALLENTOWN, PENNSYLVANIA

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NOT FOR CONSTRUCTION

ADDENDUM NO. ____
F.C.R. No. E6347
F.C.N. No. ____

RECEIVED
SUSQUEHANNA PROJECT
OCT 5 1981

P-156/3-1

No.	DATE	REVISIONS	BY	CH'K	DESIGN SUPV	ENG'R	PROJ ENGR	APPV
2						n/a		
1	9/25/81	Incorp. PLB-13563, FCR-E-5486 added new Materials DCR-403	[illegible]	[illegible]	[illegible]	n/a	[illegible]	
0	6-4-81	ISSUED FOR CONSTRUCTION	[illegible]	[illegible]	[illegible]	n/a	[illegible]	

SCALE NONE	DESIGNED W. Hopstock	DRAWN NA
BECHTEL	SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 PENNSYLVANIA POWER & LIGHT COMPANY	CHIEF ENGR JOB No. 8856 SPEC/DES GUIDE NO. 8856-E-61 REV. 1

INDEX TO

TECHNICAL SPECIFICATION FOR ELECTRICAL RACEWAY

FIRE INSULATION BARRIER

MATERIALS

TECHNICAL SPECIFICATION
FOR
ELECTRICAL RACEWAY
FIRE INSULATION BARRIER
MATERIALS

1.0 SCOPE

1.1 This specification describes the requirements for raceway insulation materials for the Susquehanna Nuclear Power Station Unit 1 and Unit 2 in accordance with the performance, design and test criteria requirements described herein.

1.2 It is not the intent to specify herein all details of design and construction. It shall be the responsibility of the Seller to insure that the materials have been designed and fabricated in compliance with this specification and with all documents referred to herein as well as in accordance with good engineering practice.

1.3 In the event of an apparent conflict between requirements of the specification and those of the Purchase Documents, or any of the attached specifications, the Seller must bring the conflict to Buyer's attention for resolution.

1.4 All materials shall be suitable for the specified service and shall be subject to the approval of the Buyer. Substitutions for articles or materials shall not be made without the specific written consent of the Buyer.

1.5 The Seller shall have full responsibility for compliance with the requirements of these specifications.

1.6 Fire stops, in walls and floors at cable tray and conduit penetrations, are not part of this specification.

2.0 WORK INCLUDED

Furnish all the necessary insulating materials, installation details, tools, equipment and services required for insulation of electrical raceway for the following:

1. Fire breaks
2. Exposure fire barriers
3. Separation barriers as described in this specification.

3.0 WORK NOT INCLUDED

3.1 The Buyer shall install all materials specified.

3.2 Unloading and storage of all materials specified.

[illegible]

4.0 CODES AND STANDARDS

4.1 The materials specified herein shall conform in all respects with applicable federal, state, and local laws, and regulations of U.S. Department of Labor Occupational Safety & Health Administration, The Commonwealth of Pennsylvania, and other local regulatory bodies having jurisdiction over such materials, in effect at the time of award.

4.1.1 In the event of any conflict of codes or standards, the following priority sequence shall be followed:

4.1.1.1 Nuclear Regulatory Commission Reg. Guides and American Nuclear Insurers (ANI).

4.1.1.2 U. S. Dept of Labor-Occupational Safety and Health Standards.

4.1.1.3 Commonwealth of Pennsylvania Regulations.

4.1.1.4 Bechtel Specification

Seller shall contact the Buyer for resolution of all conflicts.

Note:

Latest issue of specifications, standards and codes means the issue (including latest addenda) in force at the date of purchase order. Adoption of any case rulings or interpretations or any subsequent addenda issues shall be subject to Buyer's approval prior to their use.

5.0 CONDITIONS OF SERVICE (outside containment only)

5.1 Normal Environment:

Ambient Temperature. 40° to 105°F with occasional increases to 120°F.

5.2 Environmental Radiation:

Shall be capable of continuous operation under the conditions stated above and shall be able to withstand an integrated radiation dose of 5.3×10^6 rads gamma radiation over a 40-year period without failure. Radiation damage shall be construed to mean a detrimental change in the functional properties of the material or devices. Any exceptions must be approved by the Buyer.

6.0 DESIGN AND CONSTRUCTION

6.1 Fire Break Design

6.1.1 The purpose of Fire Breaks is to stop upward propagation of fire in vertical and horizontal covered cable trays.

[illegible]

[illegible]

6.1.2 Fire Breaks shall be installed in vertical cable trays every 15 ft. and [redacted] covered tray.

6.1.3 Fire Breaks shall be made from a Insulation Blanket and mastic coating, or an approved equal, see Sect. 6.7.

6.2 Fire Break Construction (Typical For Insulation Blanket Material Only)

6.2.1 Fire Breaks shall completely encapsulate the cable tray for six to eight inches (nominal Min. Dimension).

6.2.2 If the cable tray is not covered and is not completely filled with cables, Insulation Blanket, the same width as the cable tray shall be inserted over the cables in sufficient layers to bring the outer surface of the Insulation Blanket even with the top of the tray sides.

6.2.3 One layer of Insulation Blanket will then be wrapped completely around the cable tray, with a minimum of 3 inches of overlap of adjacent blankets and blanket ends. The blanket shall be secured with stainless steel straps on 12 inch centers.

6.2.4 The open ends of the Fire Break shall be packed with Bulk Insulation Fiber and sprayed with Mastic Coating to a 1/2 inch wet thickness so as to completely seal the cable tray/cable/Insulation Blanket interface.

6.3 Exposure Fire Barrier Design

6.3.1 Exposure Fire Barriers shall be installed on electrical cable trays, conduits and junction/terminal boxes at locations specified per Fire Protection Review drawings (10 CFR 50 Append. R).

6.3.2 Exposure Fire Barriers shall be made by encasing the cable trays, conduits and junction/terminal boxes in one hour rated barrier system consisting of Insulation Blanket, or an approved equal, see sect. 6.7.

6.3.3 The purpose of Exposure Fire Barriers is to prevent damage, during a 1 hour complete engulfment fire, to electrical cables serving one division of equipment required for safe shutdown of the plant.

6.4 Exposure Fire Barrier Construction (Typical For Insulation Blanket Material Only)

6.4.1 Exposure Fire Barriers shall completely encapsulate the indicated cable tray or conduit for the entire length specified.

6.4.2 If the cable tray is not covered and is not completely filled with cables, Insulation Blanket, the same width as the cable tray, shall be inserted over the cables in sufficient layers to bring the outer surface of the Insulation Blanket even with the top of the tray sides.

6.4.3 The interior layer of the Insulation Blanket shall wrap completely around the perimeter of the cable tray with the ends of the blanket overlapping a minimum of 3 inches. Adjacent blankets shall be placed tightly together so as to prevent any gaps in the butt joints between blankets. This layer shall be held in place by High Performance Filament Tape spaced not more than 14 inches apart and not less than 4 inches from butt joints.

6.4.4 The exterior layer of Insulation Blanket shall wrap completely around the perimeter of the interior layer and must also have a minimum 3 inch overlap. The overlap of the exterior layer shall be offset from the overlap of the interior layer but still remain on the top of the tray. The exterior layer blankets shall be installed such that the butt joints between adjacent exterior blankets are offset at least 12 inches from the butt joints between interior blankets.

6.4.5 The exterior blankets shall be secured in place by stainless steel straps installed not more than 14 inches apart and not less than 4 inches from exterior butt joints. The tensioning of the straps shall be sufficient to hold the blanket snugly in place without causing any sufficient cutting of, or damage to, the blanket material.

6.4.6 A protective outer wrap of Aluminized Zetex is to be secured independently of the Kaowool blanket with Polyken 237 tape. This outer wrap whall be installe of ter the stainlees steel straps. The blanket shall have a minimum 3 inch overlap. The overlaps in the outer wrap shall be offset from the overlaps in the previous layer but still remain on top of the tray. A single layer of Polyken 237 tape will be made over all joints (The above is typical for all barriers constructed with Insulation Blanket Material Kaowool)

6.4.7 Where adjoining cable tray or conduit or tray support members attached to, or come into contact with, the tray to be protected, the attaching or contacting member shall also be wrapped with two layers of Insulation Blanket as necessary to ensure complete coverage of the protected tray. No gaps or openings shall be allowed.

6.4.8 Conduits mounted on exposed unistrut shall be insulated in the same manner as cable trays, except that no filler blanket is required.

6.4.9 Conduits mounted on embedded unistrut, flush to a wall, shall be covered with two layers of Insulation Blanket. The blanket shall extend a minimum of two inches onto the surface of the wall. The edges of the blanket shall be secured to the wall by steel strips and concrete expansion anchors or an approved equivalent fastening method.

[illegible]

6.4.10 Exposed, non-supported cable transitions (air-lined) from conduit to tray or from tray to tray shall be wrapped in two layers of Blanket. Each layer shall wrap around the cables with an end overlap of not less than 3 inches. The blankets shall be secured by tying with Woven Tape at 14 inch maximum intervals.

6.4.11 At locations where the protected tray or conduit penetrates a fire barrier in a ceiling, floor or wall, both the interior and exterior layers of Insulation Blanket shall be cut and installed such that the blankets will fit snug against the firestop. The juncture will then be sealed with mastic coating. The mastic will be sprayed or troweled completely around the Insulation Blanket to not less than 1/4 inch thickness, and shall extend not less than 8 inches onto the exterior of the blanket and the surface of the fire barrier and ceiling, floor or wall.

6.5 Separation Barrier Design

6.5.1 The purpose of Separation Barriers is to reduce the exposure Class IE electrical cables serving redundant systems to damage from fire in a proximate raceway.

6.5.2 Separation Barriers shall be made by either/or the following methods per drawing E-49 (Reg. Guide 1.75)

- Installation of galvanized steel covers and/or bottoms on trays
- Installation of Insulation Blanket material or an approved equal, see Sect. 6.7, for conduit and tray.
- Installation of rigid board between redundant raceway. (Sect 6.7)

6.6 Separation Barrier Construction (Typical For Insulation Blanket Material Only)

6.6.1 Separation Barriers shall be applied to the indicated cable trays or conduit for the entire length where minimum separation can not be maintained.

6.6.2 In open cable trays, one layer of Insulation Blanket shall be laid on top of the cables. The blanket shall be tucked around the cables at the edge of the tray where possible. In vertical or inclined tray sections, Woven Tape shall be used to tie the blanket to the tray at 14 inch maximum intervals.

6.6.2.1 Cable tray and conduit shall be wrapped completely around the perimeter with one layer of Insulation Blanket. End joints and joints between adjacent blanket will be secured in place with stainless steel straps installed at each overlapped butt joint and at 14 inch maximum intervals along the blanket.

6.6.2.2 Where adjoining cable tray or conduit or tray support members attach to, or come into contact with, the tray or conduit to be protected, the attaching or contacting member shall also be wrapped with one layer of Insulation Blanket.

6.6.2.3 Exposed, non-supported cable transition (air-lined) from conduit to tray or from tray to tray shall be wrapped with one layer of Insulation Blanket.

1 6.7 Blanket Insulation/Barrier Board, Banding, Tape and Mastic Materials (Fire Breaks, Separation Barriers and Exposure Barriers)

6.7.1 Insulation/Blanket consisting of interlaced ceramic/glass fibers, one inch thick, 8 lb. per cu. ft., width and lengths are required, Babcock and Wilcox, Kaowool or approved equal.

6.7.2 Formed barrier board consisting ceramic fibers and binders, thickness and size as required, Babcock and Wilcox, Kaowool M Board or approved equal. (Junction/Terminal box covers.)

6.7.3 Protective outer wrap joint tape, Polyken 237, 2" wide, 2 mils thick, mfg. by Kendall Corp., Polyken Div. or an approved equal.

6.7.4 Aluminized protective outer wrap consisting of glass cloth, Babcock and Wilcox, Zetex Style 800, or approved equal.

1 6.7.5 High Performance Filament Tape for securing Insulation blanket on electrical cable tray and conduit shall be 1 inch wide, 3M Company Tape Number 89 or approved equal.

6.7.6 Woven Tape for securing Insulation blanket in electrical cable tray shall be a refactory silica product, 1 inch wide by by 0.125 inch nominal thickness with selvaged edges, Haveg Industries, Inc. Siltemp Code Number WT65-1 or approved

6.7.7 Mastic Coating for fire protection applications shall be Intumastic 285, manufactured by Carboline Fire Proofing Products Division, or an approved equal.

6.7.8 Galvanized steel strips and concrete expansion anchors, or approved equivalent fastening method, for attached Insulation blanket to walls.

6.7.10 Straps for securing Insulation blanket on electrical cable tray and conduit shall be 3/4 inch width by .020 inch thick Type 304 stainless steel.

6.7.10 Bolts, nuts, washers and other fasteners shall be electro-galvanized or cadmium plated.

1 6.7.11 "Approved equal" barrier system, subliming compound, Thermo-lag 330-1, water based spray coating, mfg. by TSI, Inc. consisting of Thermo-lag 351 primer and Thermo-lag 350-2000 top coat for use on raceway and junction/terminal boxes.

6.7.12 "Approved equal" Fire Barrier System, Intumescent laminated wrap material, mfg. by Quelcor, Inc. Quelpyre two-step system <u>for use on conduit only</u>.

7.0 INSPECTION AND TESTS

General

The Seller shall conduct and be responsible for the tests called for in the applicable codes and standards, and shall furnish verification of all test data.

8.0 DELIVERY AND DRAWING

8.1 Seller shall be guided by the following schedules:

8.1.1 All material is required at the jobsite as stated in the Purchase Order.

8.1.2 The number of drawings to be furnisehd is listed in the "Drawings and Data Requirements". Form G-321-C and 8856-QA-1.

9.0 SHIPPING

9.1 All material shall be arranged and fabricated to provide convenient shipping packages. Each shipping package and all parts contained therein shall be properly protected against weather and mechanical damage during transit and storage.

10.0 PRODUCT ASSURANCE REQUIREMENTS

10.1 This specification covers items and services that have safety related functions in a nuclear power plant. The Seller shall meet the specific requirements defined herein. These requirements shall be implemented by the Seller for the items and services covered by the technical specification. The requirements specified herein do not delete or revise other requirements of the procurement document.

11.0 WARRANTIES

The Seller shall warrant that the material furnished under this specification and requisition will be suitable for the required service specified herein and will conform to all applicable codes and regulations.

If the material furnished by the Seller fails to meet the requirements of this Specification and Requisition, the Seller shall bear all expenses necessary to meet the requirements.

The Seller shall state his standard warranty included with his proposal.

The Seller shall also state the additional cost, if any, of extending the warranty for a period of one (1) year from initial commercial operation. Initial commercial operation is as defined by Specification 8856-G-1.

APPENDIX C

AREA TURNOVER OR No. - N/A (A) - N/A

FIELD CHANGE REQUEST

PROJECT NO. 8856

F 15350

1. PAGE 1 OF 2

'Q'-Listed: YES NO

2. No. E-6347

3. DATE MO 12 DAY 10 YR 81

4. REF ~~DWG~~ OR SPEC. Specification-E-61 REV. 1

5. TITLE Electrical Raceway Fire Insulation Barrier Materials

6. DESIGN ORIGIN: ENGRG [X] VENDOR [ ] (IDENTIFY) NAME SEHD

7. EXISTING CONDITION: Specification-E-61 does not specifically address inspection of Thermo-Lag 330-1 Subliming Compound Barrier System

8. CHANGE REQUEST / ~~SKETCH~~

Add and/or revise the following paragraphs to read as follows:

6.7.11 "Approved Equal" barrier system, subliming compound, Thermo-Lag 330-1, water based spray coating, mfg. by TSI, Inc. consisting of Thermo-Lag 351 Primer, or Thermo-Lag Stress Skin Type 330-69 and Thermo-Lag 351 Primer, plus Thermo-Lag 330-1 Subliming Compound, for use on raceway and junction/terminal boxes.

7.0 Inspection and Tests

7.1 Each shipment of material shall be accompanied by a certificate of conformance by the manufacturer that the material is as specified on the purchase order.

7.2 Quality Control inspections shall verify that the following parameters are met.

7.2.1 Surface temperature of the substrate to receive Thermo-Lag 330-1 Subliming Compound shall be 40°F or higher prior to application of Thermo-Lag 330-1 Subliming Compound.

7.2.2 Thermo-Lag Stress Skin Type 330-69 shall be

a.) secure with the raceway

b.) the stress skin primer intact

c.) free of foreign substances prior to application of Thermo-Lag 330-1 Subliming Compound.

SEE page 2 FFZAFRA

~~7.2.3 The final dry film thickness of Thermo-Lag 330-1 Subliming Compound shall be between One-Half Inch and One Inch. The surface of the subliming compound~~ AND FOR

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DEC 23 1981

10. REVIEWED BY: Date 12-10-81
CIVIL
ELECT.
MECH.
WELDING
PIPING
INSTRUMENTATION

9. PREPARED BY: BILL HUFFMAN

11. APPROVAL OF FIELD DISPOSITION:
Project Field Engineer 12/10/81 Date

12. PROJECT ENG'R'G APPROVAL: YES [X] NO [ ] PROJ. ENGR.: E.B. Poser Date: 12-15-81

DESIGN CHANGE REQ'D: YES [X] NO [ ] REMARKS: FFZAFRA (SEE RE Comment)

Q RSB

AREA TURNOVER OR S/U No. - N/A PROJECT NO. 8856	FIELD CHANGE REQUEST F 15350	1. PAGE 2 OF 2 'Q'-Listed: ☒ YES ☒ NO	2. No. E-6347 3. DATE MO 12 DAY 10 YR 81

4. REF. DWG. OR SPEC. Specification-E-61	REV. 1	5. TITLE Electrical Raceway Fire Insulation Barrier Materials

6. DESIGN ORIGIN: ENGRG ☒ VENDOR ☐ (IDENTIFY) NAME SFHO

7. EXISTING CONDITION: See Page 1

8. CHANGE REQUEST / SKETCH

~~shall be free of textural irregularities (blisters, spalling, fissures, separations).~~

7.2.4 The repair of any surface textural irregularities shall have all damaged and loose material removed back to sound adhering material. A knife or scrapper is acceptable. The edge should be undercut to form a beveled edge as in plaster repair. All foreign matter should be removed from the substrate using a wire brush. Thermo-Lag 330-1 Subliming Compound shall be added to achieve the required dry film thickness.

7.3 Commercial quality measuring devices are acceptable for quality checks above.

7.2.3 ~~The final dry~~ The final dry film thickness of Thermo-Lag 330-1 Subliming Compound shall be one-half inch (½ inch) min. and three-fourth (3/4 inch) max. The surface of the subliming compound shall be free of textural irregularities (blisters, spalling, fissures, separations).

RE Comment.

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NOT FOR CONSTRUCTION

DEC 2 1981

BY RESIDENT ENGINEERING
SFHO CONTACT B. HOPSTOCK

10. REVIEWED BY: Date
CIVIL [signature] 12-10-81
ELECT.
MECH.
WELDING
PIPING
INSTRUMENTATION

9. PREPARED BY: BILL HUFFMAN

11. APPROVAL OF FIELD DISPOSITION:
K.D. Griffin [signature] 12/10/81
Project Field Engineer Date

12. PROJECT ENG'R'G APPROVAL: YES ☑ NO ☐ PROJ. ENGR.: Date:
DESIGN CHANGE REQ'D: YES ☑ NO ☐ REMARKS: [illegible]

APPENDIX D

[illegible]

SPECIAL DETAILED INSTRUCTIONS

IN ACCORDANCE WITH F.I.M. G-6.6.0

FOR INSPECTION ACTIVITY NOT COVERED BY A MASTER INSPECTION PLAN

______________ Q.C.E. Date ______________

Subject Installation of Thermo-Lag-330-1 Subliming Compound. Project 8856

Report # ______ - ______
Week Day

Item to Inspect Installation of The Thermo-Lag-330-1 Subliming Compound Barrier System As Per Spec-E-61, FCR-E-6347, FP-E-12.

Located at Various Areas in The Reactor Building And Control Building.

Type of Inspection Visual, Dimensional, And Temperature Checks.

Reference Criterias Spec-E-61, FCR-E-6347, FP-E-12.

Inspection equip. to use Flashlight, Tape measure, Machinest Scale, And Calibrated Thermometer.

1. Record inspection results on QC-G1-1 as satisfactory or unsatisfactory.
2. Record action taken if unsatisfactory.
3. Submit Field Inspection Report # QC-G1-1 to Discipline Lead for review & signature.
4. Record all pertinent information needed so that report will be clear and concise.
5. Other ______________

[signature]
Lead Discipline Q.C.E.

FIELD INSPECTION REPORT-#

F 1001
Revision D
Page 224
Appendix D

3. RECORD CONTROL
CONTROL NO.
FILE NO.

1. PROJECT NO. 8856 2. DATE PAGE 1 OF

4. ITEM INSPECTED Installation of The Thermo-Lag-330-1 Subliming Compound Barrier SYSTem As Per SPec-E-61, FCR-E-6347, FP-E-1

5. LOCATION Various Areas in The Reactor Building And Control Building.

6. TYPE OF INSPECTION Visual And Dimensional Checks, Temperature Ch

7. STANDARD / CODE / PROCEDURE / DRAWING / SPECIFICATION SPec-E-61, FCR-E-6347, FP-E

8. INSPECTION EQUIPMENT USED FlashLight, Tape measure, Machinest Scale, An Calibrated Thermometer.

9. RESULTS OF INSPECTION: SATISFACTORY ☐ UNSATISFACTORY ☐

10. ACTION TAKEN IF UNSATISFACTORY

Reviewed BY -

Reviewed BY & Approved BY -

Distribution:
White — QC Files
Canary — Originator

11. ENGINEER

	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

CONTINUATION SHEET-#-

F 1001
Revision 0
Page 225
Appendix D

3. RECORD CONTROL
CONTROL NO. ______
FILE NO. ______

1. PROJECT NO. 8856   2. DATE ______   4. PAGE ______ OF ______

5. BLOCK CONT'D	6. FORM NO.	7. REPORT NAME
	QC–	

8. Continuation of Block-#9- Results of Inspection:

	SAT.	UNSAT
①- Proper Installation of Thermo-Lag Type 330-69 Stress Skin or Thermo-Lag 351 Primer.		
②- Proper Temperature of Stress Skin Before Application of Thermo-Lag 330-1 Subliming Material.		
③- Proper Dry Film Thickness.		
④- Inspection for Blemishes.		
⑤- Proper Methods and Inspection for Repair Work.		

Continuation of Block-#10- Action Taken if Unsatisfactory:

Distribution:
White – QC Files
Canary – Originator

9. ENGINEER ______

2515 (7/77)

Appendix E

BILL OF MATERIALS
SECTION I

ITEM	QUANTITY	DESCRIPTION	MAT'L SPEC
A.	4	18" width x 4" depth x65" length Solid Bottom Cable Tray	E-132
B.	4	18" width x 4" high 90° inside Riser El. 12" Rad., Solid Bottom Cable Tray	E-132
C.	4	18" width x 4" depth x 65" length Ladder Bottom Cable Tray	E-132
D.	2	18" width x 4" high x 90° insider Riser El. 12" Rad., Ladder Bottom Cable Tray 18" width x 4" high x 45° inside Riser 12" Rad., Ladder Bottom Cable Tray	E-132
E.	4	18" width x 4" depth x 40" length Solid Bottom Cable Tray (Middly Section)	E-132
F.	2	18" width x 4" depth x 34" length Ladder Bottom Cable Tray (Middle Section)	E-132
	1	5" Ø Rigid Steel Conduit x 29½" length (threaded on both ends)	
H.	1	5" Ø Rigid Steel Conduit x 58" length (threaded on both ends)	
I.	2	5" Ø Rigid Steel Conduit x 50 3/4" length (threaded on both ends)	
J.	3	5" Ø Rigid Steel Conduit El. 24" Rad. (threaded on both ends)	
K.	1	5" Ø Rigid Steel Conduit x 38 3/4" length (threaded on both ends)	
L.	5	5" Ø Rigid Steel Conduit Couplings	
M.	2	5" Ø Rigid Steel Conduit x 24" length (threaded on both ends)	
O.	3	4 x 4 Tube Steel 44"	ASTM A36
P.	1	4 x 4 Tube Steel 108"	ASTM A36

BILL OF MATERIALS
SECTION I

ITEM	QUANTITY	DESCRIPTION	MAT'L SPEC
Q.	2		ASTM A36
R.	6	3/4" Ø x 12" Lg. Bolts (Hilti Kwik)	
S.	1	Conduit Clamp (Unistrut - P1123)	
T.	1	Carbon Steel Plate ½" x 6" x 12" Lg.	ASTM A36
A.A.	1	Junction Box 24" x 8" x 8", Nema Four w/mounting lugs	
B.B.	1	Channel 108" Long (Unistrut P1000)	A
	1	Channel 1-1/4" Long (Unistrut P1000)	
D.D.	4	1/2 Ø x 5" Lg. Bolts (Hilti Kwik)	
	2	P1068 Clips	
	1	5" Ø Rigid Steel Conduit x 8" Length (threaded on both ends)	
G.G.	288	3/8" - 16x 34" Lg. Spline Bolt w/Oval Type Phillips Slotted Heads w/Nuts and Locking Devices	E-132
H.H.	As Required	Cables (Refer to following page for itemized listing) IEEE-383 qualified	
I.I.	As Required	Cable Ties	
J.J.	36	Splice Plates	E-132
	4	1/2" x 1-1/2" Button Head Bolt	
	4	Flat Plate Fitting (P1964)	
	4	Husky Burnoy BKSA-L	
	8	Unistrut 1/2" Spring Nut P3010	
	2	5" Rigid Steel Conduit x 12" in Length	
	4	1/2" x 1-1/2" P1010	

BILL OF MATERIAL
SECTION II

FUNC.	TYPE	SIZE	QUANTITY	LENGTH
PWR	R75	1-750MCM A-	8	20
PWR	R50	1-500MCM A-	5	20
PWR	R35	1-350MCM A-	4	20
PWR	R04	1-4/0 A-	4	20
PWR	D42	2/C #4 Cu	6	20
PWR	D63	3/C #6 Cu	1	20
PWR	D62	2/C #6 Cu	8	20
PWR	D83	3/C #8 Cu	4	20
PWR	Z83	3/C #8 Cu	4	20
PWR/Cont	D14	4/C #10 Cu	5	20
Cont	L12	12/C #14 Cu	7	20
Cont	L07	7/C #14 Cu	7	20
Cont	Z07	7/C #14 Cu	4	20
Cont	L05	5/C #14 Cu	5	20
Cont	L03	3/C #14 Cu	5	20
Inst	Q27	7 Indiv. Shld PR #16	7	20
Inst	Q26	3 Indiv. Shld PR #16	1	20
Inst	Q25	2 Indiv. Shld Pr #16	5	20
Inst	Q16	5/C #20 Overall Shld	4	20
Inst	Q12	48/C #20 Overall Shld	5	20
Inst	Q41	RG-11U Triax	4	20
Inst	N12	12/C #16 Overall Shld	1	20

BILL OF MATERIAL
SECTION II

FUNC.	TYPE	SIZE	QUANTITY	LENGTH
PWR	R50	1-500MCM	2	1
	D63	3/C #6	2	1
PWR/Cont	D14	4/C #10	2	1
Cont	L12	12/C #14	2	1
Cont	L07	7/C #14	2	1
Cont	L05	5/C #14	2	1
Cont	L03	3/C #14	2	1
Inst	N12	12/C #16 Overall Shld	2	1
	Q27	7 Inidv Shld Prs #16	2	1
	Q26	3 Indiv Shld Prs #16	2	1
	Q25	2 Indiv Shld Prs #16	2	1
	Q12	48/C #20 Overall Shld	2	1

TABLE T1

CABLE DIST FOR 30% FILL OF CABLE TRAYS

FUNC.	CABLE TYPE	CABLE SIZE	QUANITY	LENGTH
PWR	R75	1-750MCM	3	20
PWR	R50	1-500MCM	1	20
PWR	R35	1-350MCM	1	20
PWR	R04	1-4/0	1	20
PWR	D42	2/C #4	1	20
PWR	D62	2/C #6	3	20
PWR	D83	3/C #8	1	20
PWR	Z83	3/C #8	1	20
PWR/Cont	D14	4/C #10	1	20
[illegible]	L12	12/C #14	2	20
Cont	L07	7/C #14	2	20
Cont	Z07	7/C #14	1	20
Cont	L05	5/C #14	1	20
Cont	L03	3/C #14	1	20
Inst	Q27	7 Indiv Shld Pr #16	2	20
Inst	Q25	2 Indiv Shld Pr #16	1	20
Inst	Q16	5/C #20 Over Shld	1	20
Inst	Q12	48/C #20 Overall Shld	1	20
Inst	Q41	RG-11U Triax	1	20

TABLE T2

LIGHTLY LOADED TRY (1 Layer)

FUNC.	CABLE TYPE	CABLE SIZE	QUANTITY	LENGTH
PWR	R75	1-750MCM	1	20
PWR	R50	1-500MCM	1	20
PWR	R35	1-350MCM	1	20
PWR	R04	1-4/0	1	20
PWR	D42	2/C #4	1	20
PWR	D62	2/C #6	1	20
PWR	D83	3/C #8	1	20
PWR	Z83	3/C #8	1	20
PWR/Cont	D14	4/C #10	1	20
[illegible]	L12	12/C #14	1	20
Cont	L07	7/C #14	1	20
Cont	Z07	7/C #14	1	20
Cont	L05	5/C #14	1	20
Cont	L03	3/C #14	1	20
Inst	Q27	7 Indiv Shld Pr #16	1	20
Inst	Q25	2 Indiv Shld Pr #16	1	20
Inst	Q16	5/C #20 Overall Shld	1	20
Inst	Q12	48/C #20 Overall Shld	1	20
Inst	Q41	RG-11U Triax	1	20

TABLE T3

CABLE DIST FOR 40% FILL OF 5" CONDUIT

FUNC	CABLE TYPE	CABLE SIZE	QUANTITY	LENGTH
PWR	R50	1-500MCM	1	20
PWR	D42	2/C #4	2	20
PWR	D63	3/C #6	1	20
PWR/Cont	D14	4/C #10	1	20
Cont	L12	12/C #14	1	20
Cont	L07	7/C #14	1	20
Cont	L05	5/C #14	1	20
Cont	L03	3/C #14	1	20
Inst	N12	12/C #16 Overall Shld	1	20
Inst	Q27	7 Indiv Shld Prs #16	1	20
[illegible]	Q26	3 Indiv Shld Prs #16	1	20
Inst	Q25	2 Indiv Shld Prs #16	1	20
Inst	Q12	48/C #20 Overall Shld	1	20

TABLE T4

CABLES TO BE AIR DROPPER

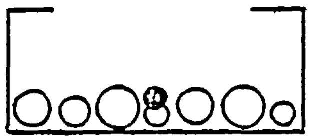
TRAY 1

CABLE FUNC.	CABLE TYPE	CABLE SIZE	QUANTITY
Power	D42	2/C #4	1
Control	L07	7/C #14	1
Inst.	Q25	2 Indiv Shld Pr #16	1
TRAY 2			
Power	D83	3/C #8	1
Control	L12	12/C #14	1
Inst.	Q27	7 Indiv Shld Pr #16	1
TRAY 3			
Power	D62	2/C #6	1
Control	L05	5/C #14	1
Inst	Q12	48/C #20 Overall Shld	1
TRAY 4			
Inst	Q16	5/C #20 Overall Shld	1

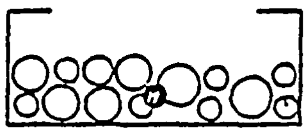
TABLE T5

CABLE INSTALLED IN EACH 1 FT SAMPLE CONDUIT 32% FULL

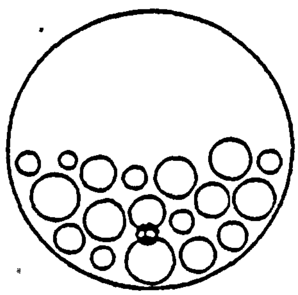
FUNC.	CABLE TYPE	CABLE SIZE	QUANTITY	LENGTH
PWR	R50	1-500MCM	1	1
PWR	D63	3/C #6	1	1
PWR/Cont	D14	4/C #10	1	1
Cont	L12	12/C #14	1	1
Cont	L07	7/C #14	1	1
Cont	L05	5/C #14	1	1
Cont	L03	3/C #14	1	1
Inst	N12	12/C #16 Overall Shld	1	1
Inst	Q27	7 Indiv Shld Prs #16	1	1
Inst	Q26	3 Indiv Shld Prs #16	1	1
[illegible]	Q25	2 Indiv Shld Prs #16	1	1
Inst	Q12	48/C #20 Overall Shld	1	1



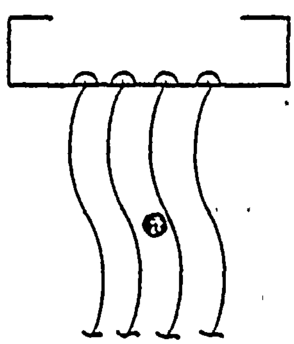
THERMOCOUPLE LOCATION FOR LIGHTLY LOADED TRAY



THERMOCOUPLE LOCATION FOR 40% TRAY FILL.



THERMOCOUPLE LOCATION FOR CONDUIT



THERMOCOUPLE LOCATION FOR FREE DROP CABLE

NOTE:
THERMOCOUPLES SHALL BE INSTALLED AT ONE FOOT INTERVALS.

TEXAS UTILITIES SERVICES, INC. C.P.S.E.S. GLEN ROSE, TEXAS					
FIRE PROTECTION TEST FOR CONDUITS, CABLE TRAYS, INSTRUMENTATION TUBING, & SUPPORTS					
DWG TITLE: THERMOCOUPLE LOCATIONS			SCALE: NONE		
3 DATE: [illegible]	DWN: ZFD	CKD MJP	APP'D [illegible]	ISSUED FOR CONSTRUCTION	DWG NO. [illegible]

EXHIBIT V

THERMOCOUPLE DATA

TABLE OF CONTENTS - EXHIBIT V

TABLE V-1

THERMOCOUPLE CHANNEL ASSIGNMENT

Thermocouple Number	Recorder Type	Recorder Channel	Function	Data Channel
F1, F2, F3	Manual Entry		Avg. Temp, 12" above cable trays	00
F4, F5, F6, F7	Manual Entry		Avg. Temp, 12" below cable trays	01
F1-F7 Average	Manual Entry		Overall Furnace Average	02
T1-1	Digi-1	2	Cable Tray 1 Data	06
T1-2	"	3	"	07
T1-3	"	4	"	08
T1-4	"	5	"	09
T1-5	"	6	"	10
T1-6	"	7	"	11
T1-7	"	8	"	12
T1-8	"	9	"	13
T1-9	"	10	"	14
T1-10	"	11	"	15
T1-11	"	12	"	16
T1-12	"	13	"	17
T1-13	"	14	"	18
T1-14	"	15	"	19
T1-15	Digi-2	2	"	20
T2-1	Digi-2	3	Cable Tray 2 Data	21
T2-2	"	4	"	22
T2-3	"	5	"	23
T2-4	"	6	"	24
T2-5	"	7	"	25
T2-6	"	8	"	26
T2-7	"	9	"	27
T2-8	"	10	"	28
T2-9	"	11	"	29
T2-10	"	12	"	30
T2-11	"	13	"	31
T2-12	"	14	"	32
T2-13	"	15	"	33
T2-14	Westronics 2000	1	"	34
T2-15	"	2	"	35

Table V-1 - Continued

Thermocouple Number	Recorder Type	Recorder Channel	Function	Data Channel
T3-1	Westronics 2000	3	Cable Tray 3 Data	36
T3-2	"	4	"	37
T3-3	"	5	"	38
T3-4	"	6	"	39
T3-5	"	7	"	40
T3-6	"	8	"	41
T3-7	"	9	"	42
T3-8	"	10	"	43
T3-9	"	11	"	44
T3-10	"	12	"	45
T3-11	"	13	"	46
T3-12	"	14	"	47
T3-13	"	15	"	48
T3-14	"	16	"	49
T3-15	"	17	"	50
T4-1	Westronics 2000	18	Cable Tray 4 Data	51
T4-2	"	19	"	52
T4-3	"	20	"	53
T4-4	"	21	"	54
T4-5	"	22	"	55
T4-6	"	23	"	56
T4-7	"	24	"	57
T4-8	Westronics 3597	1	"	58
T4-9	"	2	"	59
T4-10	"	3	"	60
T4-11	"	4	"	61
T4-12	"	5	"	62
T4-13	"	6	"	63
T4-14	"	7	"	64
T4-15	"	8	"	65
AD1-1	Westronics 3597	9	Air Drop	66
AD1-2	"	10	"	67
AD1-3	"	11	"	68
AD1-4	"	12	"	69
AD1-5	"	13	"	70
AD1-6	"	14	"	71

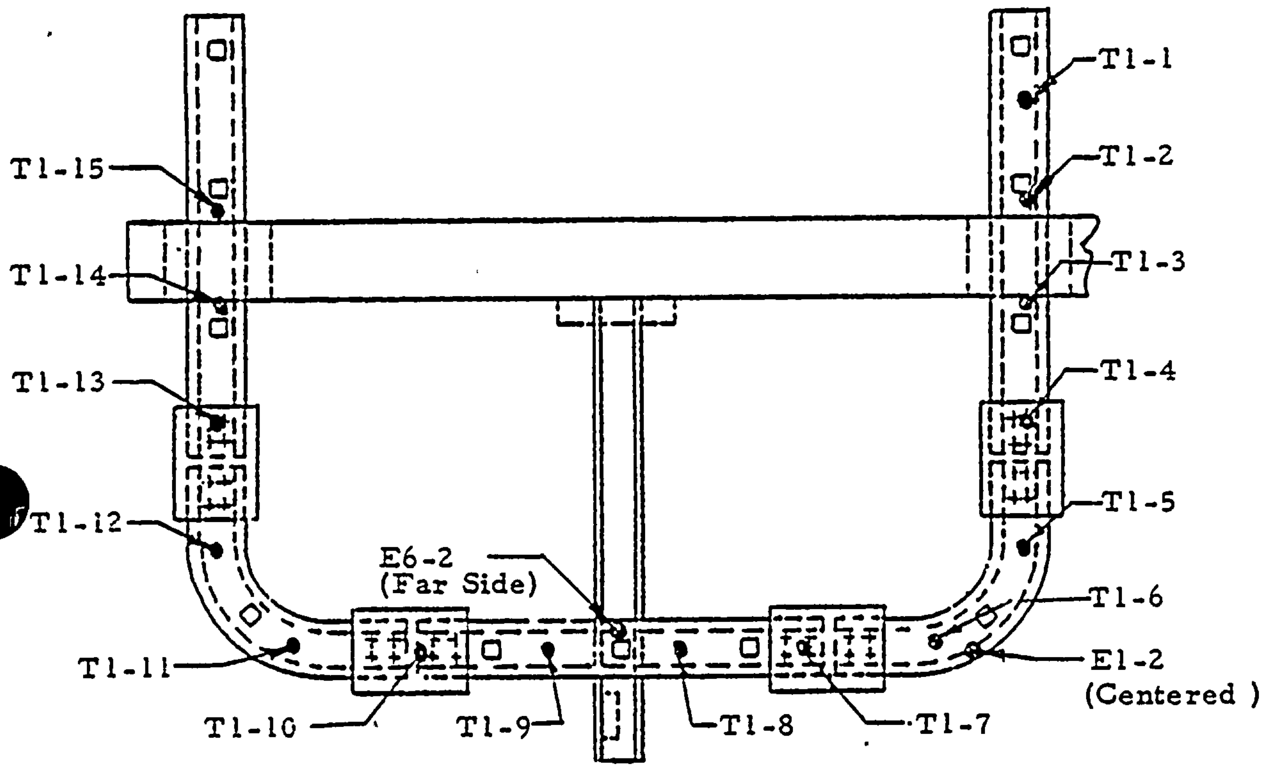
Table V-1 - Continued

Thermocouple Number	Recorder Type	Recorder Channel	Function	Data Channel
AD2-1	Westronics 3597	15	Air Drop 2 Data	72
AD2-2	"	16	"	73
AD2-3	"	17	"	74
AD2-4	"	18	"	75
AD2-5	"	19	"	76
AD2-6	"	20	"	77
AD2-7	"	21	"	78
AD2-8	"	22	"	79
AD2-9	"	23	"	80
AD3-1	Westronics 3597	24	Air Drop 3 Data	81
AD3-2	Westronics 2733	1	"	82
AD3-3	"	2	"	83
AD3-4	"	3	"	84
AD3-5	"	4	"	85
AD3-6	"	5	"	86
AD4-1	Westronics 2733	6	AIR DROP4	87
AD4-2	"	7	"	88
AD4-3	"	8	"	89
AD4-4	"	9	"	90
AD4-5	"	10	"	91
AD4-6	"	11	"	92
C1-1	Westronics 1727	1	5" Conduit Data	93
C1-2	"	2	"	94
C1-3	"	3	"	95
C1-4	"	4	"	96
C1-5	"	5	"	97
C1-6	"	6	"	98
C1-7	"	7	"	99
C1-8	"	8	"	100
C1-9	"	9	"	101
C1-10	"	10	"	102
C1-11	"	11	"	103
C1-12	"	12	"	104
C1-13	"	13	"	105
C1-14	"	14	"	106
C1-15	"	15	"	107
C1-16	"	16	"	108
C1-17	"	17	"	109

THERMOCOUPLE LOCATIONS

(DRAWINGS)

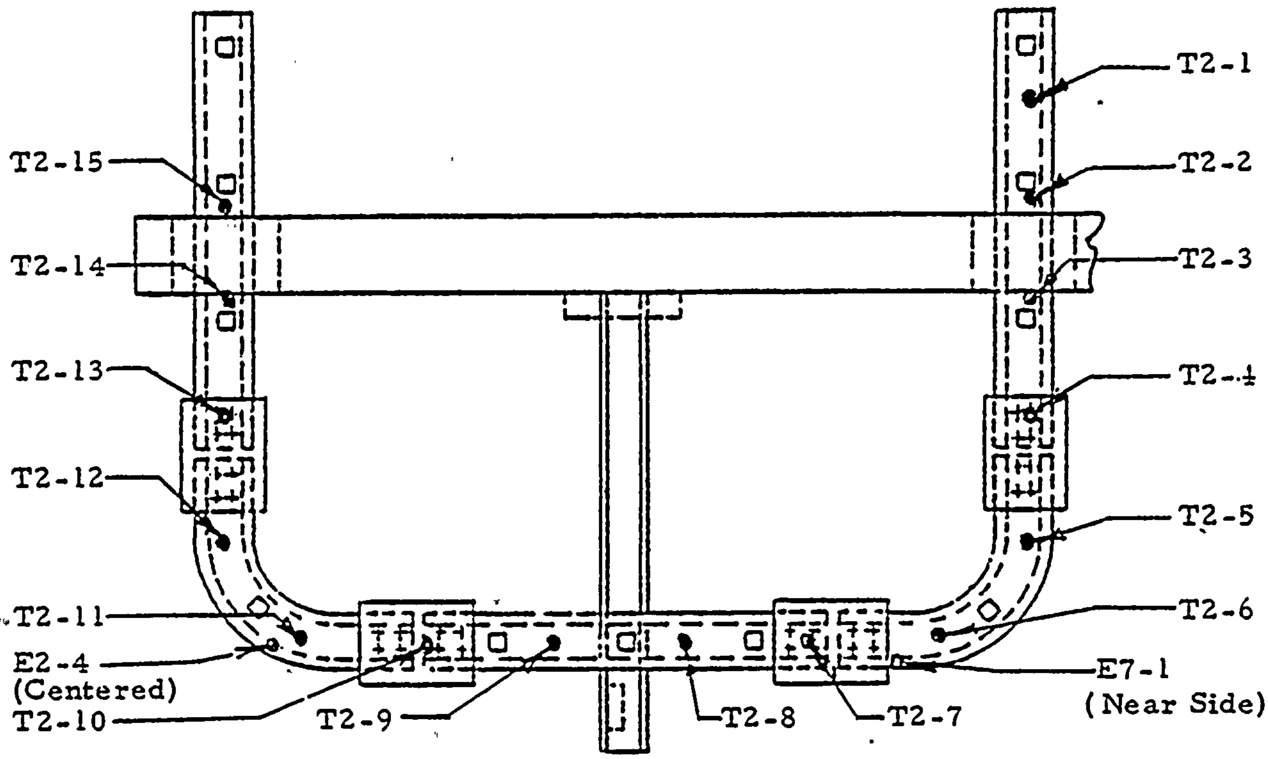
Cable Tray No. 1: 18" Ladder Back
with one layer of cable



Data Thermocouples located on center cable (W-047) at 12 o'clock position at 1 ft intervals, per Drawing FDSG-D14.

Figure V-1. Thermocouple Locations Cable Tray No. 1

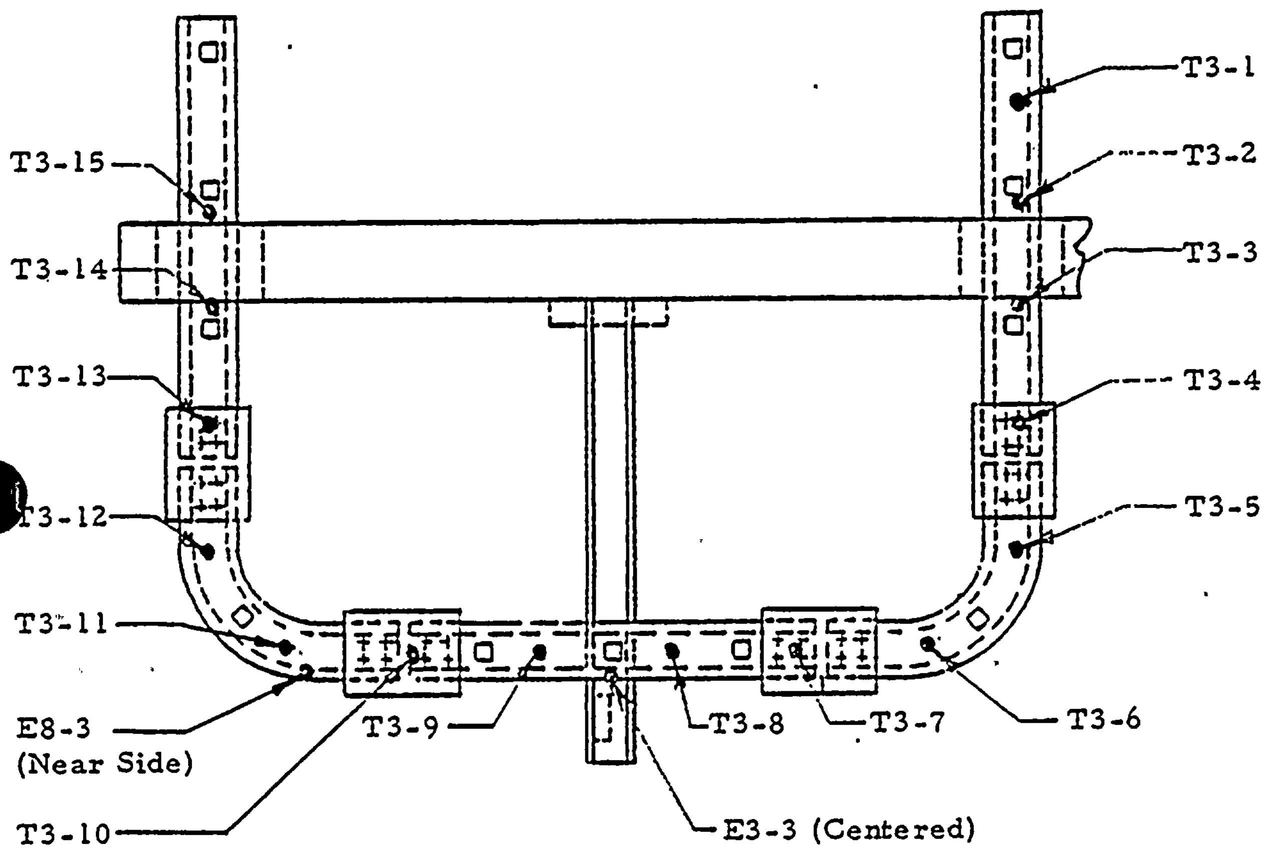
Cable Tray No. 2: 18" Solid Back
40% Cable Loading



Data Thermocouples located on center cable (W-141) at 12 o'clock position at 1 ft intervals, per Drawing FDSG-D14.

Figure V-2. Thermocouple Locations, Cable Tray No. 2

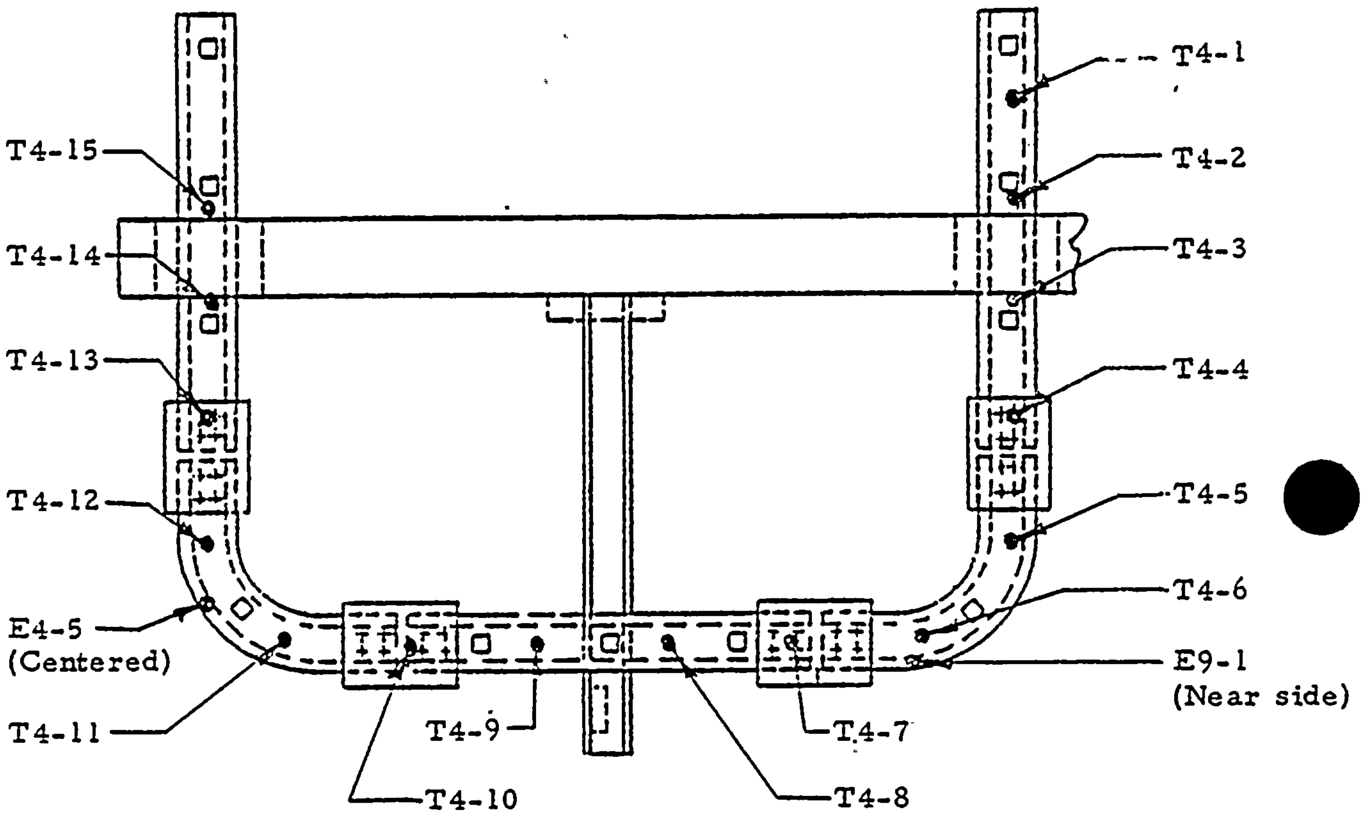
Cable Tray No. 3: 18" Ladder Back
40% Cable Loading



Data Thermocouples located on center cable (W-124) at 12 o'clock position at 1 ft intervals, per Drawing FDSG-D14.

Figure V-3. Thermocouple Locations, Cable Tray No. 3

Cable Tray No. 4: 18" Solid Back with
one layer of cable



Data Thermocouples located on center cable (W-047) at 12 o'clock position at 1 ft intervals, per Drawing FDSG-D14.

Figure V-4. Thermocouple Locations, Cable Tray No. 4

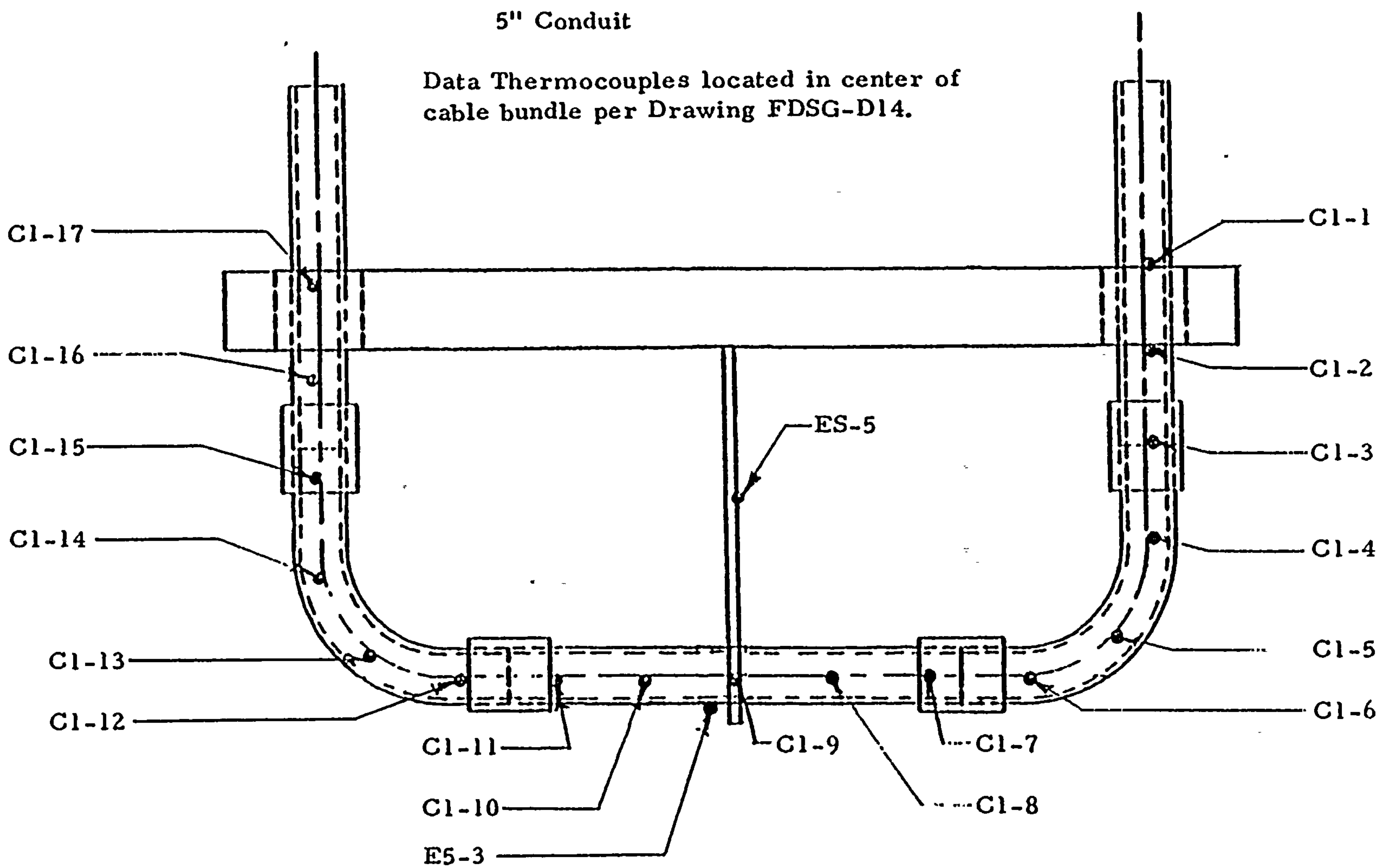


Figure V-5. Thermocouple Locations, 5" Conduit

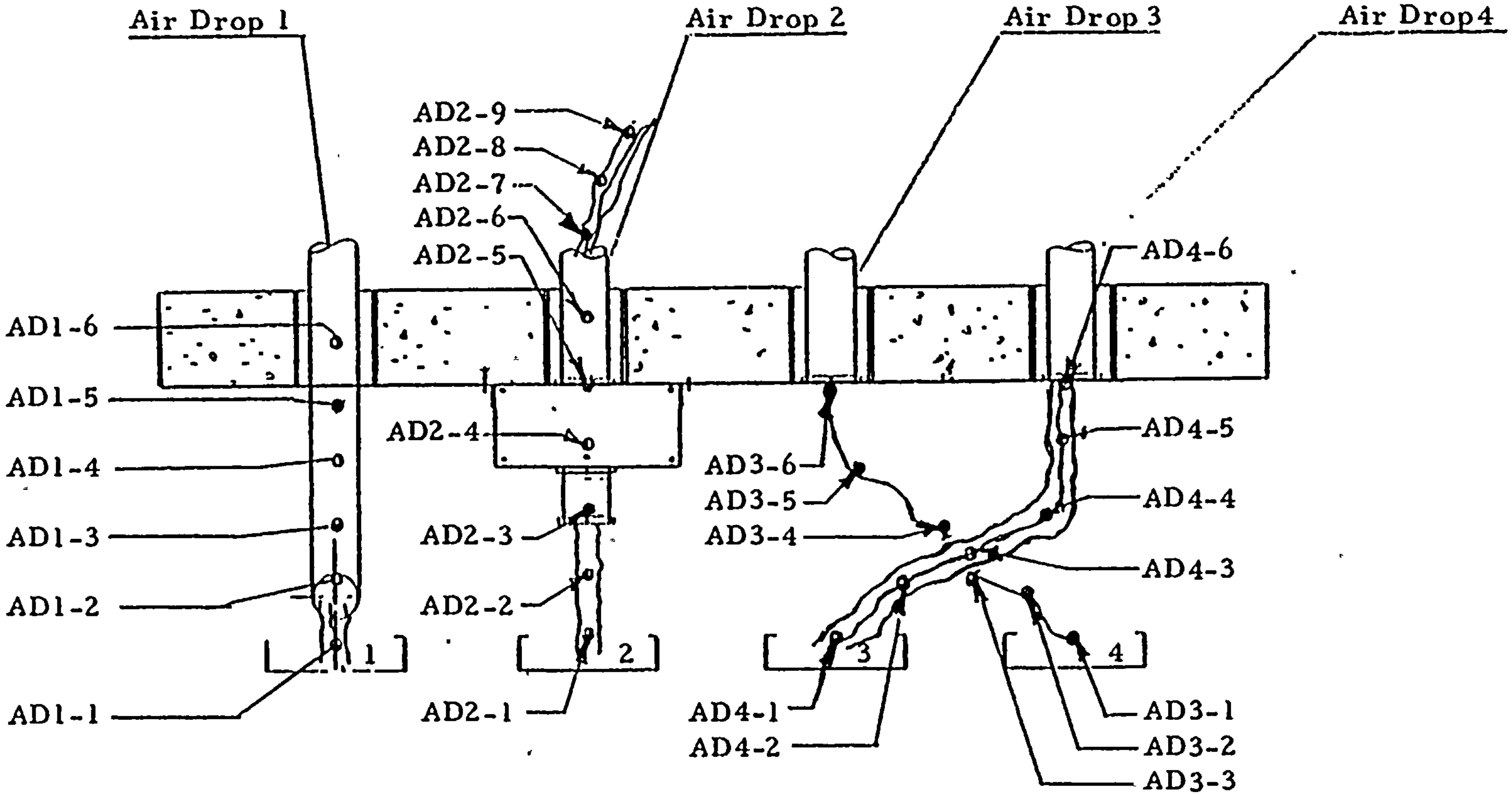


Figure V-6. Thermocouple Locations, Air Drop Cables

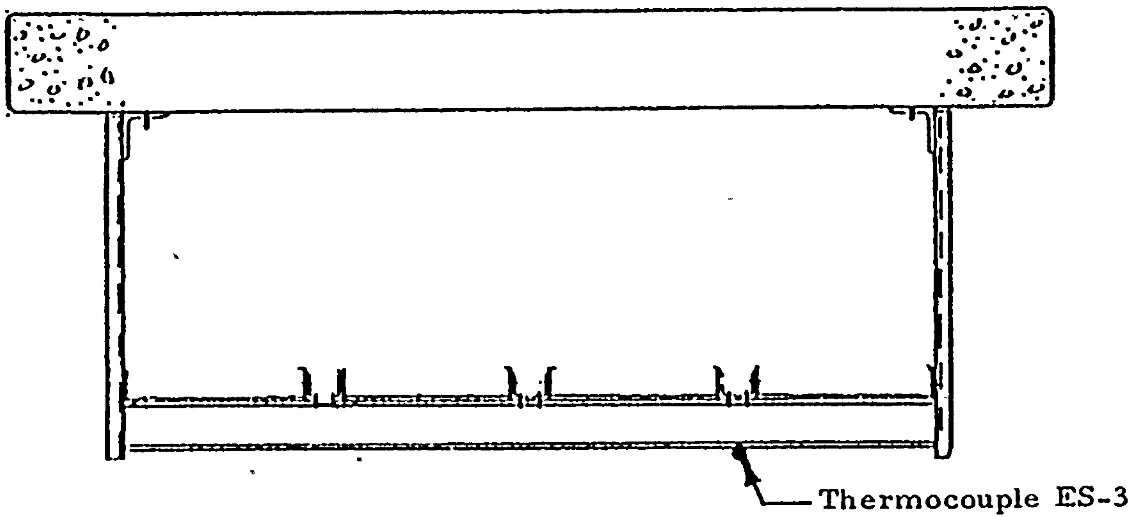


Figure V-7. Thermocouple Location, Tray Support

PP&L	ASME SECTION III OR XI ☐ SAFETY RELATED ☐ OTHER QUALITY ☒ NON QUALITY ☐ DESIGN VERIFICATION YES ☐ NO ☒	SPECIFICATION NO. F1000 FILE NO. 538 - F1000 PAGE 1 OF 9

TECHNICAL

SPECIFICATION

FOR

ELECTRICAL RACEWAY DESIGN AND INSTALLATION

OF EXPOSURE FIRE BARRIERS AND FIRE STOPS

SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2
PENNSYLVANIA POWER & LIGHT COMPANY
ALLENTOWN, PENNSYLVANIA

USER CONTROLLED

Expiration Date 8/18/82

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JUL 12 1982
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0	7/1/82	ISSUED FOR USE	Donald J. Kohn	N/A	A.W. Metzger
REV.	DATE	DESCRIPTION	PREPARED BY	VER'FD.	APPROVED

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1.0 SCOPE

1.1 DESCRIPTION

This specification describes the requirements for raceway exposure fire barriers and fire stops for the Susquehanna Steam Electric Station Unit 1 and Unit 2 in accordance with the performance, design and test criteria requirements described herein.

1.2 GENERAL

It is not the intent to specify herein all details of design and construction. It shall be the responsibility of the Seller to insure that the materials have been designed and fabricated in compliance with this specification and with all documents referred to herein as well as in accordance with good engineering practice.

1.3 WORK INCLUDED

Furnish all the necessary insulating materials, installation details, tools, equipment and services required for insulation of electrical raceway for the following:

1.3.1 Fire breaks

1.3.2 Exposure fire barriers

1.3.3 PP&L shall install all materials specified.

1.4 WORK NOT INCLUDED

1.4.1 Unloading and storage of all materials specified.

2.0 APPLICABLE CODES, STANDARDS, AND OTHER DOCUMENTS

The work to be performed under this specification shall conform to the applicable provisions of the latest revisions of the following documents. If a conflict exists between any of these documents and this specification, the specification shall govern.

a. NRC Branch Technical Position 9.5.1, Appendix A

b. American Nuclear Insurers/Mutual Atomic Energy Reinsurance Pool (ANI/MAERP) Standards

c. Susquehanna Fire Protection Review Report

d. Nuclear Department Instruction - QA-8.2.3, Quality Assurance Requirements for Fire Protection and Related Systems.

e. Operational Policy Statement (OPS) - 1

3.0 TECHNICAL REQUIREMENTS

3.1 FIRE BREAK DESIGN

3.1.1 The purpose of Fire Breaks is to stop propagation of fire in vertical and horizontal cable trays.

3.1.2 Fire Breaks shall be installed in vertical cable trays and in covered trays every 15 ft. Fire barrier penetration seals provide a fire break where they are installed.

3.1.3 Fire Breaks shall be made from an Insulation Blanket and mastic coating, or PP&L Engineering approved equal, see Section 3.5.

3.2 FIRE BREAK CONSTRUCTION (Typical For Insulation Blanket Material Only)

3.2.1 Fire Breaks shall completely encapsulate the cable tray for six to eight inches (nominal Min. Dimension).

3.2.2 If the cable tray is not completely filled with cables, Insulation Blanket, the same width as the cable tray shall be inserted over the cables in sufficient layers to bring the outer surface of the Insulation Blanket even with the top of the tray sides and completely fill all void spaces.

3.2.3 One layer of Insulation Blanket will then be wrapped completely around the cable tray. The blanket shall be secured with stainless steel straps.

3.2.4 The open ends of the Fire Break shall be packed with Bulk Insulation Fiber and sprayed with Mastic Coating to a 1/2 inch wet thickness so as to completely seal the cable tray/cable/Insulation Blanket interface.

3.3 EXPOSURE FIRE BARRIER DESIGN

3.3.1 Exposure Fire Barriers shall be installed on electrical cable trays, conduits and junction/terminal boxes at locations specified per Susquehanna Fire Protection Review Report Appendix "A".

3.3.2 Exposure Fire Barriers shall be made by encasing the cable trays, conduits and junction/terminal boxes in one hour rated barrier system.

3.3.3 The purpose of Exposure Fire Barriers is to prevent damage, during a 1 hour complete engulfment fire, to electrical cables serving one division of equipment required for safe shutdown of the plant when redundant safe shutdown divisions occupy the same fire area.

3.3.4 The Exposure Fire Barrier construction system shall also encase all raceway support steel within 18 inches of the protected raceway.

3.4 EXPOSURE FIRE BARRIER CONSTRUCTION (Typical For Insulation Blanket Material Only)

3.4.1 Exposure Fire Barriers shall completely encapsulate the indicated cable tray or conduit for the entire length specified.

3.4.2 If the cable tray is not covered and is not completely filled with cables, Insulation Blanket, the same width as the cable tray, shall be inserted over the cables in sufficient layers to bring the outer surface of the Insulation Blanket even with the top of the tray sides.

3.4.3 The first (interior) layer of the Insulation Blanket shall wrap completely around the perimeter of the cable tray with the ends of the blanket overlapping a minimum of 3 inches. Adjacent blankets shall be placed tightly together so as to prevent any gaps in the butt joints between blankets. This layer shall be held in place by High Performance Filament Tape spaced not more than 14 inches apart and not less than 4 inches from butt joints.

3.4.4 The second (exterior) layer of Insulation Blanket shall wrap completely around the perimeter of the interior layer and must also have a minimum 3 inch overlap. The overlap of the exterior layer shall be offset from the overlap of the interior layer but still remain on the top of the tray. The exterior layer blankets shall be installed such that the butt joints between adjacent exterior blankets are offset at least 12 inches from the butt joints between interior blankets.

3.4.5 The exterior blankets shall be secured in place by stainless steel straps installed not more than 14 inches apart and not less than 4 inches from exterior butt joints. The tensioning of the straps shall be sufficient to hold the blanket snugly in place without causing any sufficient cutting of, or damage to, the blanket material.

3.4.6 A protective outer wrap of Aluminized Zetex is to be secured independently of the Kaowool blanket with Polyken 237 tape. This outer wrap shall be installed after the stainless steel straps. The "zetex" shall have a minimum 3 inch overlap. The overlaps in the outer wrap shall be offset from the overlaps in the previous layer but still remain on top of the tray. A single layer of Polyken 237 tape will be made over all joints. (The above is typical for all barriers constructed with Insulation Blanket Material Kaowool.)

3.4.7 Where adjoining cable tray or conduit or tray support members attached to, or come into contact with, the tray to be protected, the attaching or contacting member shall also be wrapped with two layers of Insulation Blanket as necessary to ensure complete coverage of the protected tray. No gaps or openings shall be allowed.

3.4.8 Conduits mounted on exposed unistrut shall be insulated in the same manner as cable trays, except that no filler blanket is required.

3.4.9 Conduits mounted on embedded unistrut, flush to a wall, shall be covered with two layers of Insulation Blanket. The blanket shall extend a minimum of two inches onto the surface of the wall. The edges of the blanket shall be secured to the wall by steel strips and concrete expansion anchors or an equivalent fastening method approved by the Nuclear Plant Engineering (NPE) Civil Group Supervisor or his designee.

3.4.10 Exposed, non-supported cable transitions (air-lined) from conduit to tray or from tray to tray shall be wrapped in two layers of Blanket. Each layer shall wrap around the cables with an end overlap of not less than 3 inches. The blankets shall be secured by tying with Woven Tape at 14 inch maximum intervals.

3.4.11 At locations where the protected tray or conduit penetrates a fire barrier in a ceiling, floor or wall, both the interior and exterior layers of Insulation Blanket shall be cut and installed such that the blankets will fit snug against the firestop. The juncture will then be sealed with mastic coating. The mastic will be sprayed or troweled completely around the Insulation Blanket to not less than 1/4 inch thickness, and shall extend not less than 8 inches onto the exterior of the blanket and the surface of the fire barrier and ceiling, floor or wall.

3.5 BLANKET INSULATION/BARRIER BOARD, BANDING, TAPE AND MASTIC MATERIALS (Fire Breaks, Separation Barriers and Exposure Barriers)

3.5.1 Insulation/Blanket consisting of interlaced ceramic/glass fibers, one inch thick, 8 lb. per cu. ft., width and lengths are required, Babcock and Wilcox, Kaowool or PP&L Engineering approved equal.

3.5.2 Formed barrier board consisting of ceramic fibers and binders, thickness and size as required, Babcock and Wilcox, Kaowool M Board or PP&L Engineering approved equal. (Junction/Terminal box covers.)

3.5.3 Protective outer wrap joint tape, Polyken 237, 2" wide, 2 mils thick, mfg. by Kendall Corp., Polyken Div. or PP&L Engineering approved equal.

3.5.4 Aluminized protective outer wrap consisting of glass cloth, Babcock and Wilcox, Zetex Style 800; or PP&L Engineering approved equal.

3.5.5 High Performance Filament Tape for securing Insulation Blanket on electrical cable tray and conduit shall be 1 inch wide, 3M Company Tape Number 89 or PP&L Engineering approved equal.

3.5.6 Woven Tape for securing Insulation Blanket in electrical cable tray shall be a refactory silica product, 1 inch wide by 0.125 inch

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nominal thickness with selvaged edges, Haveg Industries, Inc. Siltemp Code Number WT65-1 or PP&L Engineering approved.

3.5.7 Mastic Coating for fire protection applications shall be Intumastic 285, manufactured by Carboline Fire Proofing Products Division, or PP&L Engineering approved equal.

3.5.8 Galvanized steel strips and concrete expansion anchors, or equivalent fastening method approved by the NPE Civil Group Supervisor or his designee, for attached Insulation Blanket to walls.

3.5.9 Straps for securing Insulation Blanket on electrical cable tray and conduit shall be 3/4 inch width by .020 inch thick Type 304 stainless steel.

3.5.10 Bolts, nuts, washers and other fasteners shall be electro-galvanized or cadmium plated.

3.6 EXPOSURE FIRE BARRIER CONSTRUCTION (Typical For TSI Inc. Material)

3.6.1 "Approved Equal" barrier system, subliming compound, Thermo-Lag 330-1, water based spray coating, mfg. by TSI, Inc. consisting of Thermo-Lag 351 Primer, or Thermo-Lag Stress Skin Type 330-69 and Thermo-Lag 351 Primer, plus Thermo-Lag 330-1 Subliming Compound, for use on raceway, junction/terminal boxes and support steel.

3.6.2 The Thermo-Lag Stress Skin Type 330-69 shall be installed as follows:

a) Secure with the raceway or support steel.

b) The stress skin primer intact.

c) Free of foreign substances prior to application of Thermo-Lag 330-1 Subliming Compound.

d) Completely encasing the raceway or support steel.

3.6.3 The Thermo-Lag 330-1 Subliming Compound shall be applied by spraying or troweling to the Stress Skin.

3.6.4 The final dry film thickness of Thermo-Lag 330-1 material shall be one-half inch (1/2 in.) minimum and three-fourths inch (3/4 in.) maximum. The finish shall be free of texture irregularities (i.e. blisters, spalling, fissures, separations, etc.).

3.6.5 The repair of any surface textural irregularities shall have all damaged and loose material removed back to sound adhering material. A knife or scrapper is acceptable. The edge should be undercut to form a beveled edge as in plaster repair. All foreign matter should be removed

from the substrate using a wire brush. Thermo-Lag 330-1 Subliming Compound shall be added to achieve the required dry film thickness.

3.6.6 Surface temperature of the substrate to receive Thermo-Lag 330-1 Subliming Compound shall be 40°F or higher prior to application of Thermo-Lag 330-1 Subliming Compound.

3.6.7 Prior to applying additional coats or layers, a surface reading of 20 or less shall be obtained using a Delmhorst Moisture Meter (Model DP) or PP&L Engineering approved equal.

3.7 TSI INC. MATERIALS

3.7.1 The material supplied shall be accompanied by a certificate of conformance by the manufacturer that the material is as specified on the purchase order, or bear the Underwriter Laboratories (U.L.) label.

3.7.2 Thermo-Lag 330-69 Stress Skin with Thermo-Lag 351 Primer.

3.7.3 Thermo-Lag 351 Primer.

3.7.4 Thermo-Lag 330-1 water based subliming coating compound.

3.8 DOCUMENTATION

All records generated as a result of this specification shall be included in the appropriate Quality Assurance Records File and SSES Records Management System File.

4.0 TESTING AND INSPECTION REQUIREMENTS

4.1 Quality Control shall check that all fire stops are installed in accordance with this specification.

4.2 Quality Control shall check that all Blanket Type Exposure Barriers are installed in accordance with this specification, and that each blanket layer completely encompasses the raceway.

4.3 Quality Control shall check that all TSI Inc. Type Exposure Barriers are installed in accordance with this specification.

4.4 The following additional requirement shall be checked for the TSI Inc. type installation: (Commercial quality measuring devices are acceptable for use.)

a) Proper installation of the Thermo-Lag Stress Skin or 351 Primer.

b) Proper temperature (above 40°F) of the substrate to which Thermo-Lag 330-1 is to be applied.

c) Proper Dry Film Thickness prior to recoat.

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d) Proper dryness between coats.

e) Inspection for surface blemishes in final surface.

f) Proper methods for repair work.

5.0 PREPARATION FOR DELIVERY

This section is not applicable to this specification.

6.0 GENERAL INFORMATION

This specification specifies the technical requirements for Exposure Fire Barriers and Fire Stops which are intended to meet the various criteria as outlined in the NRC Branch Technical Position 9.5.1 Appendix A, and the American Nuclear Insurers/Mutual Atomic Energy Reinsurance Pool (ANI/MAERP) Standards. The Susquehanna Fire Protection Review Report commits to these Fire Stops and Exposure Fire Barriers.

6.1 DEFINITION

PP&L Engineering-NPE Civil Group Supervisor or his designee.

7.0 QUALITY ASSURANCE PROGRAM

7.1 Nuclear Department Instruction - QA-8.2.3 shall apply to the activities of this specification.

7.2 Materials used for this specification are not unique to the Nuclear Industry and are commercially available.

7.3 For PP&L internal use of this specification, the Quality Assurance Program Requirements shall be as required by the scope of Operational Policy Statement - 1.

7.4 For use external to PP&L, the Quality Assurance Program Requirements shall be as required in the purchase documents or contracts and specifications for the material/services.

QUALIFICATION FIRE TEST OF A PROTECTIVE ENVELOPE SYSTEM

FINAL REPORT

SwRI Project No. 01-7163

Prepared for

Pennsylvania Power & Light Company
Two North Ninth Street
Allentown, Pennsylvania 18101

August 1982

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QUALIFICATION FIRE TEST OF A PROTECTIVE ENVELOPE SYSTEM

REPORT NO. 1

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August 1982

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Jesse J. Beitel
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Gordon E. Hartzell, Ph.D.
Director
Department of Fire Technology

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I. OBJECTIVE

The objective of this program was to evaluate a fire-proofing material for use as a fire-protective covering for redundant electrical systems. The test specifications under which this program was performed were:

A. American Nuclear Insurers/Mutual Atomic Energy Reinsurance Pool (ANI/MAERP) "Standard Fire Endurance Test Method to Qualify a Protective Envelope for Class 1E Electrical Circuits;" and,

B. Pennsylvania Power & Light Company "Technical Specification for Fire Qualification Test of a Protective Envelope System," Specification No. F1001.

A copy of specification A is provided in Appendix A. Specification B, Pennsylvania Power & Light Test Specification, is provided separately.

II. EXPERIMENTAL

A. Test Slab

A floor section test slab, 10 x 12 x 1 ft thick, was constructed of a 12-in. steel channel with a double mat of 1-in. rebar on nominal 10-in. centers. Two 10-in. x 10-ft blockouts, six 8-in. pipe sleeves and seven 1-in. pipe sleeves were cast into the test slab. Slab dimensions and reinforcement details are shown in Figures 1 and 2.

The concrete (F_s = 3,000 psi) was cured for approximately 10 months prior to test.

B. Test Trays and Conduits

An overall sketch of the test arrangement is provided in Figure 3.

Bechtel construction personnel, under the supervision of Pennsylvania Power and Light (PP&L) personnel, using PP&L furnished materials as listed in the Bill of Materials, Appendix E of PP&L Test Specification, assembled the cable trays, conduits and associated supports. General details of the installation are provided in Appendix A of PP&L specifications. Several deviations from the specifications in Appendix A of the PP&L specification did occur and details of these changes are shown in Figures 4, 5, 6, and 7.

Cables were installed in trays, conduits and air drops as described in Table I and Figures 8, 9, and 10.

C. Protective Envelope Installation

Installation of the protective envelope materials (Thermo-Lag 330-1) was performed by Bechtel construction personnel under the supervision of PP&L personnel according to procedures provided in

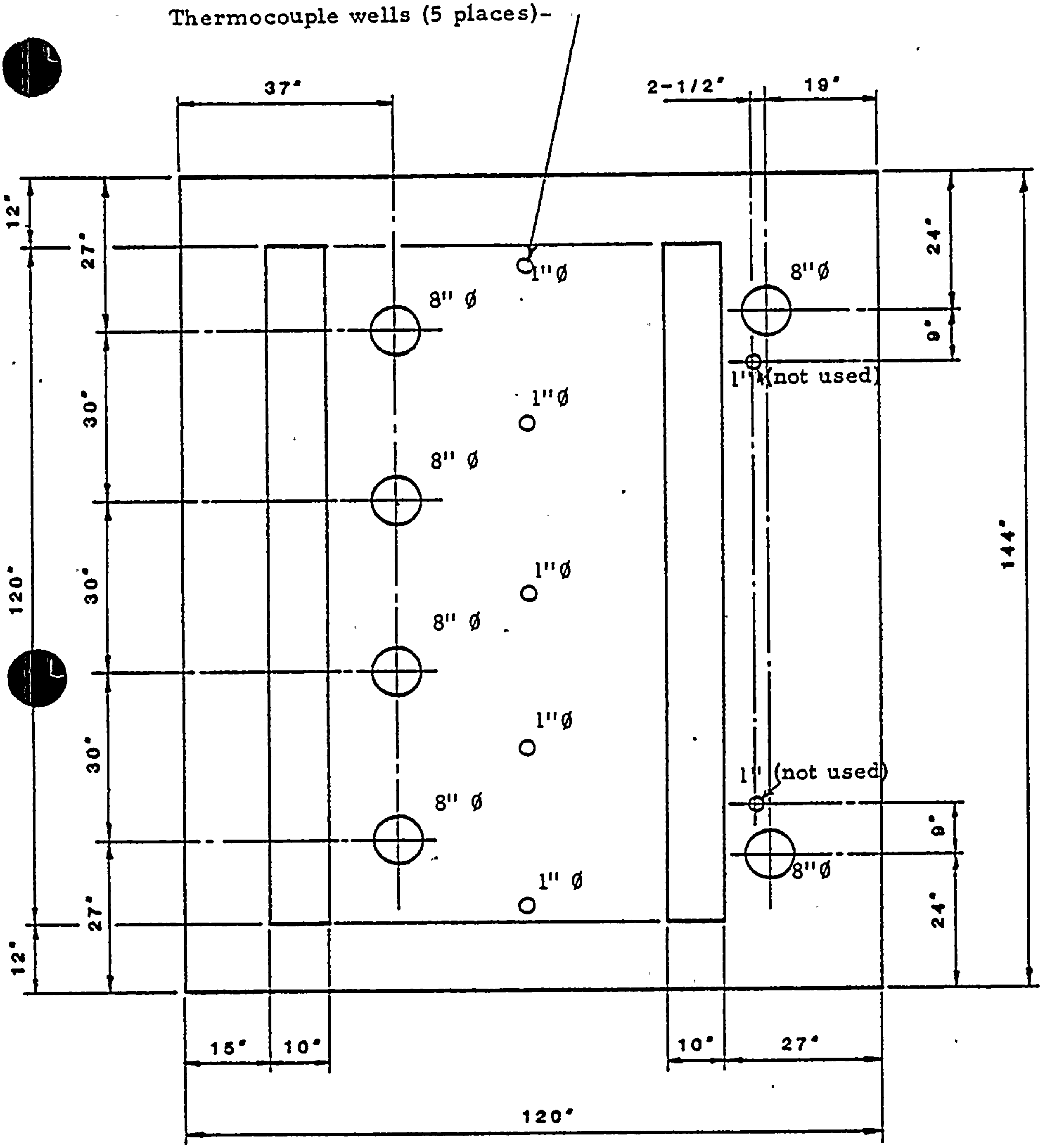


Figure 1. Test Slab Dimensions

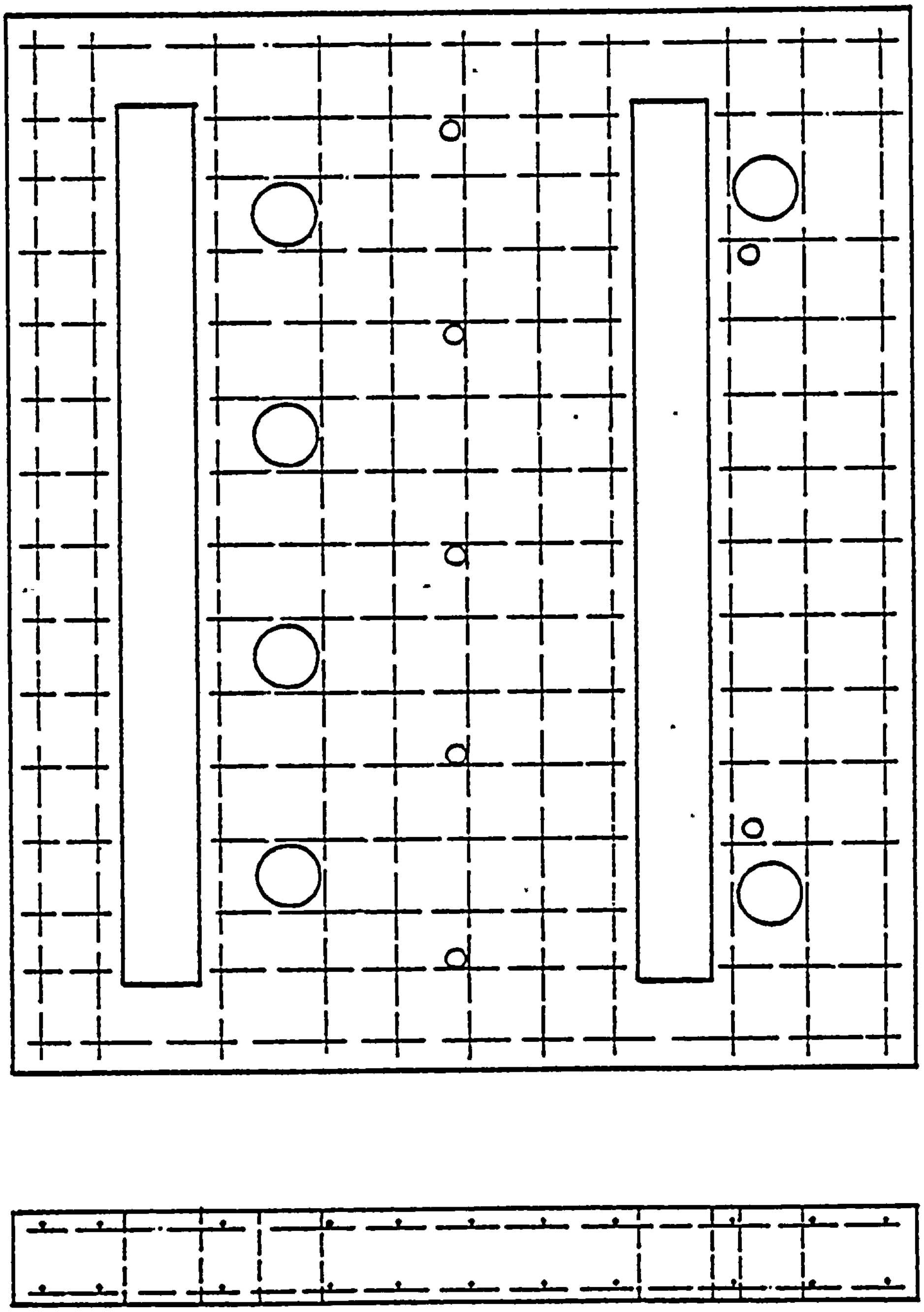


Figure 2. Reinforcement Details

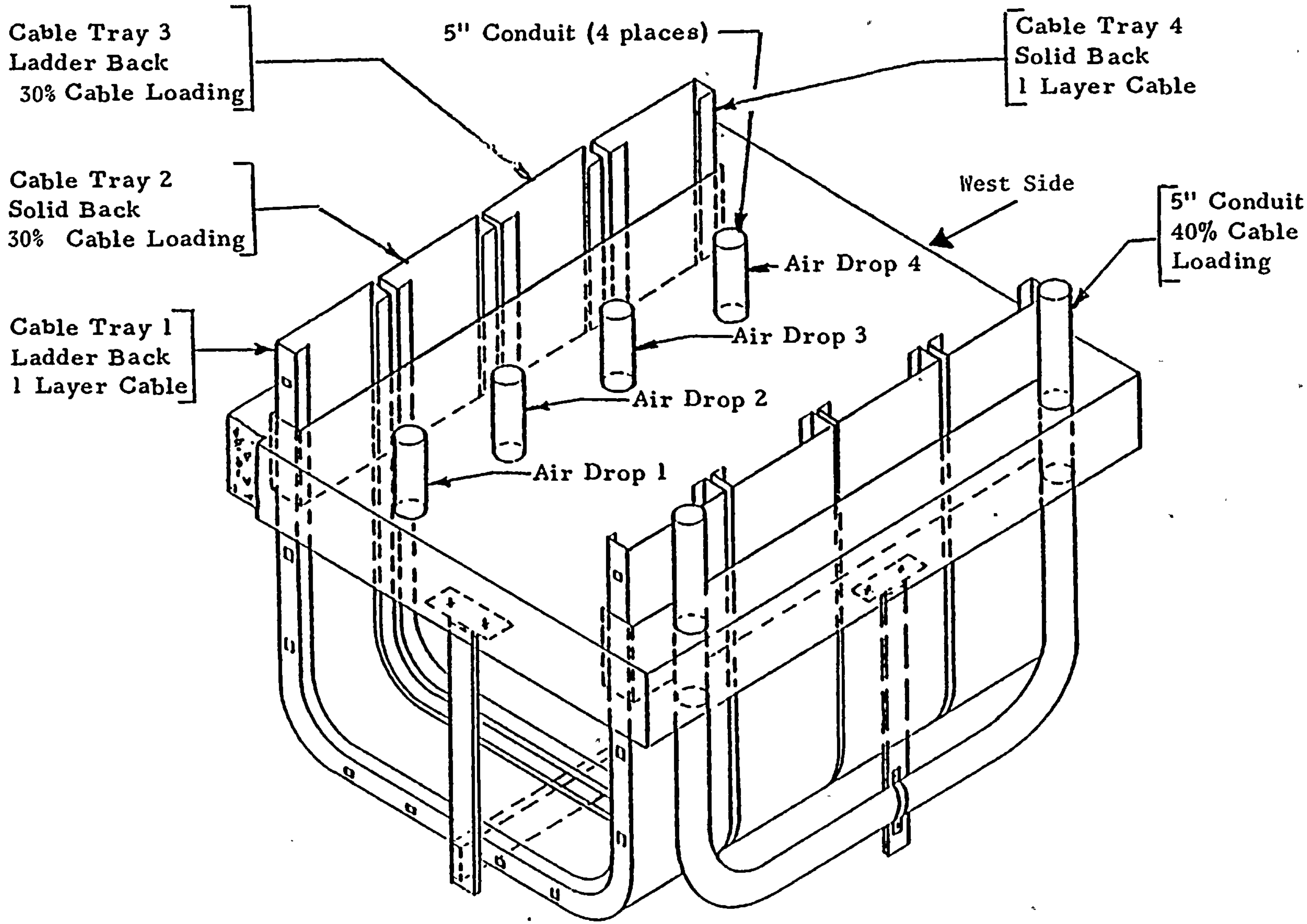


Figure 3. Test Arrangement

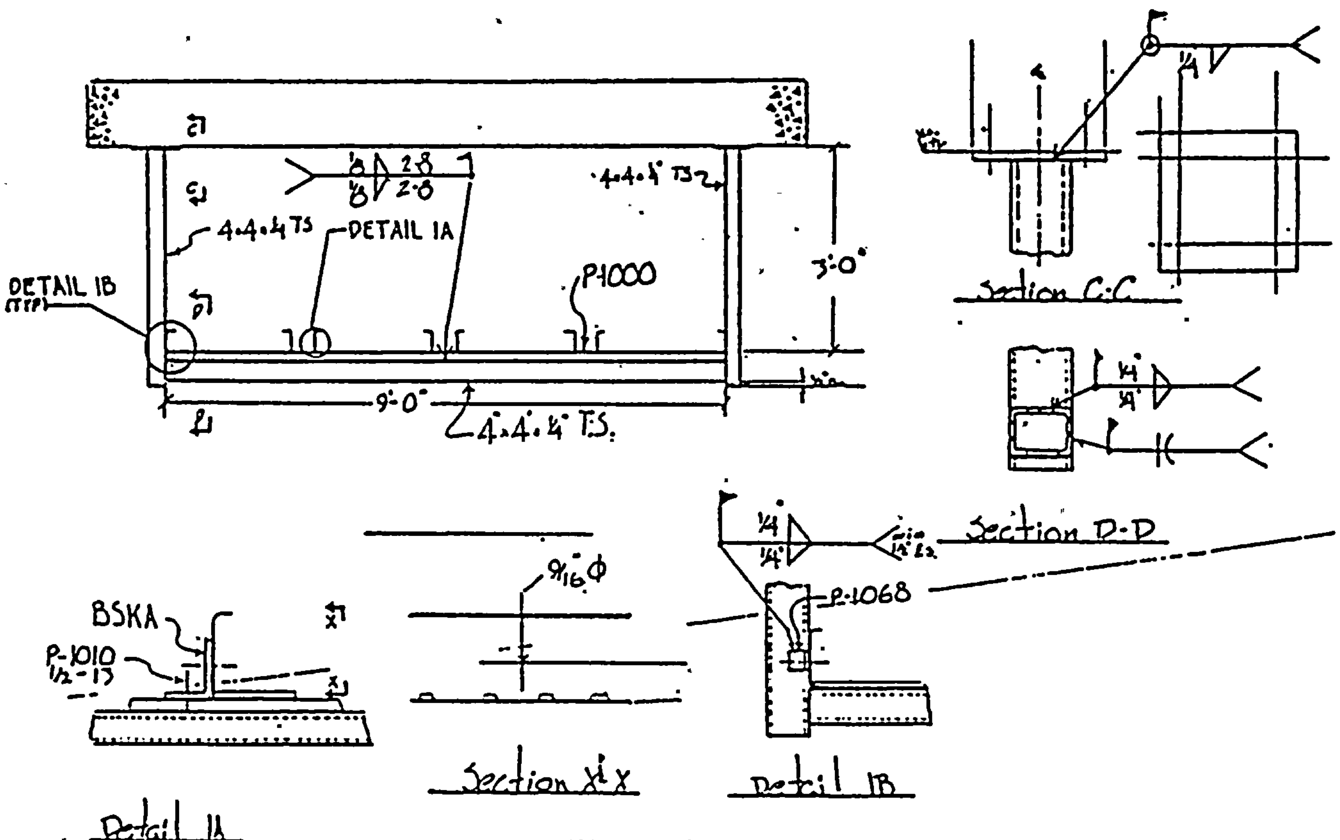


Figure 4.2

Figure 4. Tray Support Details

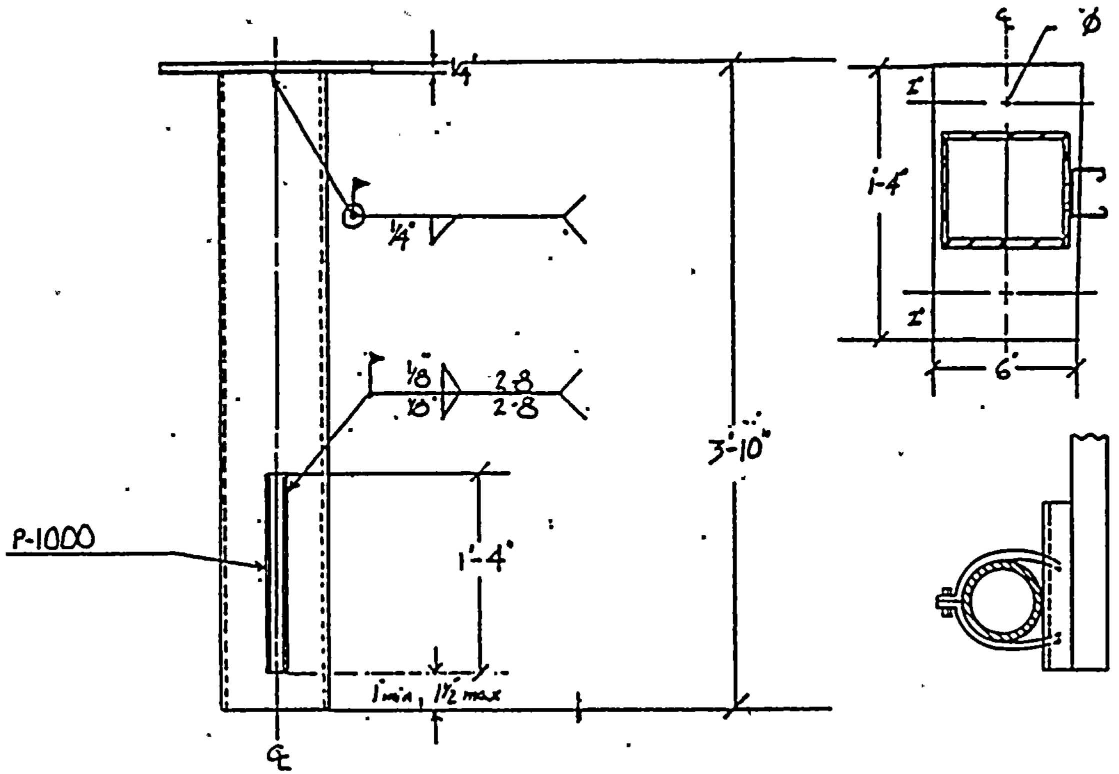


Figure 4.1

Figure 5. Conduit Support Details

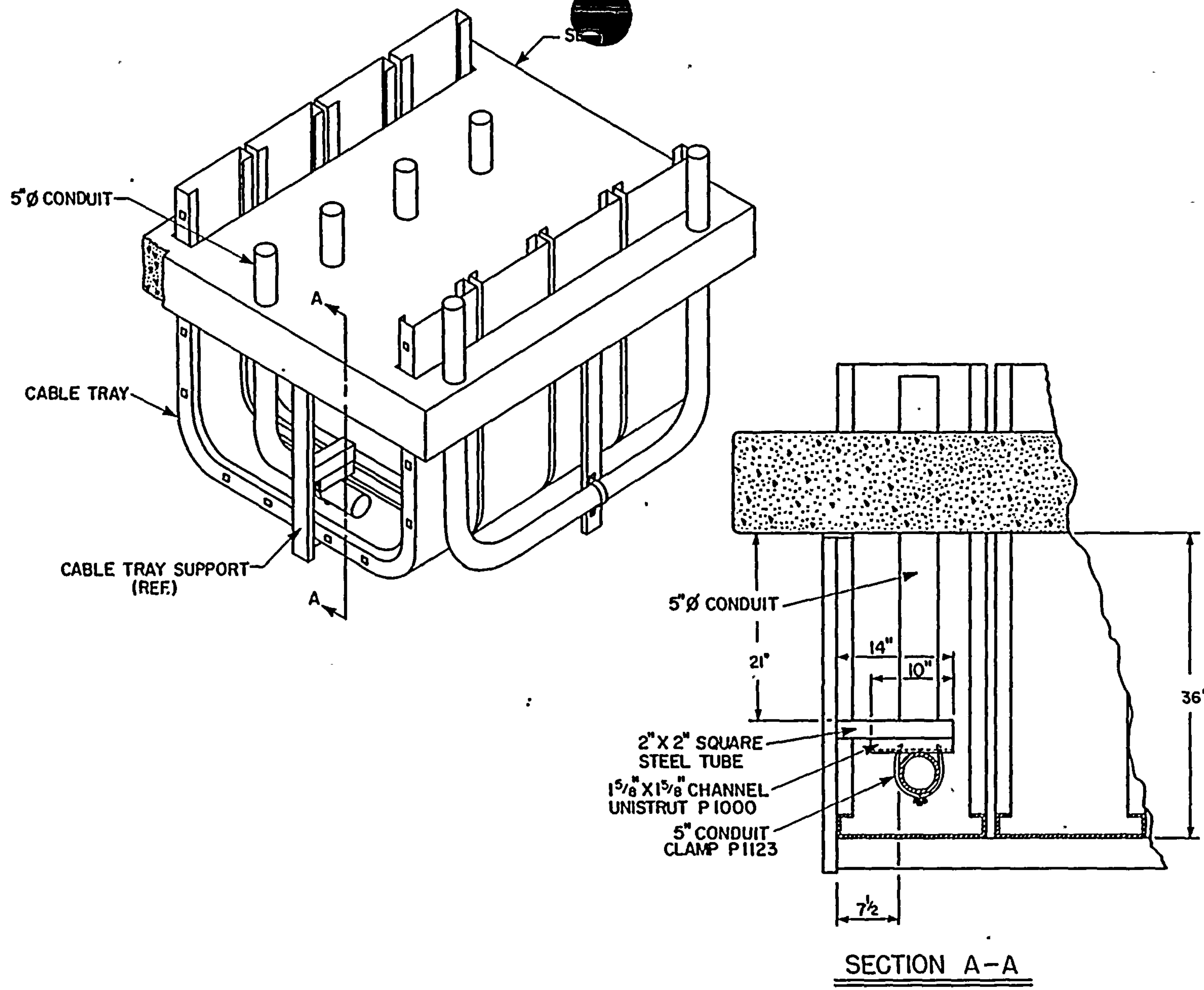


Figure 6. Air Drop Conduit Support Details

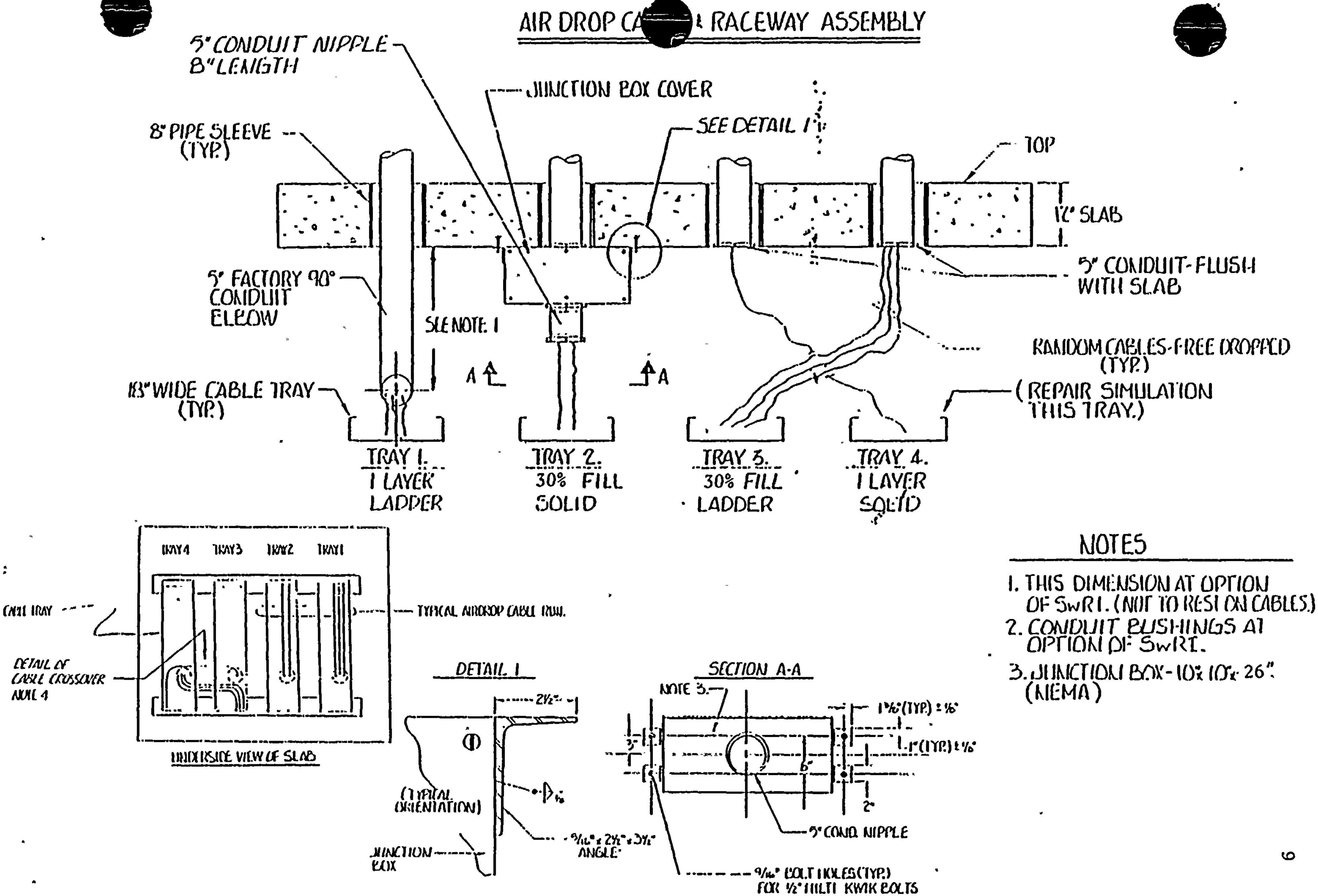


Figure 7. Air Drop Details

TABLE I
CABLE DISTRIBUTION

PENETRATION	FUNC.	CABLE TYPE	CABLE SIZE	QUANTITY
Tray #2 & 3 (30% Loading)	PWR	R75	1-750MCM	3
	PWR	R50	1-500MCM	1
	PWR	R35	1-350MCM	1
	PWR	R04	1-4/0	1
	PWR	D42	2/C #4	1
	PWR	D62	2/C #6	3
	PWR	D83	3/C #8	1
	PWR	Z83	3/C #8	1
	PWR/Cont	D14	4/C #10	1
	Cont	L12	12/C #14	2
	Cont	L07	7/C #14	2
	Cont	Z07	7/C #14	1
	Cont	L05	5/C #14	1
	Cont	L03	3/C #14	1
	Inst	Q27	7 Indiv Shld Pr #16	2
	Inst	Q25	2 Indiv Shld Pr #16	1
	Inst	Q16	5/C #20 Over Shld	1
	Inst	Q12	48/C #20 Overall Shld	1
	Inst	Q41	RG-11U Triax	1
Tray #1 & 4 (single layer)	PWR	R75	1-750MCM	1
	PWR	R50	1-500MCM	1
	PWR	R35	1-350MCM	1
	PWR	R04	1-4/0	1
	PWR	D42	2/C #4	1
	PWR	D62	2/C #6	1
	PWR	D83	3/C #8	1
	PWR	Z83	3/C #8	1
	PWR/Cont	D14	4/C #10	1
	Cont	L12	12/C #14	1
	Cont	L07	7/C #14	1
	Cont	Z07	7/C #14	1
	Cont	L05	5/C #14	1
	Cont	L03	3/C #14	1
	Inst	Q27	7 Indiv Shld Pr #16	1
	Inst	Q25	2 Indiv Shld Pr #16	1
	Inst	Q16	5/C #20 Overall Shld	1
	Inst	Q12	48/C #20 Overall Shld	1
	Inst	Q41	RG-11U Triax	1

TABLE I (Cont'd)
CABLE DISTRIBUTION

PENETRATION	FUNC.	CABLE TYPE	CABLE SIZE	QUANTITY
Conduit (40% Fill)	PWR	R50	1-500MCM	1
	PWR	D42	2/C #4	2
	PWR	D63	3/C #6	1
	PWR/Cont	D14	4/C #10	1
	Cont	L12	12/C #14	1
	Cont	L07	7/C #14	1
	Cont	L05	5/C #14	1
	Cont	L03	3/C #14	1
	Inst	N12	12/C #16 Overall Shld	1
	Inst	Q27	7 Indiv Shld Prs #16	1
	Inst	Q26	3 Indiv Shld Prs #16	1
	Inst	Q25	2 Indiv Shld Prs #16	1
	Inst	Q12	48/C #20 Overall Shld	1
Air Drop #1	PWR	D42	2/C #4	1
	Cont	L07	7/C #14	1
	Inst	Q25	2 Indiv Shld Prs #16	1
Air Drop #2	PWR	D83	3/C #8	1
	Cont	L12	12/C #14	1
	Inst	Q27	7 Indiv Shld Prs #16	1
Air Drop #4	PWR	D62	2/C #6	1
	Cont	L05	5/C #14	1
	Inst	Q12	48/C #20 Overall Shld	1
Air Drop #3	Inst	Q16	5/C #20 Overall Shld	1

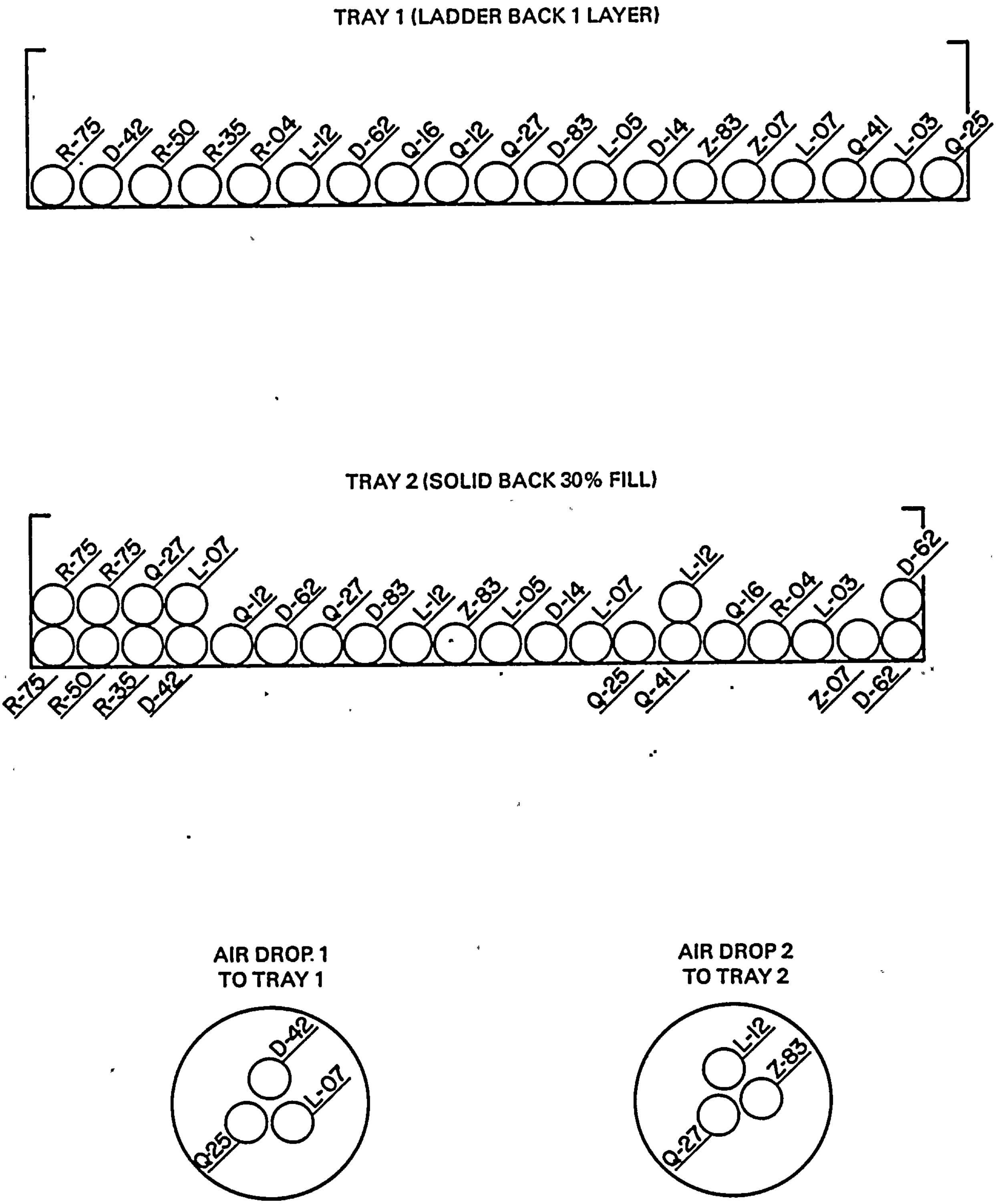


Figure 8. Cable Distribution

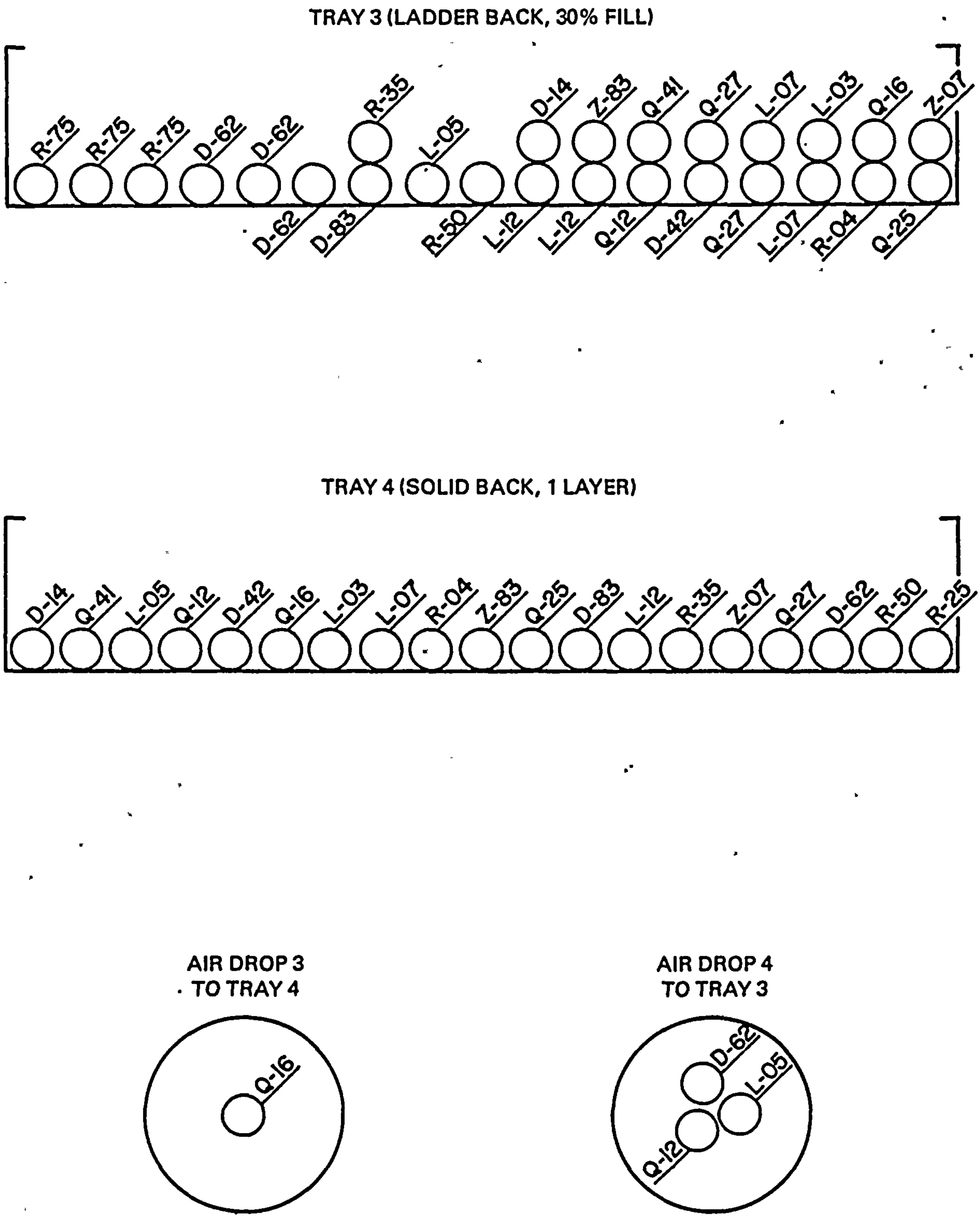


Figure 9. Cable Distribution

CABLE ARRANGEMENT

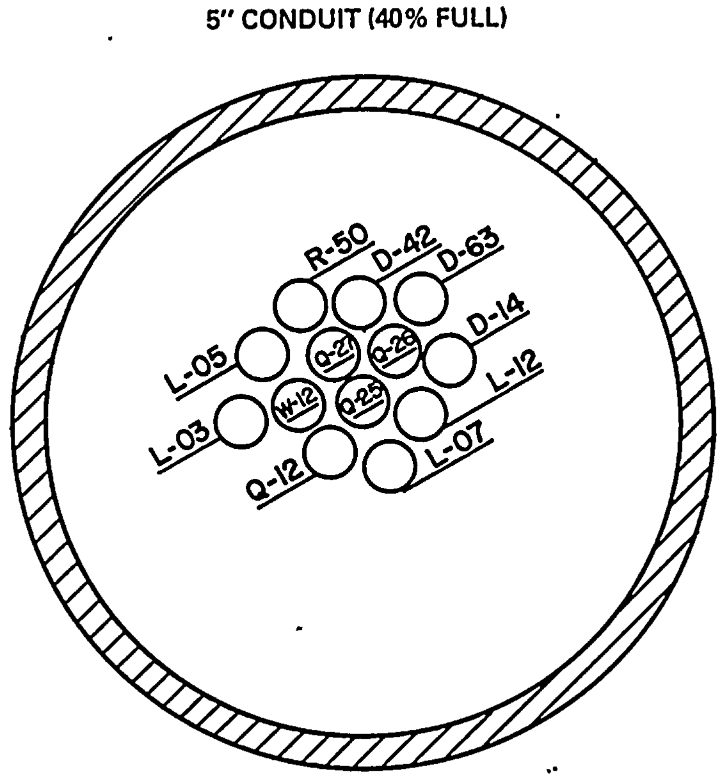


Figure 10. Cable Distribution

Appendices B, C, and D of the PP&L test specification. QA/QC surveillance of the installation of these materials was provided by SwRI personnel. Surveillance reports by SwRI personnel are provided in Appendix B. Cure time of the protective envelope materials prior to test was 13 days.

Sealing of the areas around the trays and conduits was accomplished by PP&L personnel using silicone foam.

On the exposed side of the test slab, at the interface of the silicone seals and the Thermo-Lag 330-1 material, several interface treatments were performed. These were:

1. North side trays 1 & 2: interface caulked with Dow Corning 732 caulk;
2. North side trays 3 & 4: interface caulked with Dow Corning 790 caulk;
3. South side tray 1: 1-in. M-board with Kaowool;
4. South side tray 2: 1-in. M-board with Kaowool and Dow Corning 790 caulk;
5. South side tray 3: 1-in. M-board with Kaowool and Thermo-Lag 330-1 applied with caulking gun;
6. South side tray 4: 1-in. M-board with Kaowool and Dow Corning 732 caulk; and,
7. Conduit: interface caulked with Dow Corning 790 caulk.

Figure 11 provides a photograph of the completed test slab.

D. Instrumentation

Cables in the cable trays and the 5-in. conduit were selected and wired for cable integrity monitoring as outlined in the PP&L test

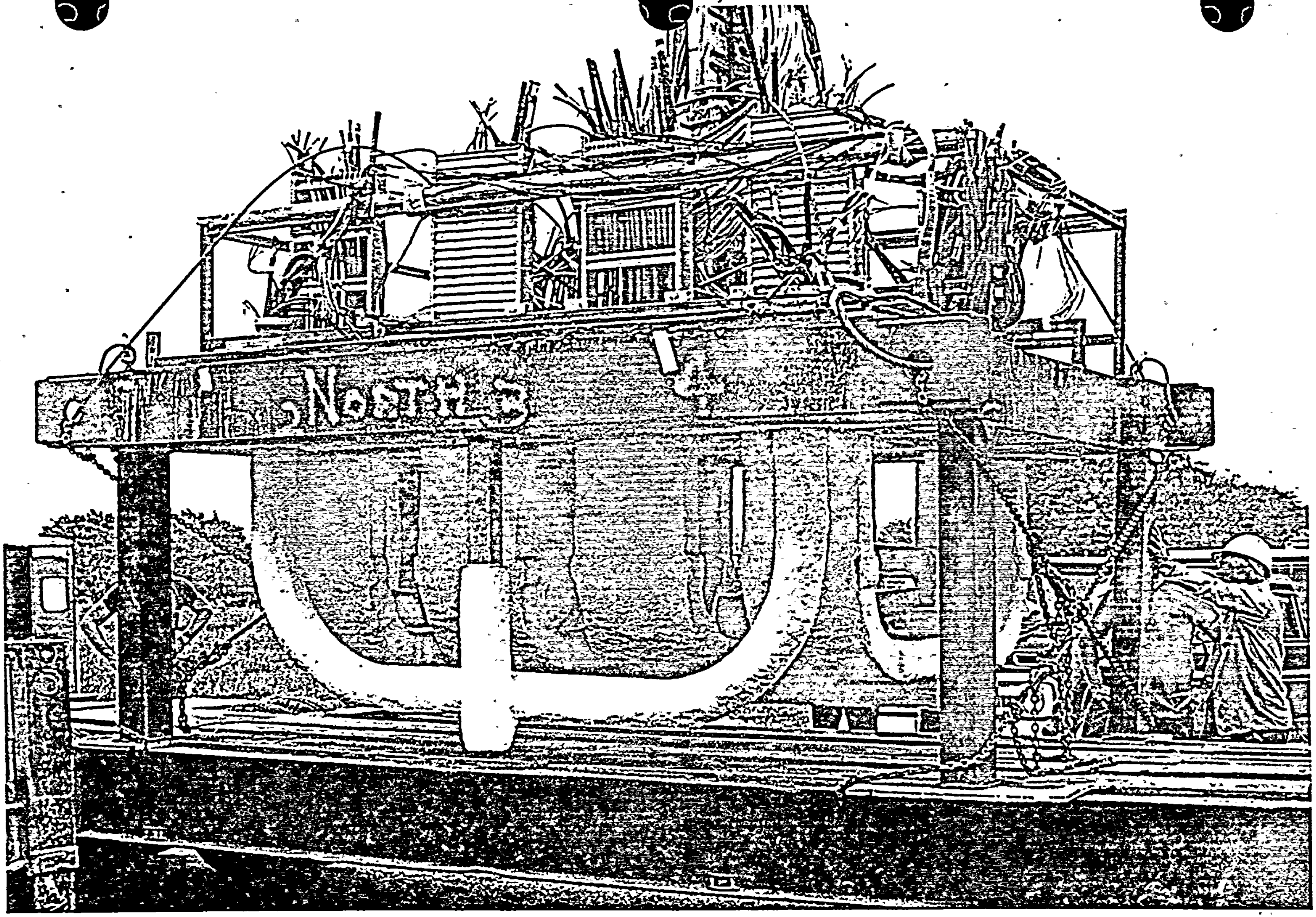


Figure 11. Completed Test Slab

specification. A listing of the cables instrumented for short circuit and continuity monitoring is provided in Table II.

A total of 120 thermocouples were installed in the cable trays, conduits, air drops and supports in compliance with the PP&L test specification. Thermocouple identification and locations are provided in Table III and Figures 12, 13, 14, 15, 16, 17, 18 and 19.

E. Test Procedures

The protective envelope fire resistance test was conducted using a horizontal furnace with a sleeve having an open area of 8 ft x 10 ft. Dimensions of the basic furnace are shown in Figure 20. A flue gas opening was provided on the west side of the furnace. Eight Maxon self-aspirating natural gas burners were mounted on the sides of the furnace. Six of the burners were used for the test.

On August 9, 1982, the prepared test assembly was moved to the furnace area and placed on the top of the furnace. The slab/furnace interface was sealed with thermal insulating wool and the pre-burn inspection, as outlined in the PP&L test specification, was performed.

On August 10, 1982, the test was conducted. All gas flow to the burners was controlled manually and the furnace temperature was monitored by the average of seven thermocouples. Three of these thermocouples were located 12 in. above the cable trays and four were located 12 in. below the cable trays. The furnace average thermocuples were connected to an Acromag multi-channel digital temperature indicator and the data acquisition system.

The thermocouples monitoring the temperatures of the cables, cable trays, air drops, etc. were connected to Kaye Ramp Scanners and

TABLE II
CABLE INTEGRITY MONITORING CIRCUITS

PENETRATION NO.	FUNCTION	TYPE	SIZE	INTEGRITY Short C - G	Short C - C	Continuity
T1	PWR	R35	1/C 350MCM	X		
T1	PWR	D83	3/C #8		X	
T1	Cont	L12	12/C #14	X		
T1	Cont	L05	5/C #14			X
T1	Inst	Q27	7 Pr #16			X
T1	Inst	Q16	5/C #20		X	
T2	PWR	R75	1/C 750MCM	X		
T2	PWR	D83	3/C #8		X	
T2	PWR/Cont	D14	4/C #10	X		
T2	Cont	L03	3/C #14			X
T2	Inst	Q25	2 Pr #16		X	
T2	Inst	Q16	5/C #20			X
T3	PWR	R75	1/C 750MCM	X		
T3	PWR	D83	3/C #8		X	
T3	PWR/Cont	D14	4/C #10	X		
T3	Cont	L03	3/C #14			X
T3	Inst	Q25	2 Pr #16		X	
T3	Inst	Q16	5/C #20			X
T4	PWR	R35	1/C 350MCM	X		
T4	PWR	D83	3/C #8		X	
T4	Cont	L12	12/C #14	X		
T4	Cont	L05	5/C #14			X
T4	Inst	Q27	7 Pr #16			X
T4	Inst	Q25	2 Pr #16		X	
C1	PWR	R50	1/C 500MCM	X		
C1	PWR	D42	2/C #4		X	
C1	Cont	L07	7/C #14			X
C1	Cont	L05	5/C #14	X		
C1	Inst	Q27	7 Pr #16		X	
C1	Inst	Q26	3 Pr #16			X
AD1	PWR	D42	2/C #4	X		
AD1	Cont	L07	7/C #14		X	
AD1	Inst	Q25	2 Pr #16			X
AD2	PWR	D83	3/C #8	X		
AD2	Cont	L12	12/C #14			X
AD2	Inst	Q27	7 Pr #16		X	
AD3	Inst	Q16	5/C #20		X	
AD4	PWR	D62	2/C #6	X		
AD4	Cont	L05	5/C #14			X
AD4	Inst	Q12	48/C #20		X	

LEGEND:

Short C to G	=	Short Circuit Monitoring, Conductor to Ground
Short C to C	=	Short Circuit Monitoring, Conductor to Conductor
Continuity	=	Continuity Monitoring, Circuit to System
T1, T2, T3, T4	=	Cable Trays 1, 2, 3 and 4, respectively
C1	=	5" Conduit
AD1, 2, 3, 4	=	Air Drop Cables

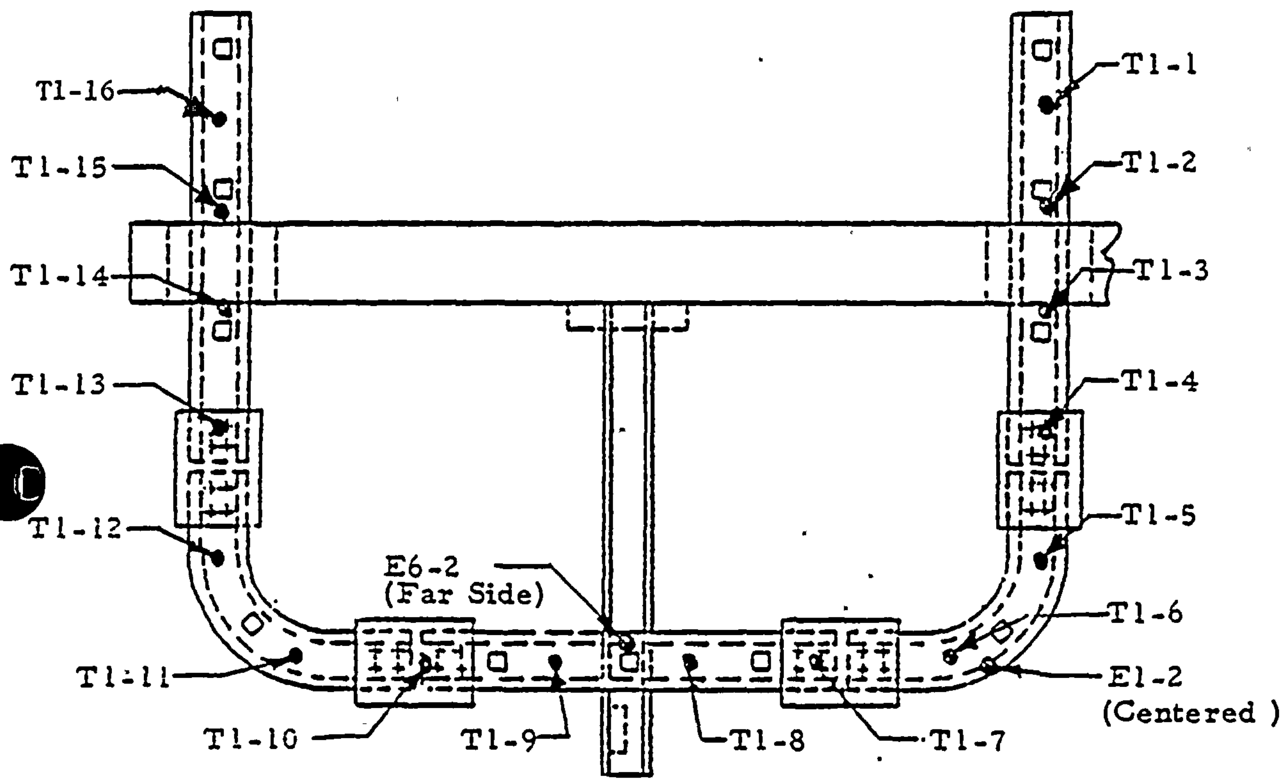
TABLE III
THERMOCOUPLE ASSIGNMENTS

TC NO.	PENETRATION NO.	TC NO.	PENETRATION NO.
T1-1	Cable Tray 1	T2-1	Cable Tray 2
T1-2	Cable Tray 1	T2-2	Cable Tray 2
T1-3	Cable Tray 1	T2-3	Cable Tray 2
T1-4	Cable Tray 1	T2-4	Cable Tray 2
T1-5	Cable Tray 1	T2-5	Cable Tray 2
T1-6	Cable Tray 1	T2-6	Cable Tray 2
T1-7	Cable Tray 1	T2-7	Cable Tray 2
T1-8	Cable Tray 1	T2-8	Cable Tray 2
T1-9	Cable Tray 1	T2-9	Cable Tray 2
T1-10	Cable Tray 1	T2-10	Cable Tray 2
T1-11	Cable Tray 1	T2-11	Cable Tray 2
T1-12	Cable Tray 1	T2-12	Cable Tray 2
T1-13	Cable Tray 1	T2-13	Cable Tray 2
T1-14	Cable Tray 1	T2-14	Cable Tray 2
T1-15	Cable Tray 1	T2-15	Cable Tray 2
T1-16	Cable Tray 1		
T3-1	Cable Tray 3	T4-1	Cable Tray 4
T3-2	Cable Tray 3	T4-2	Cable Tray 4
T3-3	Cable Tray 3	T4-3	Cable Tray 4
T3-4	Cable Tray 3	T4-4	Cable Tray 4
T3-5	Cable Tray 3	T4-5	Cable Tray 4
T3-6	Cable Tray 3	T4-6	Cable Tray 4
T3-7	Cable Tray 3	T4-7	Cable Tray 4
T3-8	Cable Tray 3	T4-8	Cable Tray 4
T3-9	Cable Tray 3	T4-9	Cable Tray 4
T3-10	Cable Tray 3	T4-10	Cable Tray 4
T3-11	Cable Tray 3	T4-11	Cable Tray 4
T3-12	Cable Tray 3	T4-12	Cable Tray 4
T3-13	Cable Tray 3	T4-13	Cable Tray 4
T3-14	Cable Tray 3	T4-14	Cable Tray 4
T3-15	Cable Tray 3	T4-15	Cable Tray 4
		T4-16	Cable Tray 4
AD1-1	Air Drop 1	AD2-1	Air Drop 2
AD1-2	Air Drop 1	AD2-2	Air Drop 2
AD1-3	Air Drop 1	AD2-3	Air Drop 2
AD1-4	Air Drop 1	AD2-4	Air Drop 2
AD1-5	Air Drop 1	AD2-5	Air Drop 2
AD1-6	Air Drop 1	AD2-6	Air Drop 2
		AD2-7	Air Drop 2
		AD2-8	Air Drop 2
		AD2-9	Air Drop 2

TABLE III (Cont'd)
THERMOCOUPLE ASSIGNMENTS

TC NO.	PENETRATION NO.	TC NO.	PENETRATION NO.
AD3-1	Air Drop 3	AD4-1	Air Drop 4
AD3-2	Air Drop 3	AD4-2	Air Drop 4
AD3-3	Air Drop 3	AD4-3	Air Drop 4
AD3-4	Air Drop 3	AD4-4	Air Drop 4
AD3-5	Air Drop 3	AD4-5	Air Drop 4
AD3-6	Air Drop 3	AD4-6	Air Drop 4
C1-1	Conduit-5"	E1-2	Engineering, Tray 1
C1-2	Conduit-5"	E2-4	Engineering, Tray 2
C1-3	Conduit-5"	E3-3	Engineering, Tray 3
C1-4	Conduit-5"	E4-4	Engineering, Tray 4
C1-5	Conduit-5"	E5-3	Engineering, Conduit
C1-6	Conduit-5"	E6-2	Engineering, Tray 1
C1-7	Conduit-5"	E7-1	Engineering, Tray 2
C1-8	Conduit-5"	E8-3	Engineering, Tray 3
C1-9	Conduit-5"	E9-1	Engineering, Tray 4
C1-10	Conduit-5"	ES-3	Engineering, Tray Support
C1-11	Conduit-5"	ES-5	Engineering, Conduit Support
C1-12	Conduit-5"		
C1-13	Conduit-5"		
C1-14	Conduit-5"		
C1-15	Conduit-5"		
C1-16	Conduit-5"		
C1-17	Conduit-5"		

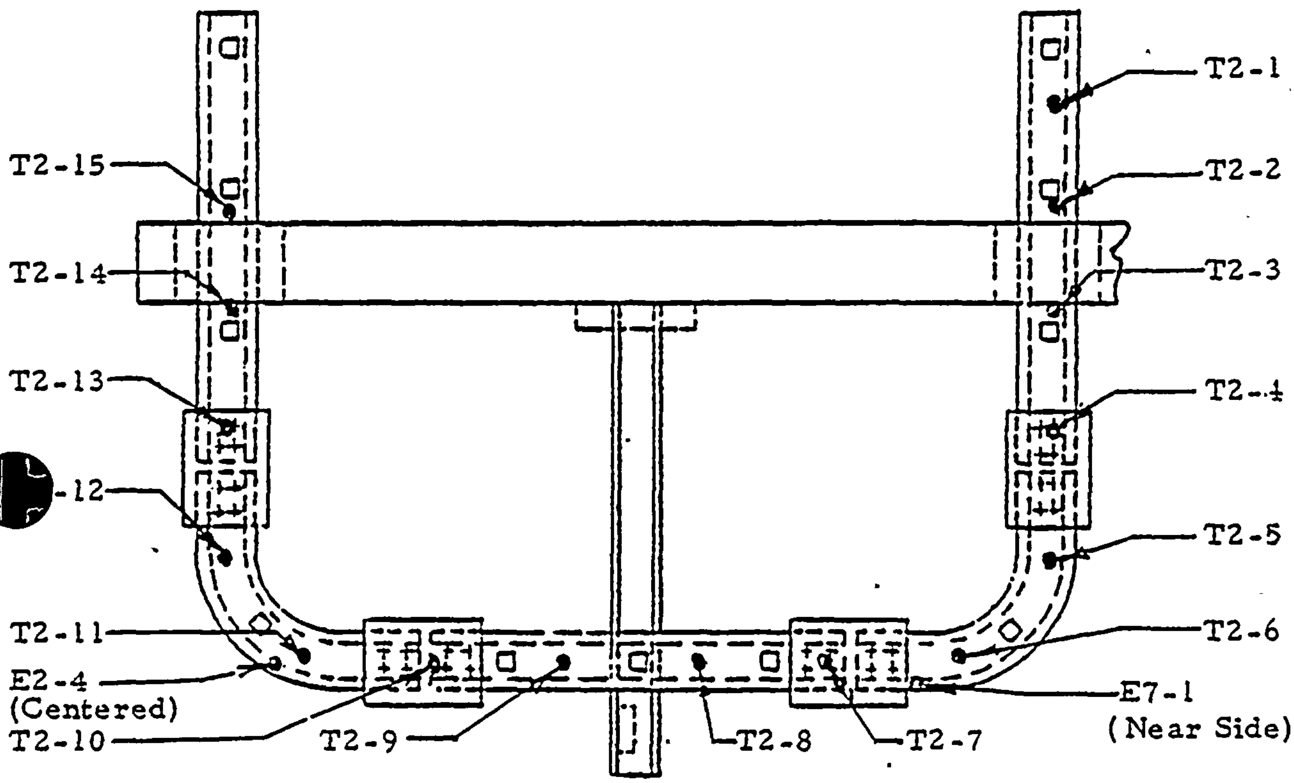
Cable Tray No. 1: 18" Ladder Back
with one layer of cable



Data Thermocouples located on center cable (W-047)
at 12 o'clock position at 1 ft intervals.

Figure 12. Thermocouple Locations - Cable Tray No. 1

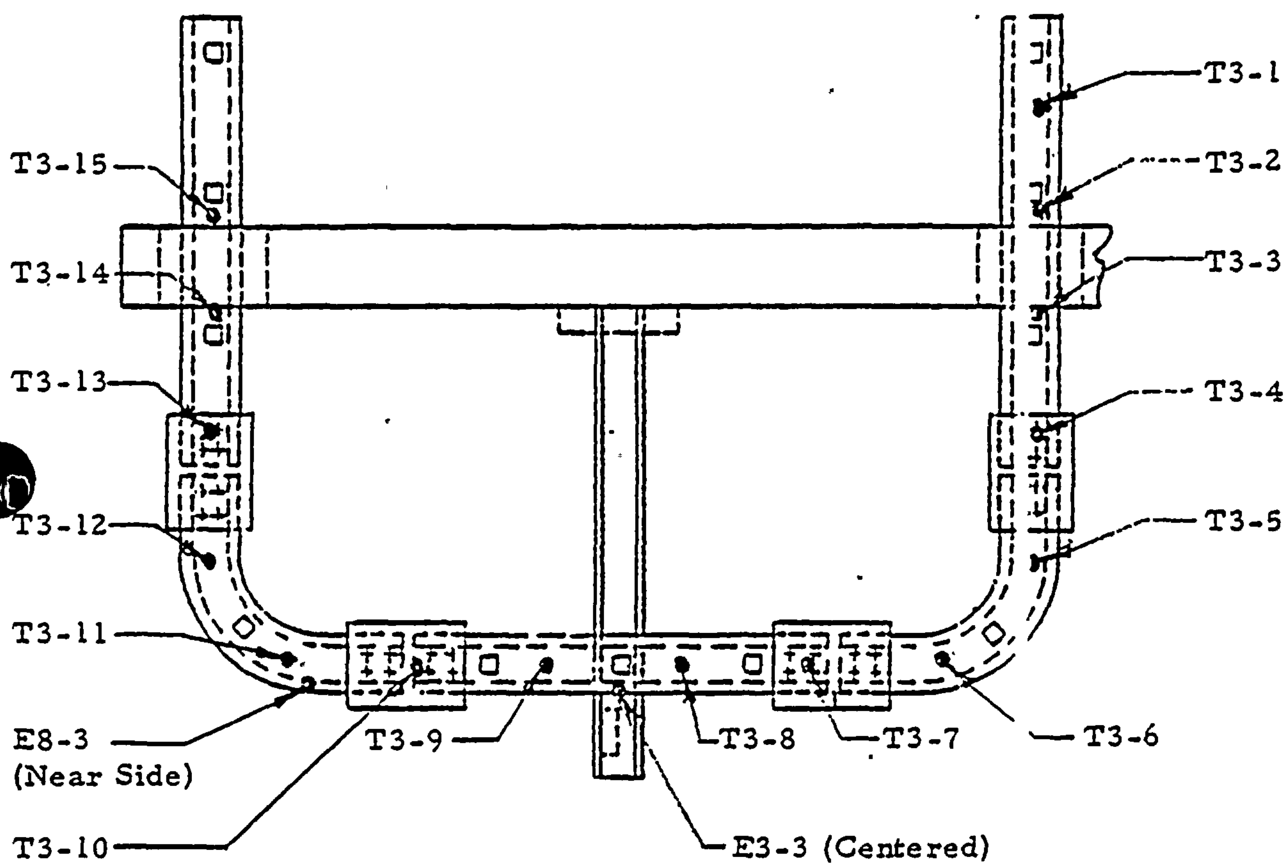
Cable Tray No. 2: 18" Solid Back
30% Cable Loading



Data Thermocouples located on center cable (W-141) at 12 o'clock position at 1 ft intervals.

Figure 13. Thermocouple Locations - Cable Tray No. 2

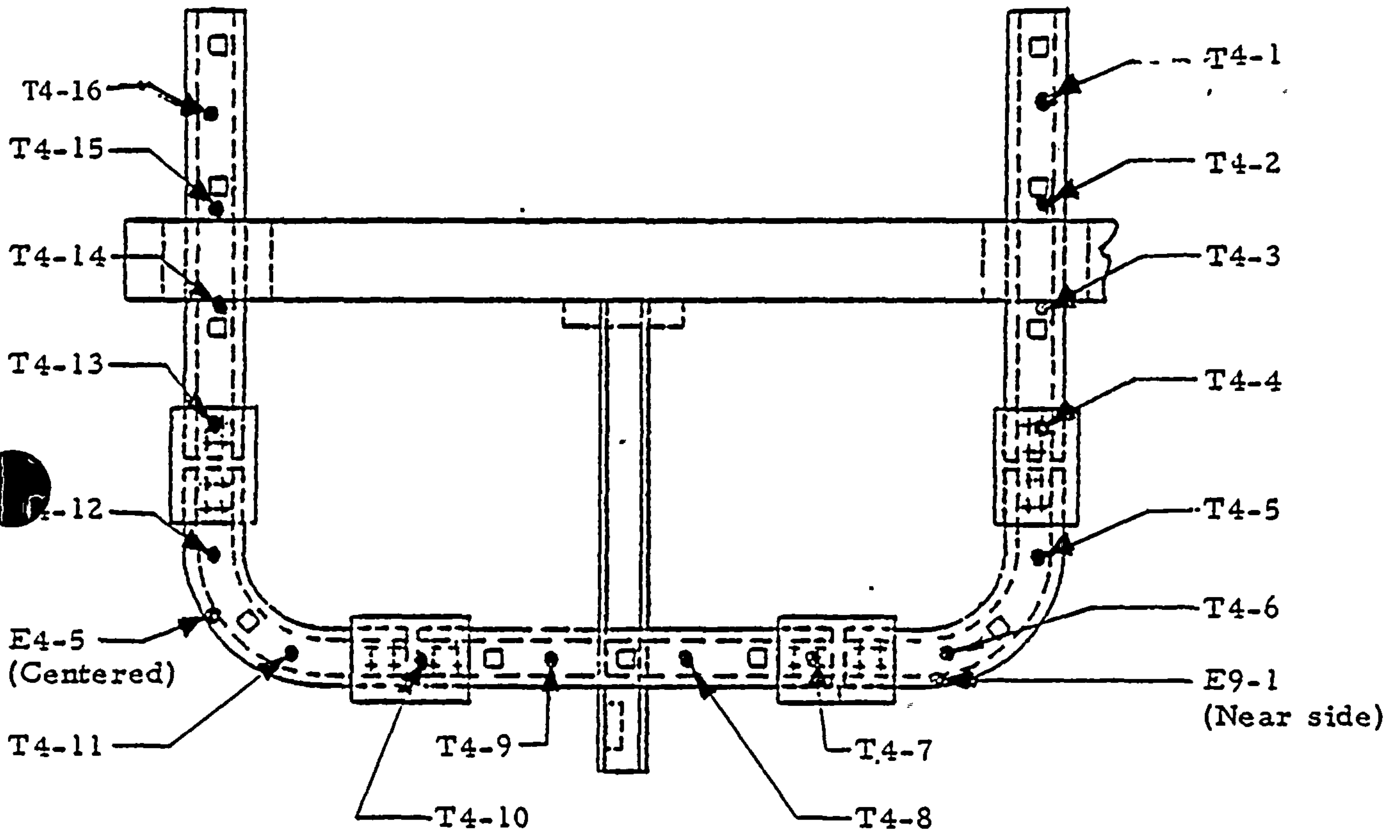
Cable Tray No. 3: 18" Ladder Back
30% Cable Loading



Data Thermocouples located on center cable W-124)
at 12 o'clock position at 1 ft intervals,

Figure 14. Thermocouple Locations - Cable Tray No. 3

Cable Tray No. 4: 18" Solid Back with one layer of cable



Data Thermocouples located on center cable (W-047) at 12 o'clock position at 1 ft intervals.

Figure 15. Thermocouple Locations - Cable Tray No. 4

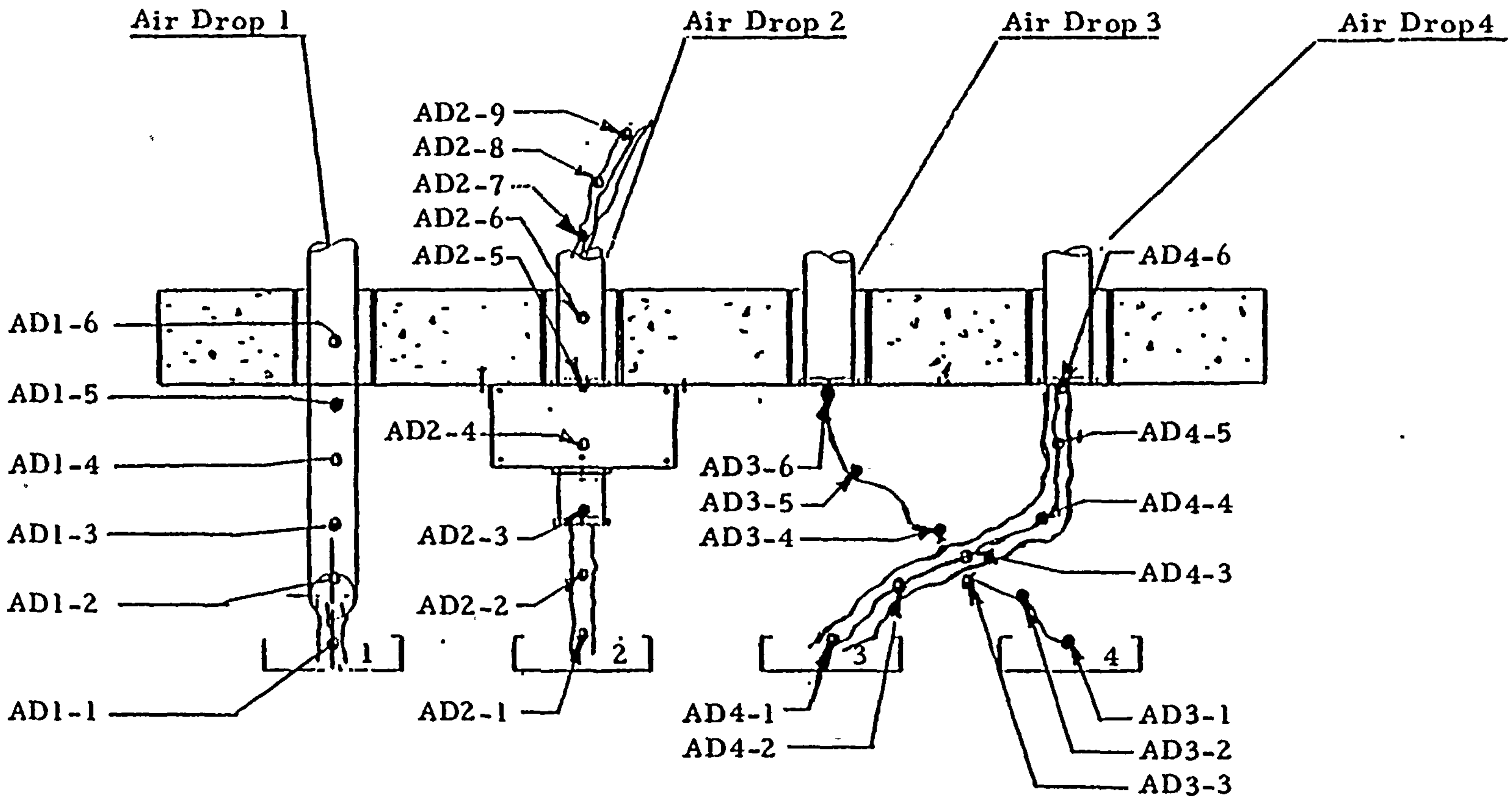


Figure 16. Thermocouple Locations - Air Drop Cables

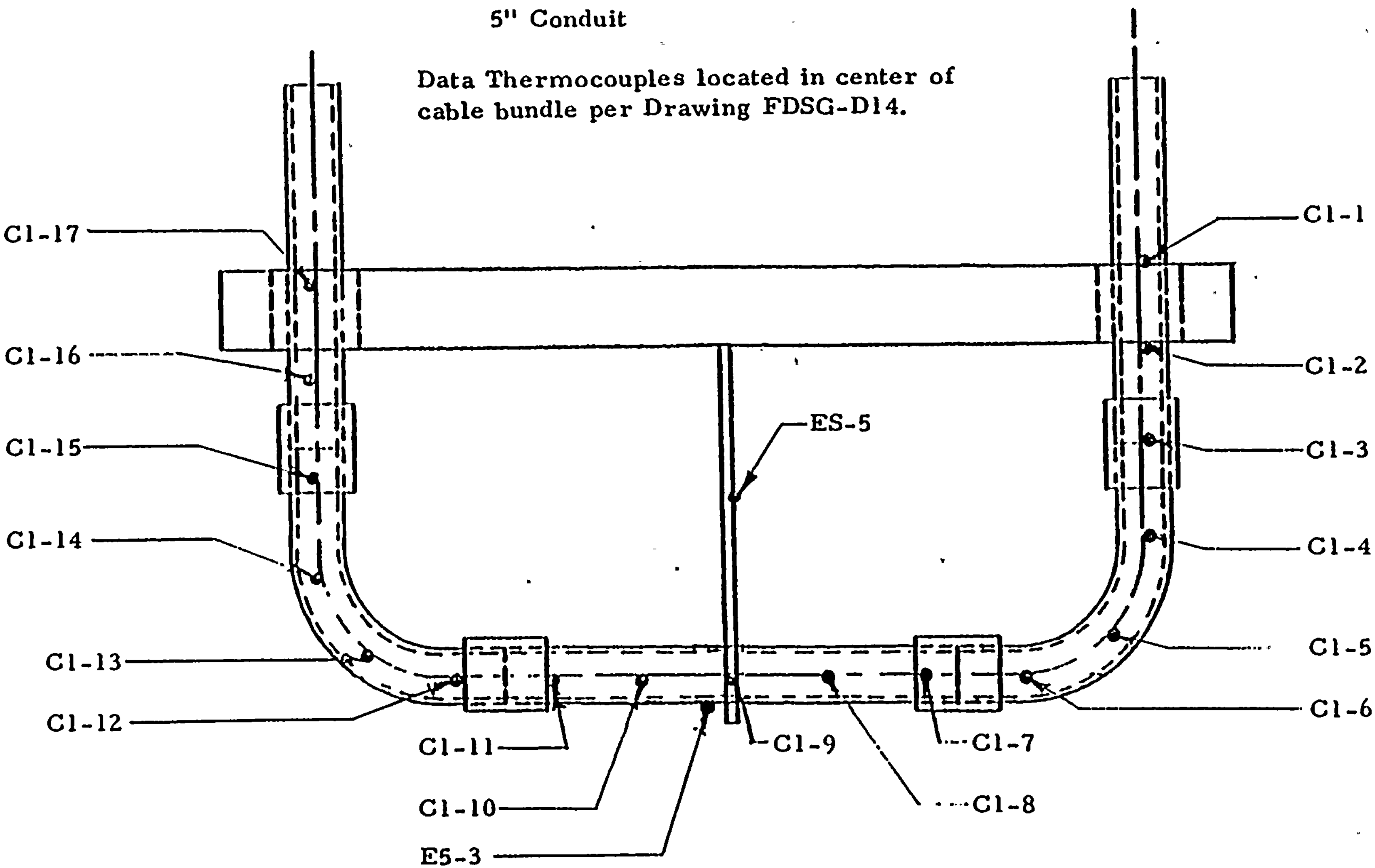


Figure 17. Thermocouple Locations - 5-in. Conduit

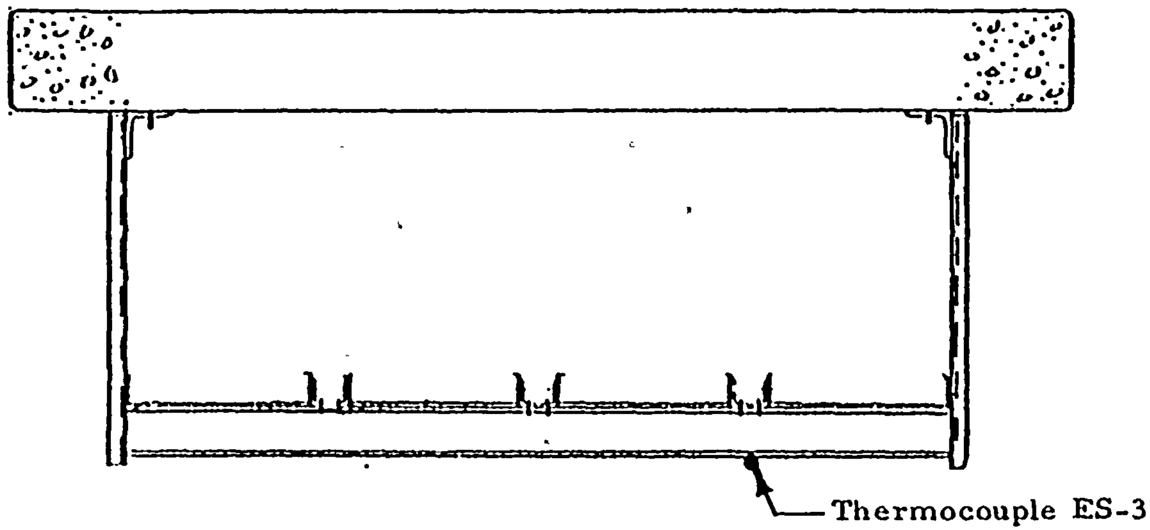


Figure 18. Thermocouple Locations - Tray Support

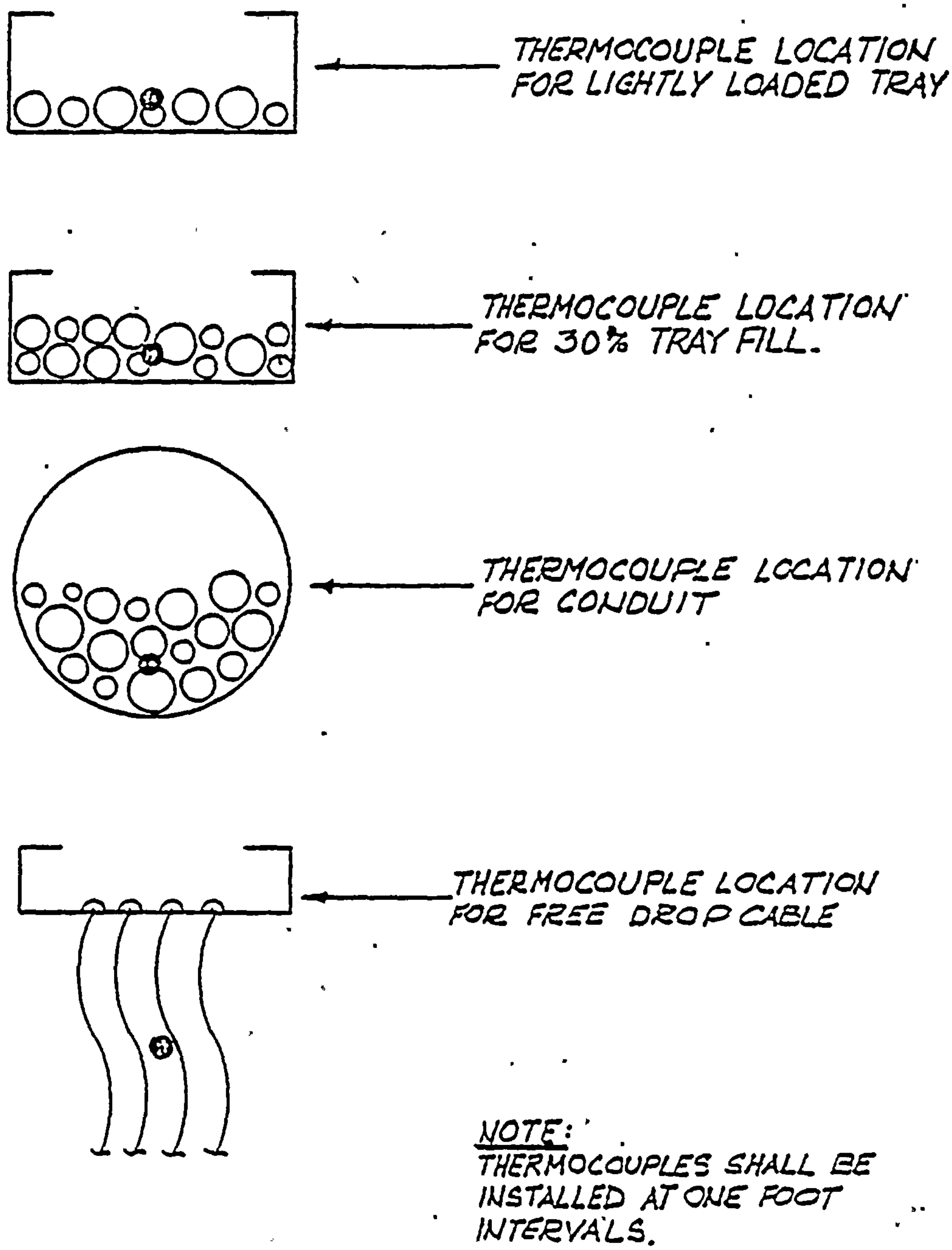


Figure 19. Thermocouple Locations

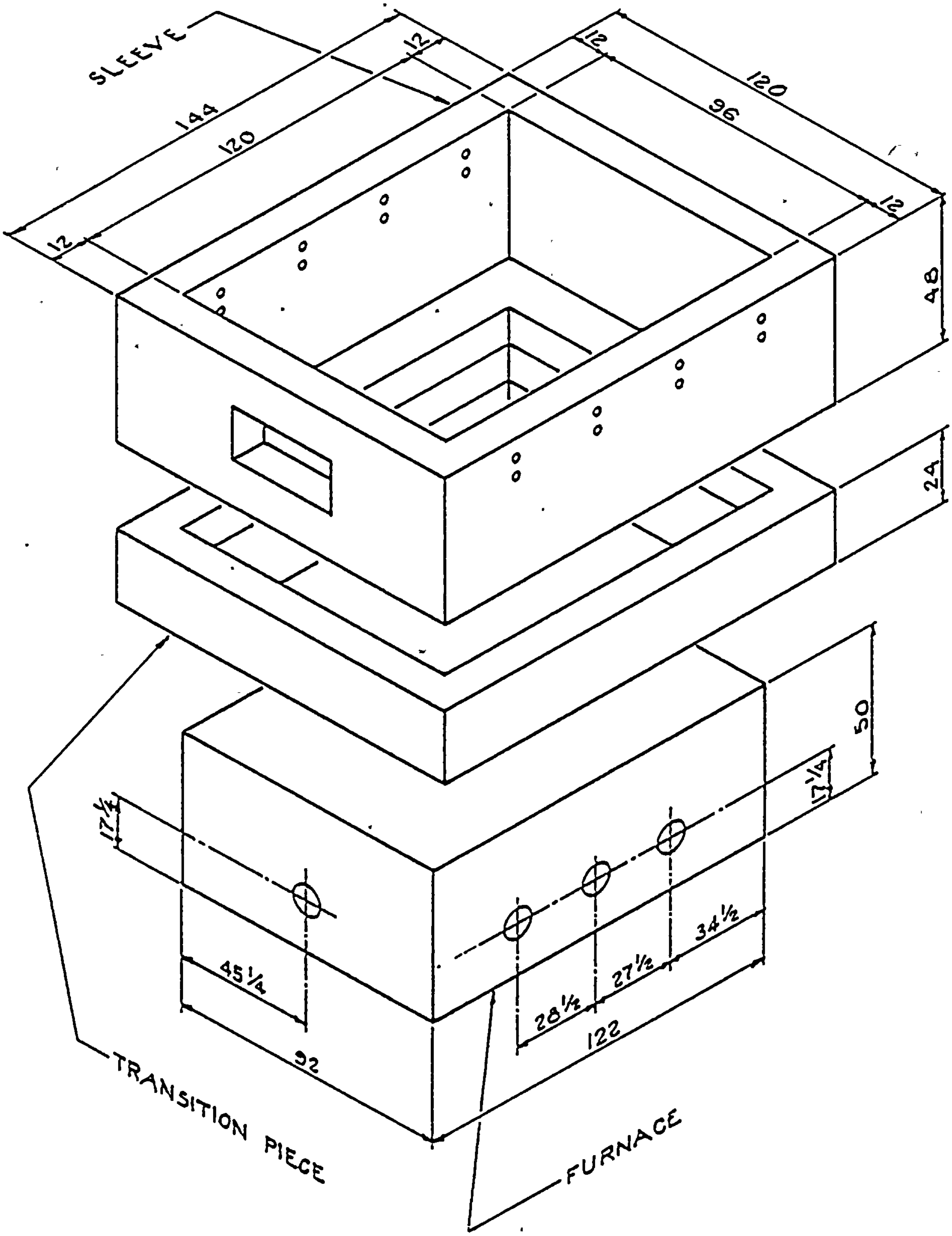


Figure 20. Test Furnace

recorded on a Wang computer system. A scan time of approximately 3 minutes was utilized.

The cable integrity circuits were monitored during the fire exposure period, and during the hose stream test.

At the end of the one-hour fire exposure period, the fuel gas was shut off and the test slab was lifted from and swung clear of the furnace. The protective envelope system was then subjected to a hose stream delivered through a 1-1/2-in. nozzle set at a discharge angle of 15°, located 10 ft from the system at a nozzle pressure of 75 psi and a minimum discharge of 75 gallons per minute.

III. TEST RESULTS

A. Temperature Data

The temperature data obtained during the test is provided in Appendix C.

Internal temperatures of over 450°F were noted in Tray 1, Tray 3, Tray 4, AD1, AD2, AD3 and AD4.

The temperature data for Tray Nos. 1, 2, 3, and 4 show several anomolies such as temperature on the unexposed portion of the tray being higher than those in the exposed area of the tray. As far as possible, thermocouple verification has been done and no satisfactory explanation for this occurrence can be found. It is believed, however, that some of these thermocouples may have absorbed moisture during the application of the protective envelope material and, therefore, gave the erroneous readings.

B. Circuit Integrity

Continuity integrity data that was obtained during the fire and hose stream tests is provided in Appendix D.

Circuit integrity of all monitored cables remained intact throughout the fire endurance test. There were no short circuits, either conductor to conductor or conductor to ground, and there was no loss of continuity in any of the circuit-to-system monitored cables.

During the hose stream test, circuit-to-circuit integrity was lost on three monitored cables. These cables were:

Cable Q16 - Air Drop 3
Cable Q12 - Air Drop 4
Cable Q16 - Tray 1

Figure 21 provides a diagram of the location of these cables. No circuit-to-ground shorts were noted in any of the monitored cables. Also, there was no loss of continuity in any of the circuit-to-system monitored cables.

C. Post-Test Examination

Post-test examination immediately after the hose stream test showed that the majority of the Thermo-Lag 330-1 material had charred and was dislodged by the hose stream. In the areas where the Thermo-Lag 330-1 did remain, it was noted that the exposed surface was charred but the material below the char was intact and appeared to be in good condition. Figures 22 and 23 provided post-test photographs of the test article.

After a cool-down period of approximately 15 hours, the protective envelope material was removed from the trays and air drops and examination of the cables was performed.

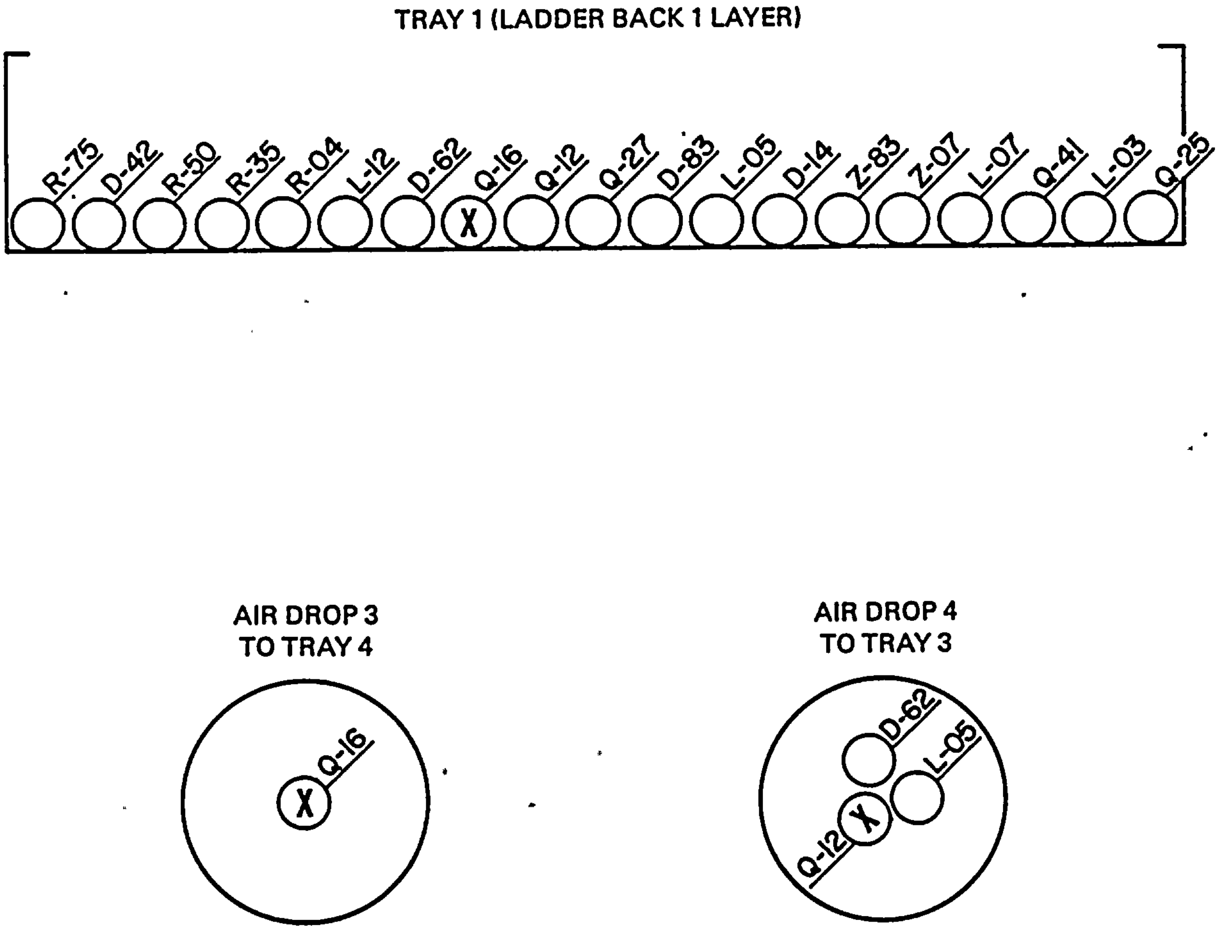
Cables in Tray 2, AD2 and the conduit showed little signs of heat damage.

Cables in Tray 3 and AD1 showed that the outer jacket of the cable insulation had softened and cracked. Insulation on individual conductors appeared to be intact.

Cables in Tray 1, Tray 4, and AD4 showed signs of insulation charring, cracked insulation and softening of the cable insulation.

The cable in AD3 was in good condition from the lower surface of the slab to the entrance in Cable Tray 4. The cable from AD3 inside Tray 4 showed signs of charred and cracked insulation.

A verification check of short circuits (circuit to ground) was performed on all cables in the test slab. Of the 113 total cables checked, five circuit-to-ground faults were found. These are shown in Figure 24.



(X) = Cable with Circuit to Circuit Short

Figure 21. Damaged Cable

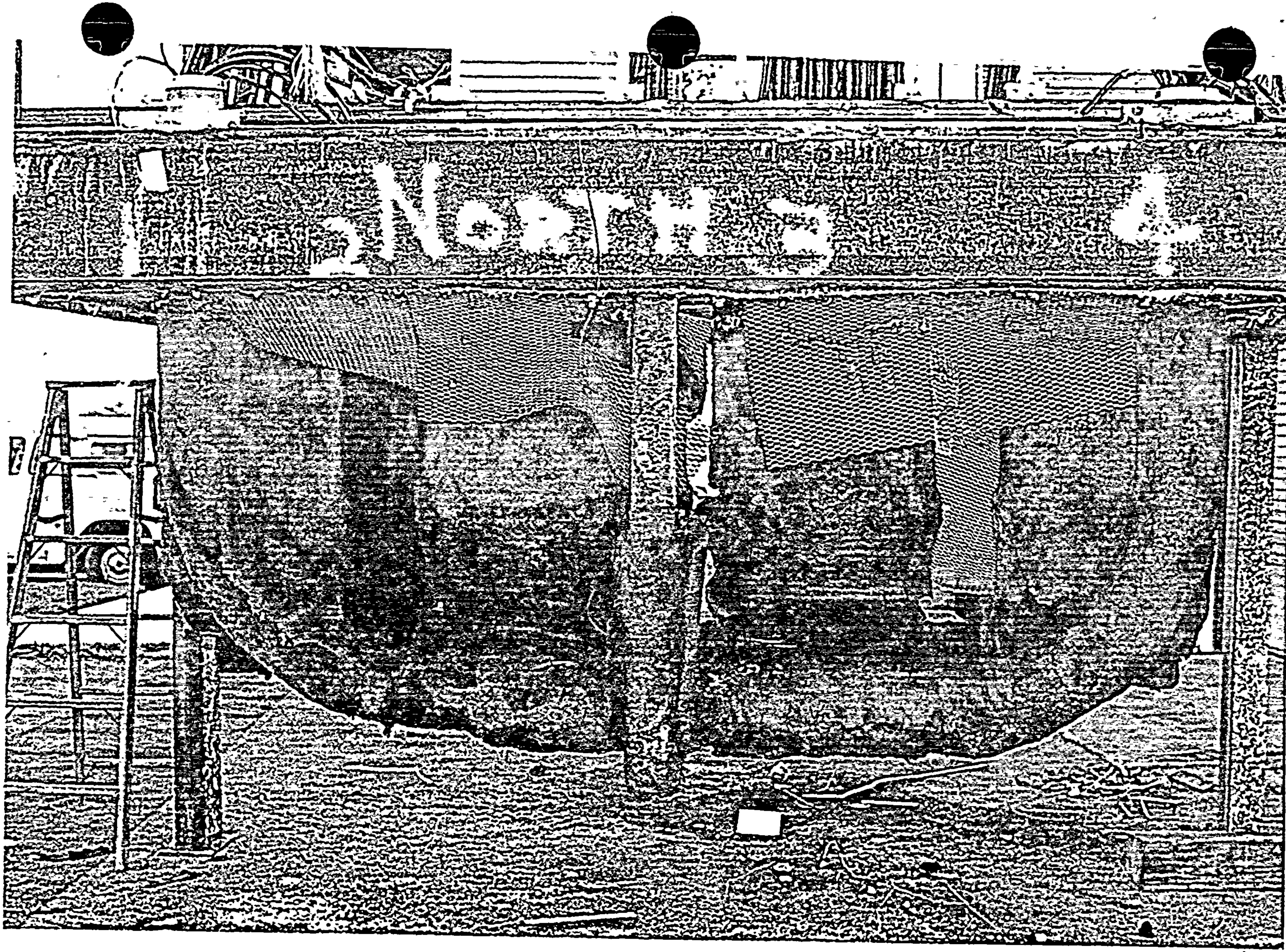


Figure 22. Post-Test Photograph

Figure 23. Post-Test Photograph

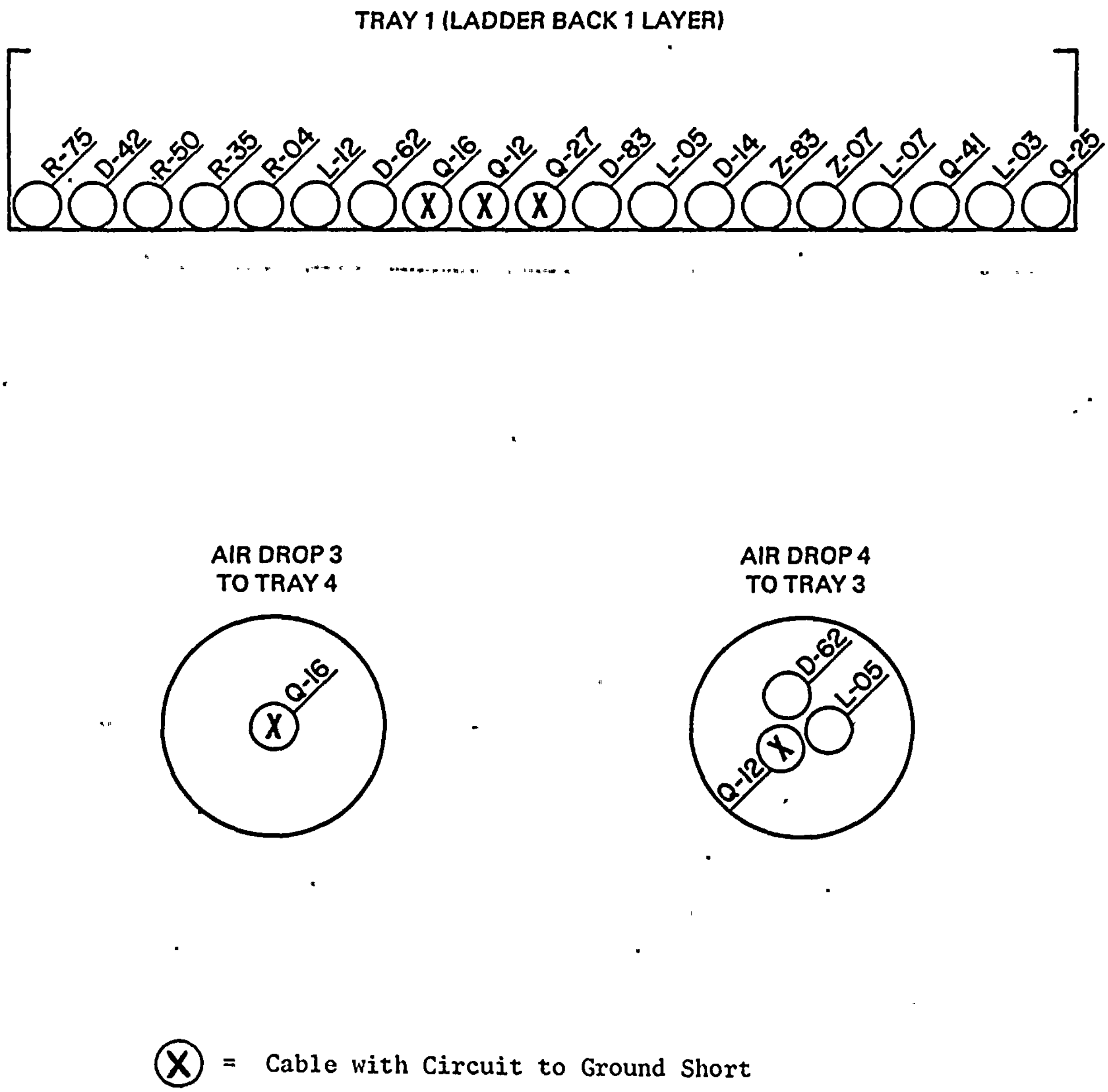


Figure 24. Damaged Cable

APPENDIX A

ANI/MAERP TEST SPECIFICATION

"Standard Fire Endurance Test Method to Qualify
a Protective Envelope for Class 1E Electrical Circuits"

AMERICAN NUCLEAR INSURERS

BURT C. PROOM, CPCU
President

ANI INFORMATION BULLETIN
#5 (79)

PROPERTY ENGINEERING DEPARTMENT
John J Carney, Vice President

BULLETIN TO AGENTS/BROKERS, INSURANCE MANAGERS & ARCHITECT ENGINEERS

Attached is the "ANI/MAERP Standard Fire Endurance Test Method to Qualify a Protective Envelope for Class IE Electrical Circuits". This Standard has been through several drafts and has benefited from suggestions from vendors, utilities and architect engineers.

This Standard is meant to meet a current need for qualifying a protective envelope for redundant safety circuits located in the same fire area. Although we don't envision industry-wide application of the protective envelope concept, we believe that it may provide a practical retrofit solution for a significant number of existing operating plants and some plants currently under construction.

If you have any questions, please contact Project Manager Don Slater or the Fire/All-Risk Administrative Engineer servicing the Utility in question.

Sincerely,

John J. Carney
Vice President - Property Engineering

JJC/jms

JULY, 1979

The Exchange, Suite 245 270 Farmington Avenue Farmington, Connecticut 06032 (203) 677-7305 · Eng. Dept. (203) 677-7715, TLX No. 643-029

AMERICAN NUCLEAR INSURERS

BURT C. PROOM, CPCU
President

PROPERTY ENGINEERING DEPARTMENT
John J. Carney, Vice President

ANI/MAERP STANDARD FIRE ENDURANCE TEST METHOD TO QUALIFY A PROTECTIVE ENVELOPE FOR CLASS 1E ELECTRICAL CIRCUITS

1.0 INTRODUCTION

The ANI/MAERP "Basic Fire Protection Guidelines" (April, 1976) recommend that redundant safety circuits be cut-off from each other by standard fire walls and floors (Item I, E-6). It has been our experience, that in new designs, this feature is "built-in". However, for operating plants, and some plants nearing completion, the provision of standard, rated, fire barriers may not be practical. When this condition exists, the options are to relocate the vital circuit to another fire area, or protect them in place. "Protecting-in-place" is defined as the ability to maintain the circuit's function during a standard exposure fire by use of a Protective Envelope.

In an effort to provide, for insurance purposes only, a reasonable and reliable means of "protecting-in-place" these vital circuits, without limiting our Insureds to conventional methods, and giving them the option of using products/materials not normally seen in this type of application, we have developed this test method. In this manner evaluations of different products/materials can be made, using a standard test approach.

In developing this Standard Test Method, the need to maintain circuit integrity during a standard "temperature-time" fire exposure was the prime consideration. In addition, the ability of the Protective Envelope to contain an internal fire exposure, was also considered important.

It should be emphasized that this Standard Test Method in no way decreases our requirements for fixed automatic fire suppression systems nor will it be considered the equivalent of rated fire barriers, where required. Its intent is to provide a means for "protecting-in-place" redundant cable systems in existing plants, or unusual situations in new designs.

The Exchange, Suite 245 270 Farmington Avenue . Farmington, Connecticut 06032 (203) 677-7305 Eng. Dept. (203) 677-7715 TLX. No. 643-029

2.1 SCOPE & PURPOSE

2.1 The purpose of this test is to qualify for insurance purposes a Protective Envelope for Redundant Class 1E Cables in Nuclear Power Plants when located in the same fire area. (A fire area is defined as that portion of a building that is encompassed by rated fire walls, ceilings and floors.) The maintenance of circuit integrity in these Class 1E safety circuits during a postulated fire is of prime importance.

2.2 The intent of this Test Method is to establish a protective envelope that maintains circuit integrity for safety circuits when:

---Redundant safety circuits, located in the same fire area, are exposed to a fire outside of the cable system, or

---Redundant safety circuits, located in the same fire area, are exposed by a fire originating in an adjacent "protected-in-place" cable system, or

---Redundant safety circuits, located in the same fire area, are subjected to mechanical impact damage as simulated by a hose stream, or other impact test.

3.0 ACCEPTANCE CRITERIA

ANI/MAERP Acceptance will be based on the completion and review of all of the following:

3.1 Successful passage of fire tests, as outlined in Section 3.4 of this test method, and submittal of necessary test documentation as prepared by a recognized testing laboratory or consultant.

3.2 A Quality Control/Quality Assurance Program for the system/design should be submitted for review. Complete details covering installation procedures, physical characteristics, identification methods, sample forms for third party sign-off, etc. should be included.

The QC/QA Program is considered an integral part of the acceptance process and variations between the QC/QA Program for the test and the program developed for the actual installation will not be acceptable.

3.3 All materials and components in the completed system, with the exception of the cable, shall be rated as non-combustible i.e., Flame Spread, Fuel Contributed, and Smoke Developed ratings of 25 or less.

Materials or components that are combustible or hazardous during the installation phase, should have a material hazard analysis performed with procedures developed for quantities on hand, storage practices, and precautions to be taken during installation.

3.4 The Cable Protective Envelope shall be exposed to the following fire endurance and hose stream tests. Test configuration and details should be submitted for review and comment prior to test.

3.4.1 Test I - Exposure Fire - The Protective Envelope shall be exposed to the standard temperature-time curve found in ASTM E-119-76 (ANSI A2.1) for a minimum of one hour. Sketch # 1 outlines a suggested test configuration.

3.4.2 Hose Stream Test - Immediately following Test I, accessible surfaces of the Protective Envelope shall be subjected to one of the following hose stream tests. The hose stream shall be applied for a minimum of 2 1/2 minutes, without de-energizing the circuits. PROPER SAFETY PRECAUTIONS SHALL BE EXERCISED. One of the following tests shall be used:

1. The stream shall be delivered through a 2 1/2 inch national standard playpipe equipped with 1 1/8 inch tip, nozzle pressure of 30 psi, located 20 feet from the system.

or

2. The stream shall be delivered through a 1 1/2 inch nozzle set at a discharge angle of 30° with a nozzle pressure of 75 psi and a minimum discharge of 75 gpm with the tip of the nozzle a maximum of 5 ft. from the system.

or

3. The stream shall be delivered through a 1 1/2 inch nozzle set at a discharge angle of 15° with a nozzle pressure of 75 psi and a minimum discharge of 75 gpm with the tip of the nozzle a maximum of 10 ft. from the system.

NOTE: #1 is the preferred test.

3.4.3 Test II - Internal Fire - For systems/designs that require heat to activate the Protective Envelope, the system shall also be subjected to Test II - Internal Fire. Sketch #2 outlines a suggested test configuration.

3.4.4 Cable Construction & Test Details

3.4.4.1 Cables shall be energized for circuit monitoring during Test Method I. For the purpose of this test method, "energized" means sufficient current to monitor failure.

3.4.4.2 Cable constructions shall be representative of cable used at the site. Cable tray loadings shall be in accordance with suggested test layouts.

3.4.4.3 In both test methods, cable tray construction shall be representative of actual site conditions, where applicable.

3.4.4.4 Cable system supports shall be those currently found in nuclear power plants and follow accepted installation procedures. Care should be exercised in using only supports that are necessary for the test. Supports that are used for the Protective Envelope shall be part of the final installed design.

3.4.4.5 Thermocouples shall be located strategically on the surface and at one foot intervals in the cable system and temperatures recorded throughout the test.

3.4.4.6 Fire stops or breaks, if used, shall be acceptable to American Nuclear Insurers. Failure of the fire stop or break shall not necessarily constitute a failure of the the Protective Envelope.

3.5 The tests shall be constituted a failure if any of the following occur:

1. Circuits fail or fault during the fire test as required in Test I or fail during the hose stream test.

2. Cotton waste in Test II ignites during the test period.

3.6 The minimum fire endurance rating acceptable for Test I shall be one hour. If longer ratings are desired, they shall be in one hour increments, such as 2 hr. and 3 hr. ratings.

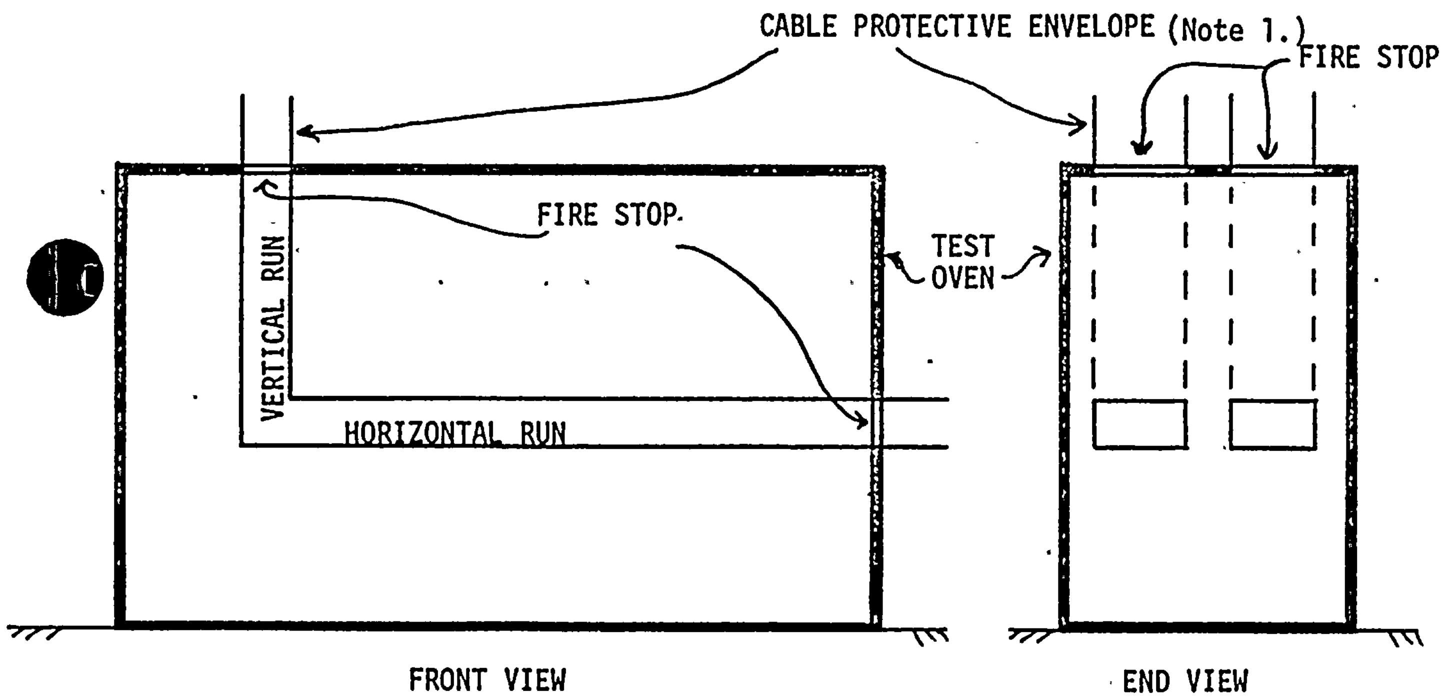
4.0 FINAL ACCEPTANCE

Prior to any installation at plants insured by American Nuclear Insurers, or Mutual Atomic Energy Reinsurance Pool, complete plans outlining system to be installed, location, etc. shall be submitted for review and acceptance.

JULY, 1979

SUGGESTED TEST LAYOUT - TEST METHOD 1

EXPOSURE FIRE TEST



(NO SCALE)

NOTE 1: TWO PROTECTIVE ENVELOPES TO BE TESTED. ONE LOADED TO MAXIMUM (40%) DESIGN AND ONE LIGHTLY LOADED.(ONE LAYER).

SUFFICIENT CIRCUITS TO BE MONITORED TO DETECT FAILURE; CIRCUIT TO CIRCUIT, CIRCUIT TO SYSTEM, OR CIRCUIT TO GROUND.

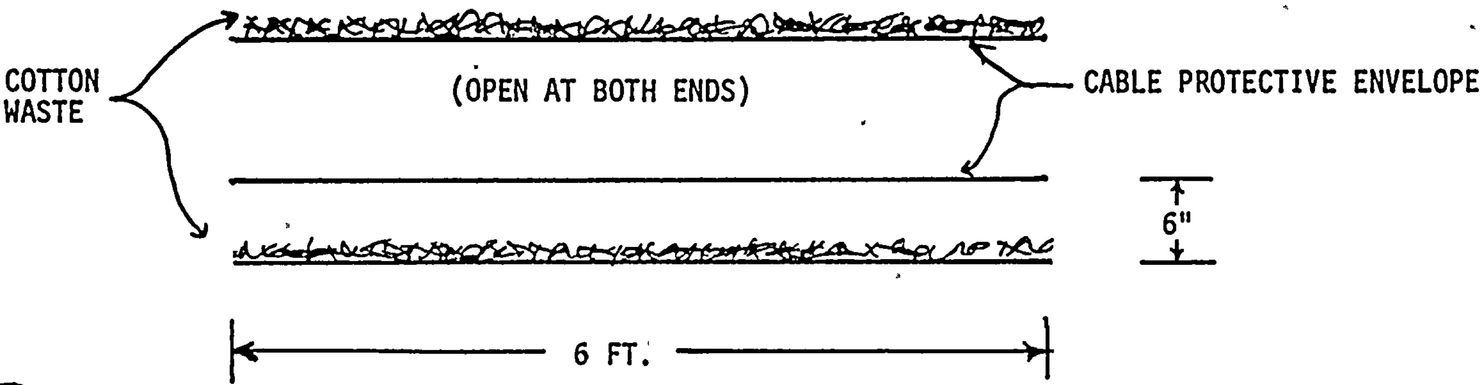
VARIOUS TYPES OF CABLE; SUCH AS POWER, CONTROL AND INSTRUMENTATION.

CABLE SHOULD NOT EXTEND MORE THAN THREE FEET OUTSIDE THE TEST OVEN.

NOTE 2: DUE TO FURNACE DESIGN, IT MAY BE NECESSARY TO ENTER AND EXIT THE FURNACE ON THE TOP OR THE SIDE.

SUGGESTED TEST LAYOUT - TEST METHOD 2

INTERNAL FIRE TEST



NOTE 1: COTTON WASTE SHALL BE PLACED OVER THE ENTIRE TOP SURFACE OF THE TEST SYSTEM AND A SAMPLE SYSTEM 6 INCHES BELOW THE TEST SYSTEM.

NOTE 2: THE CABLES USED IN THE TEST SHALL BE REPRESENTATIVE OF THE CABLE USED AT THE SITE. LOADINGS SHOULD BE 20% FILL WITH RANDOM LAY.

THE CABLES IN THE TRAY SHALL BE IGNITED USING THE "OIL SOAKED BURLAP" METHOD AS OUTLINED IN IEEE/ICC/WG 12-32, DATED 6/27/73, OR OTHER ACCEPTABLE "FLAME SOURCE", DEPENDING ON DESIGN AND OPERATING CONDITIONS OF THE COATING. THE FLAME SOURCE SHALL BE LOCATED AT THE MID-POINT OF THE CABLE SYSTEM. THE INTENT BEING TO PROVIDE AN IGNITION/FLAME SOURCE THAT IS DESIGNED TO LAST APPROXIMATELY 20 MINUTES AND ACTIVATE THE PROTECTIVE ENVELOPE.

OBSERVATIONS AND THERMOCOUPLE READINGS SHALL BE MAINTAINED FOR ONE HOUR FROM THE POINT OF IGNITION OF THE "FLAME SOURCE".

APPENDIX B

SwRI SURVEILLANCE REPORT

Report No. 82-033
Date: 23 JULY 82
Page: of

Project No. 01-7163

SURVEILLANCE REPORT

Surveillance Scope: Witnessed completion of stress skin installation

Reference Documents: PP&L F1000 7.6.2

Starting Date: 23 JULY 82 Ending Date: 23 JULY 82

Conducted By: R Ward

Persons Contacted: TERRY KLOCK, BOB MARKLE & RICK EVINA

Related Record Numbers:

Attachments:

Satisfactory Findings: INSPECTED STRESS SKIN PRIOR TO FIRST COAT OF THERMO-LAG 330-1. FOUND STRESS SKIN TO BE COMPLETE, VERY SECURE, FREE OF FOREIGN MATERIAL WITH PRIMER INTACT. NO PREFORMED PANELS WERE USED. A 10"X10"X26" JUNCTION BOX WAS USED IN PLACE OF 10X10X24" T-2 AN ADDITIONAL SUPPORT WAS USED ON LOWER END OF 5" AIR DROP CONDUIT.

Unsatisfactory Findings:
NO DOCUMENTATION OR IDENTIFYING LABELS ARE AVAILABLE TO VERIFY STRESS SKIN IS THERMO LAG 330-69/351

Recommendations/Action:

NONE

Distribution: Original - Manager of QA BEM
Copies - Originator RGW
Inspection Engineer J. Schubert (01)
Project Manager J. Beitel (01)
VP, QAS&E CEL
Person(s) Responsible for Corrective Action N/A

Approved: [signature]
Manager of Quality Assurance

TELEPHONE CONVERSATION RECORD

osal No.:

Date: 8/24/8_ Time: 3:__ pm

ct 81-7163

ract No.:

r:

:

Mr./~~Mrs.~~ DONALD KOHN

Phone No.: 215/ 770-[illegible]

Organization: PP&L

Ext.:

Address: ALLENTOWN PA.

Telephone Charge:

City:

☐ Incoming ☐ Outgoing

pose: SPOKE w/ DON KOHN concerning DNR # 82-091

ume: Don said that PP&L will provide documentation that the [illegible] [illegible] used in the test is Thermo-Lag 330-69/351. Documentation will be provided to the NRC.

ion to be Taken:

ion to be Taken by:

Required Date:

tribution:

DNR No. 82-091

Signature:

SOUTHWEST RESEARCH INSTITUTE

DEVIATION AND NONCONFORMANCE REPORT

PURCHASE ORDER NO.	PROJECT NO.	JOB REQUEST NO.	DNR NO.
—	01-7163	—	82-091

ITEM NAME OR ACTIVITY	MFG./PERFORMED BY
PP&L FIRE TEST	PP&L / SwRI

ITEM DESCRIPTION (S/N, MODEL, WELD, SITE, NAME, ETC.)

DOCUMENTATION IDENTIFYING STRESS SKIN AS THERMOLAG 330-69/351

DESCRIPTION OF DEVIATION OR NONCONFORMANCE:

NO DOCUMENTATION WAS AVAILABLE TO IDENTIFY THE STRESS SKIN AS THERMO LAG 330-69/351

PROBABLE CAUSE OF DEVIATION OR NONCONFORMANCE:

ORIGINATOR (NAME)	DATE:
JESSE J. BRITEL	8/24/82

DESCRIPTION OF CORRECTIVE ACTION:

PP&L WILL PROVIDE DOCUMENTATION TO NRC

CORRECTIVE ACTION TO BE TAKEN BY (NAME):	TARGET DATE FOR INITIATION / OR COMPLETION
PP&L	

DISPOSITION:

- [x] ACCEPT
- [ ] REWORK
- [ ] SCRAP
- [ ] RETURN TO VENDOR
- [ ] HOLD
- [ ] OTHER (SPECIFY)

BASIS FOR DECISION AND NOTES:

DISCUSSION W/ PROJECT MANAGER (PP&L)

LIST OF ATTACHMENTS:	STATUS:
	☐ OPEN ☒ CLOSED

PROJECT MANAGER (SIGNATURE)	DATE	DISTRIBUTION:
[signature]	8/24/82	MANAGER OF Q A BEM
MANAGER OF QA (SIGNATURE)	DATE	ORIGINATOR J. Britel (01)
[signature]	8/24/82	PROJECT MANAGER (PROJECT FILES) J. Britel (01)
		PERSON RESPONSIBLE FOR CORRECTIVE ACTION PP&L

SwRI FORM QA 20-4

M-2

SHIPPING NOTICE

JOB NO. 8856

SN NO. 8856-12513

DATE JULY 9, 19 82

CONSIGNED TO SOUTHWEST RESEARCH INST.
6220 CULEBRA ROAD

ADDRESS SAN ANTONIO, TX 78284 ATTN: JESS BEITEL, BUILDING 143

ROUTING R.L. JEFFERIES

SHIP VIA	COLLECT	PREPAID
AIR EXPRESS		
EXPRESS		
RAIL FREIGHT		
MOTOR FREIGHT		X
PARCEL POST		
BEARER		

PURCHASE ORDER NO.	O S & D NO.	ORIGINAL MRR NO.
8856 F-63871	N/A	N/A

MATERIAL ORIGINALLY PURCHASED ON P.O. NO. N/A

VENDOR N/A

REASON FOR SHIPMENT. PPEL TESTING

SHIPMENT AUTHORIZED FOR BECHTEL BY: C. MARSHALL/H. CAPITA

BILL OF LADING ATTACHED

ITEM NO.	QUANTITY	UNIT	COMPLETE DESCRIPTION
1.	1	LOT	VARIOUS MATERIAL AS PER ATTACHED ~~3~~ 4 PAGES.

RETURN AUTHORIZED BY:

AUTHORIZATION NUMBER:

CREDIT TERMS:

COMPANY

SHIPPER
Bechtel POWER CORPORATION

ADDRESS PO BOX 380
BERWICK, PA 18603

PER

ACCEPTED FOR SHIPMENT

DATE 19

CARRIER

PER

SN NO. 8856-12513

2

3230 (5-68)

M-3

Assorted Hand Tools

Rubber Gloves and Goggles

1 Silicone Foam Machine

2 10 to 1 Grayco Pumps

Spare Machine Parts

3 Binks Spray Gums

2 5/8" Drills

4 Jiffy Mixers

Chicken Buckets

Garbage Bags

Roll of Plastic

6 Rolls of White Tape

2 Boxes of Resperiators

2 Boxes of Stainless Steel Wire

2 5Gallon Buckets of Instumastic

2 Boxes of Kao-Wool

4 Air Hoses

1 Moisture Meter and Batteries

Caulking

Empty 5 Gallon Buckets

Stress Skin

1 Hilti Drill

50 Foot of Rope

2 Lugalls

18' 5" CONDUIT

1. SKID MISC ELECT PARTS

1 " " WIRE "

2. CONDUIT SUPPORTS

1. BARREL STRESS SKIN

1. CABLE TRAY ASS'Y.

Chalk Line and Square

2 Slings

Assorted Hilti Drills

10 Sets of SF-20 Foam

5 Sets of Elastomer

7 Sheets of M-Board

M-4

INTRANSIT WEPS

APPENDIX 1

BILL OF MATERIALS

TOTAL CABLES REQUIRED

* Assign Individual
* Pre Fab
* Who spray?
* 30 days to dry

CABLE FUNCTION	CABLE TYPE	CABLE SIZE	QUANTITY	LENGTH
Power	W-008	1/C 750 MCM	3	20 Ft.
Power	W-709	1/C 500 MCM	1	20 Ft.
Power	W-710	1/C 350 MCM	4	20 Ft.
Power	W-211	1/C 4/0 AWG	2	20 Ft.
Power	W-012	4/0 Triplex	2	20 Ft.
Power	W-713	2/0 Triplex	2	20 Ft.
Power	W-715	# 2 Triplex	2	20 Ft.
Power	W-116	2/C # 2 AWG	4	20 Ft.
Power	W-017	3/C # 4 AWG	2	20 Ft.
Power	W-220	3/C # 6 AWG	2	20 Ft.
Power	W-221	2/C # 6 AWG	2	20 Ft.
Power	W-123	3/C # 8 AWG	4	20 Ft.
Power	W-124	2/C # 8 AWG	3	20 Ft.
Control	W-141	4/C #10 AWG	8	20 Ft.
Control	W-045	12/C#12 AWG	15	20 Ft.
Control	W-046	9/C #12 AWG	12	20 Ft.
Control	W-047	7/C #12 AWG	13	20 Ft.
Control	W-048	5/C #12 AWG	13	20 Ft.
Control	W-850	3/C #12 AWG	14	20 Ft.
Instrumentation	W-061	12 Shielded twisted pairs # 16 AWG	4	20 Ft.
Instrumentation	W-062	6 Shielded twisted pairs #16 AWG.	2	20 Ft.
Instrumentation	W-263	4 Shielded twisted pairs #16 AWG	5	20 Ft.
Instrumentation	W-264	2 Shielded twisted pairs #16 AWG	4	20 Ft.
Instrumentation	W-069	22/C#16 AWG with overall shield	4	20 Ft.
Instrumentation	W-071	5/C #16 AWG with overall shield	2	20 Ft.
Instrumentation	W-076	6 Twisted pair #16; 1 twisted pair #14; 2 # 16 drain wire	4	20 Ft.
Instrumentation	W-081	7 Shielded triads	6	20 Ft.
Instrumentation	W-372	1TQ #16 Shield	3	20 Ft.
Instrumentation	W-058	RG-11U Triaxial	3	20 Ft.
Instrumentation	W-067	48/C #16 Shield	3	20 Ft.

Note: All vendors supplying IEEE 383 qualified cables shall be represented in the fire test.

M-5

APPENDIX 1

BILL OF MATERIALS

ITEM	QUANTITY	DESCRIPTION	MAT'L SPEC
[illegible]	1	C4 x 7.25 x 3'-8" Lg. (channel)	ASTM A36
V.	2	½" x 2 1/8" x 6" Lg. Filler Plate, Carbon Steel	ASTM A36
W.	6	Carbon Steel Plate 3/16" x 2" x 4" Lg.	ASTM A36
X.	6	5/8" Ø Bolts x 2½" Lg. w/nut & std. Hardened Washer	A-325
Y.	12	½" Ø RD. HD. Bolts w/Hex. nut & std. washer x 2" Lg.	A-325
Z.	6	Bevel Washers for 5/8" Ø Bolts Carbon Steel	A-325
A.A.	1	Junction Box 24" x 18" x 10", Nema Four w/mounting lugs	ES-23A
B.B.	2	Channel Combinations 28" Long (Unistrut-P1001)	
C.C.	6	3/8" Ø x 1" Lg. Bolts (Unistrut)	
D.D.	4	3/8" Ø x 5" Lg. Bolts (Hilti Kwik)	
E.E.	2	½" Ø x 1½ Lg. Hex HD. Bolts w/Hex nut & Bevel Washers	A-325
F.F.	1	5" Ø Rigid Steel Conduit x 8" Length (threaded on both ends)	ES-23A
G.G.	256	3/8" - 16 x ~~34~~ 3/4" Lg. Spline Bolt w/Oval Type Phillips Slotted Heads w/Nuts and Locking Devices	A-307
H.H.	As Required	Cables (Refer to following page for itemized listing) IEEE-383 qualified	ES-13
I.I.	As Required	Cable Ties	
J.J.	32	Splice Plates	ES-19
K.K.	6	L 3½" x 2½" x 5/16" x 4" Long	ASTM A
L.L.	1	Carbon Steel Plate ½" x 6" x 1'-4"	ASTM A

M-6 BILL OF MATERIALS

ITEM	QUANTITY	DESCRIPTION	MAT'L SPEC
A.	4	18" width x 4" depth x 65" length Solid Bottom Cable Tray	ES-19
B.	4	18" width x 4" high 90° inside Riser El. 12" Rad., Solid Bottom Cable Tray	ES-19
C.	4	18" width x 4" depth x 65" length Ladder Bottom Cable Tray	ES-19
D.	4	18" width x 4" high x 90° inside Riser El. 12" Rad., Ladder Bottom Cable Tray	ES-19
E.	2	18" width x 4" depth x 40" length Solid Bottom Cable Tray (Middly Section)	ES-19
F.	2	18" width x 4" depth x 34" length Ladder Bottom Cable Tray (Middle Section)	ES-19
G.	1	5" Ø Rigid Steel Conduit x 29½" length (threaded on both ends)	ES-23A
H.	1	5" Ø Rigid Steel Conduit x 58" length (threaded on both ends)	ES-23A
I.	2	5" Ø Rigid Steel Conduit x 50 3/4" length (threaded on both ends)	ES-23A
J.	3	5" Ø Rigid Steel Conduit El. 24" Rad. (threaded on both ends)	ES-23A
K.	1	5" Ø Rigid Steel Conduit x 38 3/4" length (threaded on both ends)	ES-23A
L.	5	5" Ø Rigid Steel Conduit Couplings	ES-23A
M.	2	5" Ø Rigid Steel Conduit x 24" length (threaded on both ends)	ES-23A
N.	2	Carbon Steel Plate 3/8" x 3" x 3" Lg.	ASTM A3
O.	2	C6 x 8.2 x 44" Lg. (channel)	ASTM A3
P.	1	C6 x 13 x 108" Lg. (channel)	ASTM A3
Q.	2	L6 x 6 3/4 x 1'-6" Lg. (angle)	ASTM A3
R.	6	1" Ø x 12" Lg. Bolts (Hilti Kwik)	
S.	1	Conduit Clamp (Unistrut - P2558-50)	
T.	1	Carbon Steel Plate ½" x 6" x 6" Lg.	ASTM A3

M-T

TSI

CERTIFICATE OF CONFORMANCE

PRODUCT DESCRIPTION	QUANTITY	BATCH NUMBER
THERMO-LAG STRESS SKIN TYPE 330-69	4,000 Sq.Ft.	T-32-21682-F-2

This will certify that the THERMO-LAG Material, as listed above, shipped to Bechtel Power Corporation, Agents for Pennsylvania Power & Light Co., Susquehanna Steam Electric Station, 5 Miles N.E. of Berwick, PA. on Route 11, North Purchase Order Number 8856-F-56718 REV. 2, meets TSI's manufacturing and written quality control specifications.

Allen Thorpe

Allen Thorpe
Manager of Quality Control

DATE: 8 April 1982

Bill of Lading No: 12013

Mode of Transportation: Trans Con Truck Lines

TSI, INC. • 3260 BRANNON AVE. • ST. LOUIS, MO. 63139 • (314) 352-8422 • Telex: 44-2384

M-8

TSI

CERTIFICATE OF CONFORMANCE

PRODUCT DESCRIPTION	QUANTITY	LOT NUMBER
THERMO-LAG STRESS SKIN TYPE 330-69	126 pieces 3'x8' Total: 3,024 Sq.Ft.	A-006

This will certify that the THERMO-LAG Materials listed above and shipped to Bechtel Power Corporation, Agents for Pennsylvania Power & Light Company, Susquehanna Steam Electric Station, 5 miles N.E. Of Berwick, PA. on Route 11 North, Under Bechtel's Purchase. Order No. 8856-F-56718, Revision 1, meets TSI's manufacturing and written quality control specifications.

Allen Thorpe

ALLEN THORPE
MANAGER OF QUALITY CONTROL

DATE: February 22, 1982

TSI B/L No: 11962

AIR FREIGHT CARRIER: EMERY AIR FREIGHT

EMERY AIR FREIGHT NO: STL 12998

M-9

CERTIFICATE OF CONFORMANCE

PRODUCT DESCRIPTION	QUANTITY	LOT NUMBER
THERMO-LAG STRESS SKIN TYPE 330-69	42 pieces 3'x8' Total: 1,008 Sq. Ft.	A-006

This will certify that the THERMO-LAG Material listed above and shipped to Bechtel Power Corporation, Agents for Pennsylvania Power & Light Company, Susquehanna Steam Electric Station, 5 Miles ~~N.E. of~~ Berwick, PA on Route 11 North, under Bechtel's Purchase Order #8856-F-56718, Revision 1, meets TSI's manufacturing and written quality control specifications.

Allen Thorpe
ALLEN THORPE
MANAGER OF QUALITY CONTROL

DATE: 12 February 1982

TSI B/L NO: 11953

AIR FREIGHT CARRIER: EMERY AIR FREIGHT

EMERY AWB NO: 12996

TSI, INC. • 3260 BRANNON AVE. • ST. LOUIS, MO. 63139 • (314) 352-8422 • Telex: 44-2384

Report No. 82-034
Date: 24 July 82
Page: of

Project No. 01-7163

SURVEILLANCE REPORT

Surveillance Scope: INSPECTED CABLES/TRAYS

Reference Documents: PP&L SPEC. F1001 REV. 0 APPENDIX E

Starting Date: 24 July 82 Ending Date: 24 JULY 82

Conducted By: R. Ward

Persons Contacted: TERRY KLOCK

Related Record Numbers:

Attachments:

Satisfactory Findings:

CABLE FILL IN ACCORDANCE WITH ABOVE SPEC.

Z 83 SUBSTITUTED FOR D83 PER TERRY K.

Unsatisfactory Findings:

NONE

Recommendations/Action:

NONE

Distribution: Original - Manager of QA BEM
Copies - Originator RGW
Inspection Engineer J. Schubert (C1)
Project Manager J. Beitel (D1)
VP, QAS&E CEL
Person(s) Responsible for Corrective Action N/A

Approved: [signature]
Manager of Quality Assurance

Report No. 82-035

Date: 25 JULY 82

Project No. .01-7165

Page: of

SURVEILLANCE REPORT

Surveillance Scope: Witnessed Finish of second coat of Thermo-Lag 330-1

Reference Documents: PP&L Spec. E-1000 3.6.3.

Starting Date: 25 July 82 Ending Date: 25 July 82

Conducted By : R. WARD

Persons Contacted: Terry Klock, Bob Markle, Rick Evina

Related Record Numbers:

Attachments:

Satisfactory Findings:

Material: Thermo-Lag 330-1 with UL label and certificate of conformance. Batch # 13764

Temperature: 68° F. Inst. used - Acromag - Calibrated 20 April 82 - Due 21 Oct. 82

Moisture Meter used: Delmhorst Model DP S/N 1758

Unsatisfactory Findings:

A Moisture Reading of 80 is Being used Between coats. This is not per PPL Spec E-1000 Rev. 0 3.6.7 Spec Reads 20

Recommendations/Action:

Distribution: Original - Manager of QA BEM

Copies - Originator RGW

Inspection Engineer J. Schubert (01)

Project Manager J. Beitel (01)

VP, QAS&E CEL

Person(s) Responsible for Corrective Action

Approved: [signature]

Manager of Quality Assurance

SOUTHWEST RESEARCH INSTITUTE

DEVIATION AND NONCONFORMANCE REPORT

PAGE 1 OF 1

PURCHASE ORDER Nº.	PROJECT Nº.	JOB REQUEST Nº.	DNR Nº.
N/A	01-7163	N/A	82-078

ITEM NAME OR ACTIVITY	MFG./PERFORMED BY
PP&L FIRE TEST	PP&L/SWRI

ITEM DESCRIPTION (S/N, MODEL, WELD, SITE, NAME, ETC.)

MOISTURE READING BETWEEN COATS OR LAYERS OF SUBLIMING COMPOUND

DESCRIPTION OF DEVIATION OR NONCONFORMANCE:

A READING OF 80 OR LESS IS BEING USED – PP&L SPEC. F1000 REV.0 3.6.7 READ 20 OR LESS

PROBABLE CAUSE OF DEVIATION OR NONCONFORMANCE:

UNKNOWN

ORIGINATOR (NAME)	DATE:
R. Ward	25 July 82

DESCRIPTION OF CORRECTIVE ACTION:

"20%" should read "80%" – Typo. error.

CORRECTIVE ACTION TO BE TAKEN BY (NAME):	TARGET DATE FOR INITIATION ______ OR COMPLETION ______

DISPOSITION:

- [x] ACCEPT
- [ ] REWORK
- [ ] SCRAP
- [ ] RETURN TO VENDOR
- [ ] HOLD
- [ ] OTHER (SPECIFY)

BASIS FOR DECISION AND NOTES:

Discussion with project manager (PP&L)

LIST OF ATTACHMENTS:

STATUS: ☐ OPEN ☒ CLOSED

PROJECT MANAGER (SIGNATURE)	DATE
	8/11/82
MANAGER OF QA (SIGNATURE)	DATE
	8/11/82

DISTRIBUTION:
- MANAGER OF Q A
- ORIGINATOR
- PROJECT MANAGER (PROJECT FILES)
- PERSON RESPONSIBLE FOR CORRECTIVE ACTION

SwRI FORM QA 20-4

Report No. 82036
Date: 26 JULY 82
Page: of

Project No. 01-7163

SURVEILLANCE REPORT

Surveillance Scope: inspected cable/conduit

Reference Documents: PP&L SPEC. E1001 Rev0 Appendix E

Starting Date: 26 July 82 Ending Date: 26 July 82

Conducted By: R. Wood

Persons Contacted: Terry Hlook

Related Record Numbers:

Attachments:

Satisfactory Findings: inspected cable fill in 5" conduit and found as per specification Table T3

Unsatisfactory Findings:
None

Recommendations/Action:
None

Distribution: Original - Manager of QA BEM
Copies - Originator RGW
Inspection Engineer J. Schubert (c1)
Project Manager J. Beitel (c1)
VP, QAS&E CEL
Person(s) Responsible for Corrective Action N/A

Approved: [signature]
Manager of Quality Assurance

Report No. 82-037
Date: 27 July 82
Page: 1 of 1

Project No. 01-7163

SURVEILLANCE REPORT

Surveillance Scope: Witnessed preperation for application of third coat of subliming compound.

Reference Documents: PP&L Spec. F1000 3.6.6.7

Starting Date: 27 July 82 Ending Date: 27 July 82

Conducted By : R. Ward

Persons Contacted: Terry Klock, Bob Markle, Rick Evina.

Related Record Numbers:

Attachments:

Satisfactory Findings:

Temperature - 69° (Above 40°)
Moisture Readings with Delmhorst DP Meter
Below 80 - Typ. 40, 60, 20, 40, 50 etc.

Unsatisfactory Findings:

NONE.

Recommendations/Action:

NONE.

Distribution: Original - Manager of QA BEM
Copies - Originator RGW
Inspection Engineer J. Schubert (01)
Project Manager J. Beitel (01)
VP, QAS&E CEL
Person(s) Responsible for Corrective Action N/A

Approved: [signature]
Manager of Quality Assurance

Project No. 01-7163-002

Report No. 82-040
Date: 8 Aug 82
Page: 1 of 1

SURVEILLANCE REPORT

Surveillance Scope: Witnessed completion of stress skin installation on back up unit

Reference Documents: PP&L Spec F1000 3.6.2 Rev.0

Starting Date: 8 Aug 82 Ending Date: 8 Aug 82

Conducted By: R Ward

Persons Contacted: Jerry Klock, Bob Markle, Rick Evina

Related Record Numbers:

Attachments:

Satisfactory Findings: Inspected stress skin prior to 1st application of subliming compound. Stress skin found to be properly supported, secure, clean, with primer intact.

Unsatisfactory Findings:

None

Recommendations/Action:

None

Distribution: Original - Manager of QA BEM
Copies - Originator RGW
Inspection Engineer J. Schubert (01)
Project Manager J. Beitel (01)
VP, QAS&E CEL
Person(s) Responsible for Corrective Action N/A

Approved:
Manager of Quality Assurance

Project No. 01-7163-002

Report No. 82-039
Date: 9 Aug 82
Page: 1 of 1

SURVEILLANCE REPORT

Surveillance Scope: Witnessed Dry Film Thickness Measurements of Thermo-Lag 330-1

Reference Documents: PP&L Spec F 1000 Rev 0 3.6.4

Starting Date: 9 Aug. 82 Ending Date: 9 Aug. 82

Conducted By : R. Ward

Persons Contacted: Rick Evina

Related Record Numbers:

Attachments:

Satisfactory Findings:

Measurements were taken on all trays, cable drops, junction box and conduit w/o measurements, all with-in specifications (1/2"-3/4")

Unsatisfactory Findings:

None

Recommendations/Action:

None

Distribution: Original - Manager of QA BEM
Copies - Originator RGW
Inspection Engineer J. Schubert (01)
Project Manager J. Beitel (01)
VP, QAS&E CEL
Person(s) Responsible for Corrective Action N/A

Approved: [signature]
Manager of Quality Assurance

Project No. 01-7163-002

Report No. 82-041
Date: 10 Aug. 82
Page: 1 of 1

SURVEILLANCE REPORT

Surveillance Scope: Witnessed Fire Endurance Test

Reference Documents: PP&L Spec F1001 Rev0 App A 1.0~5.0

Starting Date: 10 Aug 82   Ending Date: 10 Aug 82

Conducted By : RWard

Persons Contacted: Don Kohn, Terry Klock, Bob Markle, Rick Evina, Frank Farese, Bill Evans, Jesse Beitel

Related Record Numbers:

Attachments:

Satisfactory Findings: Fire Endurance (1hr.) Test was properly conducted per above specifications. Average Furnace Temperatures were monitored on Acromag Digital Instrument S/N F10711, Calibrated 6 Aug 82. Fire exposure data was recorded on the Wang computer through two Kaye scanners; #1 128RR/6935 calibrated 6 Aug 82. #2 128RR/6936 calibrated 5 Aug. 82

Unsatisfactory Findings:

None

Recommendations/Action:

None

Distribution: Original - Manager of QA
Copies - Originator
Inspection Engineer
Project Manager
VP, QAS&E
Person(s) Responsible for Corrective Action

Approved: [signature]
Manager of Quality Assurance

ENTERED
AUG 13 1982

SOUTHWEST RESEARCH INSTITUTE

DEVIATION AND NONCONFORMANCE REPORT

PURCHASE ORDER NO.	PROJECT NO.	JOB REQUEST NO.	DNR NO.
N/A	01-7163	N/A	82-087

ITEM NAME OR ACTIVITY	MFG./PERFORMED BY
FPTL Fire Test	FPTL / SwRI

ITEM DESCRIPTION (S/N, MODEL, WELD, SITE, NAME, ETC.):
Testing of Sample conduits

DESCRIPTION OF DEVIATION OR NONCONFORMANCE:
Section 4.2 of FPTL Spec requires two small conduit to be tested at time of main test. The small conduits were not tested

PROBABLE CAUSE OF DEVIATION OR NONCONFORMANCE:
Space limitation inside furnace.

ORIGINATOR (NAME)	DATE:
J. Beitel	8/10/82

DESCRIPTION OF CORRECTIVE ACTION:
Small conduits will be tested at a later date.

CORRECTIVE ACTION TO BE TAKEN BY (NAME):	TARGET DATE FOR INITIATION OR COMPLETION
J. Beitel	9/16/82

DISPOSITION:
ACCEPT ☒ REWORK ☐ SCRAP ☐ RETURN TO VENDOR ☐ HOLD ☐ OTHER (SPECIFY) ☐

BASIS FOR DECISION AND NOTES:

LIST OF ATTACHMENTS:
None

STATUS: ☒ OPEN ☐ CLOSED

PROJECT MANAGER (SIGNATURE)	DATE
[signature]	8/16/82
MANAGER OF QA (SIGNATURE)	**DATE**
[signature] BEM	8/16/82

DISTRIBUTION:
MANAGER OF Q A BEM
ORIGINATOR J. Beitel (01)
PROJECT MANAGER (PROJECT FILES) J. Beitel (01)
PERSON RESPONSIBLE FOR CORRECTIVE ACTION J. Beitel (01)

SwRI FORM QA 20-4

SOUTHWEST RESEARCH INSTITUTE

DEVIATION AND NONCONFORMANCE REPORT
CLOSE OUT

PAGE ___ OF ___

THIS PAGE IS NOT TO BE USED UNLESS CORRECTIVE ACTION FOLLOWUP IS NECESSARY

CORRECTIVE ACTION TO BE TAKEN BY (NAME): JESS BRITEL

DNR NO.: 82-087

NOTIFICATION OF CORRECTIVE ACTION COMPLETE: (PROVIDE DATE, NAMES, RELATED RECORD NUMBERS, ETC., AS APPLICABLE):

Testing of SAMPLE CONDUIT WAS PERFORMED ON 8/19/82.

IF CORRECTIVE ACTION IS NOT THE SAME AS ORIGINALLY SPECIFIED, EXPLAIN HERE:

Sample conduit was tested at different time than main test due to space limitations inside furnace.

CORRECTIVE ACTION COMPLETED BY (SIGNATURE): [signature]

DATE: 8/20/82

FINAL APPROVAL FOR CLOSEOUT:

[signature] 8/20/82
PROJECT MANAGER (SIGNATURE) DATE

[signature] 8/24/82
MANAGER OF QA (SIGNATURE) DATE

DISTRIBUTION:

MANAGER OF QA
ORIGINATOR
PROJECT MANAGER (PROJECT FILES)
PERSON RESPONSIBLE FOR CORRECTIVE ACTION

NOTES:

SWRI FORM QA-208-1

APPENDIX G

TEMPERATURE DATA

P P & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

TIME MIN	SEC	T1-1	T1-2	T1-3	T1-4	T1-5	T1-6	T1-7	T1-8	T1-9	T1-10	T1-11	T1-12	T1-13	T1-14	T1-15	T1-16
0	0	80	79	81	81	82	83	97	82	86	92	105	80	81	80	82	85
3	15	81	80	82	83	83	83	97	83	86	92	105	80	82	81	83	86
6	0	90	84	87	88	87	83	98	88	85	90	105	83	87	88	85	92
9	14	113	99	104	105	105	85	98	106	84	89	106	100	110	108	88	112
12	0	153	131	137	128	134	91	99	136	87	89	106	154	177	126	79	152
15	13	126	150	152	157	172	115	99	178	82	88	106	213	241	156	117	196
18	0	145	152	179	176	191	152	100	187	84	64	105	194	240	176	141	200
21	13	160	171	184	189	195	176	100	188	86	52	106	181	234	194	174	202
24	0	174	186	200	195	202	183	100	195	86	57	106	188	232	204	192	203
27	3	184	195	206	199	203	187	100	199	87	70	106	205	224	208	205	219
30	16	192	199	209	200	202	187	100	204	87	75	105	218	219	211	215	226
33	0	200	206	216	204	206	188	101	214	88	76	106	225	218	391	178	339
36	13	222	223	239	208	210	186	102	231	90	89	105	225	218	319	200	241
39	0	240	258	287	211	216	184	101	242	94	98	105	224	215	247	232	241
42	14	281	289	320	222	232	183	102	258	92	98	105	220	239	272	257	233
45	0	308	317	344	253	254	185	104	279	93	102	107	232	265	305	283	258
48	14	334	350	369	273	274	185	105	300	96	102	107	257	292	331	315	284
51	0	345	389	418	289	289	186	106	321	94	104	108	272	318	355	354	309
54	14	372	466	428	326	303	189	107	346	92	104	108	283	340	406	409	356
57	0	401	527	455	351	314	191	108	369	92	104	108	29[illegible]	[illegible]	428	453	400
60	14	444	593	469	380	330	192	108	402	91	105	107	320	351	439	472	427
63	0	481	662	511	412	344	192	108	424	89	103	106	337	357	463	500	460
66	14	208	229	186	388	351	196	109	341	61	74	107	327	363	141	272	262
69	0	200	152	149	360	329	198	110	215	62	88	105	303	344	174	194	279
72	14	209	140	137	341	315	191	111	206	78	104	104	291	334	209	171	343

P F & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

TIME MIN	SEC	T2-1	T2-2	T2-3	T2-4	T2-5	T2-6	T2-7	T2-8	T2-9	T2-10	T2-11	T2-12	T2-13	T2-14	T2-15
0	0	93	90	82	81	79	79	78	78	79	78	78	80	79	83	90
3	15	92	90	82	81	79	80	78	78	79	78	78	81	80	83	90
6	0	93	91	82	84	80	81	78	78	79	77	81	85	86	84	90
9	14	94	91	83	94	89	84	79	79	81	79	88	103	113	89	90
12	0	94	92	84	114	107	94	81	83	87	84	103	128	143	110	90
15	13	93	91	90	146	164	104	88	80	87	84	117	134	168	128	91
18	0	94	91	101	174	160	133	90	87	90	88	129	159	177	145	91
21	13	94	92	122	192	182	143	90	87	92	92	146	173	184	156	91
24	0	94	92	144	199	193	159	101	92	99	98	159	178	189	163	92
27	3	95	93	162	244	190	171	111	105	108	104	168	188	196	169	93
30	16	94	93	171	201	198	185	121	116	118	108	177	197	208	173	94
33	0	93	93	172	203	199	187	128	119	128	113	183	215	216	176	95
36	13	90	95	175	205	200	192	134	125	137	117	188	216	239	180	96
39	0	93	94	176	210	200	195	145	146	141	123	191	235	253	180	97
42	14	93	94	177	227	204	195	153	156	148	131	197	264	267	181	99
45	0	95	96	180	245	220	200	162	166	156	139	205	280	282	183	102
48	14	95	98	181	262	239	211	170	176	164	146	214	296	297	184	104
51	0	93	98	182	275	261	227	176	184	171	152	232	309	312	185	105
54	14	95	98	184	291	290	267	186	194	178	160	261	326	330	190	107
57	0	94	98	186	304	319	298	196	203	185	167	278	340	344	200	108
60	14	93	98	188	321	357	334	211	214	193	175	295	358	360	214	109
63	0	91	98	190	338	385	367	226	223	201	183	307	373	375	221	111
66	14	89	99	193	358	410	404	248	232	211	193	292	396	397	227	112
69	0	94	100	197	337	376	227	267	242	218	202	252	387	402	237	114
72	14	95	102	195	319	345	241	276	246	226	212	248	360	388	250	116

P P & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

TIME MIN	SEC	T3-1	T3-2	T3-3	T3-4	T3-5	T3-6	T3-7	T3-8	T3-9	T3-10	T3-11	T3-12	T3-13	T3-14	T3-15
0	0	91	90	82	79	79	77	78	78	78	78	78	78	80	81	89
3	15	92	91	82	80	79	77	78	78	78	78	78	78	80	82	89
6	0	92	91	82	81	80	77	80	78	79	80	79	83	86	82	89
9	14	94	93	83	96	89	77	90	84	95	93	84	110	121	94	90
12	0	94	93	83	134	99	77	83	90	99	92	72	145	159	117	90
15	13	93	92	85	174	145	85	75	98	104	91	118	172	182	138	91
18	0	93	92	90	186	167	77	112	106	110	125	147	183	189	149	91
21	13	94	97	98	194	181	77	148	113	146	153	165	188	193	158	91
24	0	94	93	107	196	189	77	167	140	164	170	177	191	196	163	92
27	3	94	94	115	197	192	77	176	159	178	182	184	196	200	168	93
30	16	94	94	123	197	194	77	182	170	185	188	188	204	215	174	94
33	0	94	94	125	198	193	77	165	176	190	206	191	211	218	175	95
36	13	93	96	131	202	194	69	187	181	196	222	204	232	240	175	96
39	0	93	95	136	210	196	77	185	187	203	205	211	257	263	179	98
42	14	92	95	139	219	204	76	213	196	222	222	232	281	286	184	99
45	0	94	96	144	244	226	79	263	211	253	251	249	301	307	192	102
48	14	95	98	148	267	248	80	285	234	272	273	267	322	329	198	103
51	0	95	98	152	285	264	80	297	255	293	292	283	341	346	201	105
54	14	94	98	158	315	282	80	319	277	317	318	303	364	363	208	106
57	0	93	98	165	323	297	80	345	299	340	340	321	380	373	217	107
60	14	92	98	175	333	318	79	463	332	371	369	345	398	396	229	108
63	0	92	98	183	346	335	79	505	364	395	394	368	413	416	241	109
66	14	93	97	189	374	361	80	494	397	210	211	392	441	444	258	111
69	0	92	94	191	384	374	80	210	197	188	210	398	427	452	271	113
72	14	93	98	194	384	385	79	172	251	203	201	379	405	453	283	116

P P & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

TIME MIN	SEC	T4-1	T4-2	T4-3	T4-4	T4-5	T4-6	T4-7	T4-8	T4-9	T4-10	T4-11	T4-12	T4-13	T4-14	T4-15	T4-16
0	0	78	88	81	79	78	78	78	93	78	78	78	78	79	82	96	79
3	15	78	88	81	79	78	78	78	94	78	79	79	80	79	82	97	79
6	0	79	88	81	83	78	82	82	94	81	81	81	88	84	82	97	84
9	14	95	88	93	108	83	95	98	96	96	96	93	114	105	84	98	109
12	0	109	89	117	134	92	118	112	96	101	114	117	144	133	91	99	155
15	13	118	89	146	168	115	139	115	95	126	118	147	173	175	107	100	168
18	0	131	89	163	186	144	163	120	95	132	147	180	192	186	125	100	174
21	13	141	90	176	193	172	181	162	96	143	176	192	197	189	143	100	187
24	0	174	90	181	198	181	189	182	96	168	189	196	200	193	154	113	198
27	3	191	91	187	192	194	195	192	97	185	197	199	202	197	162	101	210
30	16	198	92	189	202	198	200	199	97	189	200	201	204	200	167	101	227
33	0	201	92	187	203	201	222	214	96	191	210	209	215	201	169	101	240
36	13	199	92	186	208	203	243	228	96	198	218	221	264	186	171	106	261
39	0	197	94	187	213	206	249	237	97	204	226	237	292	204	173	102	279
42	14	204	94	185	229	216	274	264	96	221	240	300	313	219	174	102	301
45	0	213	97	188	252	234	300	286	97	248	273	334	349	261	177	104	325
48	14	234	98	194	274	255	329	313	99	266	301	371	385	287	179	106	352
51	0	258	99	201	290	273	357	339	99	284	324	408	416	304	184	105	374
54	14	284	100	207	309	298	392	369	98	306	350	466	465	323	187	107	401
57	0	307	101	223	326	328	421	397	97	337	379	484	479	340	189	108	427
60	14	332	101	246	351	362	458	434	97	381	416	513	480	365	191	108	456
63	0	360	102	264	374	391	494	470	96	435	463	544	496	388	192	108	482
66	14	388	103	274	404	433	536	530	97	481	518	567	534	447	197	109	519
69	0	208	103	283	423	453	514	464	93	401	495	574	547	467	204	111	401
72	14	204	103	295	437	460	502	428	93	399	460	578	560	477	209	112	365

P P & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

TIME MIN	SEC	AD1-1	AD1-2	AD1-3	AD1-4	AD1-5	AD1-6
0	0	80	80	82	82	83	87
3	15	101	84	83	84	84	87
6	0	114	90	84	97	92	87
9	14	149	112	126	127	111	88
12	0	171	143	172	151	126	88
15	13	192	171	211	186	146	88
18	0	210	192	225	215	165	89
21	13	209	197	232	243	179	90
24	0	212	199	229	238	186	91
27	3	236	205	226	247	196	92
30	16	264	213	229	269	193	93
33	0	241	226	231	278	231	81
36	13	312	251	240	308	242	86
39	0	329	281	252	312	259	98
42	14	352	307	265	327	273	99
45	0	372	326	281	343	288	103
48	14	394	341	301	361	302	106
51	0	418	380	319	377	315	108
54	14	450	416	338	396	331	111
57	0	471	434	352	411	344	113
60	14	496	458	373	429	359	116
63	0	518	476	390	443	371	118
66	14	466	492	407	430	384	121
69	0	408	473	255	285	325	126
72	14	366	450	303	313	301	131

P P & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

TIME MIN	SEC	AD2-1	AD2-2	AD2-3	AD2-4	AD2-5	AD2-6	AD2-7	AD2-8	AD2-9
0	0	80	81	82	81	81	85	97	97	96
3	15	82	83	84	82	81	85	98	98	96
6	0	85	96	92	91	82	85	99	100	96
9	14	91	140	113	120	83	85	101	101	97
12	0	103	174	136	148	86	86	100	100	97
15	13	127	207	178	169	94	86	97	97	97
18	0	140	210	192	182	107	87	98	98	84
21	13	159	207	199	191	121	88	99	99	98
24	0	146	209	205	199	131	89	101	100	97
27	3	181	215	208	207	141	91	101	101	98
30	16	186	228	212	218	161	93	97	98	119
33	0	189	236	213	245	151	96	98	98	97
36	13	227	247	214	204	143	77	61	75	116
39	0	196	261	217	298	162	100	96	99	96
42	14	208	275	226	326	164	101	95	99	96
45	0	223	292	246	350	169	105	97	97	97
48	14	250	315	278	377	174	107	97	98	98
51	0	272	342	297	395	178	109	97	97	97
54	14	295	376	315	418	184	111	96	96	97
57	0	315	410	332	441	192	113	95	95	96
60	14	351	452	353	463	201	114	95	94	95
63	0	368	487	371	481	211	116	94	92	93
66	14	370	260	394	501	228	119	91	89	91
69	0	322	203	229	479	237	124	91	87	89
72	14	305	190	248	442	233	128	93	89	91

P P & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK.........JB-3

TIME MIN	SEC	AD3-1	AD3-2	AD3-3	AD3-4	AD3-5	AD3-6
0	0	79	80	81	80	79	81
3	15	79	80	81	80	79	81
6	0	80	82	85	85	86	81
9	14	87	132	133	124	143	82
12	0	127	187	199	184	196	86
15	13	188	197	208	208	205	101
18	0	202	203	208	208	206	122
21	13	206	203	207	208	204	144
24	0	202	201	205	210	202	160
27	3	159	193	200	208	202	176
30	16	194	185	196	204	245	198
33	0	194	182	195	202	204	213
36	13	189	175	202	212	278	216
39	0	190	180	221	221	218	195
42	14	186	228	257	246	231	195
45	0	185	273	293	280	255	197
48	14	191	321	337	318	287	197
51	0	205	362	375	350	317	196
54	14	225	410	422	387	354	197
57	0	253	453	467	419	387	197
60	14	289	506	524	460	429	195
63	0	321	552	571	499	469	203
66	14	362	599	633	548	516	231
69	0	389	625	670	590	360	255
72	14	409	654	682	575	272	273

P P & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

TIME MIN	SEC	AD4-1	AD4-2	AD4-3	AD4-4	AD4-5	AD4-6
0	0	79	79	80	79	79	81
3	15	83	80	85	80	84	82
6	0	109	91	128	84	121	98
9	14	202	179	199	115	177	155
12	0	204	193	201	139	189	186
15	13	198	189	198	159	193	196
18	0	196	189	204	175	198	200
21	13	213	195	231	191	206	199
24	0	251	202	285	204	210	202
27	3	289	216	333	224	219	212
30	16	314	256	374	254	226	226
33	0	334	288	410	280	234	247
36	13	295	455	497	314	258	251
39	0	390	356	490	343	351	280
42	14	419	397	550	379	380	301
45	0	446	439	606	412	392	318
48	14	479	509	661	451	416	339
51	0	510	536	713	485	440	354
54	14	551	593	794	524	466	377
57	0	617	720	857	551	495	385
60	14	675	789	892	576	534	403
63	0	738	872	939	604	560	426
66	14	678	809	823	657	599	452
69	0	511	648	710	687	623	460
72	14	425	572	605	648	623	452

P P & L

TEST 1

DATE OF TEST...10 AUG 82   PROJECT NO::..01-7163-001
DATA FILE......PP&L3   DISK..........JB-3

TIME MIN	SEC	C1-1	C1-2	C1-3	C1-4	C1-5	C1-6	C1-7	C1-8	C1-9	C1-10	C1-11	C1-12	C1-13	C1-14	C1-15	C1-16	C1-17
0	0	90	84	79	79	78	78	78	78	78	79	78	78	78	78	79	82	87
3	15	91	85	80	79	78	78	78	78	78	79	78	78	78	78	79	82	87
6	0	91	85	80	79	78	78	78	78	78	79	78	78	78	79	80	82	87
9	14	92	85	81	79	78	78	79	80	79	79	78	78	79	80	82	82	88
12	0	92	85	82	79	78	78	80	83	80	80	79	78	82	83	86	82	88
15	13	92	85	84	79	79	79	83	89	83	81	81	79	88	89	91	83	89
18	0	91	85	86	80	79	81	88	95	88	57	85	81	94	95	92	84	89
21	13	92	85	89	81	79	84	93	104	95	86	89	84	103	104	105	85	90
24	0	92	86	91	82	80	88	98	111	102	89	94	88	111	111	112	87	90
27	3	91	86	95	85	82	93	103	118	109	94	99	92	117	119	120	89	90
30	16	90	86	98	87	84	98	120	124	115	100	104	98	123	125	127	91	91
33	0	90	86	126	90	86	116	113	130	121	105	108	103	127	131	134	93	91
36	13	87	87	105	93	90	105	119	138	128	112	102	110	131	142	140	95	90
39	0	90	87	107	97	92	111	124	143	133	117	119	115	139	145	150	98	92
42	14	89	87	110	100	96	116	130	150	140	123	125	121	146	153	159	101	92
45	0	89	90	117	106	101	122	138	160	149	132	133	129	154	163	169	106	94
48	14	90	91	123	111	106	129	146	170	157	140	141	136	163	172	180	110	95
51	0	89	92	129	117	110	135	153	179	164	148	147	143	171	181	189	114	96
54	14	87	93	137	122	115	142	161	189	172	157	155	151	181	191	198	120	96
57	0	86	95	144	128	120	151	169	199	179	164	163	158	189	200	208	124	97
60	14	86	97	155	137	125	160	178	210	187	176	172	166	200	212	214	131	98
63	0	85	98	165	145	129	168	186	219	195	187	180	174	210	222	220	137	98
66	14	88	101	176	157	137	177	196	233	205	195	190	185	223	234	231	146	100
69	0	88	104	181	163	141	181	203	240	210	202	197	190	230	242	238	152	102
72	14	86	107	186	169	148	185	209	246	214	210	205	195	236	248	251	159	103

P P & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

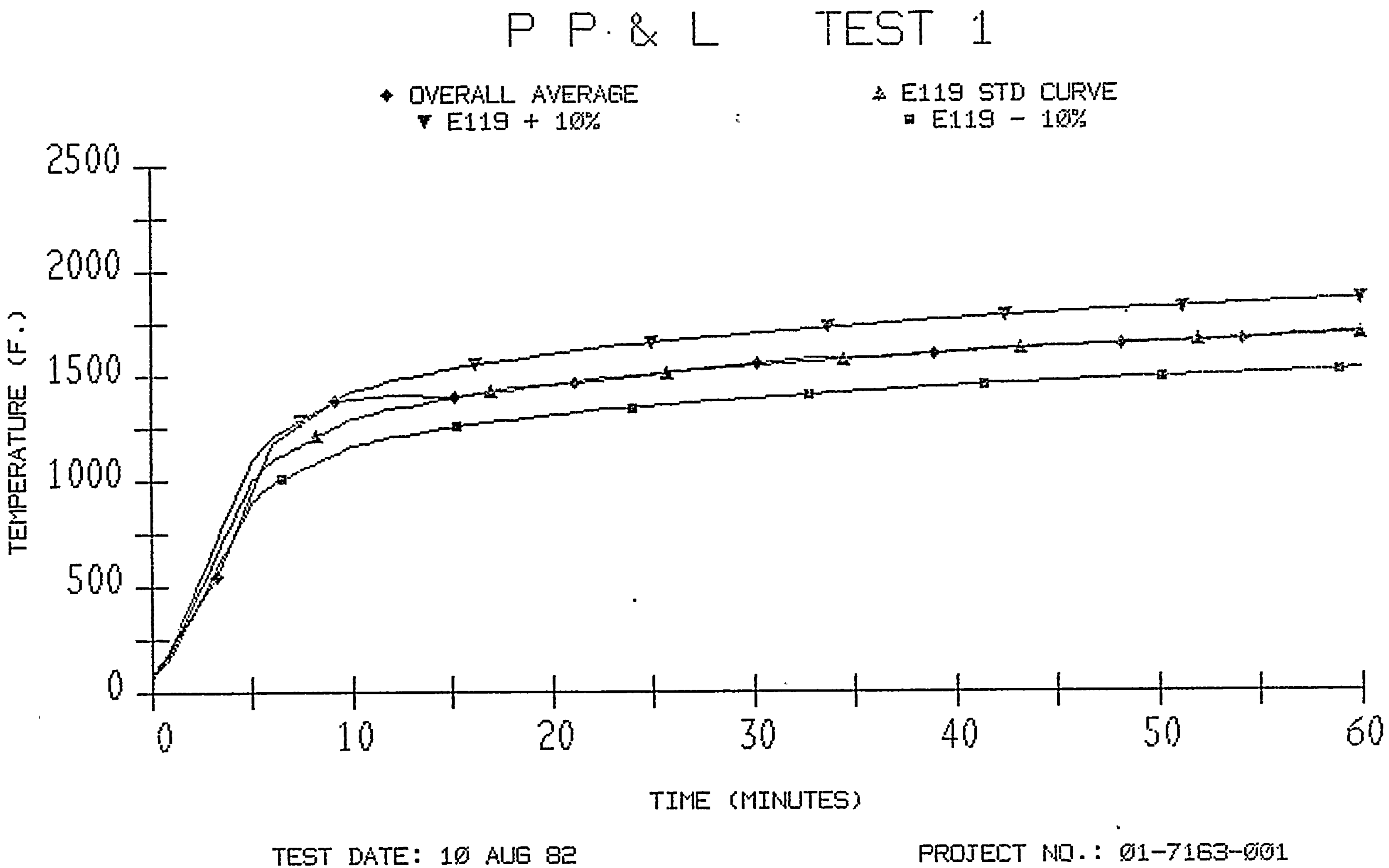
TIME MIN	SEC	E1-2	E2-4	E3-3	E4-4	E5-3	E6-2	E7-1	E8-3	E9-1	ES-3	ES-5
0	0	79	78	78	79	76	81	79	80	79	80	77
3	15	80	80	78	79	111	82	80	81	92	88	155
6	0	90	87	79	86	158	91	88	90	127	117	243
9	14	123	99	94	117	201	126	118	139	161	146	403
12	0	158	112	116	177	258	175	152	197	195	178	593
15	13	161	117	116	189	331	164	164	190	179	193	865
18	0	165	135	128	190	490	168	165	186	181	199	1122
21	13	185	148	151	201	685	171	171	182	185	210	1468
24	0	197	163	168	201	733	189	174	186	192	213	1552
27	3	202	176	181	200	667	214	182	205	196	242	1516
30	16	213	188	186	207	606	238	188	233	199	270	1411
33	0	264	199	190	222	567	255	188	253	206	289	1363
36	13	311	211	198	350	513	276	190	273	286	304	1339
39	0	345	221	205	419	495	300	195	295	317	323	1324
42	14	381	239	225	526	468	325	198	319	382	344	1315
45	0	408	257	242	597	454	349	201	338	429	363	1275
48	14	430	276	258	656	433	376	204	359	478	420	1293
51	0	485	295	277	697	426	398	220	399	514	462	1303
54	14	551	311	303	751	417	426	376	461	556	511	1307
57	0	601	325	334	792	418	452	519	514	593	547	1323
60	14	658	340	387	861	425	485	654	570	635	582	1352
63	0	694	354	417	886	433	515	677	602	681	595	1341
66	14	152	352	210	847	424	246	169	582	736	570	396
69	0	131	317	182	734	303	262	212	198	626	499	168
72	14	120	289	174	649	256	219	205	171	551	412	197

P P & L

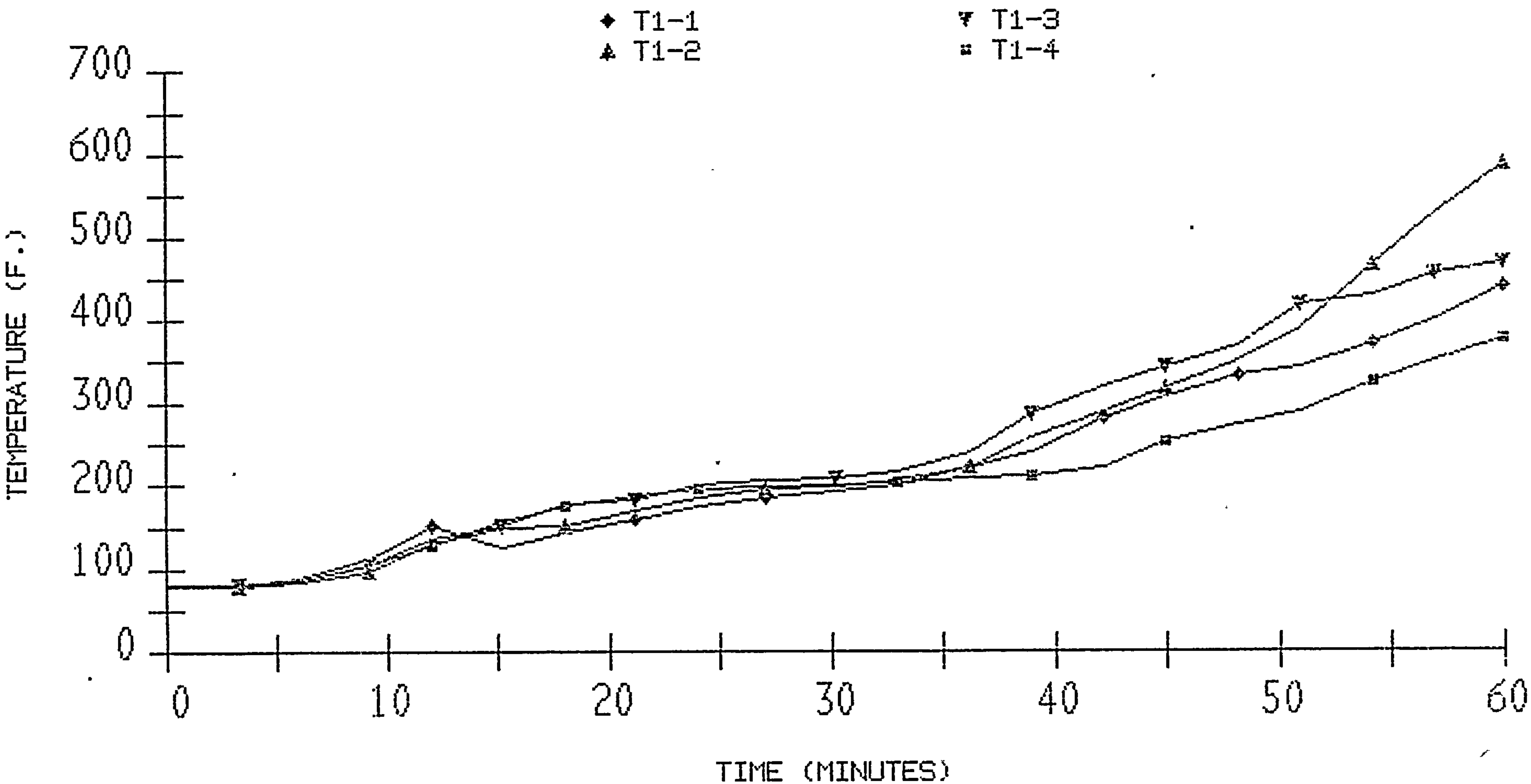
TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

TIME MIN	SEC	TOP AVG	BOT AVG	OVERALLAVG
0	0	88	79	79
3	15	91	429	551
6	0	92	878	1180
9	14	93	1125	1387
12	0	94	1174	1413
15	13	92	1188	1403
18	0	92	1224	1447
21	13	94	1259	1472
24	0	95	1308	1498
27	3	1425	1325	1530
30	16	1449	1366	1561
33	0	1472	1410	1586
36	13	1569	1436	1589
39	0	1549	1481	1609
42	14	1572	1521	1631
45	0	1586	1551	1640
48	14	1607	1578	1655
51	0	1624	1585	1663
54	14	1644	1595	1673
57	0	1657	1622	1696
60	14	1677	1653	1706
63	0	0	0	0
66	14	0	0	0
69	0	0	0	0
72	14	0	0	0

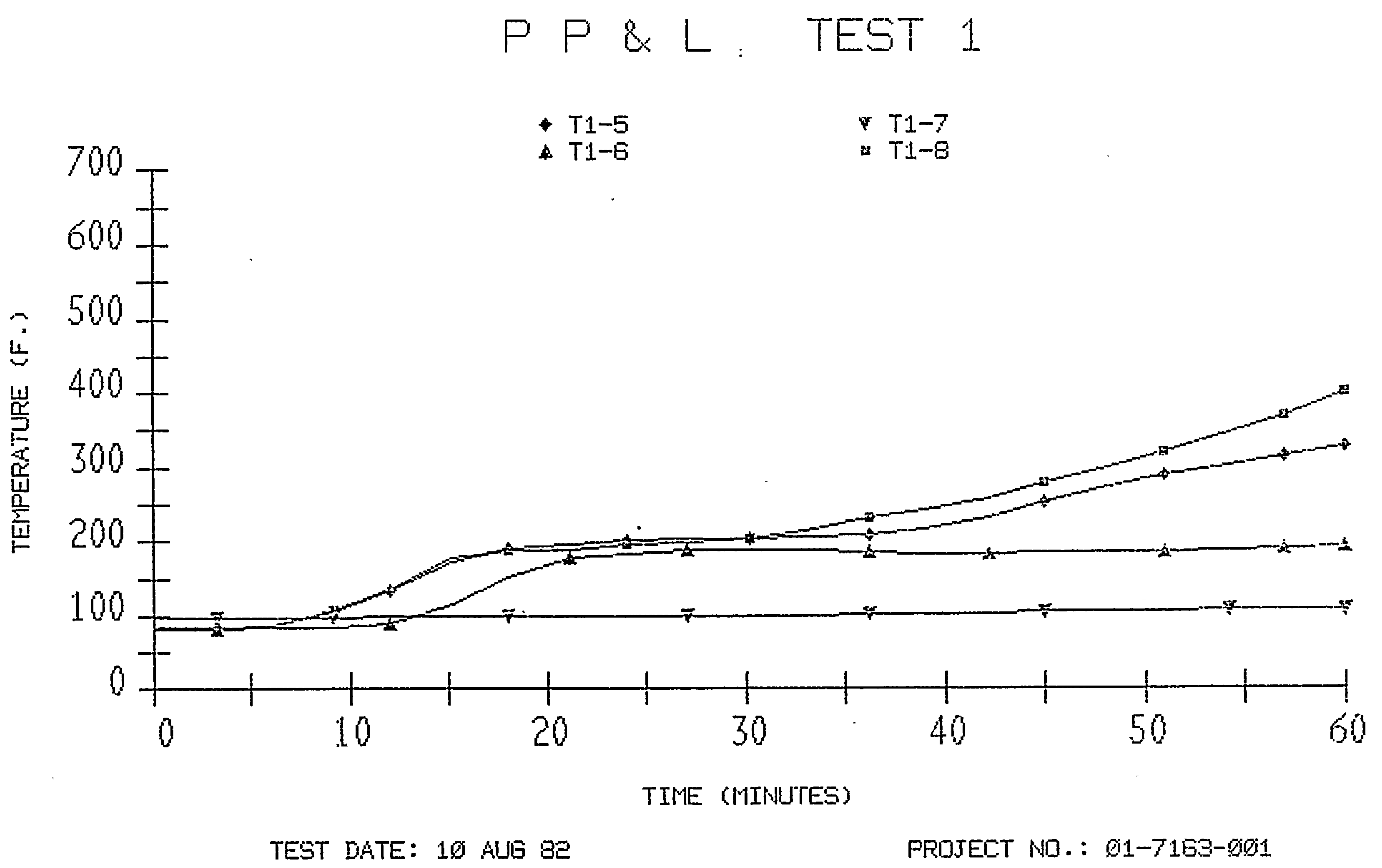

P P & L TEST 1
OVERALL AVERAGE
E119 + 10%
E119 STD CURVE
E119 - 10%
2500
2000
1500
1000
500
0
TEMPERATURE (F.)
0
10
20
30
40
50
60
TIME (MINUTES)
TEST DATE: 10 AUG 82
PROJECT NO.: 01-7163-001

P P & L TEST 1

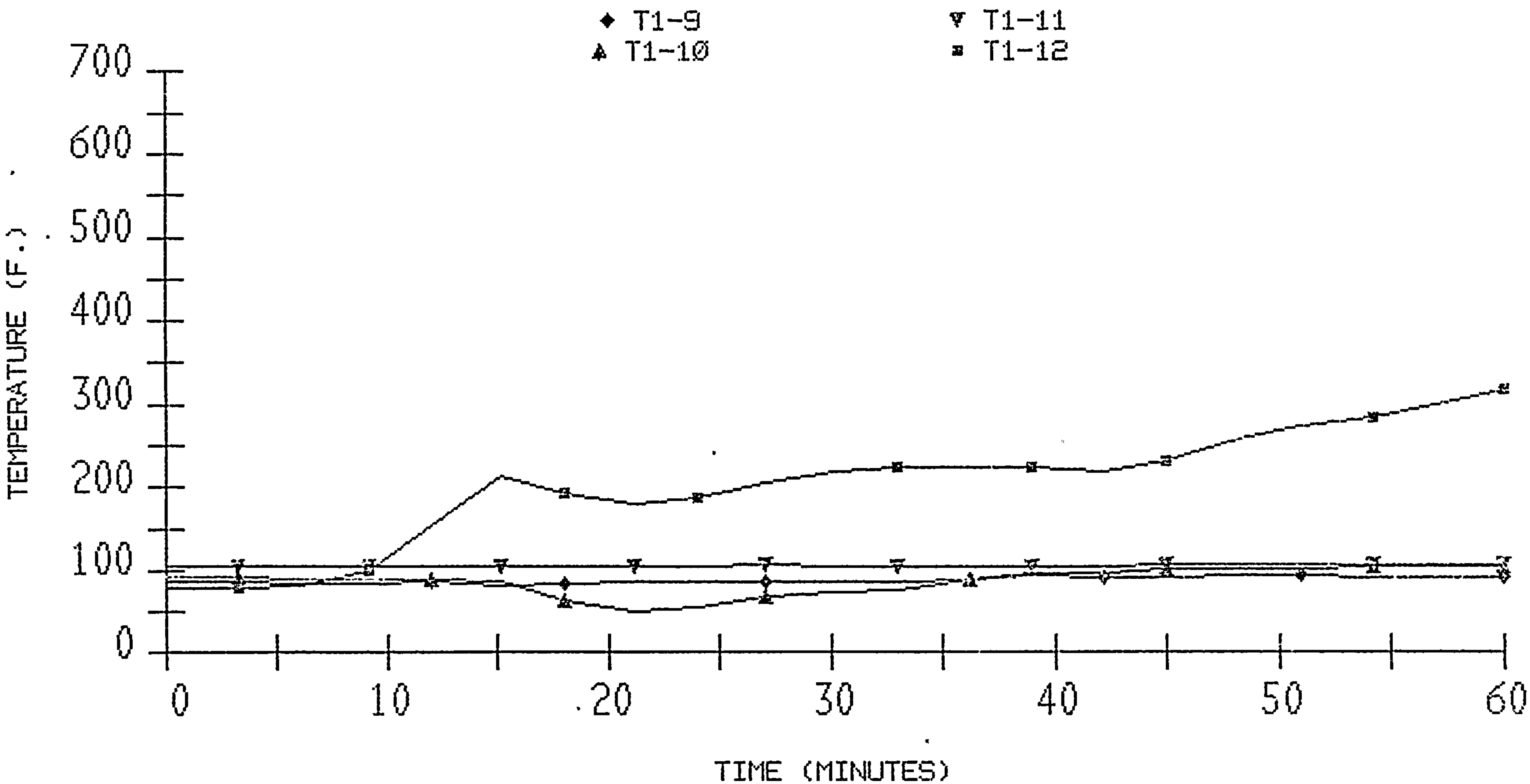


TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001


P P & L. TEST 1
T1-5
T1-6
T1-7
T1-8
TEMPERATURE (F.)
700
600
500
400
300
200
100
0
0
10
20
30
40
50
60
TIME (MINUTES)
TEST DATE: 10 AUG 82
PROJECT NO.: 01-7163-001

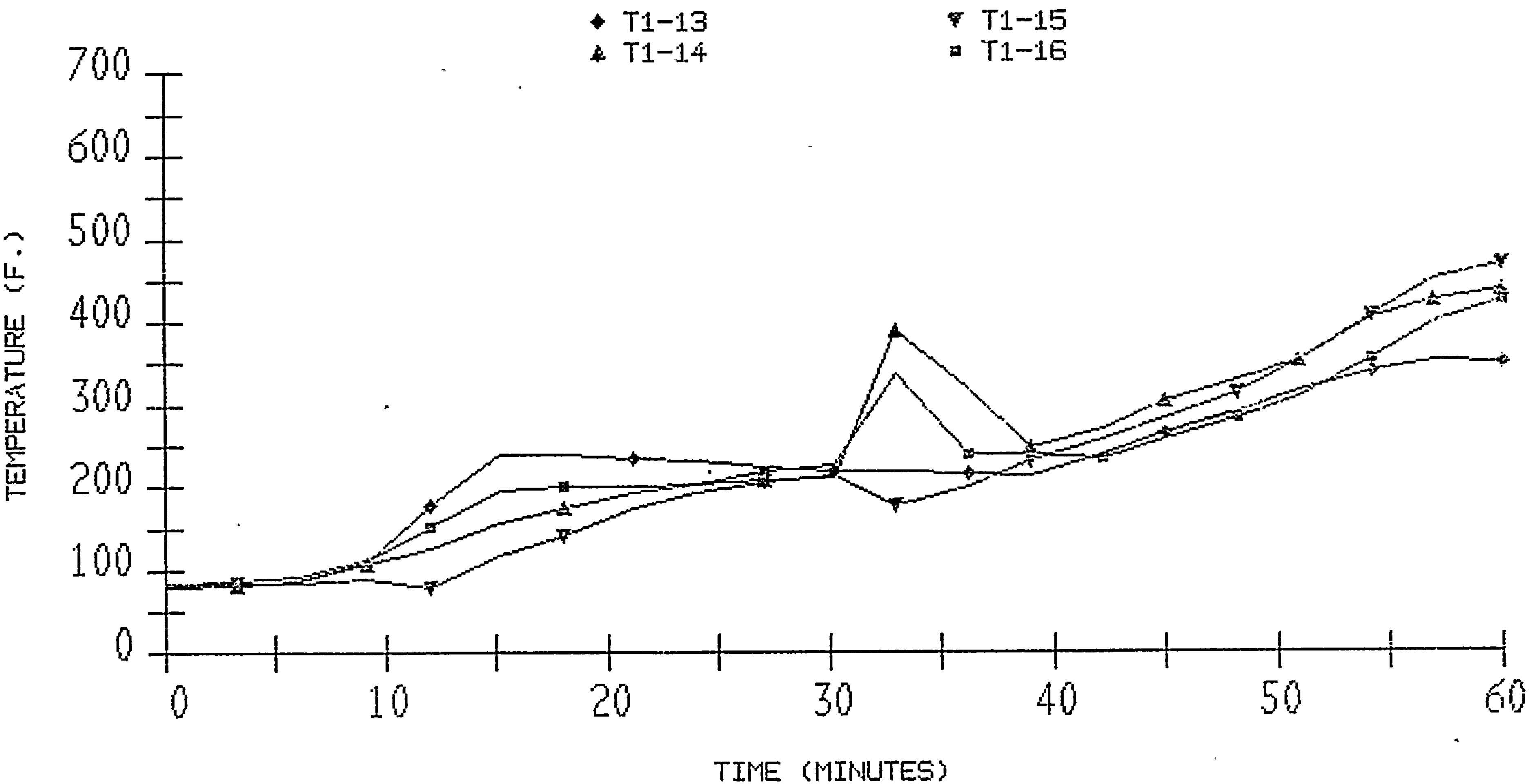
P P & L : TEST 1



TEST DATE: 10 AUG 82

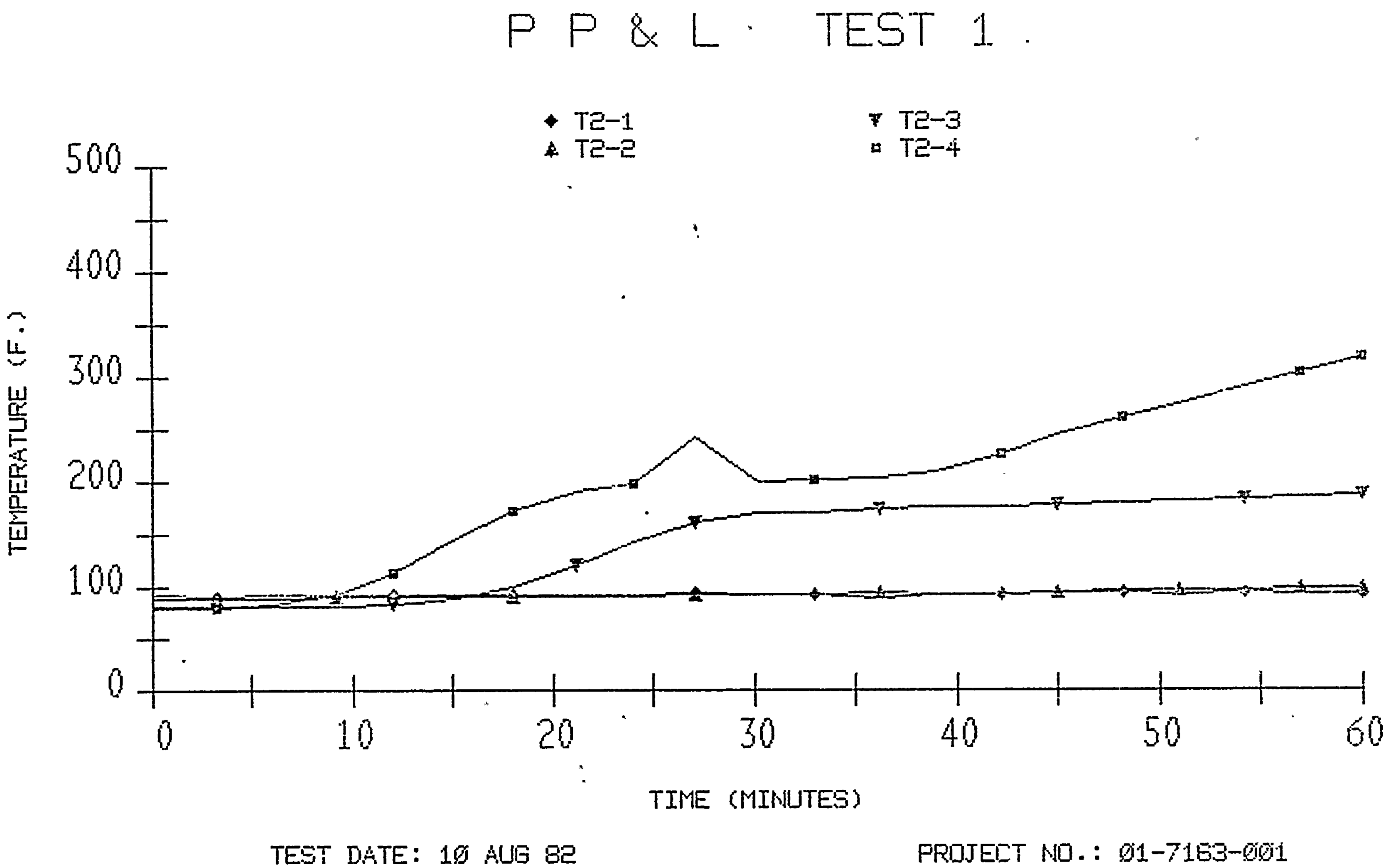
PROJECT NO.: 01-7163-001

P P & L. TEST 1

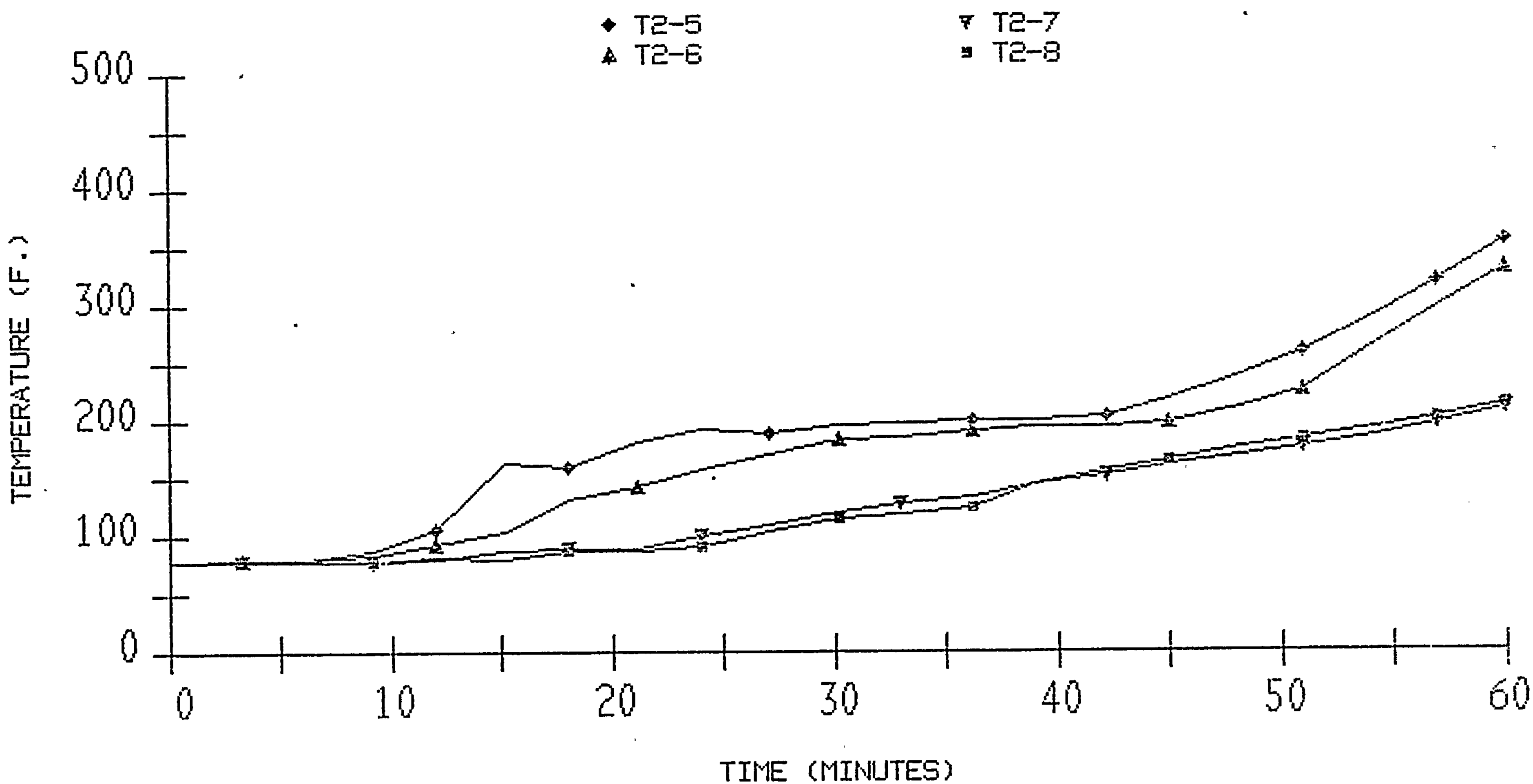


TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001


P P & L TEST 1
T2-1
T2-2
T2-3
T2-4
TEMPERATURE (F.)
500
400
300
200
100
0
0
10
20
30
40
50
60
TIME (MINUTES)
TEST DATE: 10 AUG 82
PROJECT NO.: 01-7163-001

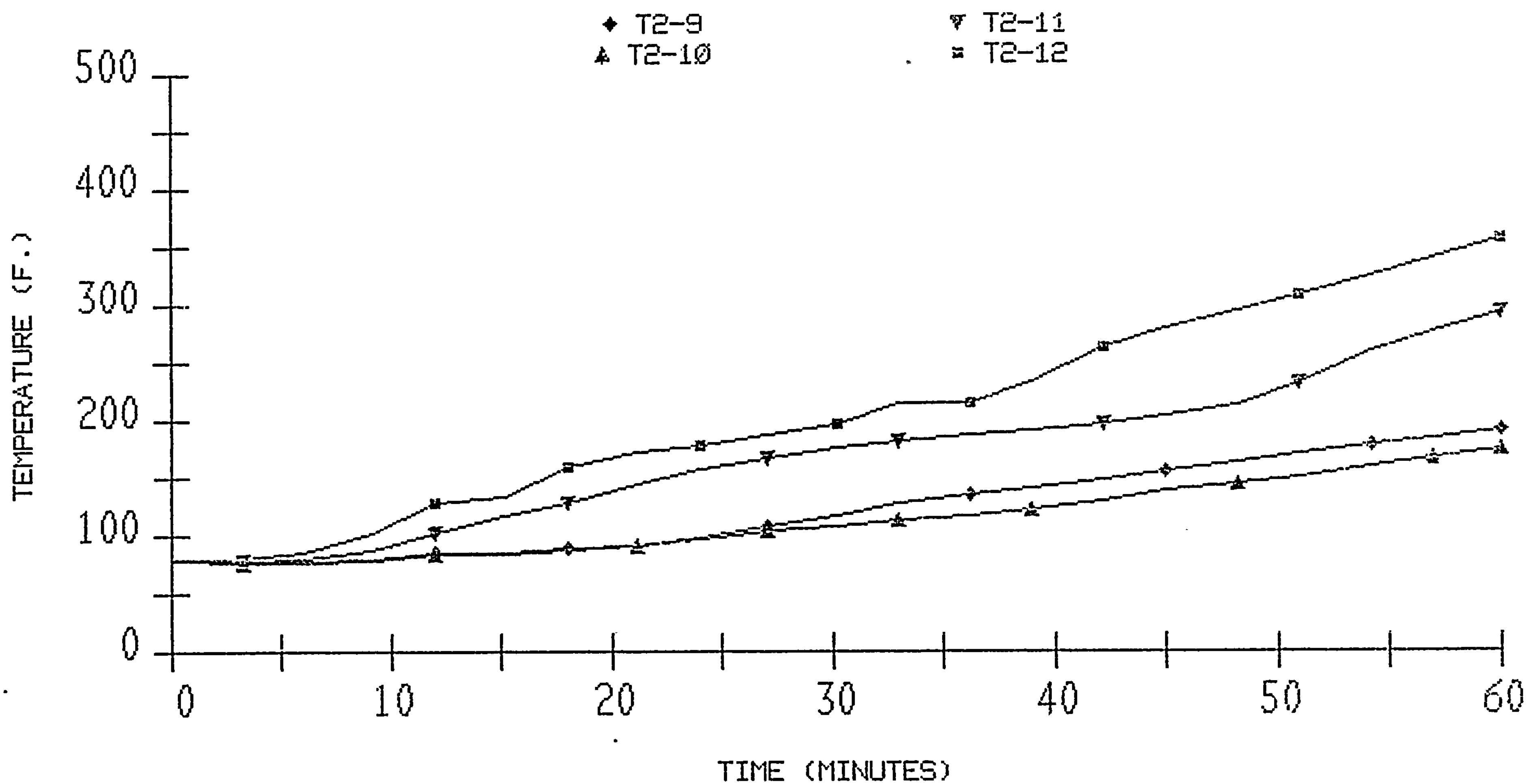
P P & L. TEST 1



TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001

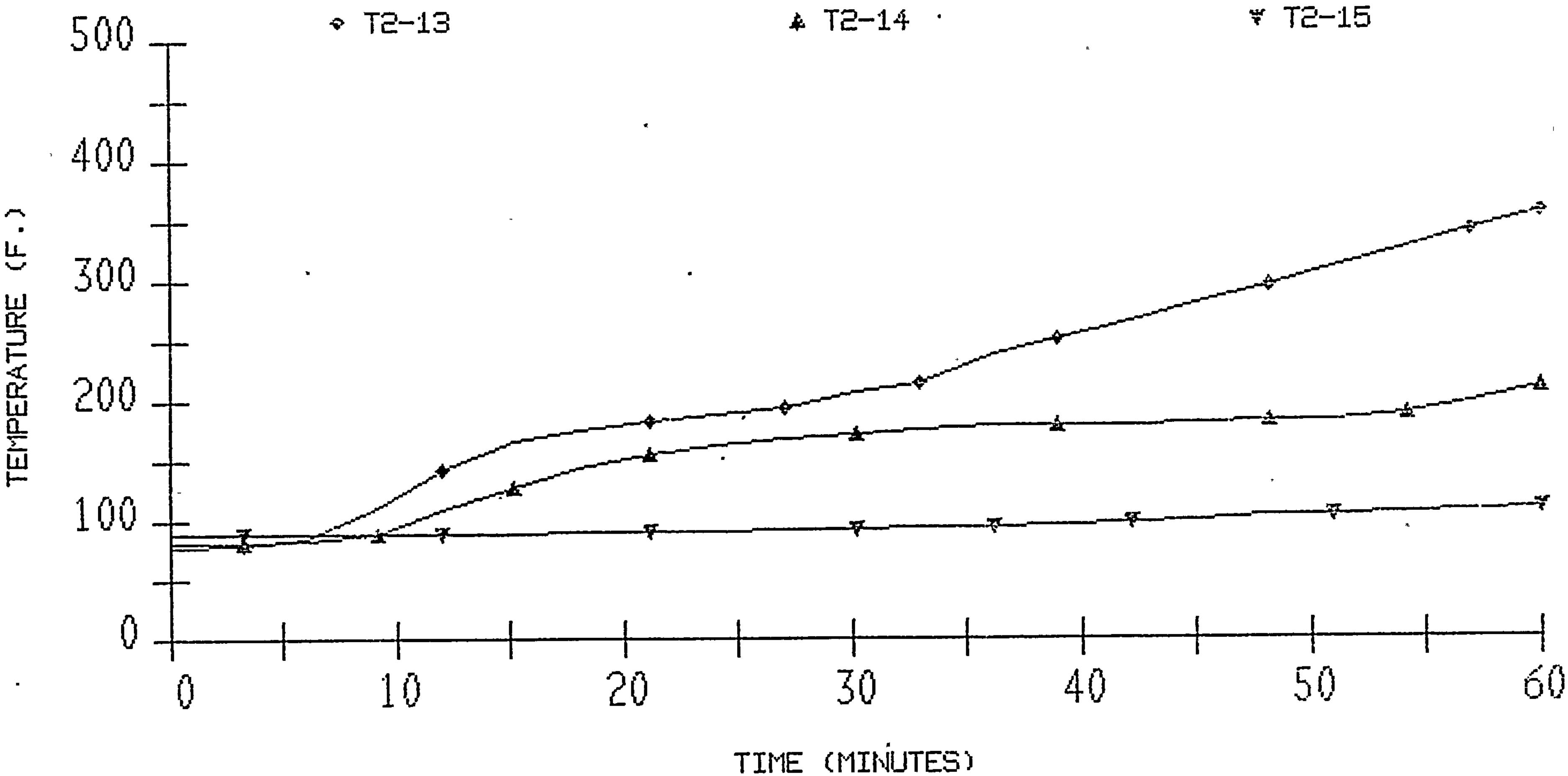
P P & L. TEST 1



TEST DATE: 1Ø AUG 82

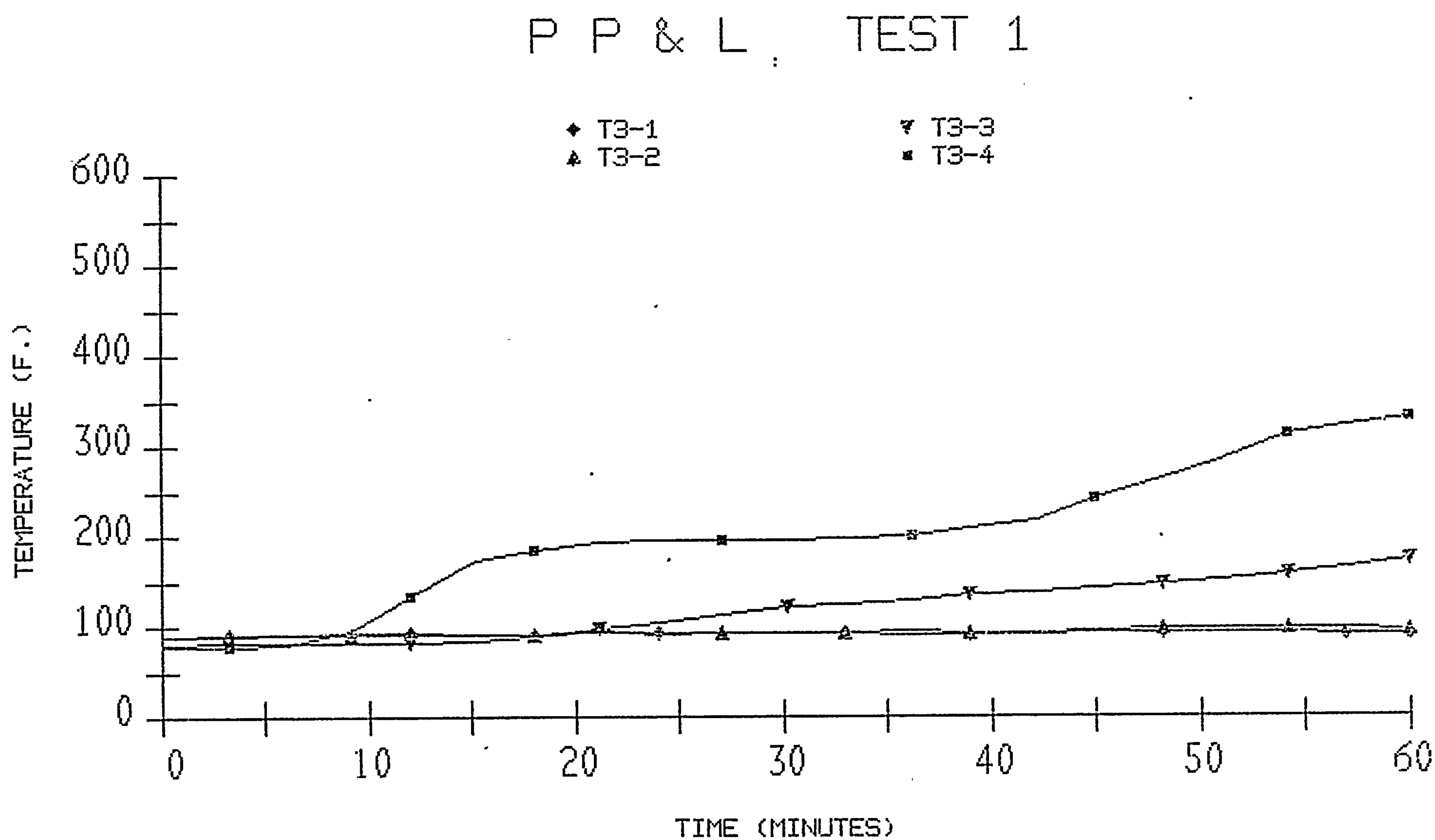
PROJECT NO.: Ø1-7163-ØØ1

P P & L. TEST 1



TEST DATE: 10 AUG 82

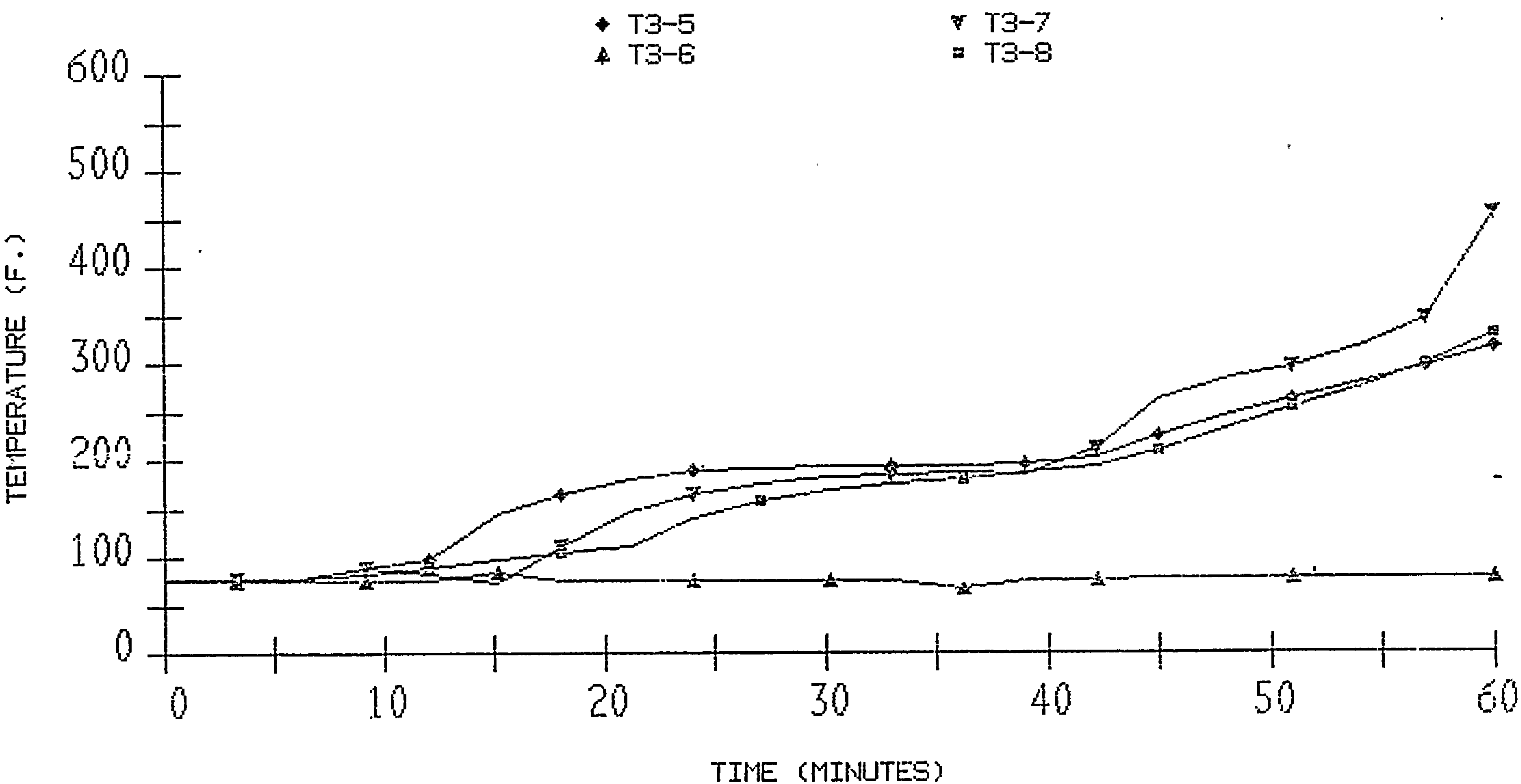
PROJECT NO.: 01-7163-001



TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001

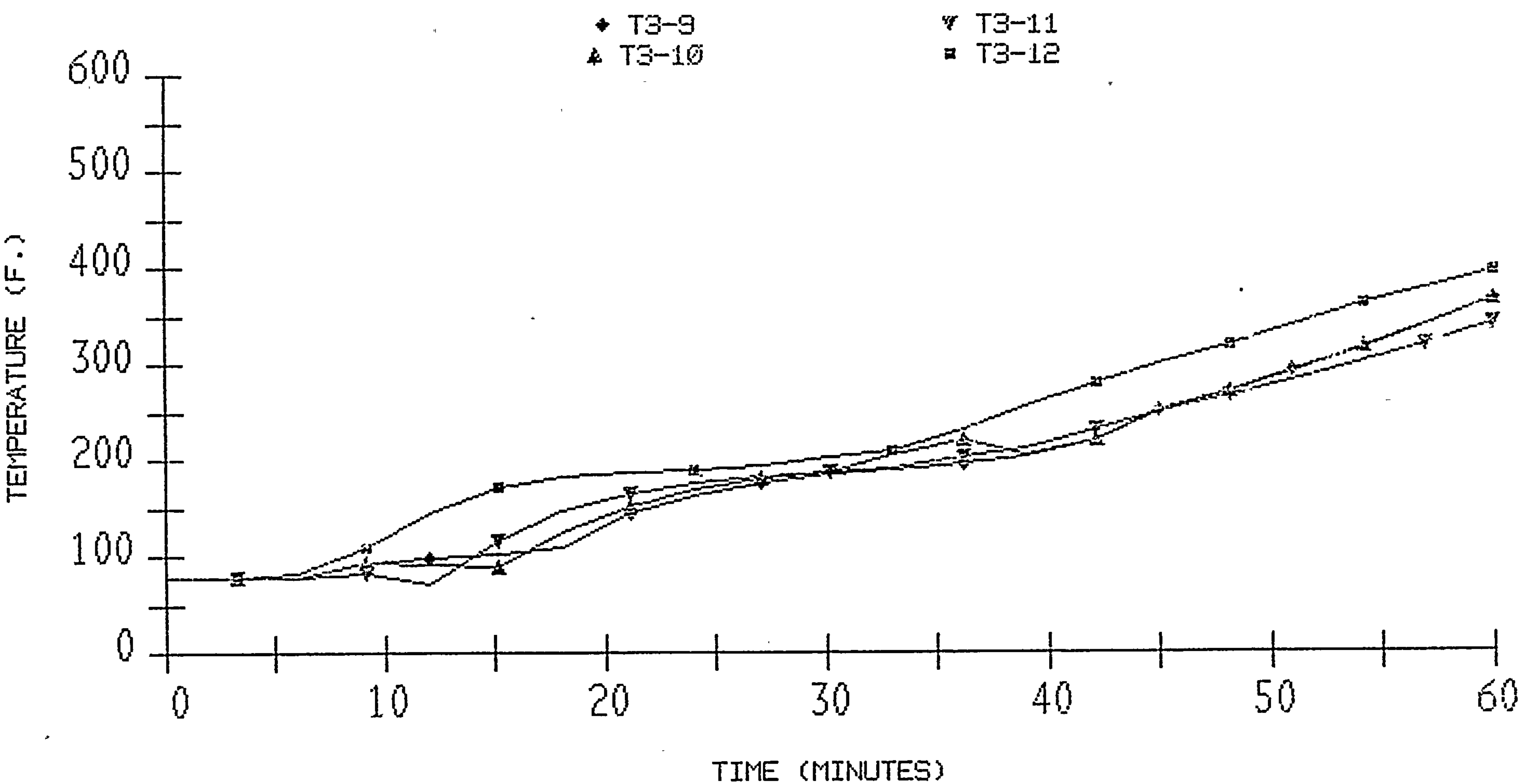
P P & L. TEST 1



TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001

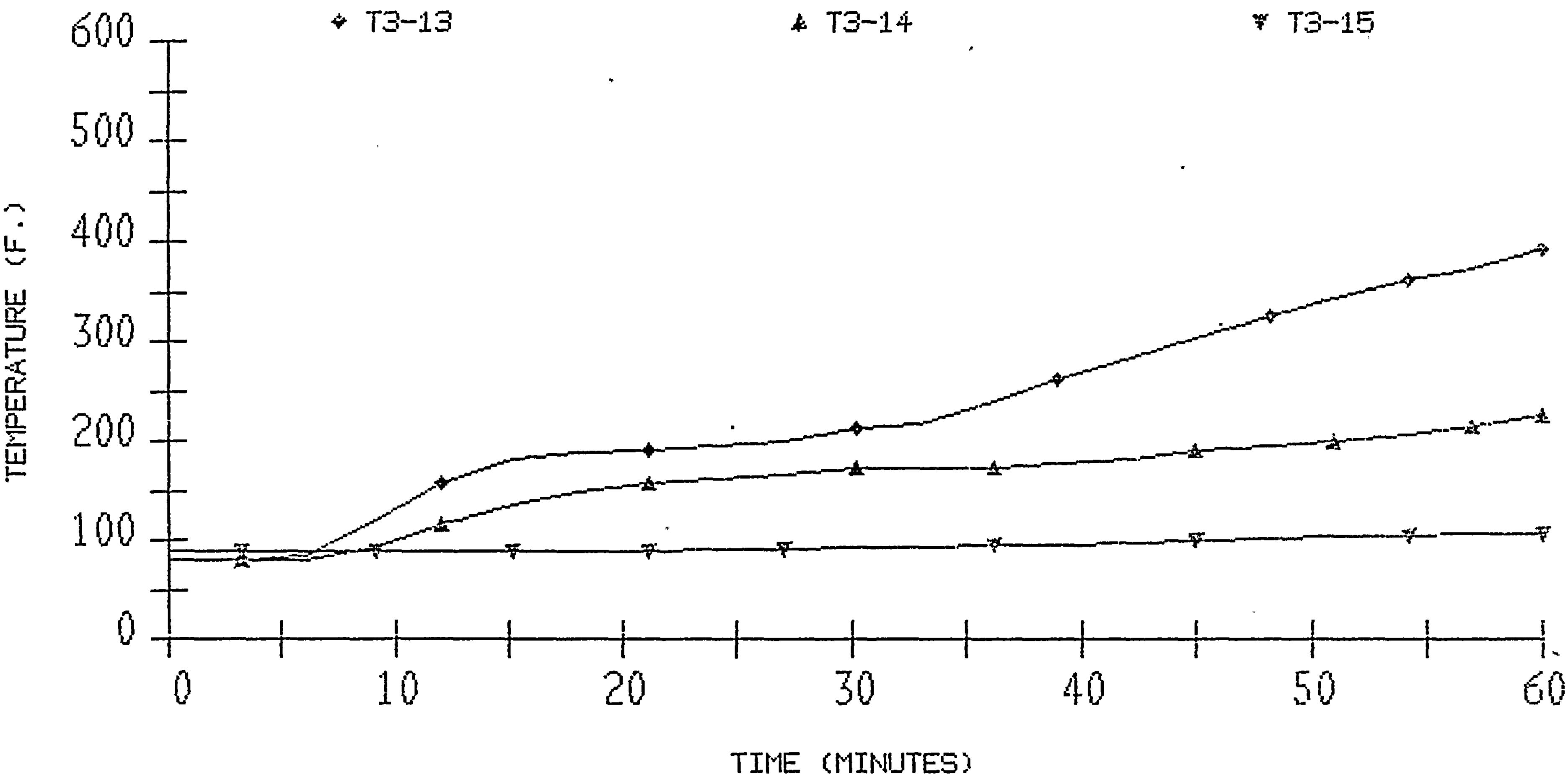
P P & L. TEST 1



TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001

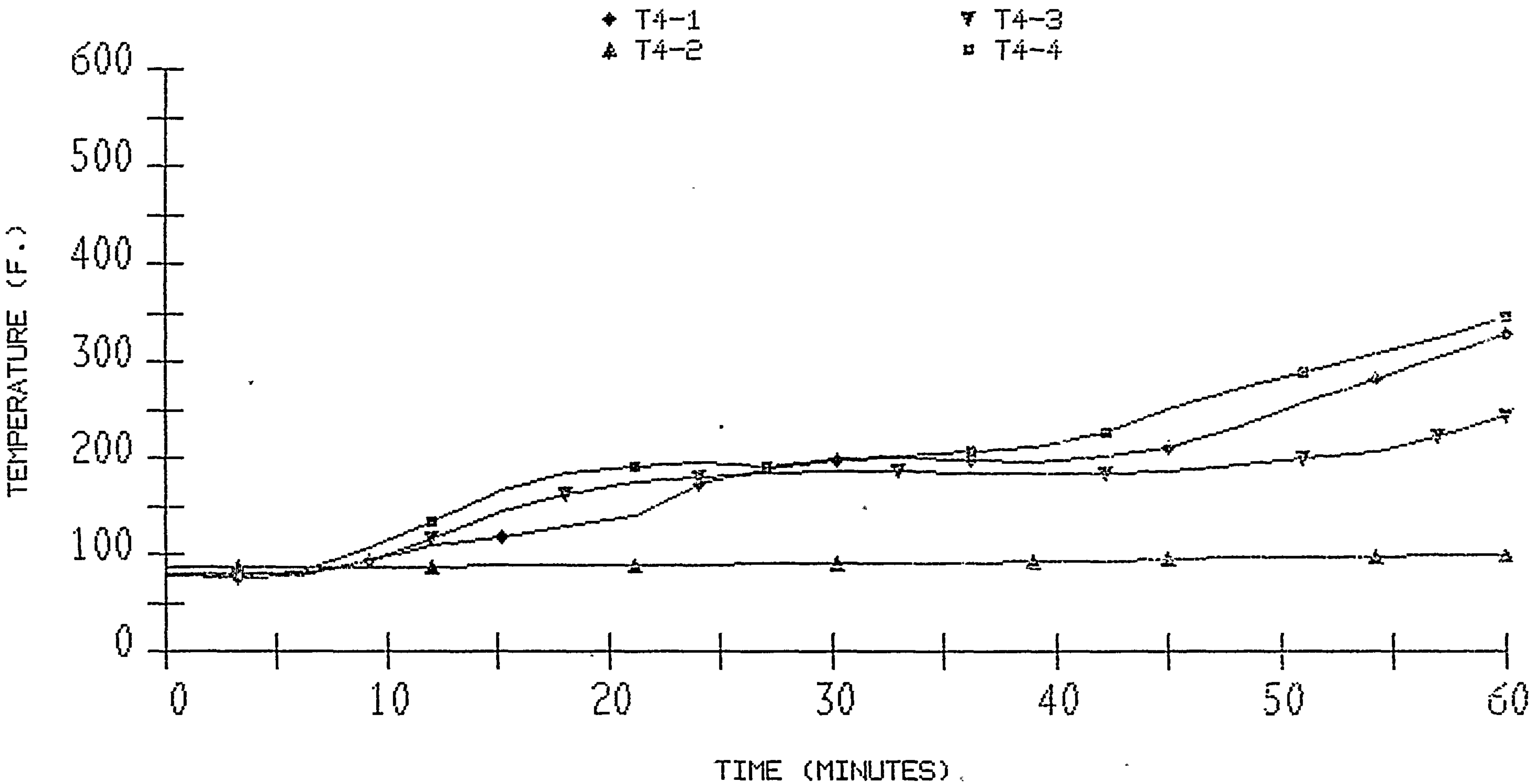
P P & L : TEST 1



TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001

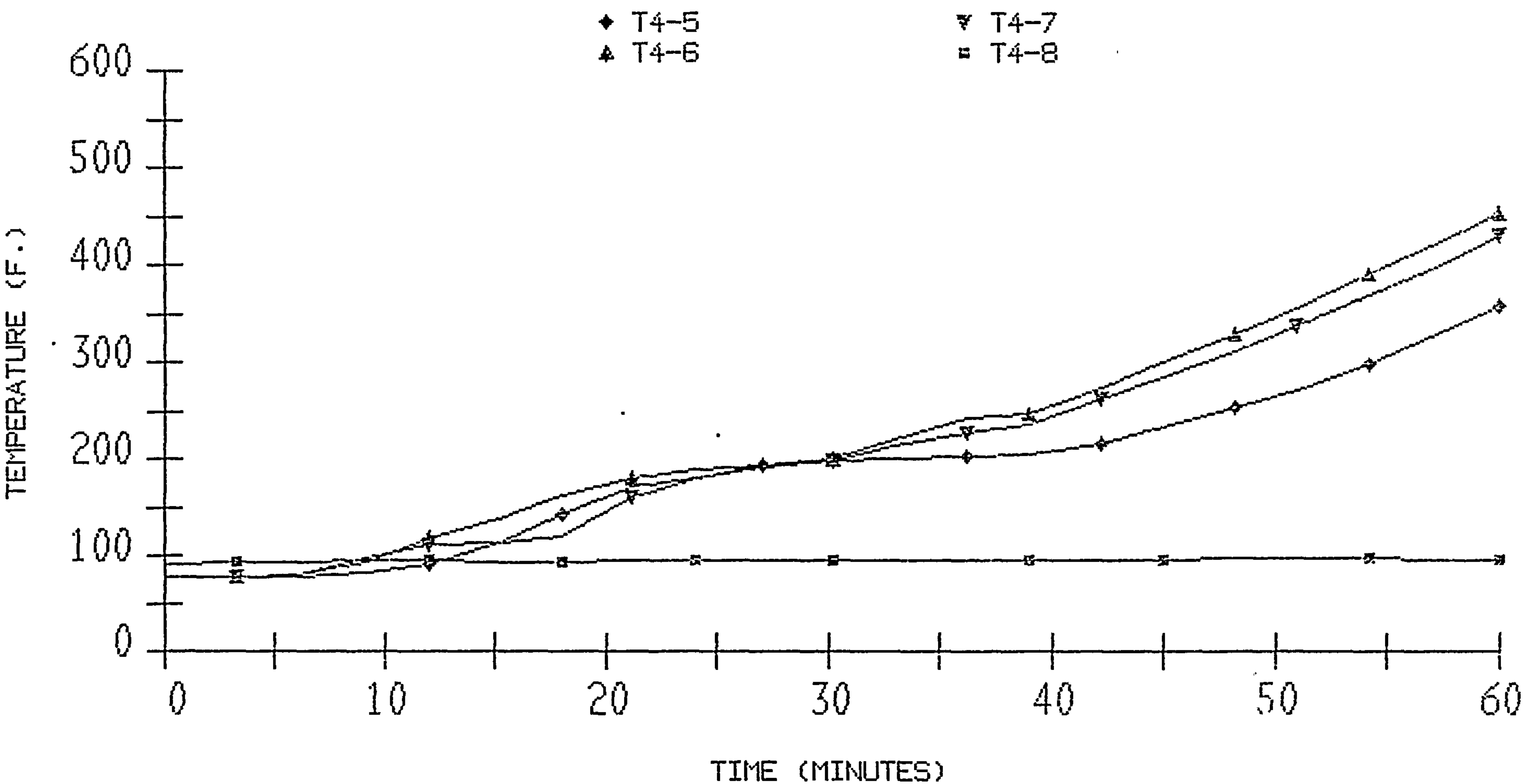
P P & L. TEST 1



TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001

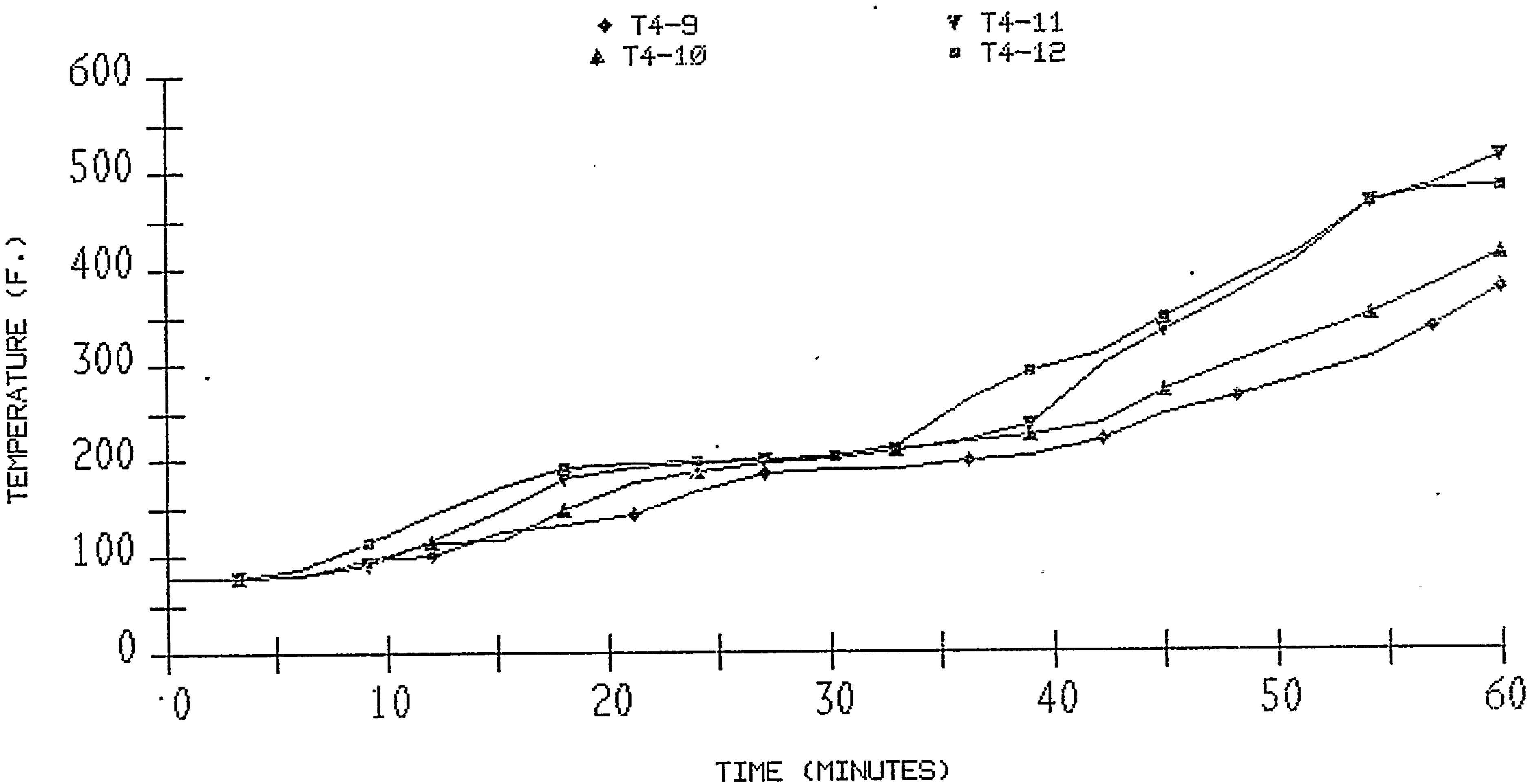
P P & L TEST 1



TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001

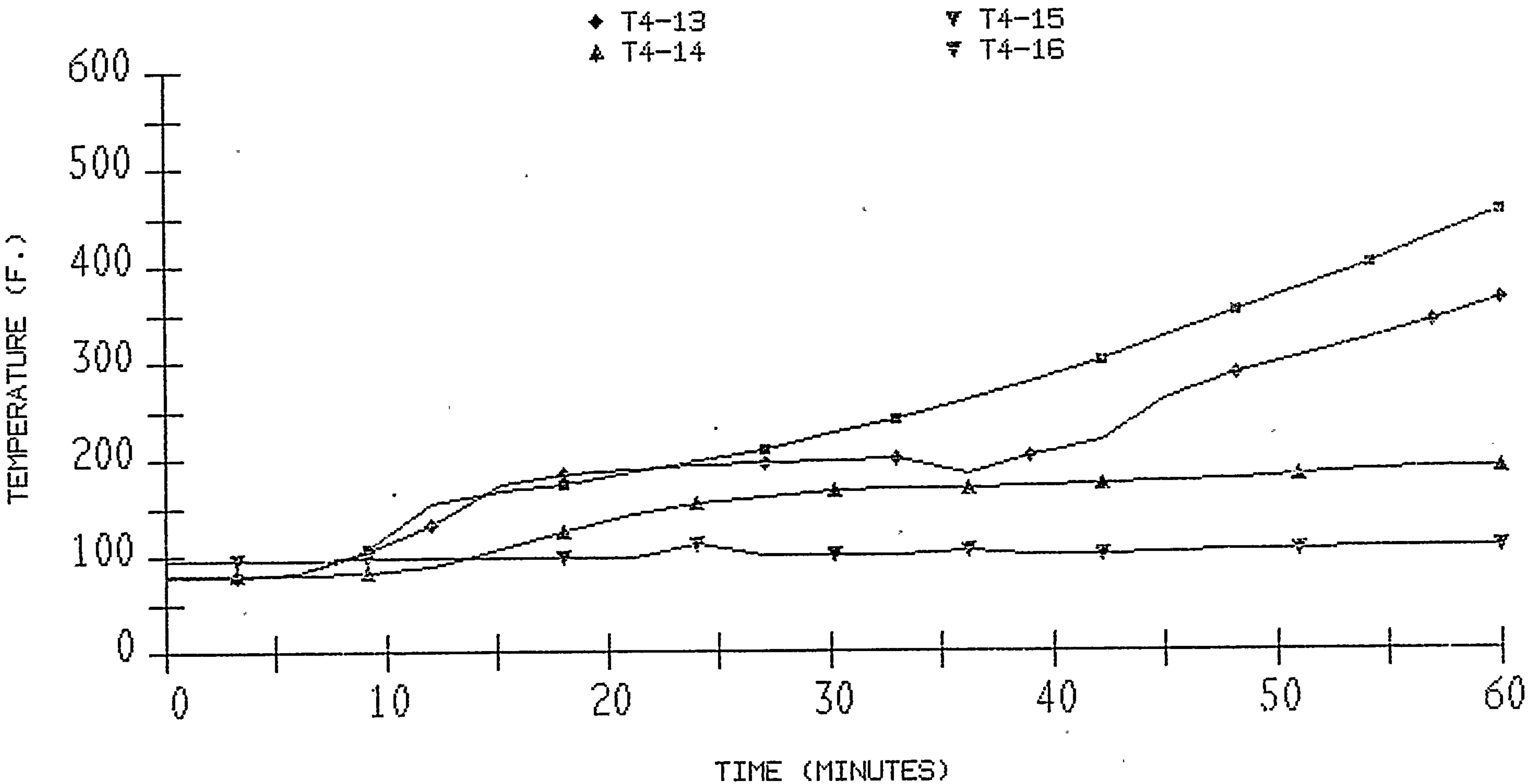
P P & L : TEST 1



TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001

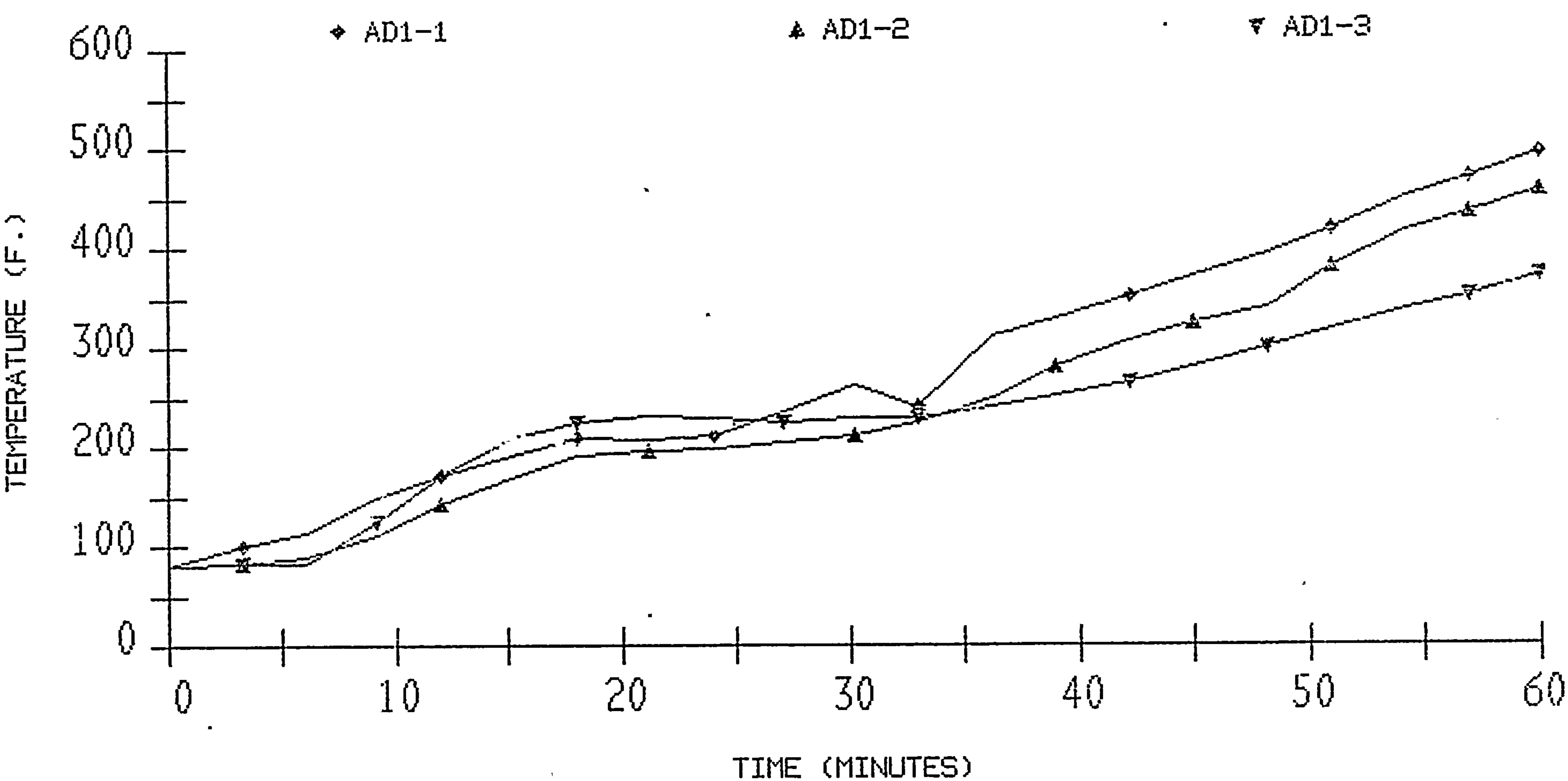
P P & L TEST 1



TEST DATE: 1Ø AUG 82

PROJECT NO.: Ø1-7163-ØØ1

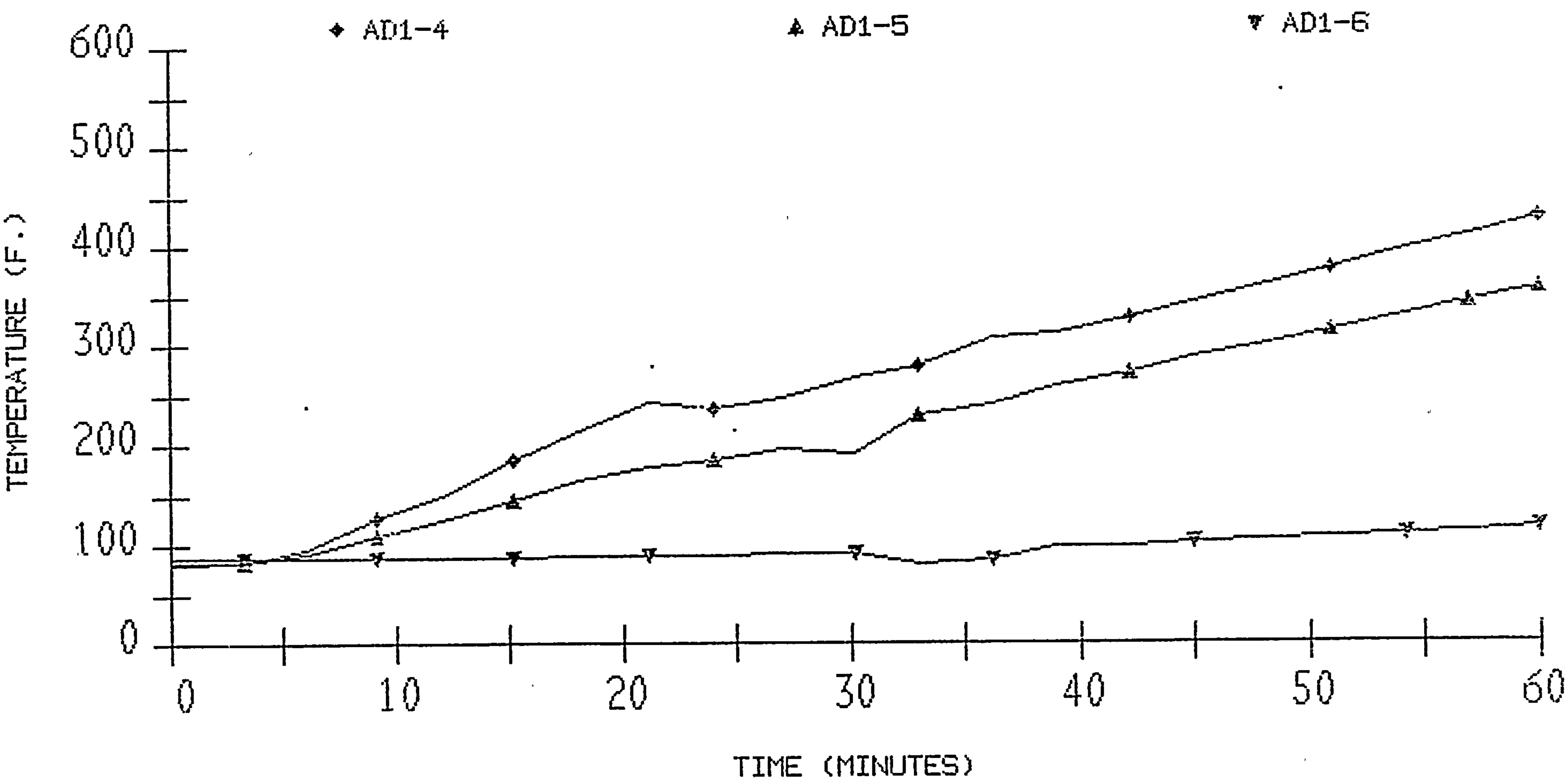
P P & L : TEST 1



TEST DATE: 1Ø AUG 82

PROJECT NO.: Ø1-7163-ØØ1

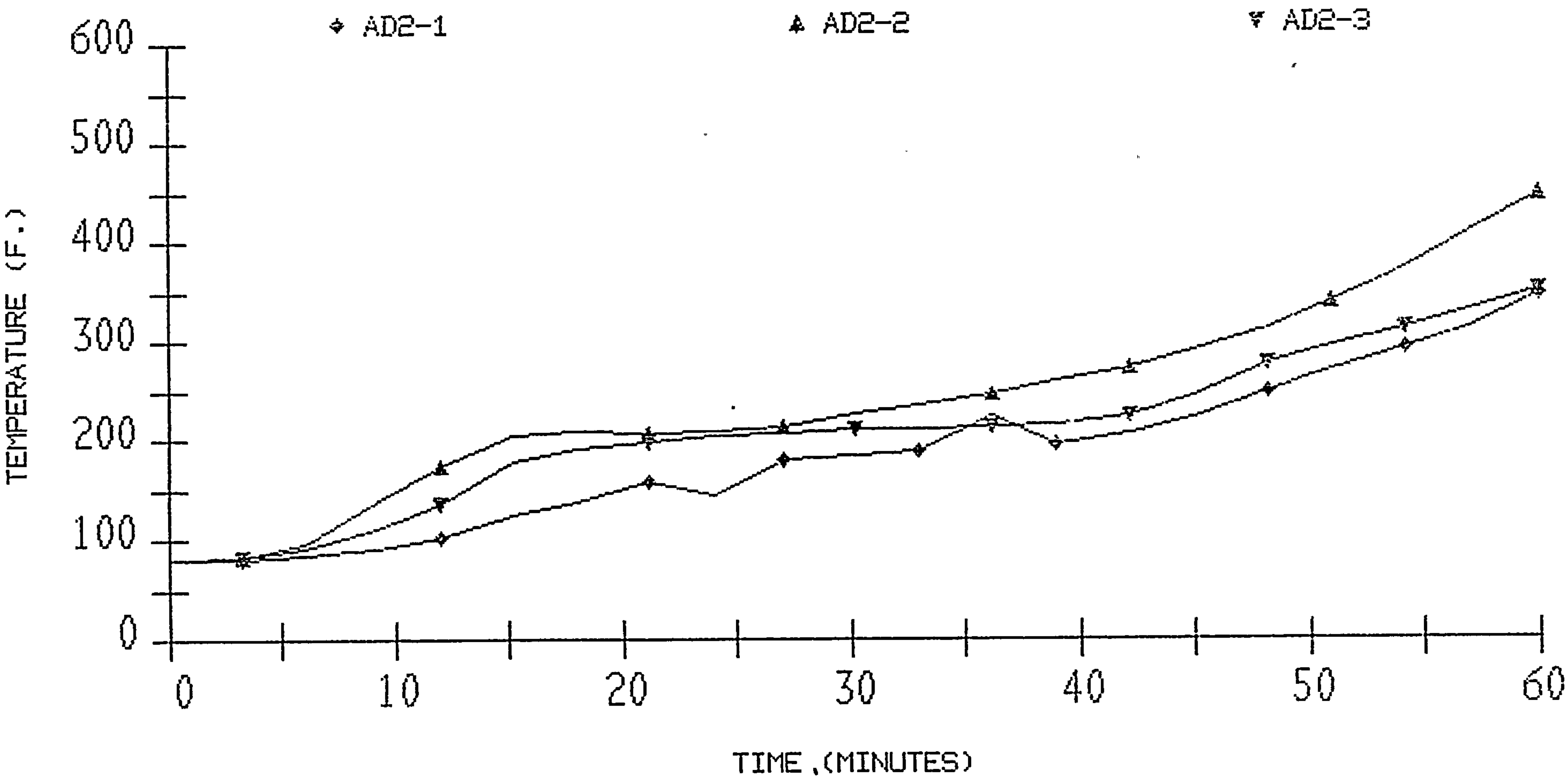
P P & L TEST 1



TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001

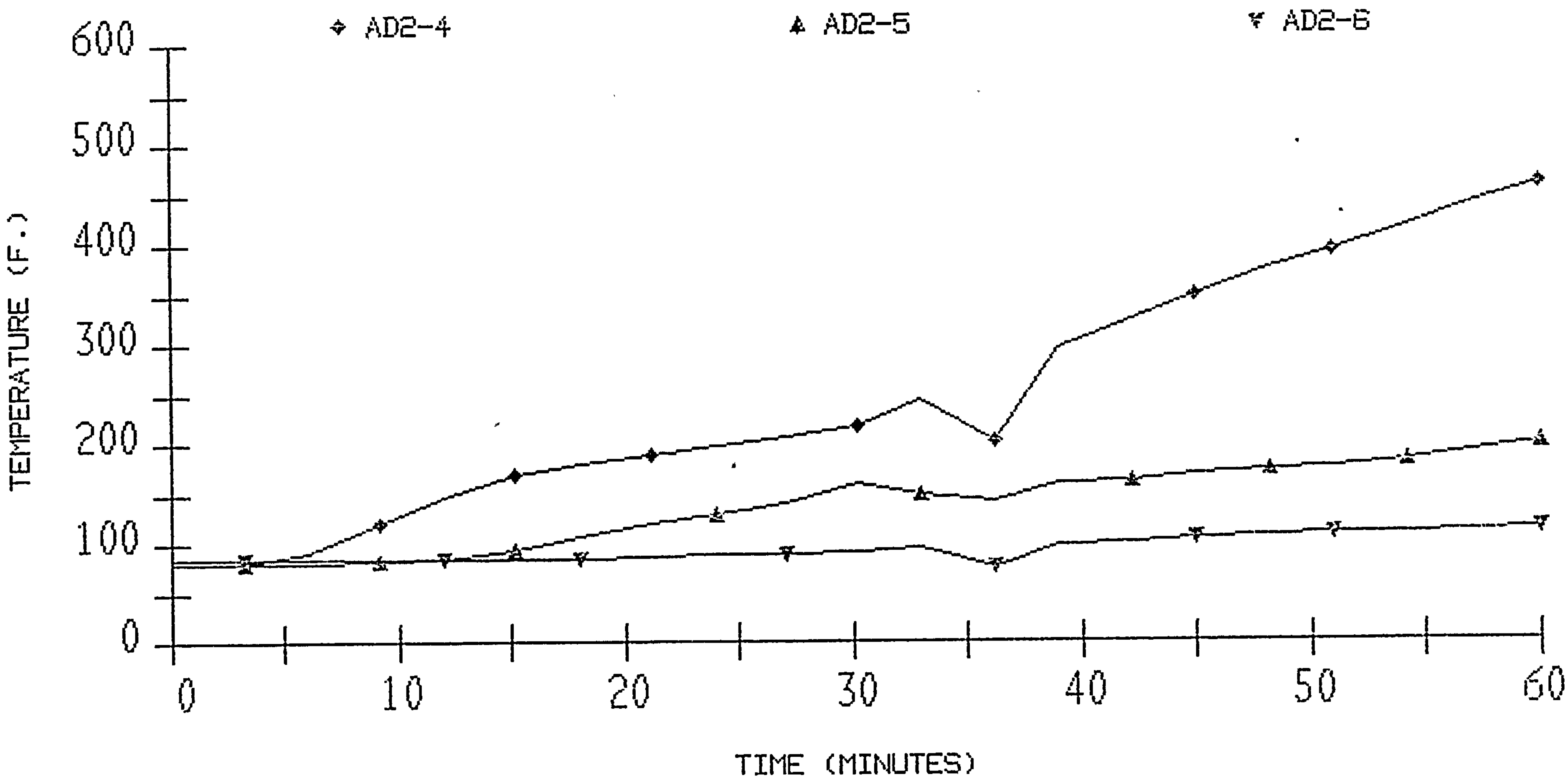
P P & L TEST 1



TEST DATE: 1Ø AUG 82

PROJECT NO.: Ø1-7163-ØØ1

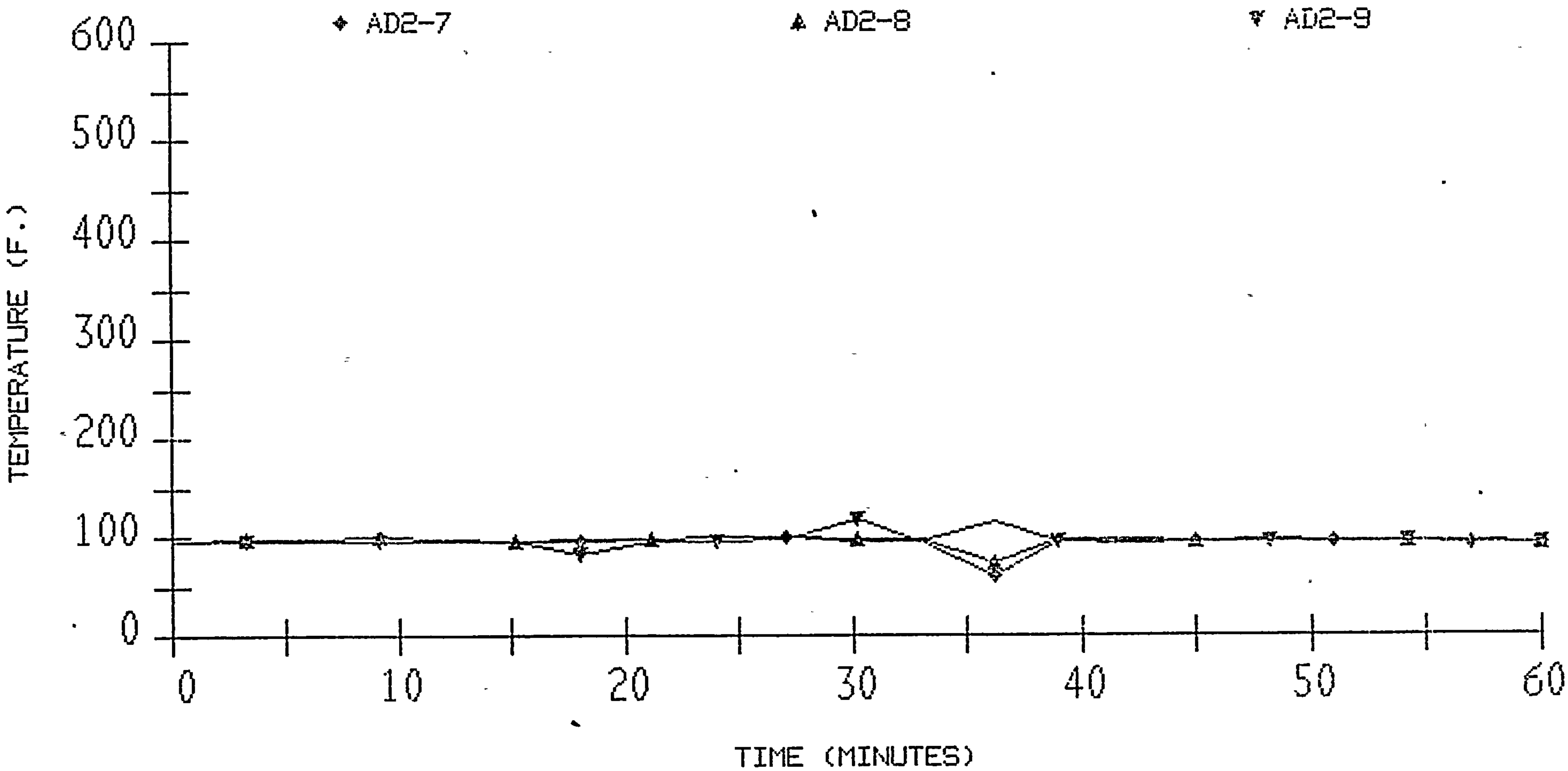
P P & L TEST 1



TEST DATE: 1Ø AUG 82

PROJECT NO.: Ø1-7163-ØØ1

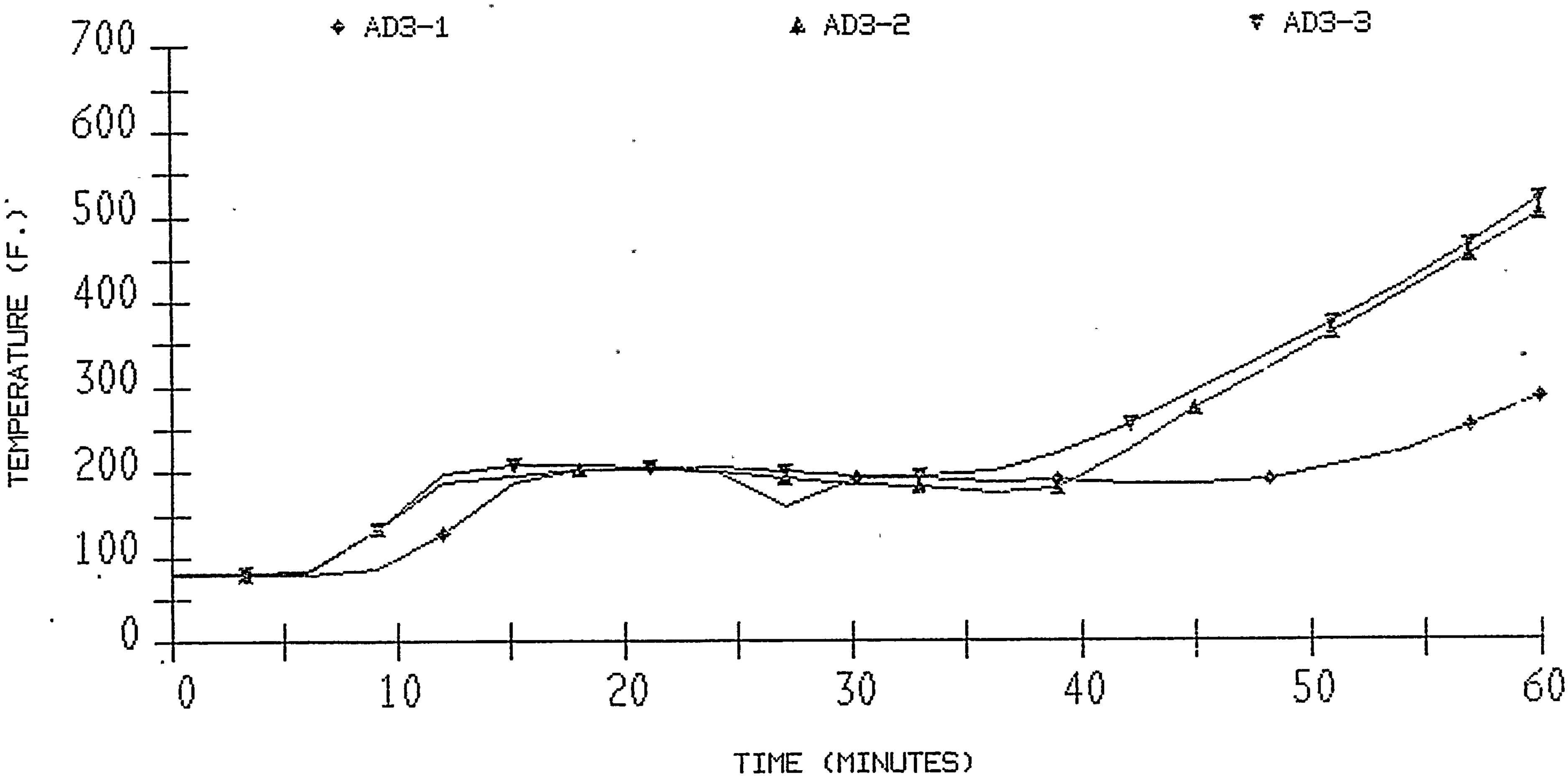
P P & L TEST 1



TEST DATE: 10 AUG 82

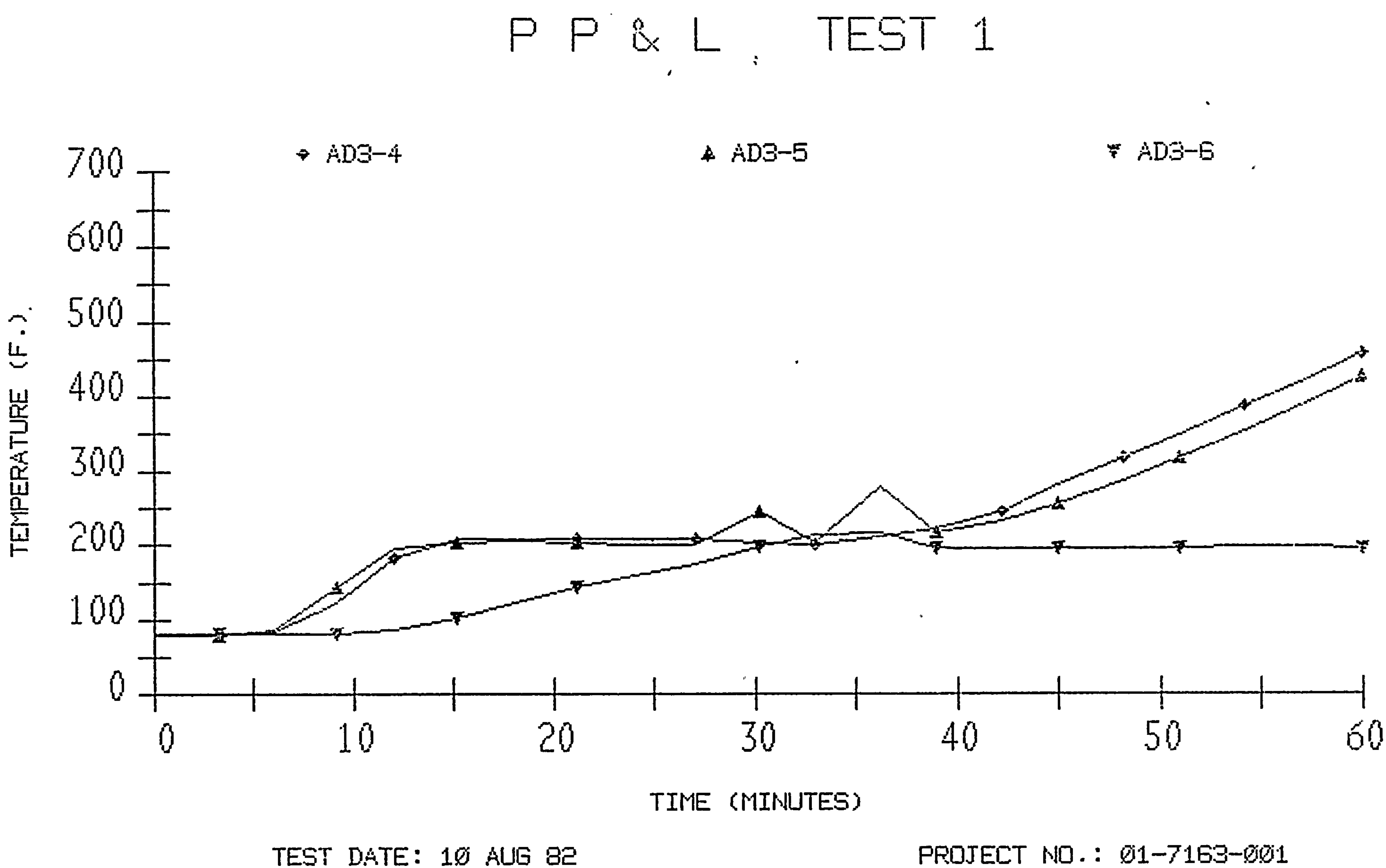
PROJECT NO.: 01-7163-001

P P & L. TEST 1

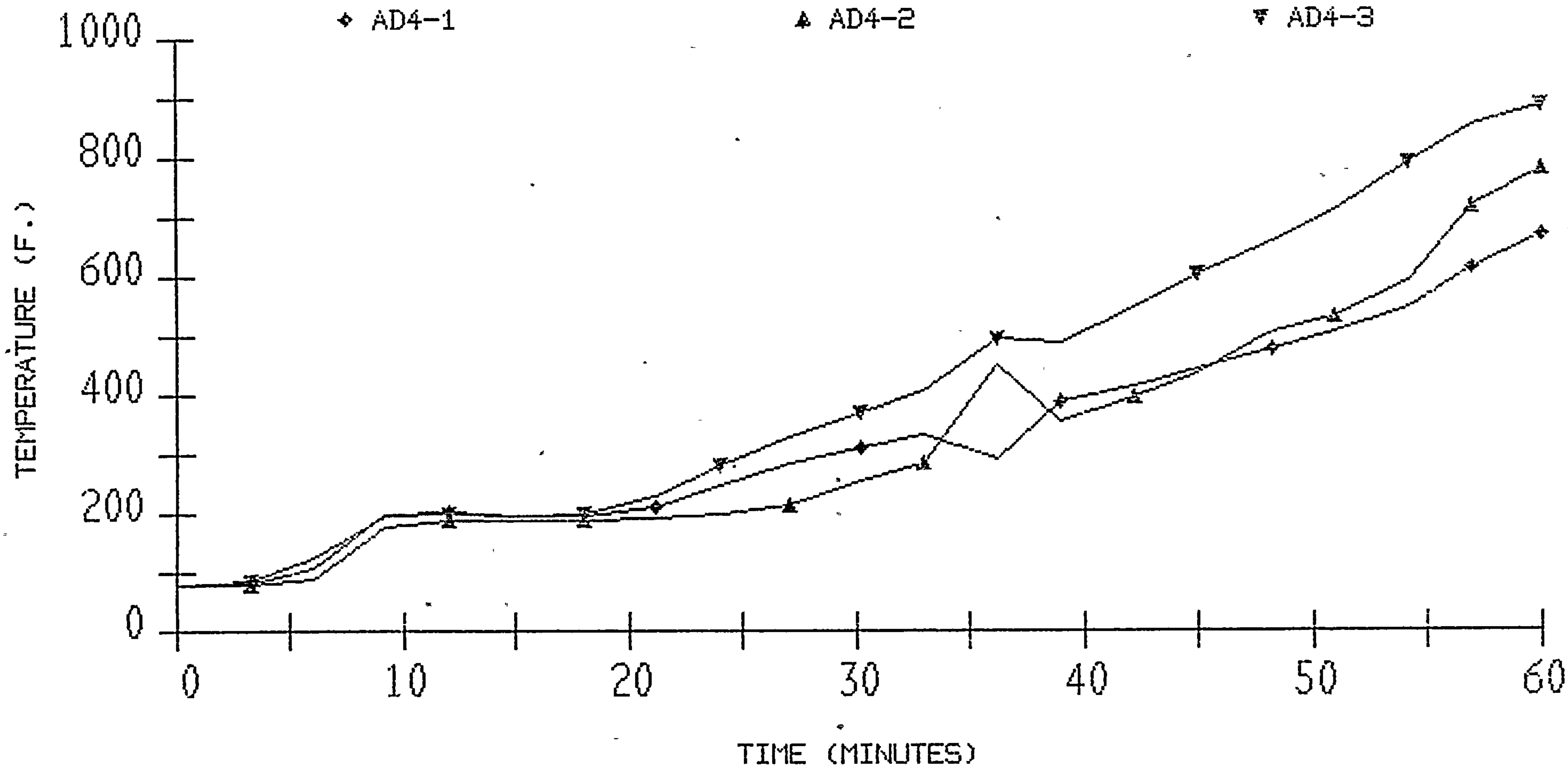


TEST DATE: 1Ø AUG 82

PROJECT NO.: Ø1-7163-ØØ1


P P & L TEST 1
AD3-4
AD3-5
AD3-6
TEMPERATURE (F.)
700
600
500
400
300
200
100
0
0
10
20
30
40
50
60
TIME (MINUTES)
TEST DATE: 10 AUG 82
PROJECT NO.: 01-7163-001

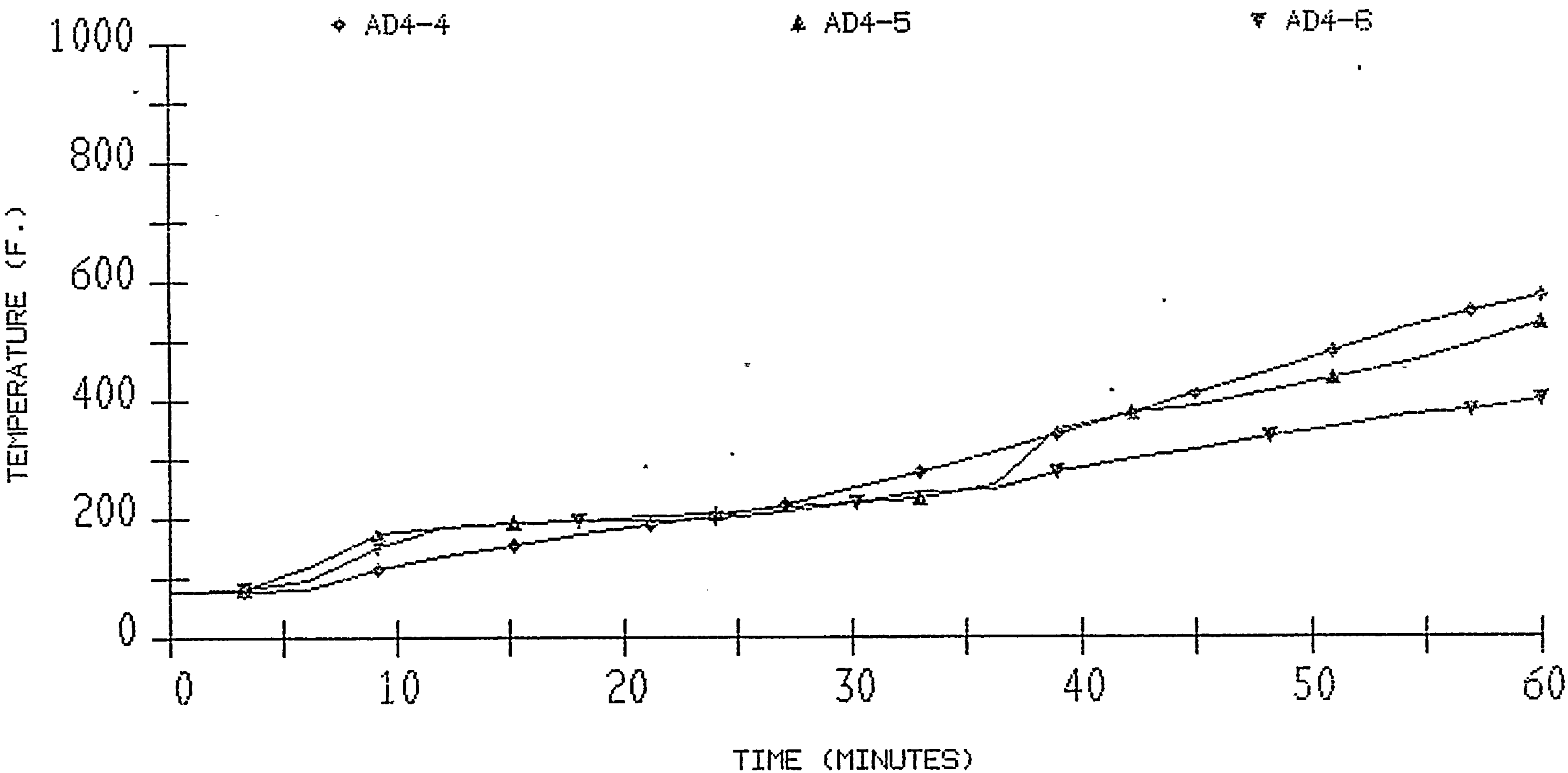
P P & L TEST 1



TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001

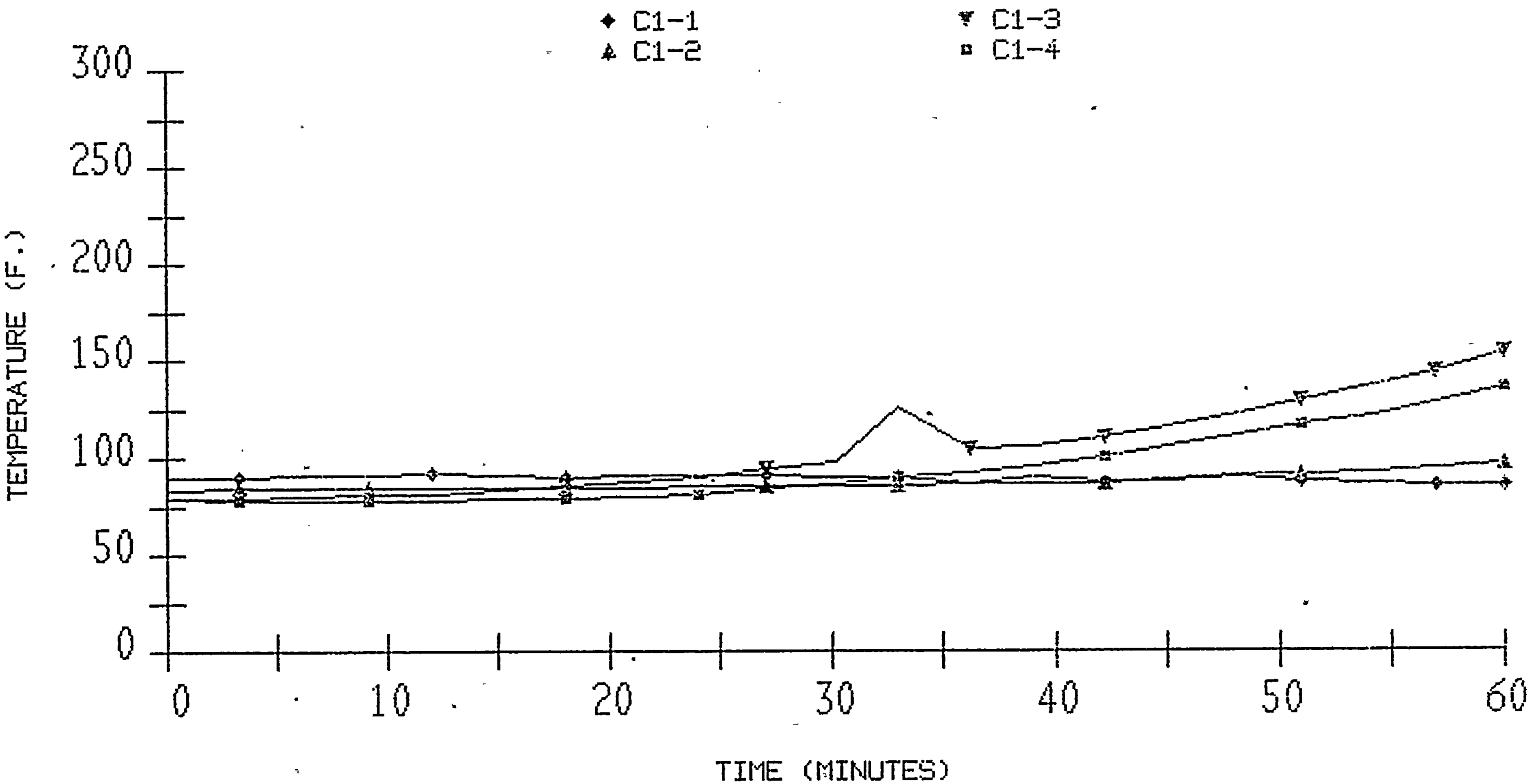
P P & L TEST 1



TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001

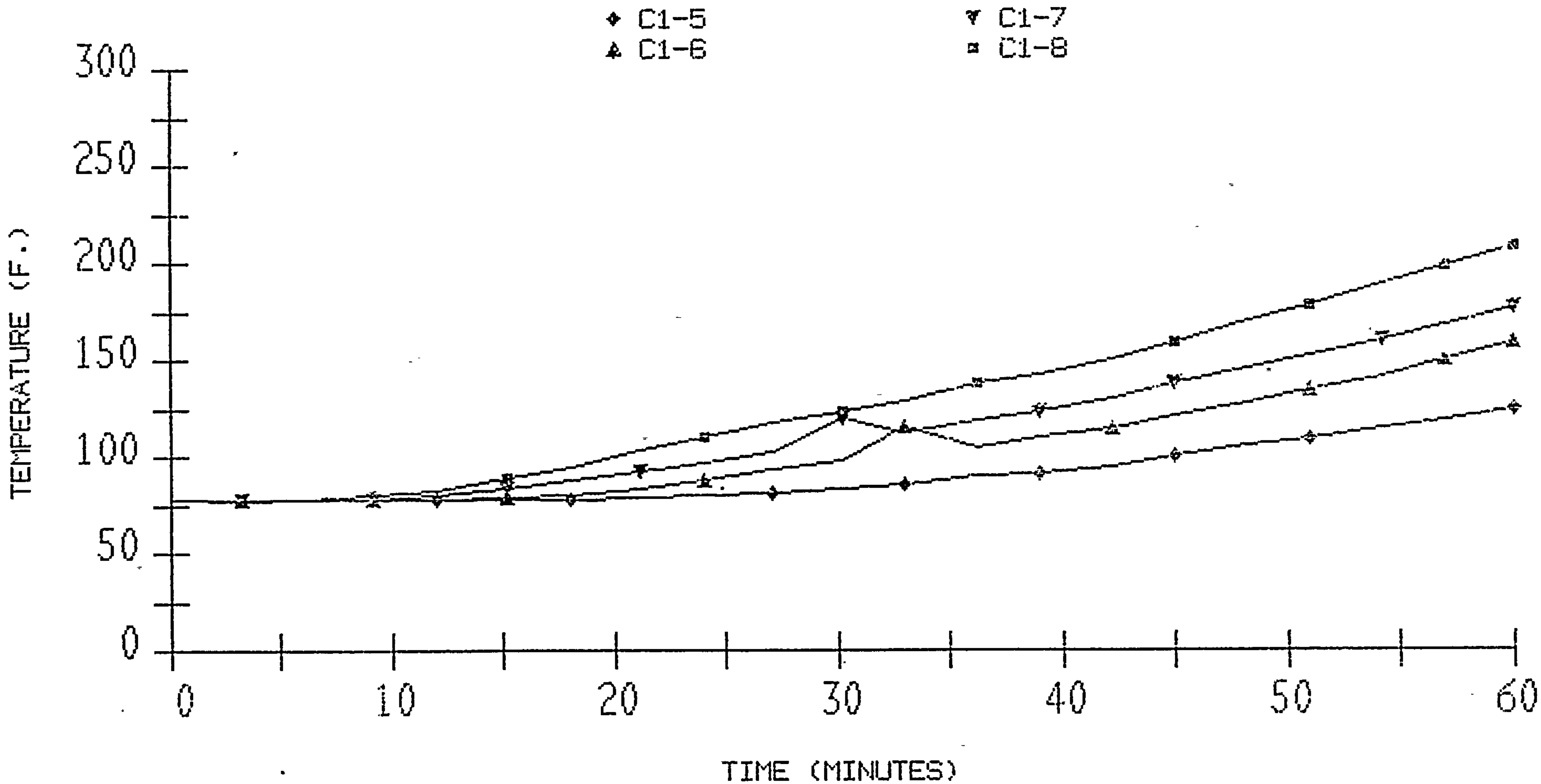
P P & L TEST 1



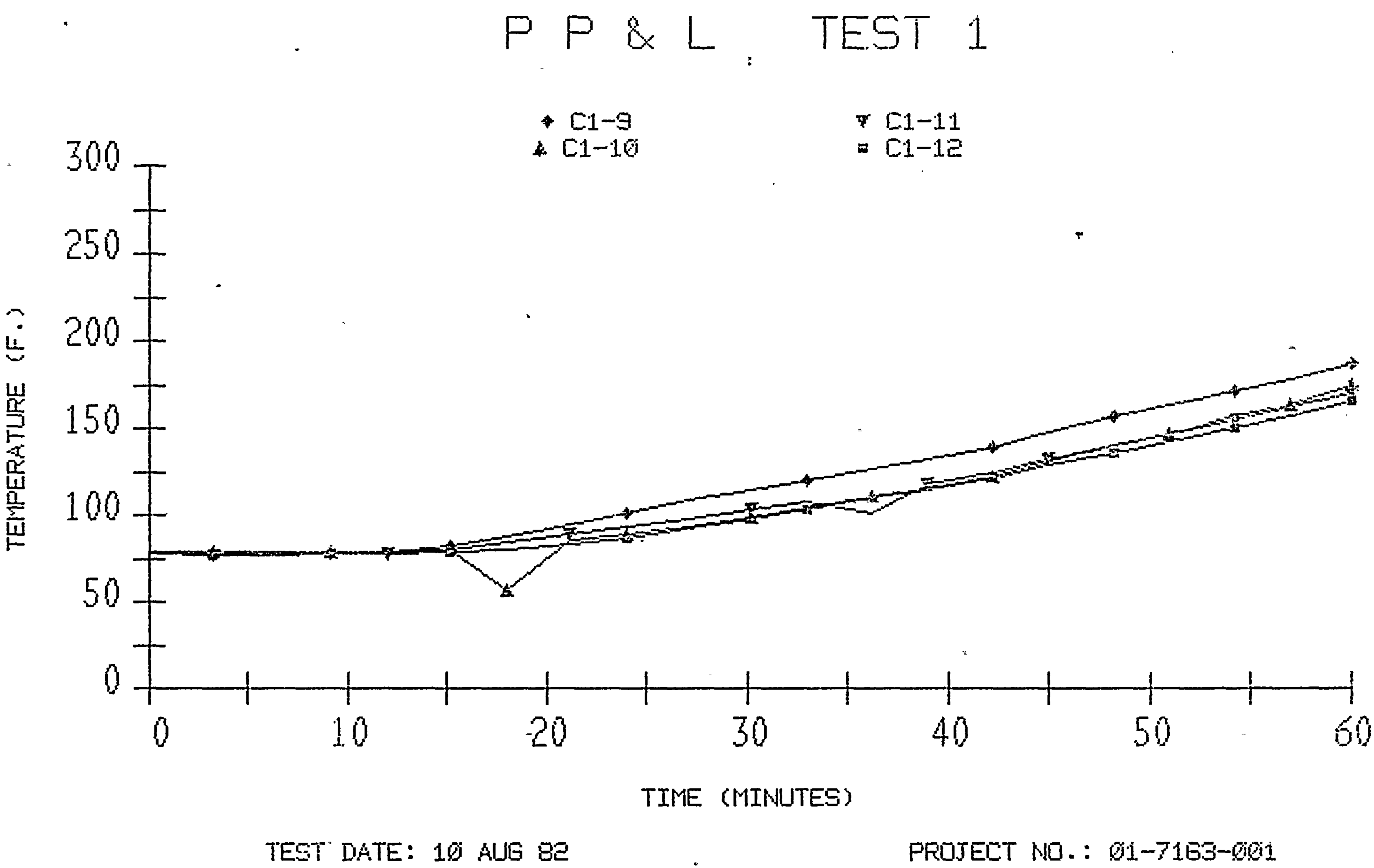
TEST DATE: 1Ø AUG 82

PROJECT NO.: Ø1-7163-ØØ1

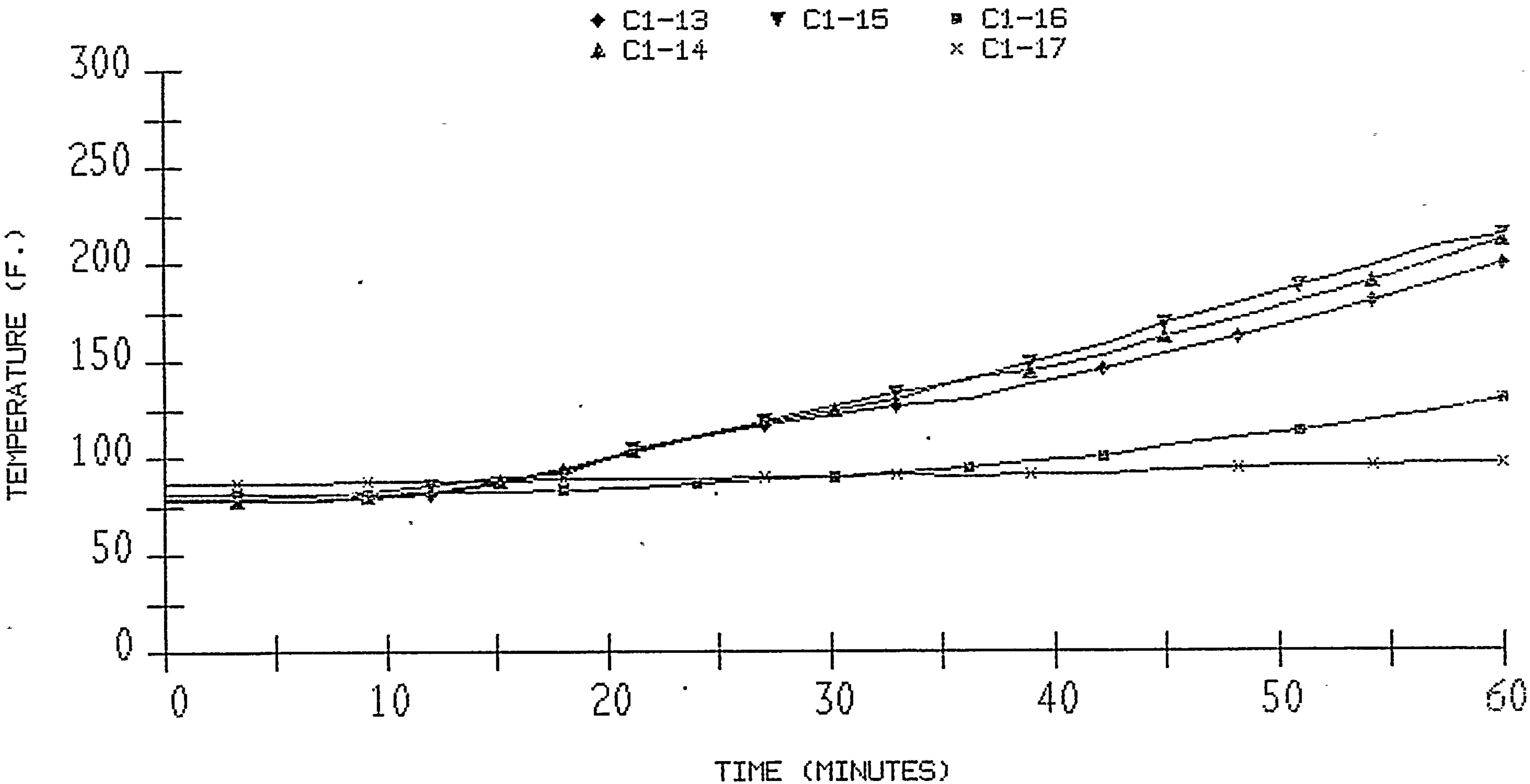
P P & L TEST 1



TEST DATE: 10 AUG 82 PROJECT NO.: 01-7163-001


P P & L TEST 1
C1-9
C1-10
C1-11
C1-12
TEMPERATURE (F.)
300
250
200
150
100
50
0
0
10
20
30
40
50
60
TIME (MINUTES)
TEST DATE: 10 AUG 82
PROJECT NO.: 01-7163-001

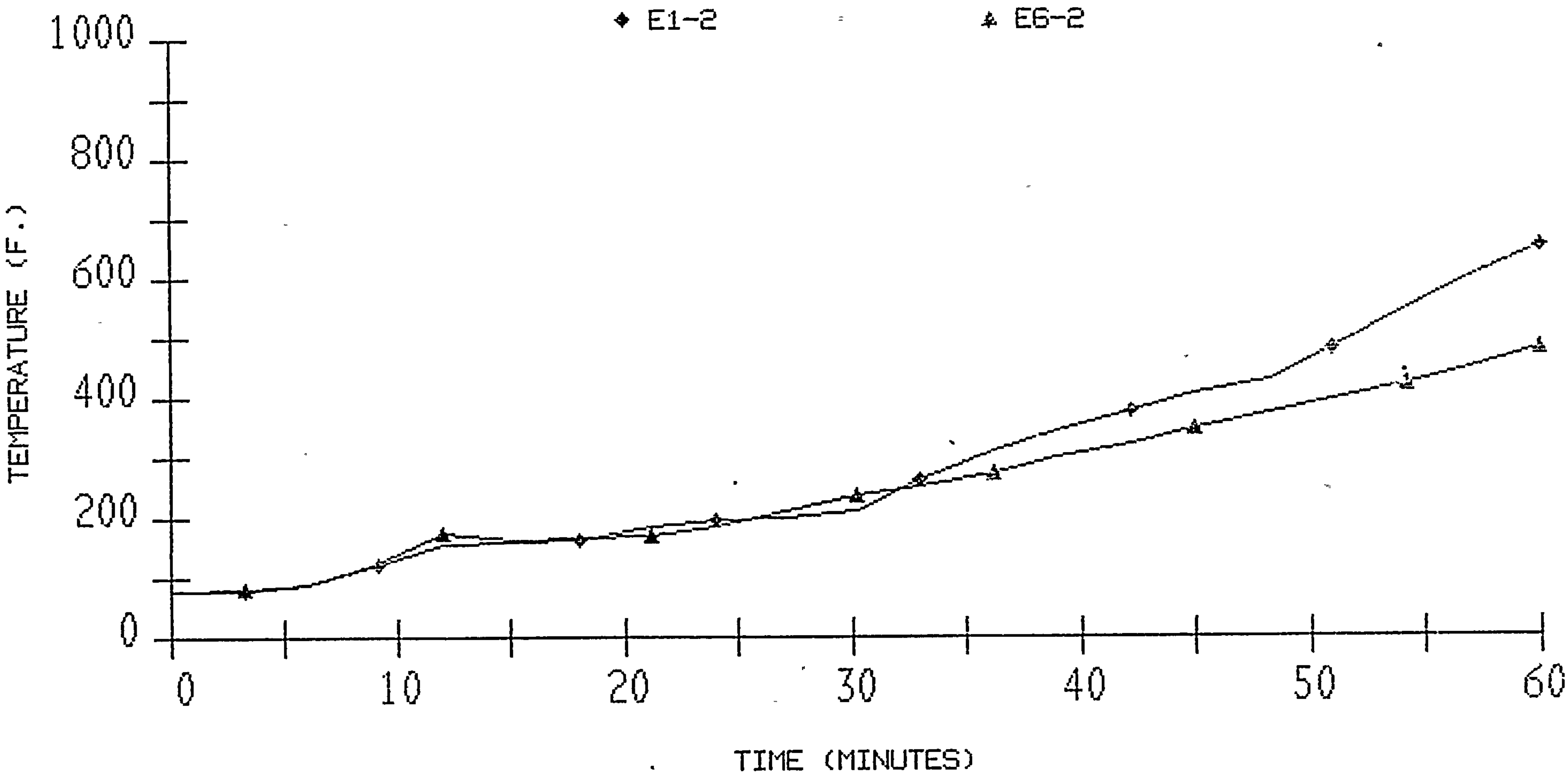
P P & L TEST 1



TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001

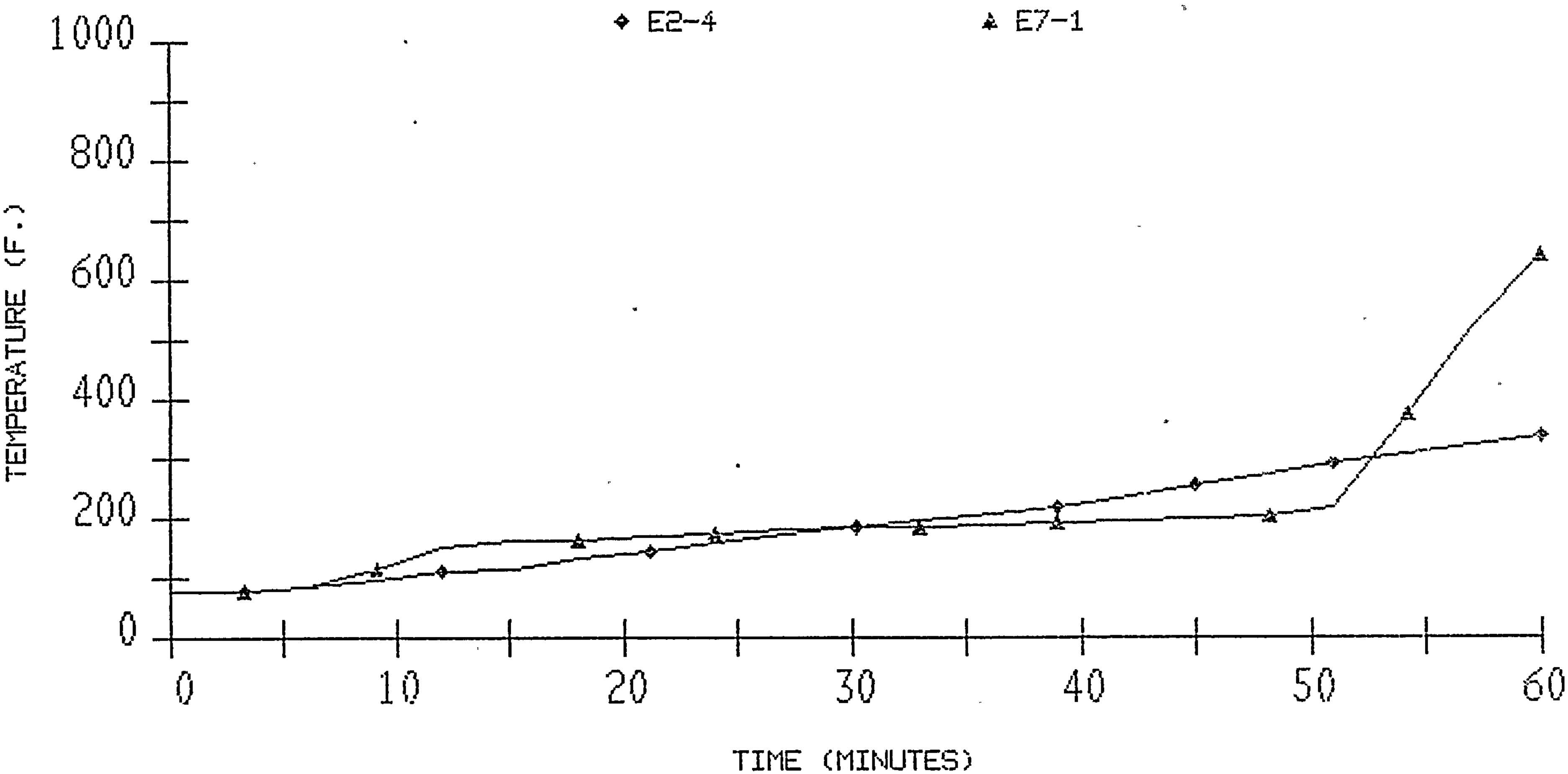
P P & L TEST 1



TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001

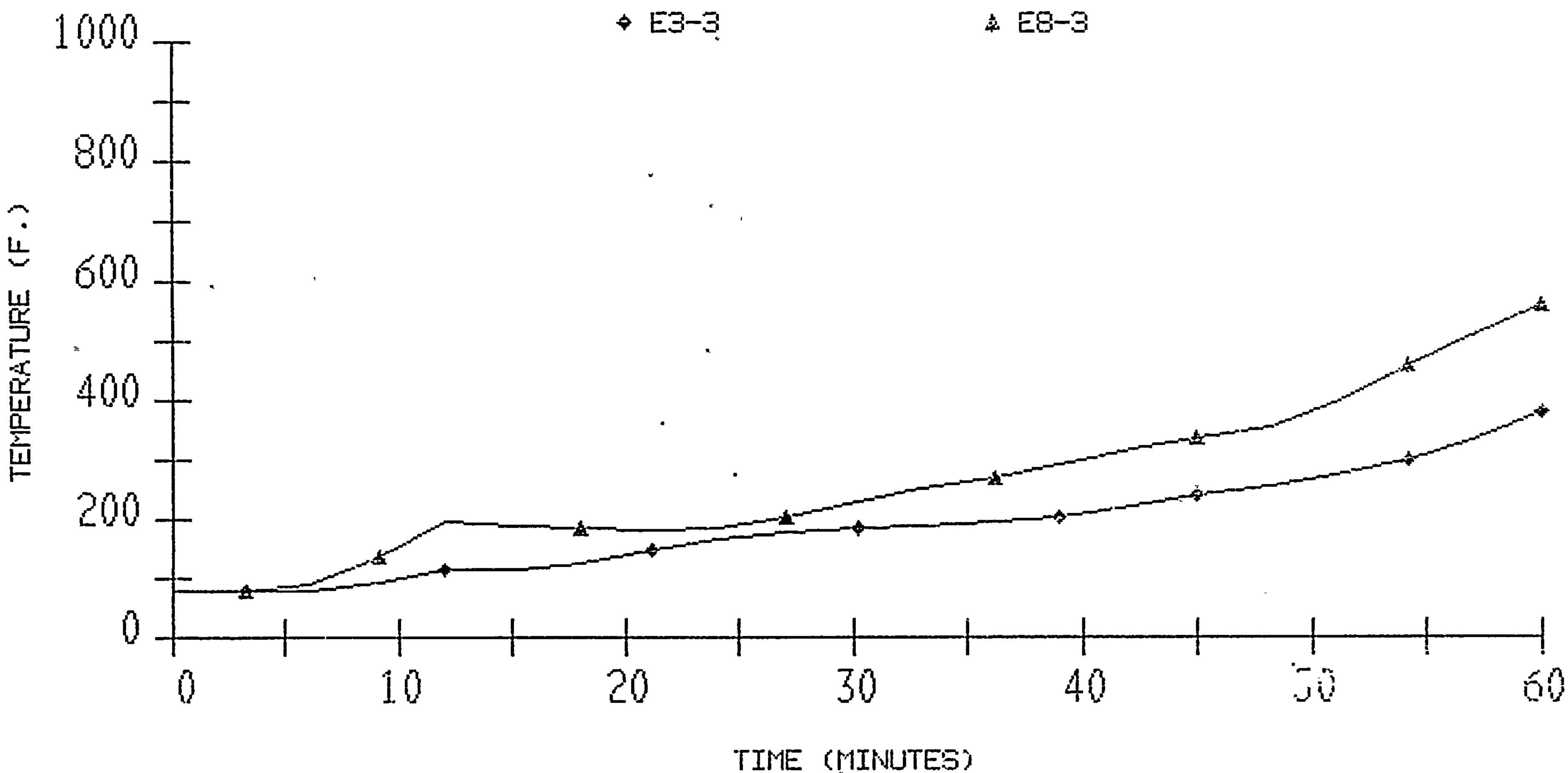
P P & L TEST 1



TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001

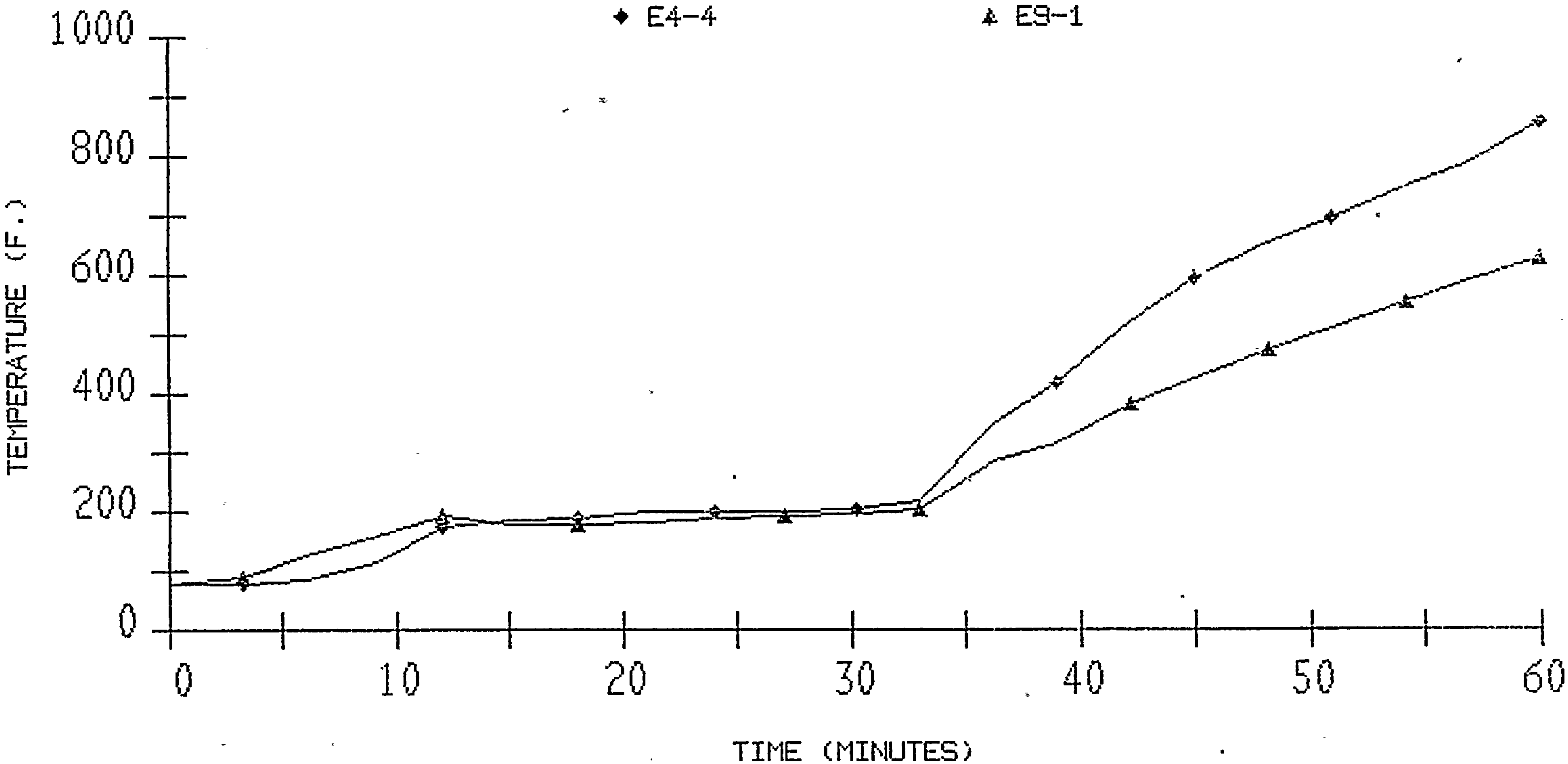
P P & L TEST 1



TEST DATE: 10 AUG 82

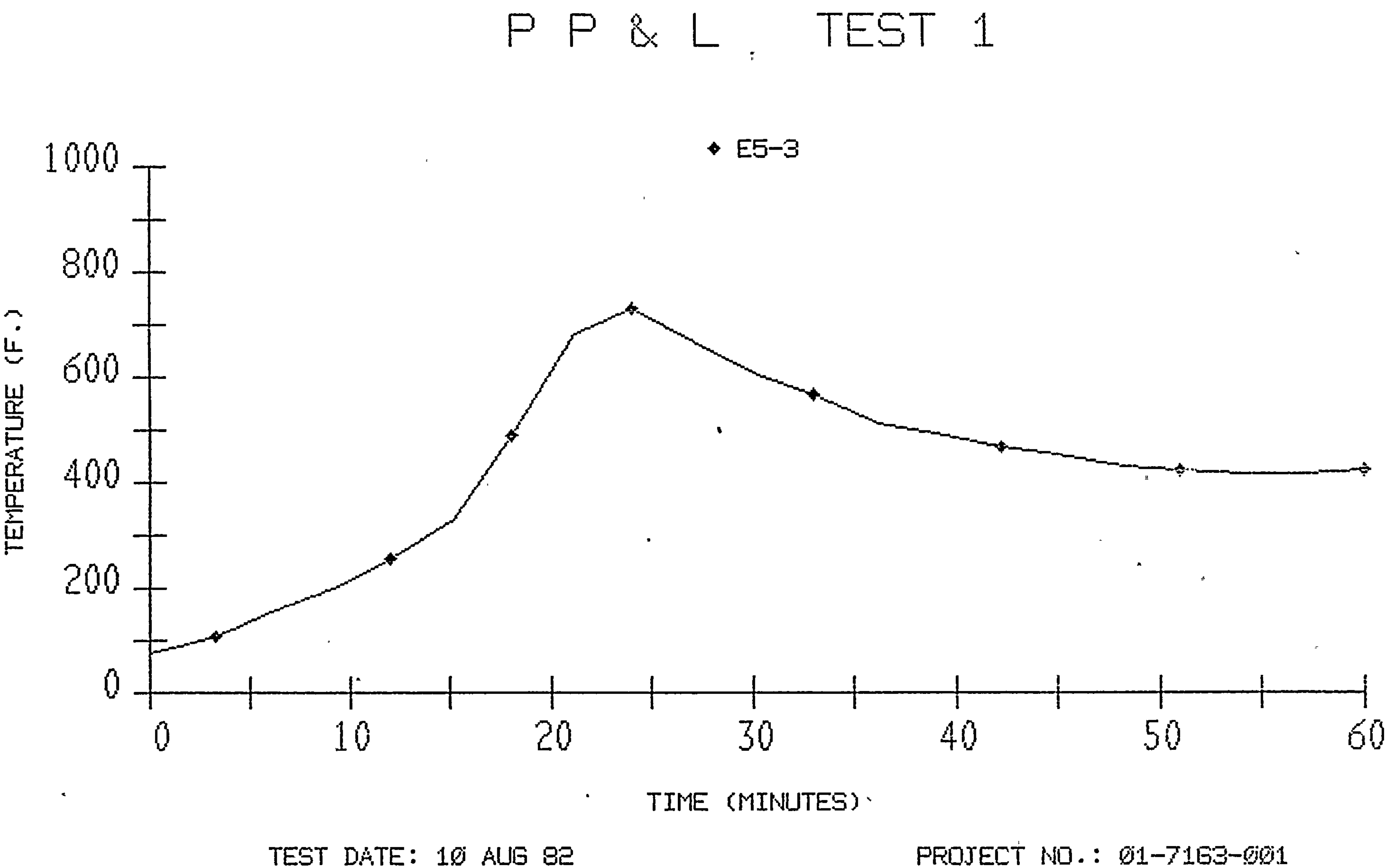
PROJECT NO.: 01-7163-001

P P & L TEST 1

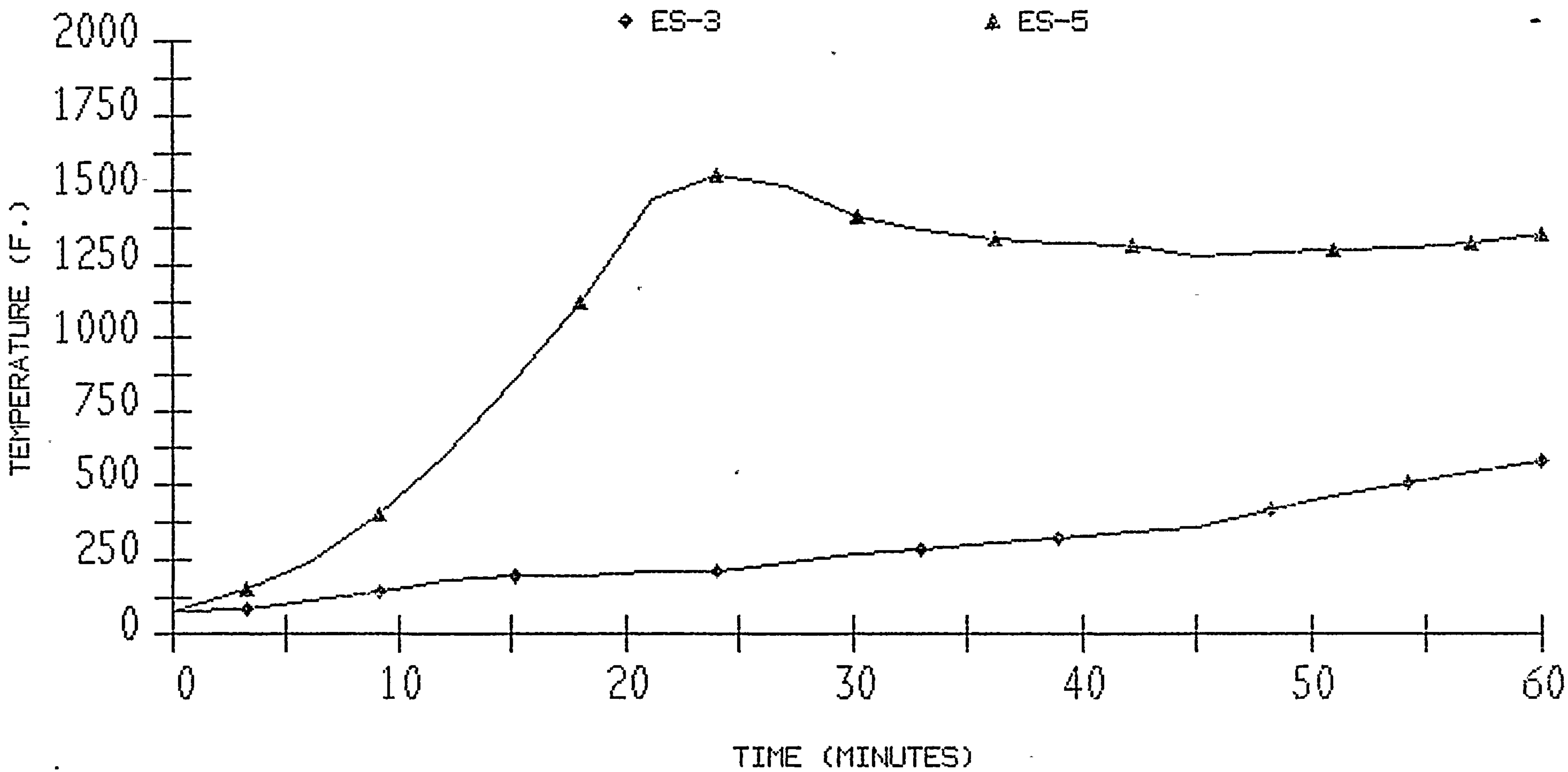


TEST DATE: 1Ø AUG 82

PROJECT NO.: Ø1-7163-ØØ1


P P & L TEST 1
E5-3
1000
800
600
400
200
0
TEMPERATURE (F.)
0
10
20
30
40
50
60
TIME (MINUTES)
TEST DATE: 1Ø AUG 82
PROJECT NO.: Ø1-7163-ØØ1

P P & L TEST 1



TEST DATE: 10 AUG 82

PROJECT NO.: 01-7163-001

APPENDIX D

CIRCUIT INTEGRITY DATA

P P & L

TEST 1

DATE OF TEST...10 AUG 82   PROJECT NO.:..01-7163-001
DATA FILE......PP&L3   DISK..........JB-3

TIME MIN	SEC	T1-CC-D83	T1-CC-Q16	T1-CG-L12	T1-CG-R35	T1-CON-L05	T1-CON-Q27
0	0	999999	999999	999999	999999	999999	999999
3	15	999999	999999	999999	999999	999999	999999
6	0	999999	999999	999999	999999	999999	999999
9	14	999999	999999	999999	999999	999999	999999
12	0	999999	999999	999999	999999	999999	999999
15	13	999999	999999	999999	999999	999999	999999
18	0	999999	999999	999999	999999	999999	999999
21	13	999999	999999	999999	999999	999999	999999
24	0	999999	999999	999999	999999	999999	999999
27	3	999999	999999	999999	999999	999999	999999
30	16	999999	999999	999999	999999	999999	999999
33	0	999999	999999	999999	999999	999999	999999
36	13	999999	999999	999999	999999	999999	999999
39	0	999999	999999	999999	999999	999999	999999
42	14	999999	999999	999999	999999	999999	999999
45	0	999999	999999	999999	999999	999999	999999
48	14	999999	999999	999999	999999	999999	999999
51	0	999999	999999	999999	999999	999999	999999
54	14	999999	999999	999999	999999	999999	999999
57	0	999999	999999	999999	999999	999999	999999
60	14	999999	999999	999999	999999	999999	999999
63	0	999999	999999	999999	999999	999999	999999
66	14	999999	0	999999	999999	999999	999999
69	0	999999	0	999999	999999	999999	999999
72	14	0	0	0	999999	999999	999999

P P & L

TEST 1

DATE OF TEST...10 AUG 82   PROJECT NO.:..01-7163-001
DATA FILE......PP&L3   DISK..........JB-3

TIME MIN	SEC	T2-CC-D83	T2-CC-025	T2-CG-750	T2-CG-D14	T2-CON-L03	T2-CON-016
0	0	999999	999999	999999	999999	999999	999999
3	15	999999	999999	999999	999999	999999	999999
6	0	999999	999999	999999	999999	999999	999999
9	14	999999	999999	999999	999999	999999	999999
12	0	999999	999999	999999	999999	999999	999999
15	13	999999	999999	999999	999999	999999	999999
18	0	999999	999999	999999	999999	999999	999999
21	13	999999	999999	999999	999999	999999	999999
24	0	999999	999999	999999	999999	999999	999999
27	3	999999	999999	999999	999999	999999	999999
30	16	999999	999999	999999	999999	999999	999999
33	0	999999	999999	999999	999999	999999	999999
36	13	999999	999999	999999	999999	999999	999999
39	0	999999	999999	999999	999999	999999	999999
42	14	999999	999999	999999	999999	999999	999999
45	0	999999	999999	999999	999999	999999	999999
48	14	999999	999999	999999	999999	999999	999999
51	0	999999	999999	999999	999999	999999	999999
54	14	999999	999999	999999	999999	999999	999999
57	0	999999	999999	999999	999999	999999	999999
60	14	999999	999999	999999	999999	999999	999999
63	0	999999	999999	999999	999999	999999	999999
66	14	999999	999999	999999	999999	999999	999999
69	0	999999	999999	999999	999999	999999	999999
72	14	999999	999999	999999	999999	999999	999999

P P & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

TIME MIN	SEC	T3-CC-D83	T3-CC-025	T3-CG-750	T3-CG-D14	T3-CON-L03	T3-CON-016
0	0	999999	999999	999999	999999	999999	999999
3	15	999999	999999	999999	999999	999999	999999
6	0	999999	999999	999999	999999	999999	999999
9	14	999999	999999	999999	999999	999999	999999
12	0	999999	999999	999999	999999	999999	999999
15	13	999999	999999	999999	999999	999999	999999
18	0	999999	999999	999999	999999	999999	999999
21	13	999999	999999	999999	999999	999999	999999
24	0	999999	999999	999999	999999	999999	999999
27	3	999999	999999	999999	999999	999999	999999
30	16	999999	999999	999999	999999	999999	999999
33	0	999999	999999	999999	999999	999999	999999
36	13	999999	999999	999999	999999	999999	999999
39	0	999999	999999	999999	999999	999999	999999
42	14	999999	999999	999999	999999	999999	999999
45	0	999999	999999	999999	999999	999999	999999
48	14	999999	999999	999999	999999	999999	999999
51	0	999999	999999	999999	999999	999999	999999
54	14	999999	999999	999999	999999	999999	999999
57	0	999999	999999	999999	999999	999999	999999
60	14	999999	999999	999999	999999	999999	999999
63	0	999999	999999	999999	999999	999999	999999
66	14	999999	999999	999999	999999	999999	999999
69	0	999999	999999	999999	999999	999999	999999
72	14	999999	999999	999999	999999	999999	999999

P P & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

TIME MIN	SEC	T4-CC-D83	T4-CC-025	T4-CG-350	T4-CG-L12	T4-CON-L05	T4-CON-027
0	0	999999	999999	999999	999999	999999	999999
3	15	999999	999999	999999	999999	999999	999999
6	0	999999	999999	999999	999999	999999	999999
9	14	999999	999999	999999	999999	999999	999999
12	0	999999	999999	999999	999999	999999	999999
15	13	999999	999999	999999	999999	999999	999999
18	0	999999	999999	999999	999999	999999	999999
21	13	999999	999999	999999	999999	999999	999999
24	0	999999	999999	999999	999999	999999	999999
27	3	999999	999999	999999	999999	999999	999999
30	16	999999	999999	999999	999999	999999	999999
33	0	999999	999999	999999	999999	999999	999999
36	13	999999	999999	999999	999999	999999	999999
39	0	999999	999999	999999	999999	999999	999999
42	14	999999	999999	999999	999999	999999	999999
45	0	999999	999999	999999	999999	999999	999999
48	14	999999	999999	999999	999999	999999	999999
51	0	999999	999999	999999	999999	999999	999999
54	14	999999	999999	999999	999999	999999	999999
57	0	999999	999999	999999	999999	999999	999999
60	14	999999	999999	999999	999999	999999	999999
63	0	999999	999999	999999	999999	999999	999999
66	14	999999	999999	999999	999999	999999	999999
69	0	999999	999999	999999	999999	999999	999999
72	14	999999	999999	999999	999999	999999	999999

P P & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

TIME MIN	SEC	AD1-CCL07	AD1-CGD42	AD1-CONQ25
0	0	999999	999999	999999
3	15	999999	999999	999999
6	0	999999	999999	999999
9	14	999999	999999	999999
12	0	999999	999999	999999
15	13	999999	999999	999999
18	0	999999	999999	999999
21	13	999999	999999	999999
24	0	999999	999999	999999
27	3	999999	999999	999999
30	16	999999	999999	999999
33	0	999999	999999	999999
36	13	999999	999999	999999
39	0	999999	999999	999999
42	14	999999	999999	999999
45	0	999999	999999	999999
48	14	999999	999999	999999
51	0	999999	999999	999999
54	14	999999	999999	999999
57	0	999999	999999	999999
60	14	999999	999999	999999
63	0	999999	999999	999999
66	14	999999	999999	999999
69	0	999999	999999	999999
72	14	999999	999999	999999

P P & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

TIME MIN	SEC	AD2-CC027	AD2-CGD83	AD2-CONL12
0	0	999999	999999	999999
3	15	999999	999999	999999
6	0	999999	999999	999999
9	14	999999	999999	999999
12	0	999999	999999	999999
15	13	999999	999999	999999
18	0	999999	999999	999999
21	13	999999	999999	999999
24	0	999999	999999	999999
27	3	999999	999999	999999
30	16	999999	999999	999999
33	0	999999	999999	999999
36	13	999999	999999	999999
39	0	999999	999999	999999
42	14	999999	999999	999999
45	0	999999	999999	999999
48	14	999999	999999	999999
51	0	999999	999999	999999
54	14	999999	999999	999999
57	0	999999	999999	999999
60	14	999999	999999	999999
63	0	999999	999999	999999
66	14	999999	999999	999999
69	0	999999	999999	999999
72	14	999999	999999	999999

P P & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

TIME MIN	SEC	AD3-CC-Q16
0	0	999999
3	15	999999
6	0	999999
9	14	999999
12	0	999999
15	13	999999
18	0	999999
21	13	999999
24	0	999999
27	3	999999
30	16	999999
33	0	999999
36	13	999999
39	0	999999
42	14	999999
45	0	999999
48	14	999999
51	0	999999
54	14	999999
57	0	999999
60	14	999999
63	0	999999
66	14	0
69	0	0
72	14	0

P P & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

TIME MIN	SEC	AD4-CCQ12	AD4-CGD62	AD4-CONL05
0	0	999999	999999	999999
3	15	999999	999999	999999
6	0	999999	999999	999999
9	14	999999	999999	999999
12	0	999999	999999	999999
15	13	999999	999999	999999
18	0	999999	999999	999999
21	13	999999	999999	999999
24	0	999999	999999	999999
27	3	999999	999999	999999
30	16	999999	999999	999999
33	0	999999	999999	999999
36	13	999999	999999	999999
39	0	999999	999999	999999
42	14	999999	999999	999999
45	0	999999	999999	999999
48	14	999999	999999	999999
51	0	999999	999999	999999
54	14	999999	999999	999999
57	0	999999	999999	999999
60	14	999999	999999	999999
63	0	999999	999999	999999
66	14	0	999999	999999
69	0	0	999999	999999
72	14	0	999999	999999

P P & L

TEST 1

DATE OF TEST...10 AUG 82 PROJECT NO.:..01-7163-001
DATA FILE......PP&L3 DISK..........JB-3

TIME MIN	SEC	CON-CCD42	CON-CCQ27	CON-CG500	CON-CGL05	CON-CONL07	CON-CONQ26
0	0	999999	999999	999999	999999	999999	999999
3	15	999999	999999	999999	999999	999999	999999
6	0	999999	999999	999999	999999	999999	999999
9	14	999999	999999	999999	999999	999999	999999
12	0	999999	999999	999999	999999	999999	999999
15	13	999999	999999	999999	999999	999999	999999
18	0	999999	999999	999999	999999	999999	999999
21	13	999999	999999	999999	999999	999999	999999
24	0	999999	999999	999999	999999	999999	999999
27	3	999999	999999	999999	999999	999999	999999
30	16	999999	999999	999999	999999	999999	999999
33	0	999999	999999	999999	999999	999999	999999
36	13	999999	999999	999999	999999	999999	999999
39	0	999999	999999	999999	999999	999999	999999
42	14	999999	999999	999999	999999	999999	999999
45	0	999999	999999	999999	999999	999999	999999
48	14	999999	999999	999999	999999	999999	999999
51	0	999999	999999	999999	999999	999999	999999
54	14	999999	999999	999999	999999	999999	999999
57	0	999999	999999	999999	999999	999999	999999
60	14	999999	999999	999999	999999	999999	999999
63	0	999999	999999	999999	999999	999999	999999
66	14	999999	999999	999999	999999	999999	999999
69	0	999999	999999	999999	999999	999999	999999
72	14	999999	999999	999999	999999	999999	999999