ENCLOSURE 2

TEST PLAN

ONE HOUR FIRE ENDURANCE TESTS OF ARTICLES PROTECTED WITH THE TSI THERMO-LAG 330 FIRE BARRIER SYSTEM

1.0 SCOPE

This test plan describes the methods and guidelines for five fire endurance tests. This test plan includes the preparation of five test decks and specimens, installation of the THERMO-LAG 330 Fire Barrier System, performance of fire endurance and hose stream tests, temperature monitoring, and all applicable documentation of these tasks and the test results. The test decks will consist of a combination of junction boxes and conduits as shown in Appendix A.

2.0 OBJECTIVE

The objective of these tests is to qualify a protective generic fire barrier system for redundant essential cables at Tennessee Valley Authority's (TVA) Watts Bar Nuclear Plant (WBN). Successful results of this test program will provide documented evidence that the fire barrier systems will satisfactorily withstand an ASTM E119-88 fire exposure for a period of one hour, followed by a hose stream test. These tests shall satisfy the requirements for fire testing the cable raceway and junction box fire barriers as detailed in Underwriters Laboratories, Inc. (UL) Subject 1724, "Outline of Investigation for Fire Tests for Electrical Circuit Protective Systems," Issue Number 2, August 1991 except where clarified and, in the absence of other standards for these specific types of tests, standard practice shall be invoked.

3.0 ACCEPTANCE CRITERIA

3.1 The exterior surface temperature of each conduit and junction box will be recorded (cold side of the barrier). If the average temperature recorded by the exterior raceway thermocouples is less than 250°F (121°C) above their initial temperature and no individual thermocouple is in excess of 325°F (181°C) above its initial temperature, the fire barrier shall be acceptable for use with any type cable.

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3.2 The thermocouples located on the bare copper cable (#8 AWG) installed inside the electrical raceway will be recorded. The highest thermocouple temperature rise above its initial temperature and the average temperature rise above their initial temperature will be recorded for each electrical raceway configuration. These results will be analyzed at a later date to determine the unique electrical applications.

3.3 A hose stream test as described in Section 8.2 will be performed at the end of the fire endurance test. The hose stream test shall not cause any openings through which the electrical raceway is visible.

4.0 REFERENCES

4.1 10CFR50, Appendix R - Fire Protection Program for Operating Nuclear Power Plants.

4.2 American Society for Testing and Materials (ASTM) E119-88 - Standard Test Methods for Fire Tests of Building Construction and Materials.

4.3 Underwriters Laboratories, Inc. (UL) Subject 1724-91 - Outline of Investigation for Fire Tests for Electrical Circuit Protective Systems.

4.4 TVA Position on Fire Testing Criteria for Fire Barrier Systems Used to Protect Electrical Cables Required for 10CFR50 Appendix R Compliance.

5.0 RESPONSIBILITIES

5.1 TENNESSEE VALLEY AUTHORITY (TVA)

5.1.1 Establish the criteria, guidelines, drawings (draft quality), recommendations, etc., to govern the installation of the test items.

5.1.2 Establish the criteria, guidelines, drawings (draft quality), recommendations, etc., to govern the installation of the fire penetration seal systems, if any (other than deck through-penetration seals).

5.1.3 Establish the criteria, guidelines, drawings (final, report quality if needed), recommendations, hold points, etc., to govern the installation of the Thermo-Lag 330 fire barrier system materials to the test articles.

5.1.4 Provide specific installation procedures and work package documentation for each test.

5.1.5 Provide the Thermo-Lag fire barrier system materials and personnel to install the fire barrier systems.

5.1.6 Supply personnel to witness assembly and test article raceway configurations and Thermo-Lag installation at TVA's discretion.

5.2 OMEGA POINT LABORATORIES, INC. (Lab)

5.2.1 Prepare the test furnace, deck and slab assemblies and provide all required test instrumentation in accordance with its Appendix B Quality Assurance and Quality Control Programs and other applicable procedures.

5.2.2 Provide thermocouple calibration and instrumentation, storage temperature records, surface temperature probe and relative humidity instrumentation.

5.2.3 Provide, assemble, install and document the installation of all conduits, junction boxes, cable, etc. Provide computer generated drawings of conduit/junction box systems which clearly indicate critical dimensions, thermocouple locations, etc.

5.2.4 Coordinate all phases of the fire test preparation.

5.2.5 Supply QC personnel to witness and document assembly and test article raceway configurations.

5.2.6 Provide all applicable quality control documentation for the fire barrier system materials, cables and installation of the fire barrier system to each test article.

5.2.7 Observe and document the installation of the Thermo-Lag fire barrier system materials to the test articles, and attendant instrumentation on each test article.

5.2.8 Conduct the fire endurance and water hose stream tests.

5.2.9 Document the test parameters and provide a formal detailed written report of the test program and test results.

5.2.10 Notify TVA within three (3) working day of completion of test specimen.

5.3 LAB QUALITY ASSURANCE/QUALITY CONTROL

5.3.1 Verify the quality control documentation of the fire barrier system materials used in the test program.

5.3.2 Perform and document inspections of the fire barrier system materials at various points during the installation process.

5.3.3 Verify and document that TVA's installation procedures are used in the installation of the fire barrier system.

5.3.4 Inspect and document the construction and instrumentation of the test articles.

5.3.5 Provide written calibration documentation of all thermocouples, measurement devices and data acquisition systems used in this test program.

6.0 SPECIAL PRECAUTIONS

6.1 PRECAUTIONS FOR INSTALLATION OF THE FIRE BARRIER SYSTEM MATERIALS

6.1.1 Observe specific precautions recommended by Thermal Science, Inc. and other's material safety data sheets.

6.2 PRECAUTIONS FOR CONDUCTING THE FIRE ENDURANCE TEST

6.2.1 Proper safety precautions shall be exercised to preclude personnel from direct exposure to the flame environment, hot objects, hazardous gases, and all other related hazards.

7.0 PREREQUISITES

7.1 GENERAL TEST CONFIGURATION REQUIREMENTS

The conduit and junction box sizes and installation configurations for the five tests shall be as shown on drawings in Appendix A.

7.2 TRACEABILITY REQUIREMENTS

To ensure that the materials used in this test are representative of those in actual use or to be used at Watts Bar or other TVA facilities, all aspects of traceability as required by the Laboratory QA Program shall be applied.

All thermocouples used in this test program shall be teflon coated and traceable to the respective thermocouple manufacturer, with calibration certification.

7.3 DIMENSIONED DRAWINGS

All test articles shall conform to the draft dimensioned drawings (see Appendix A). Final, dimensioned drawings will be prepared by the Laboratory.

7.4 SHIPPING, RECEIVING, MATERIAL INSPECTION

Make a visual inspection of all materials for damage.

Record lot numbers and expiration dates of materials as applicable.

Thermo-Lag bulk grade materials are shipped under "protective service" with an in-transit temperature chart recorder included with each shipment in an identifiable container. That container reads "RECORDER IN HERE". The chart tape produced by this recorder shall be inspected by Laboratory personnel upon arrival of the shipment to insure that the temperature limitations of 32°F to 100°F were not exceeded.

Thermo-Lag fire barrier materials shall be stored off the ground when not in use. The materials shall be stored in a totally enclosed and weather protected area when not in use (ANSI N45.2.2, level B or better). The bulk grade (trowel grade) material shall be maintained within the temperature limitations of 32°F to 100°F.

Prior to application of the bulk grade material, check that the expiration date of the products have not passed. All bulk product expiration dates are good through the end of the expiration date month.

7.5 TEST CONFIGURATION

7.5.1 General

The test articles shall be sufficiently secured to the test deck by Laboratory personnel and sealed in accordance with instructions and drawings.

7.5.2 Conduit and Junction Box Items

Conduit and junction box test configurations for this program will consist of three concrete slabs with the following test specimen descriptions.

1. Slab 1 and 2 consists of five junction boxes attached to the concrete slab and various sizes of conduits running from one junction box to another. A two inch conduit will penetrate the slab into three of the junction boxes (see Attachment A) to allow routing of the bare #8 copper conductor through each conduit and junction box.

2. Slab 3 consist of three conduits that penetrate the concrete slab, enter LBs, exit the LBs in a horizontal plane and terminate on a large junction box.

The conduit and junction box sizes and locations are to be as shown on the drawings in Appendix A.

7.5.3 Conduit Items

Conduit test configurations for this program will consist of conduit assemblies which penetrate the steel deck and enter a standard 90° elbow, continue horizonally and enter a LB, and exit through the steel deck (see drawings in Appendix A). The conduit and LB sizes and locations are to be as shown on the drawings in Appendix A.

7.6 CABLE LOADING REQUIREMENTS

The single #8 bare copper conductor within the electrical circuit protective system is to be in accordance with section 4.4 of reference 4.3 (UL Subject 1724).

7.7 CABLE INSTALLATION

The bare copper conductor shall be instrumented as described in section 7.8 and installed along the entire length of each conduit and through the junction box being protected.

7.8 THERMOCOUPLE INSTALLATION

All thermocouples used in this test program shall be provided and installed by the Laboratory, with QC surveillance by Laboratory personnel. The thermocouple wires shall be calibrated (by Lot Number) prior to installation and/or use, and applicable quality control documentation for record purposes generated. All thermocouples will consist of Teflon coated, 24 GA, type K, Chromel-Alumel (Special Limits of Error ±1.1°C) electrically welded thermojunctions. Calibration will consist of manufacturer supplied (and audited)

certifications of calibrations at five temperatures of thermocouples taken from both ends of each purchased lot number.

The thermocouple placements and methods of attachment shall be in accordance with the requirements of sections 4.18, 19, 20 and 21 of reference 4.3 (UL Subject 1724) except that the spacing shall be on 6-inch centers on both the conduit and the bare copper wire.

7.9 INSTALLATION OF THE FIRE BARRIER SYSTEM TO THE TEST ARTICLES

Thermo-Lag 330 fire barrier system materials shall be installed by TVA crafts in accordance with applicable specifications, design drawings and procedures provided by TVA. Details of the fire barrier configurations including fasteners, orientation of structural ribs, etc., shall be documented in the final test report.

7.10 FIRE SEAL INSTALLATION

Upon completion of the fabrication and installation of the fire barrier systems to the test articles (or prior to, depending on the situation), all openings in the test articles shall be sealed by Omega Point. All openings in the test slab assemblies shall be sealed by the laboratory. All open ends of raceways which extend through the slab shall be sealed with both internal and external fire and smoke seals. Internal seals shall consist of silicone foam material, installed to a depth of nominally 6" and located at the end of the exposed raceways.

7.11 PREBURN INSPECTION

7.11.1 Prior to the commencement of the fire endurance test, a thorough check of the test assembly and associated equipment (including data recording equipment) shall be performed and documented by the Laboratory.

7.11.2 TVA shall inspect the fire barrier system for workmanship, surface defects, etc. prior to test.

7.11.3 Written approval of the construction, assembly, installation and instrumentation will be supplied by the Laboratory prior to performance of each fire exposure test (a sign-off sheet for this purpose will be supplied by the Laboratory and included in the final report).

7.11.4 Fire endurance testing of assemblies will not commence until the Thermo-Lag fire barrier materials attain a moisture meter reading that does not exceed 20 when using a meter with a scale of 0-100 such as a Delmhorst Model DP or equivalent, or until it has cured for 30 days.

8.0 PROCEDURE

8.1 FIRE ENDURANCE TEST

8.1.1 The protected test article shall be exposed to the standard time/temperature curve found in ASTM E119-88 for one hour. TVA personnel may request stopping of test if premature failure of the specimen occurs.

8.1.2 The testing organization shall adapt their testing procedures to assure the fire test complies with the requirements established in all referenced 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.

8.2 WATER HOSE STREAM TEST

8.2.1 Immediately following the fire endurance test, accessible surfaces of the protected test article shall be subjected to the cooling, impact and erosion effects of a hose stream test delivered through a 1½ inch fog nozzle set at a discharge angle of 30° with a nozzle pressure of 75 psig and a minimum discharge of 75 gpm will be used. The nozzle orifice is to be a maximum of 5 feet from the edge of the tested assembly.

9.0 DATA SYSTEMS

During the fire exposure period, the thermocouples will be scanned at one minute intervals or less. Data storage for reporting purposes will be at one minute intervals (minimum); however, the furnace thermocouples should be scanned at 15 second intervals to allow close control of the furnace. A printer output of all thermocouple data should be done every 30 seconds.

10.0 FIRE TEST REPORT

10.1 The Laboratory shall submit a report on the results of the test and thermocouple data. The test report shall be prepared and submitted in accordance with the requirements of Attachment B of contract 92NNA-75726B and subsections 10.2 and 10.3.

10.2 The Laboratory will assemble the final test report, containing the collected data and required quality control documentation.

10.3 The test report shall be prepared in sufficient detail to summarize the total testing activity. The report shall include as a minimum:

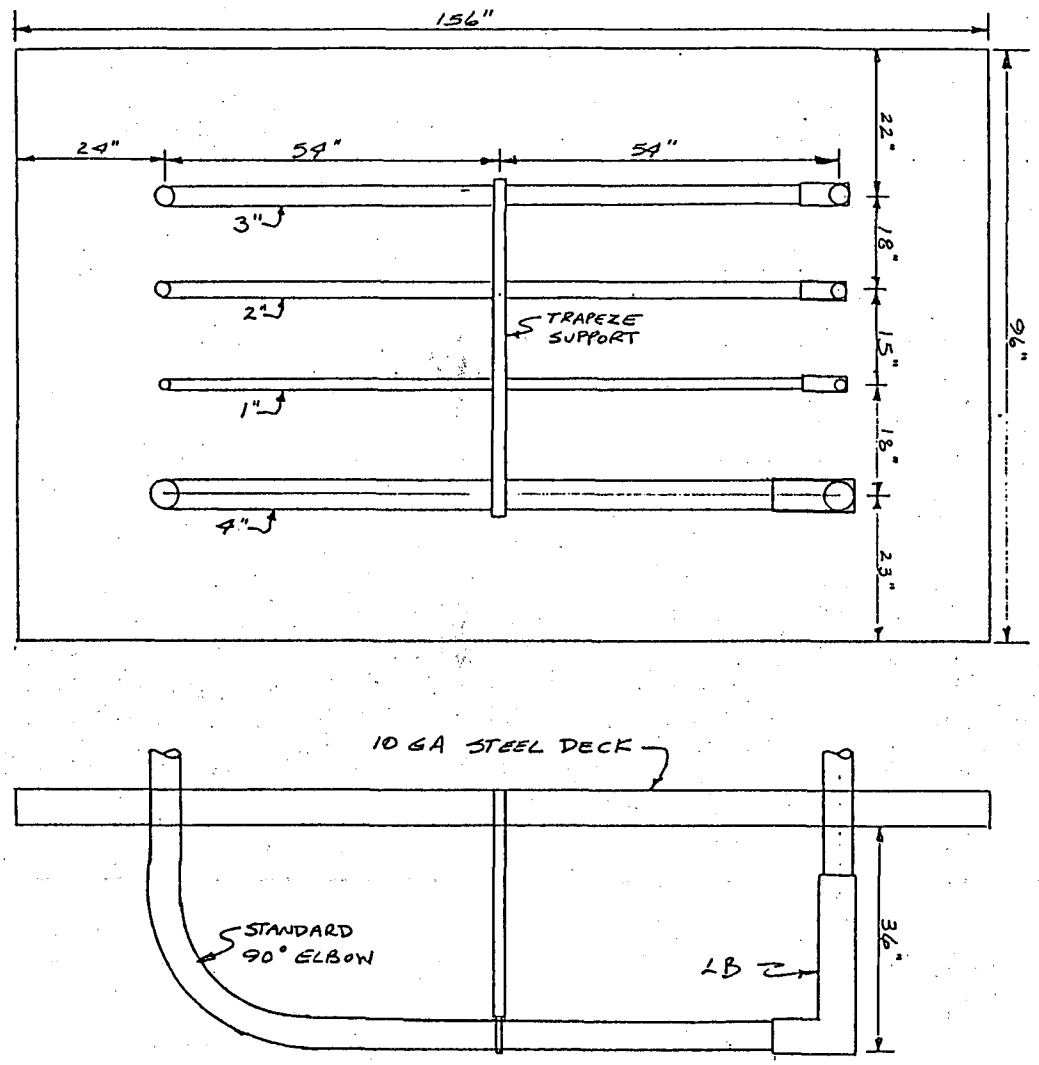
a) Date of the test
b) Location of the test
c) Description of the test furnace and test article
d) Calibration documentation of all thermocouples
e) Qualification and certification for test personnel
f) Test procedures used
g) Acceptance criteria
h) Provide quality control records for:
   * Test article construction
   * Qualification and certification for installation and inspection personnel
   * Identification and installation of fire barrier material
   * Thermocouple locations
   * Cables, sizes, type and location
i) Computer printout and graphic results of the fire endurance test
j) All raw data
k) 35mm photographic coverage of the test project and video tape documentation of the installation of the fire barrier and fire and hose stream test.
l) Provide a chronological log (Event Log) of all activities from receipt of materials through final test report
m) A copy of the test plan and fire barrier installation procedures provided by TVA

APPENDIX A

DESIGN DRAWINGS

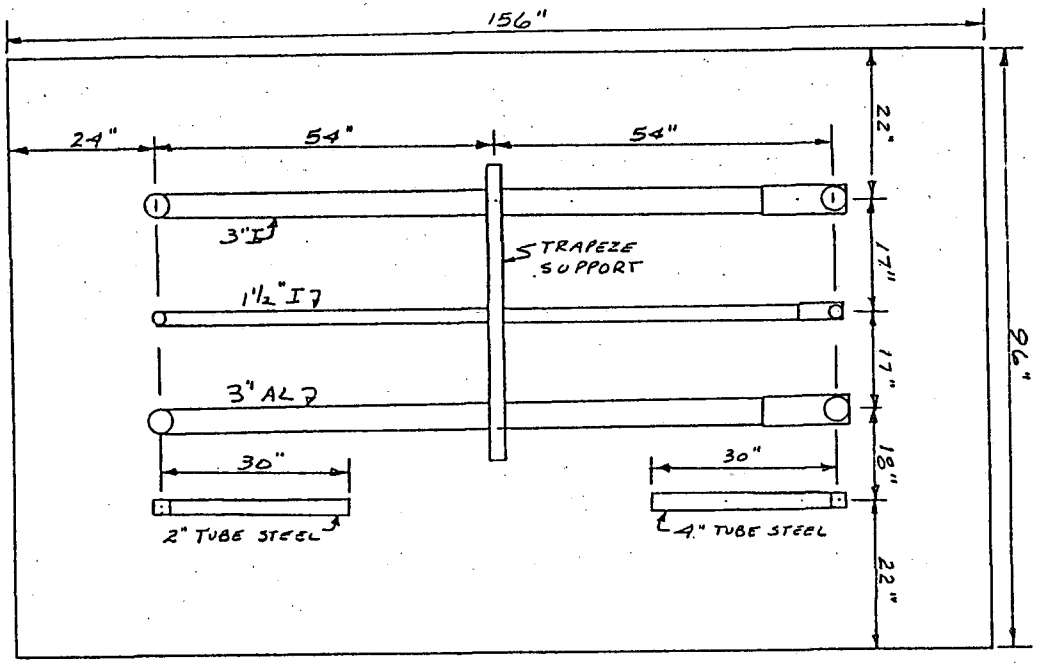
FIRE TEST DECK–4

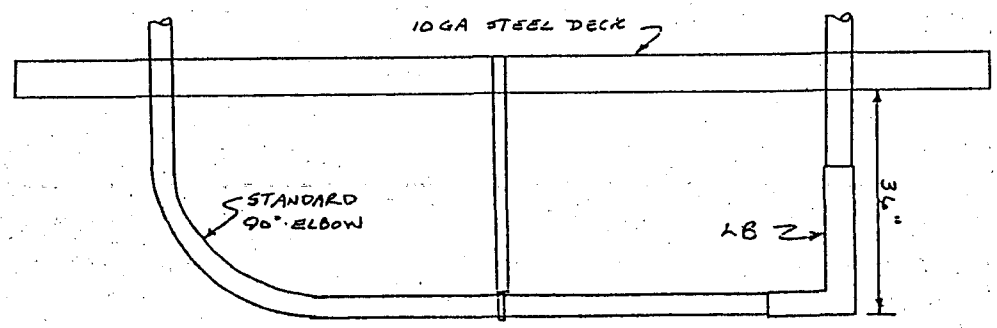
CONDUITS



FIRE TEST DECK–5

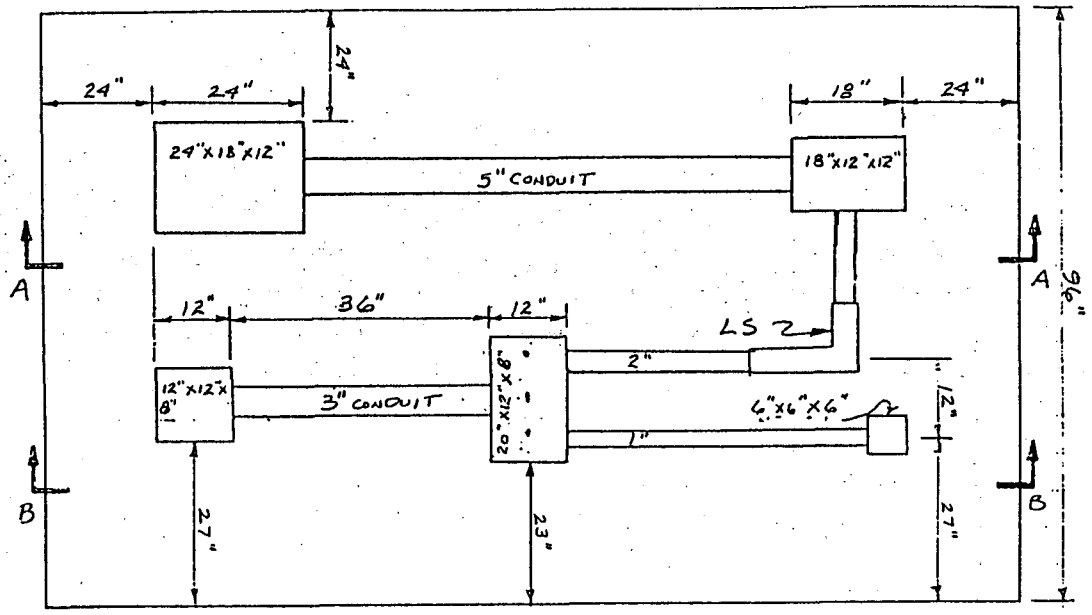
CONDUITS



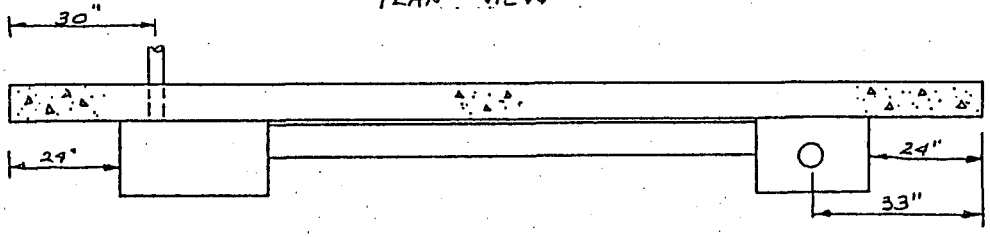


FIRE TEST DECK-6/7

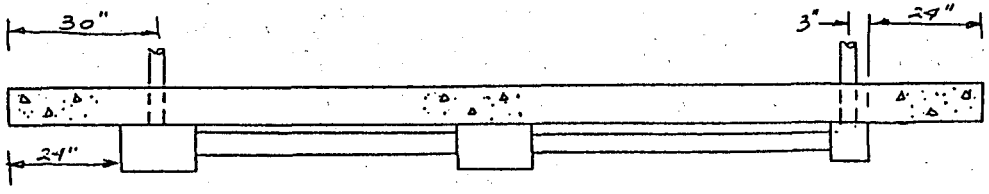
JUNCTION BOXES/MISC.



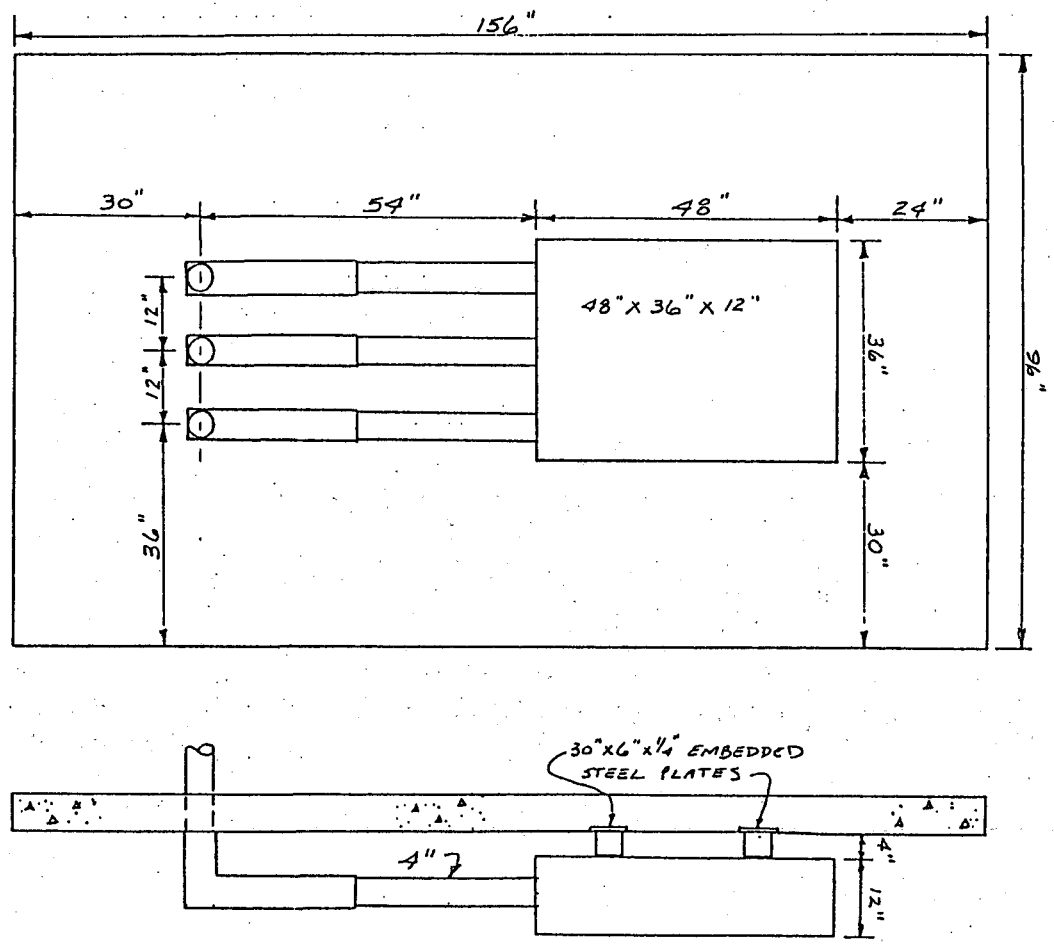
PLAN VIEW



A-A



FIRE TEST DECK-8
JUNCTION BOXES/MISC.



ENCLOSURE 3