TSI TECHNICAL NOTE 20684-BV

THERMO-LAG 330 FIRE BARRIER SYSTEM

INSTALLATION PROCEDURES MANUAL

NUCLEAR PLANT APPLICATIONS

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PREPARED FOR:

STONE & WEBSTER ENGINEERING CORPORATION

BEAVER VALLEY NUCLEAR POWER PLANT

THERMAL SCIENCE, INC. • 2200 CASSENS DR. • ST. LOUIS, MO 63026 • (314) 349-1253
Telex: Domestic 44-2384 • Overseas 209901 • Telecopier (314) 349-1207

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APPENDIX III

TO THERMAL SCIENCE, INC.'S RESPONSE TO THE

UNITED STATES NUCLEAR REGULATORY COMMISSION'S

LETTER DATED 10 SEPTEMBER 1991

Enclosure 36

TSI Technical Note 20684-BV

THERMO-LAG 330 Fire Barrier System Installation Procedures Manual

Nuclear Plant Applications Prepared For Stone & Webster Engineering

Corporation, Beaver Valley Nuclear Power Plant

REV 2 November 15, 1985

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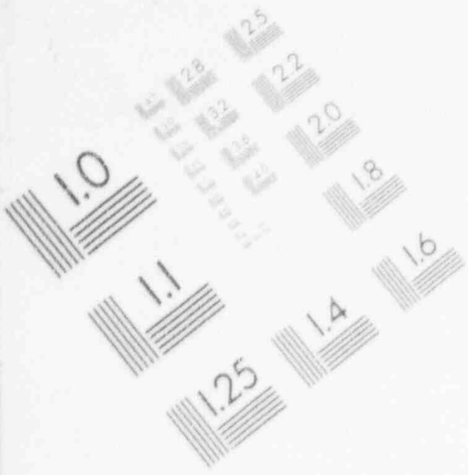
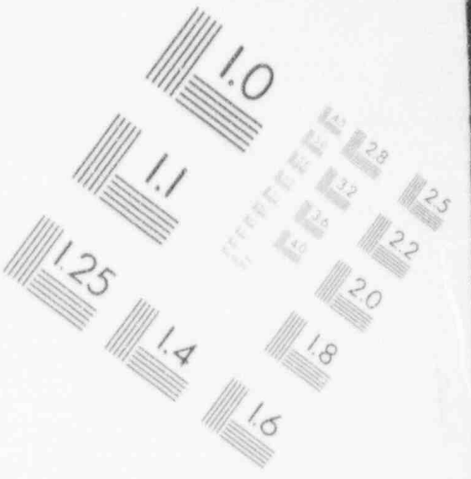
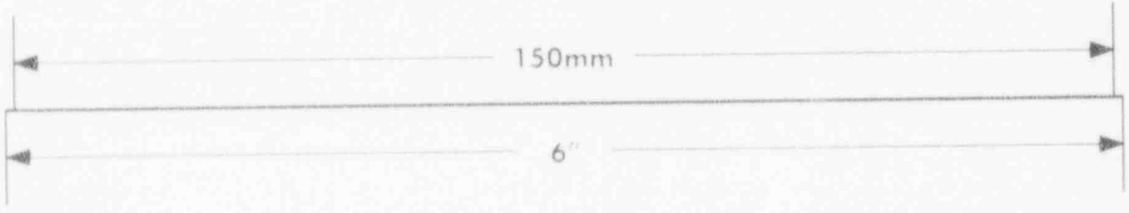
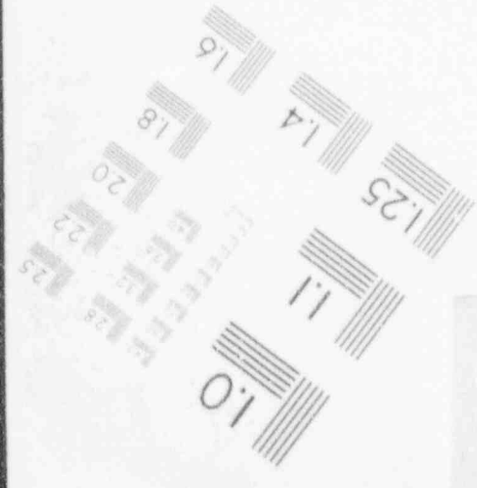
IMAGE EVALUATION TEST TARGET (MT-3)









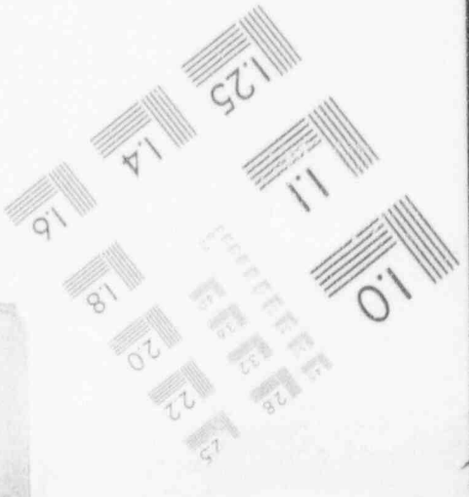


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IMAGE EVALUATION TEST TARGET (MT-3)

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LIST OF TYPICAL INSTALLATION FIGURES

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LIST OF TYPICAL INSTALLATION FIGURES CONTINUED

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THERMO-LAG 330 FIRE BARRIER SYSTEM
INSTALLATION PROCEDURES MANUAL
NUCLEAR PLANT APPLICATIONS

SECTION 1

GENERAL DESCRIPTION

SECTION I

GENERAL DESCRIPTION

1.0 INTRODUCTION

This section describes the THERMO-LAG 330 Fire Barrier System and its material components. The System is comprised of THERMO-LAG Stress Skin Type 330-69 and THERMO-LAG 330-1 Subliming Material. The System may be installed as Prefabricated Panels, Preshaped Conduit Sections, THERMO-LAG 330-660 Flexi-Blanket or by trowel methods. It is used in nuclear power plants to protect cable trays, conduit, cable drops (cables in free space), junction boxes and structural supports and hangers. THERMO-LAG 330-660 Flexi-Blanket is used in the protection of flex conduit and cable drops.

2.0 FIRE BARRIER DESIGNS

The designs of the THERMO-LAG 330 Fire Barrier System have applications in nuclear power generating installations. The designs are:

A. Prefabricated Panel Design
B. Preshaped Conduit Section Design
C. Flexi-Blanket Design

Each of these basic designs have been approved for installation in nuclear plant facilities by the American Nuclear Insurers and are installed in a number of plants accepted for operational licensing by the Nuclear Regulatory Commission.

The material components of A and B are identical. Each of the two (2) designs are comprised of THERMO-LAG Stress Skin Type 330-69 and THERMO-LAG 330-1 Subliming Material. The designs are either prefabricated or preformed at the factory.

The material components of (C) Design is a subliming high temperature, heat blocking, flexible thermal barrier reinforced on both sides with a low density fiberglass cloth, further implemented by a heat blocking thermal catalyzer. This design is prefabricated or preformed at the factory.

2.1 Prefabricated Panel Design

The Prefabricated Panel Design is fabricated and installed at the jobsite from THERMO-LAG 330-1 Prefabricated Panels. This installation involves cutting the number of sections required to form the Fire Barrier from the THERMO-LAG Prefabricated Panels and then mounting the sections on the entity to be protected using .020" minimum X .500" minimum stainless steel banding. The assembly is completed by filling in the scored areas and joints with THERMO-LAG 330-1 Subliming Material-Trowel Grade. The Prefabricated Panel Design lends itself to installations in the nuclear power generating industry and is used to protect cable trays, cable drops (cables in free space), conduit, junction boxes, structural supports and hangers. This design is preferred over alternative spray application designs in most nuclear power plant installations because it eliminates the overspray protection requirements of the direct spray-on method.

2.2 Preshaped Conduit Section Design

The Preshaped Conduit Section Design is shipped to the jobsite ready for installation. Installation involves mounting the preshaped conduit sections on the conduit or cable drops to form cylindrical sections around the conduit or cable drop, and then fastening the sections together with .020" minimum X .500" minimum stainless steel banding material. The precoating of the sections prior to installation and the filling in of gaps or openings at the edges or joints of the assembled sections is accomplished using THERMO-LAG 330-1 Subliming Material-Trowel Grade, as required.

The Preshaped Conduit Section Design is used in the nuclear power generating industry to protect conduit, cable drops and instrumentation tubing. As with the Prefabricated Panel Design, this design is also preferred over alternative spray application designs in most nuclear power plant installations because it eliminates the overspray protection requirements of direct spray-on methods.

2.3 Flexi-Blanket Design

The THERMO-LAG 330-660 Flexi-Blanket Thermal Barrier is a subliming, high temperature, heat blocking, flexible thermal barrier. It is reinforced on both sides with a low density fiberglass cloth, further implemented by a heat blocking thermal catalyzer.

The one hour fire rated design of the THERMO-LAG 330-660 Flexi-Blanket Thermal Barrier System is comprised on two (2) each 0.250 inch nominal thickness layers. The three hour fire rated design of the THERMO-LAG 330-660 Flexi-Blanket Thermal Barrier is comprised of five (5) each 0.250 inch nominal thickness layers. THERMO-LAG Fire Retardant Adhesive is used to seal the overlap seams of the Flexi-Blanket layers and THERMO-LAG 330-660 Bulk Grade Material is used to fill all joints and openings.

3.0 MATERIAL COMPONENTS

The material components which are utilized in the various designs of the THERMO-LAG 330 Fire Barrier System are as follows:

3.1 THERMO-LAG Stress Skin Type 330-69

This material provides the strong mechanical base for the THERMO-LAG 330-1 Subliming Material. It is comprised of a pretreated open weave, self stiffened, steel mesh and is used to provide an enclosure over cable trays, conduits and other items.

3.2 THERMO-LAG 330-1 Subliming Material

This material provides the level of fire resistance specified for the installation. It is a water based, subliming, thermally activated fire resistive material which volatilizes at fixed temperatures, exhibits a volume increase through the formation of a multi-cellular matrix, and blocks heat to protect the substrate material to which it is applied.

This material will be supplied in a trowel grade consistency (THERMO-LAG 330-1 Subliming Material - Trowel Grade) which is suitable for troweling or caulking type applications. It is used in the fabrication of Prefabricated Panels and Preshaped or Preformed Sections.

3.3 THERMO-LAG 330-660 Flexi-Blanket Thermal Barrier

This is a subliming, high temperature, heat blocking, flexible, thermal barrier. It is reinforced on both sides with a low density, fiberglass cloth, further implemented by a heat blocking thermal catalyzer. This material is applied in the required thickness to provide the specified level of fire resistance.

3.4 Banding

The banding material for attaching the THERMO-LAG 330 Fire Barrier System, as tested is .020" minimum X .500" minimum stainless steel banding. The 18 gauge minimum standard stainless steel wire can be used to install THERMO-LAG 300-600 Flexi-Blanket Thermal Barrier.

A required on site quality control procedure is shown in Section III.

SECTION I

GENERAL DESCRIPTION

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The Preshaped Conduit Section Design is used in the nuclear power generating industry to protect conduit, cable drops and instrumentation tubing. As with the Prefabricated Panel Design, this design is also preferred over alternative spray application designs in most nuclear power plant installations because it eliminates the overspray protection requirements of direct spray-on methods.

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The material components which are utilized in the various designs of the THERMO-LAG 330 Fire Barrier System are as follows:

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3.2 THERMO-LAG 330-1 Subliming Material

This material provides the level of fire resistance specified for the installation. It is a water based, subliming, thermally activated fire resistive material which volatilizes at fixed temperatures, exhibits a volume increase through the formation of a multi-cellular matrix, and blocks heat to protect the substrate material to which it is applied.

This material will be supplied in a trowel grade consistency (THERMO-LAG 330-1 Subliming Material - Trowel Grade) which is suitable for troweling or caulking type applications. It is used in the fabrication of Prefabricated Panels and Preshaped or Preformed Sections.

3.3 THERMO-LAG 330-660 Flexi-Blanket Thermal Barrier

This is a subliming, high temperature, heat blocking, flexible, thermal barrier. It is reinforced on both sides with a low density, fiberglass cloth, further implemented by a heat blocking thermal catalyzer. This material is applied in the required thickness to provide the specified level of fire resistance.

3.4 Banding

The banding material for attaching the THERMO-LAG 330 Fire Barrier System, as tested is .020" minimum X .500" minimum stainless steel banding. The 18 gauge minimum standard stainless steel wire can be used to install THERMO-LAG 300-600 Flexi-Blanket Thermal Barrier.

A required on site quality control procedure is shown in Section III.

4.0 Primary Raceway Supports and All Penetrations into The THERMO-LAG 330 Fire Barrier System

A. Structural steel supports forming a part or supporting the THERMO-LAG 330 fire barrier system, structures and components contained therein which are important to safe shutdown should be protected to provide fire resistance equivalent to that required by the barrier.

B. To prevent heat transfer into the fire barrier system all penetrations (i.e. secondary supports, electrical or seismic) into the fire barrier system, should be fire protected to the same level of fire resistance as the raceway for a distance of at least 18 in. minimum as measured from the outer surface of the fire barrier; covering all continuous paths. (A fire test report regarding the eighteen inch (18") minimum fire protection requirement is presented in TSI's Technical Note 84-12-181 - See Attachment 1).

TSI TECHNICAL NOTE 20684-BV

THERMO-LAG 330 FIRE BARRIER SYSTEM

INSTALLATION PROCEDURES MANUAL

NUCLEAR PLANT APPLICATIONS

SECTION II

INSTALLATION PROCEDURES

SECTION II

INSTALLATION PROCEDURES

This section sets forth the sequential steps involved in the installation of the THERMO-LAG 330 Fire Barrier System to cable trays, conduit, cable drops, junction boxes, structural supports and hangers.

1.0 PRE-APPLICATION PRACTICES

1.1 Qualification of Contractor

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

1.2 Safety Precautions

On site safety standards to apply - reference Thermal Science, Inc. Material Safety Data Sheets. (See Section IV).

1.3 Delivery

The THERMO-LAG 330 Fire Barrier System materials shall be delivered to the jobsite on pallets or in original containers which show the product name, color, name of the manufacturer, and in case of bulk material, the expiration date.

1.4 Storage

The THERMO-LAG 330 Fire Barrier System materials shall be stored off the ground when not in use in totally enclosed and weather protected areas provided for this purpose.

The Prefabricated Panels, Preshaped Conduit Sections and Flexi-Blanket do not require any temperature protection. THERMO-LAG 330-1 Trowel Grade and 330-660 Bulk Grade material shall be protected against freezing and from temperatures above 100F.

2.0 PREFABRICATED PANEL READY ACCESS DESIGNS FOR CABLE TRAYS

Installation of the Prefabricated Panel Ready Access Design to cable trays involves cutting the number of sections required to form the Fire Barrier from one or three hour fire rated THERMO-LAG Prefabricated Panels, and then mounting the sections on the cable tray to be protected using .020" minimum X .500" minimum stainless steel banding. The sequential steps involved in installing this fire barrier design onto the cable trays are described in the following paragraphs.

2.1 Installation of the One Hour Ready Access Fire Barrier Design

2.1.1 Cut a piece of material large enough to form the bottom section from a one hour rated Prefabricated Panel. The width of the bottom section shall be equal to the sum of the base and both flanges plus both sides of the cable tray. The length of the bottom section shall not exceed 6.5 feet since longer sections are unwieldy and more difficult to install.

2.1.2 Form a rectangular shaped bottom section by making two 90 degree bends which provide for the side panels.

2.1.3 Cut a piece of material large enough to form the top section from a one hour rated Prefabricated Panel. The width of the top section shall be equal to the base plus both flanges of the cable tray, plus the thickness of each of the two sides of the bottom rectangular section.

2.1.4 Mount the rectangular shaped bottom section on the cable tray using .020" minimum X .500" minimum stainless steel banding as shown in Figure 1. Use a minimum of two (2) bandings per section.

2.1.5 Attach the flat top section to the installed bottom section using .020" minimum X .500" minimum stainless steel banding as shown in Figure 2. The required maximum spacing between the banding should not exceed 12 inches.

2.1.6 Attach additional top and bottom sections to previously installed sections by butt joining them together at their ends.

2.1.7 Complete the installation by filling in the edges and joints with THERMO-LAG 330-1 Subliming Material - Trowel Grade.

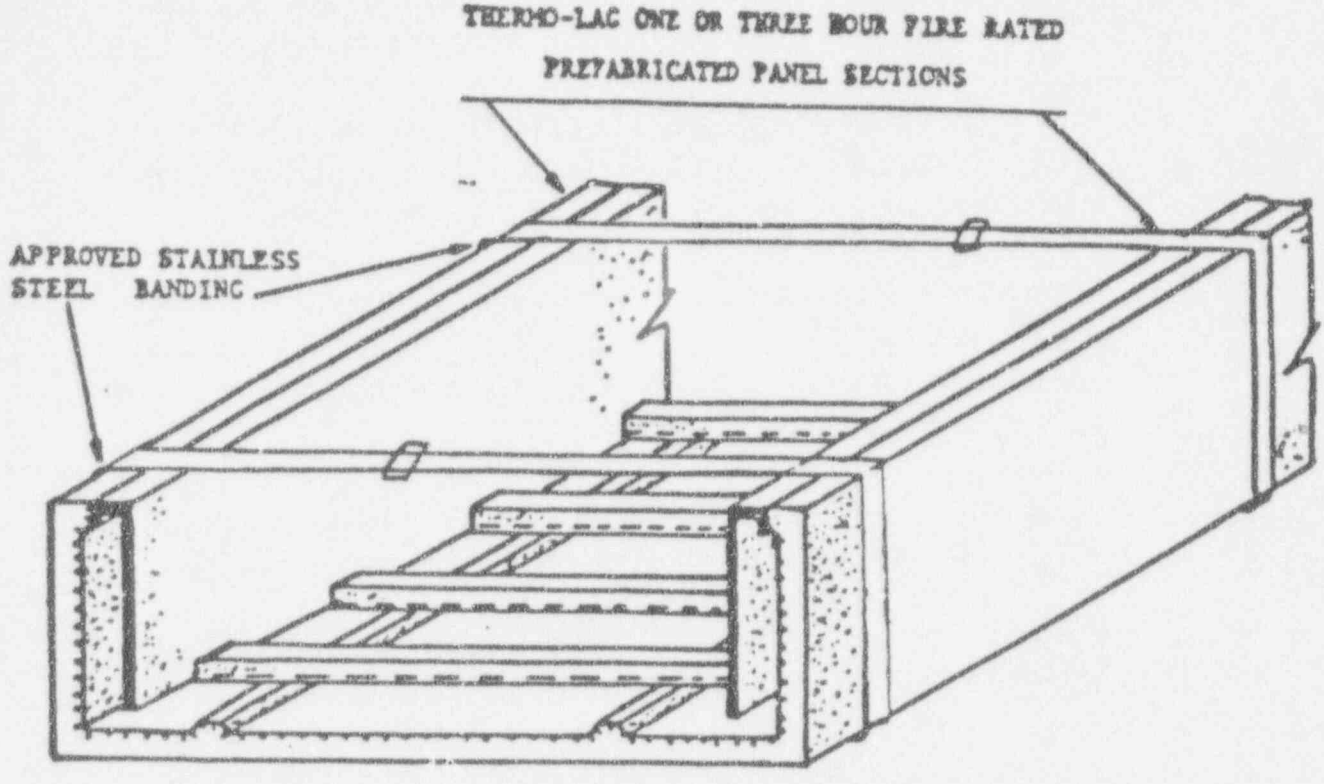
2.2 Installation of the Three Hour Ready Access Fire Barrier Design

2.2.1 Using three hour fire rated Prefabricated Panels, form and mount a three hour ready access Fire Barrier onto the cable trays following the procedures previously described in Steps 2.1.1 through 2.1.7.

3.0 PREFABRICATED PANEL DESIGN FOR JUNCTION BOXES

Installation of the Prefabricated Panel Design on a junction box involves cutting sections of one or three hour fire rated THERMO-LAG Prefabricated Panel large enough to provide a rectangular shape around the junction box and then mounting the sections onto the junction box, using .020" minimum X .500" minimum stainless steel banding. The sequential steps involved in installing the fire barrier design are described in the following paragraphs.

THERMO-LAG 330 FIRE BARRIER SYSTEM
PREFABRICATED PANEL READY ACCESS DESIGN FOR CABLE TRAYS
LADDER TRAY - BOTTOM SECTION DETAILS



TYPICAL INSTALLATION

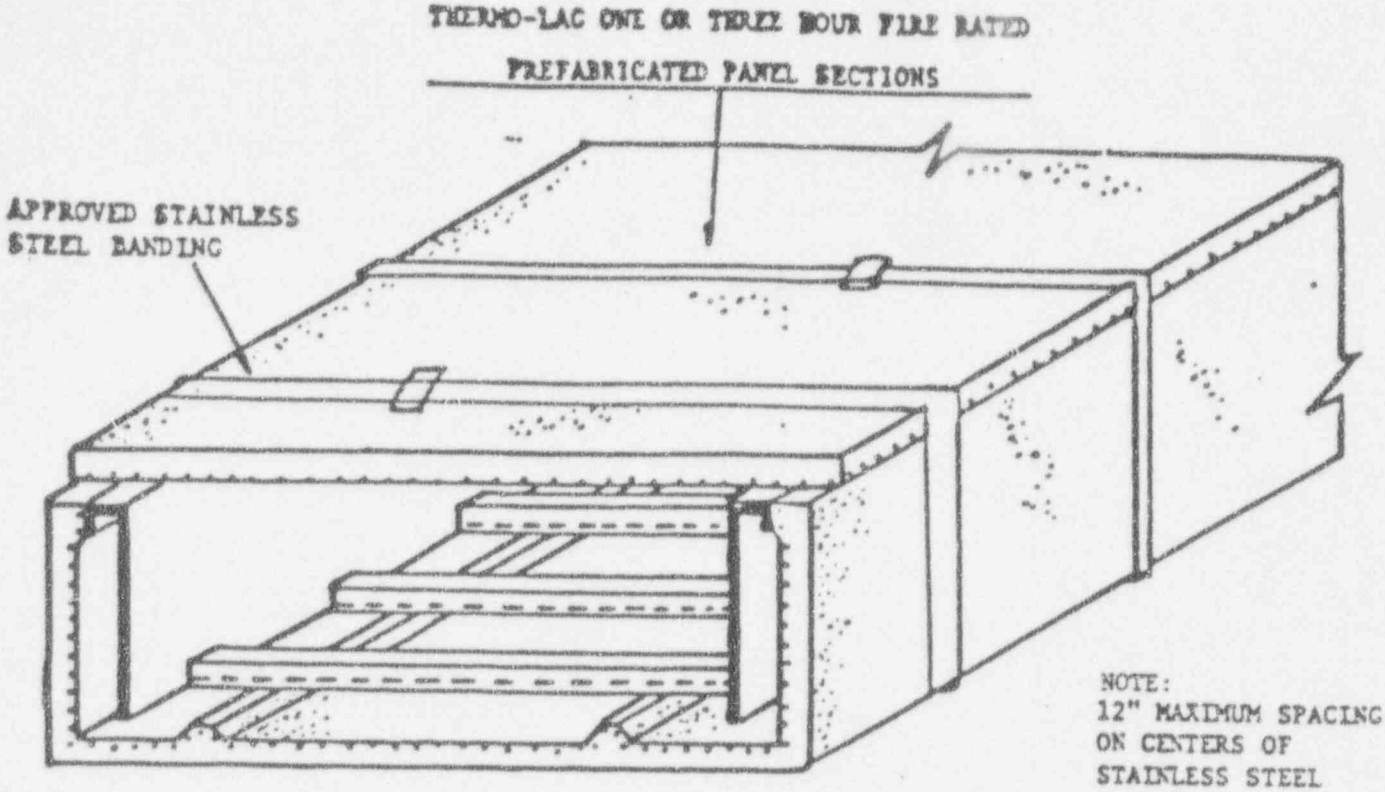
TSI, INC. 3260 BRANNON ST. LOUIS, MO. 631

NONE

2-6-84

THERMO-LAG 330 FIRE BARRIER SYSTEM PREFABRICATEI
PANEL READY ACCESS DESIGN FOR CABLE TRAYS (1 HOU
OR 3 HOUR) LADDER TRAY - BOTTOM

FIGURE



TYPICAL INSTALLATION

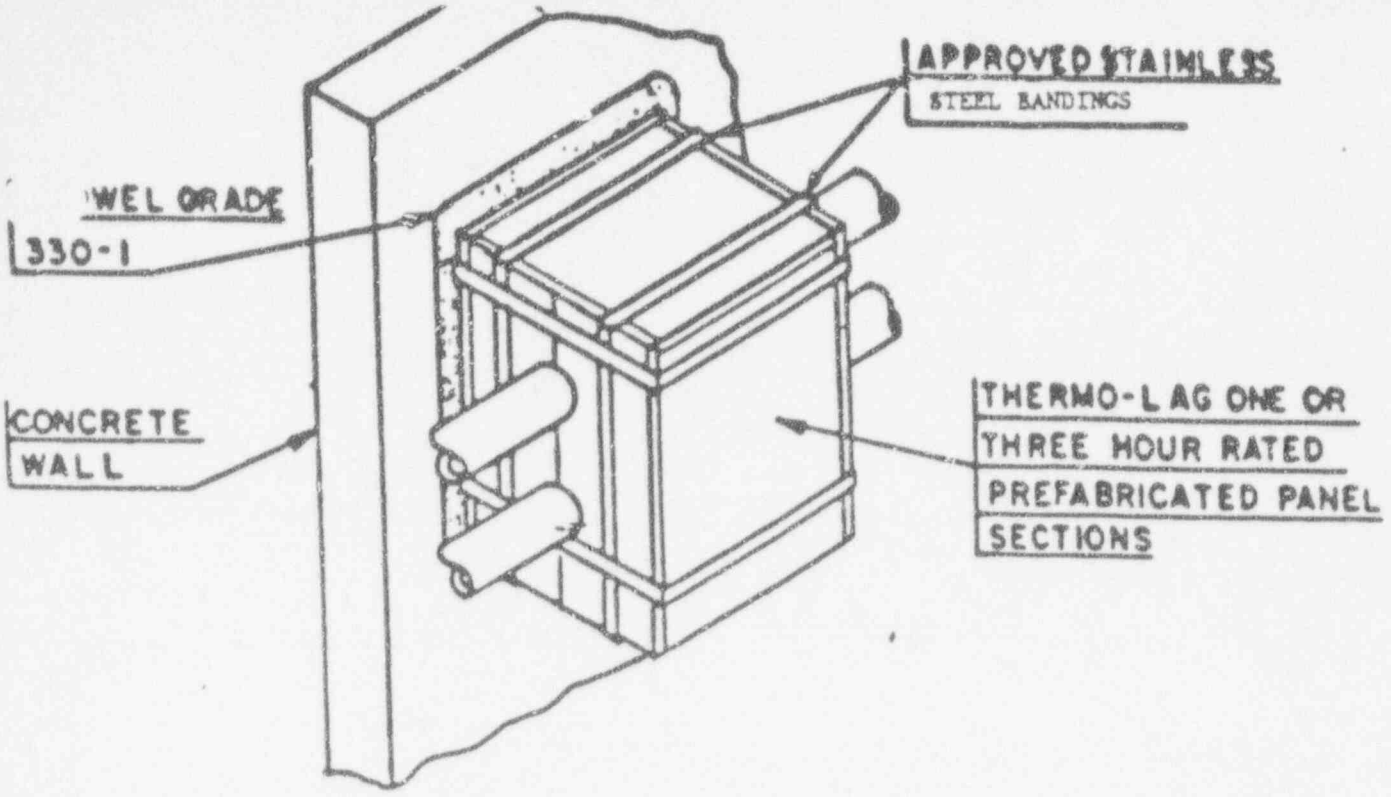
TSI, INC. 3260 BRANNON.ST.LOUIS,MO.63139.

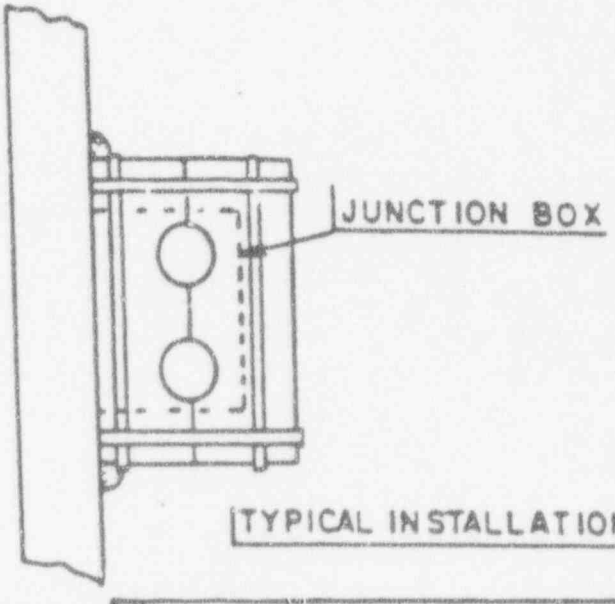
NONE		
2-7-84		

2-5

THERMO-LAG 330 FIRE BARRIER SYSTEM PREFABRICATED PANEL READY ACCESS DESIGN FOR CABLE TRAYS(1 HOUR OR 3 HOUR) LADDER TRAY FIRE BARRIER ASSEMBLY

FIGURE 2





TYPICAL INSTALLATION

TSI	2200 CASSENS DRIVE ST LOUIS, MISSOURI 63026	
...NONE		...DJ
...10-7-85		

THERMO-LAG 330 FIRE BARRIER SYSTEM PREFABRICAT
PANEL DESIGN FOR SURFACE MOUNTED JUNCTION BOX
(1 HOUR OR 3 HOUR) — FIGURE 3

3.1 Installation of One Hour Fire Barrier Design

FOR A SURFACE MOUNTED JUNCTION BOX

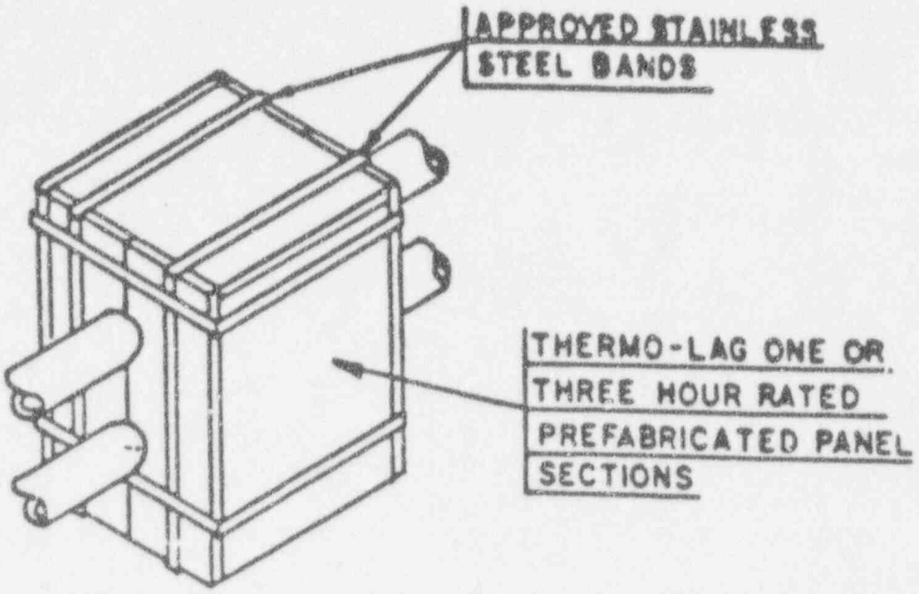
3.1.1 Cut individual sections from a one hour fire rated Prefabricated Panel large enough to form the top, front and bottom panels and when necessary top and bottom flanges of the fire barrier assembly. Ref. Figure 3.

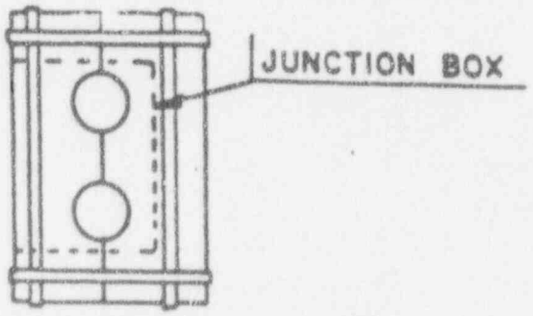
3.1.2 When attached to wall score the Prefabricated Panel section to shape the top, front and bottom panels and two flanges of the fire barrier enclosure.

3.1.3 When attached to wall form the top, front and bottom panels and top and bottom flanges by making 90 degree bends.

3.1.4 Cut two sections from a one hour fire rated Prefabricated Panel for the side panels of the fire barrier enclosure. Cut holes for conduit penetrations in the top, front and bottom panels as required and then cut the panel or panels into two pieces to facilitate installation around the conduit. Mount the side panels on the installed top, front and bottom section enclosure using the .020" minimum x .500" minimum stainless steel banding.

3.1.5 When stainless steel banding can be used around junction box wall in all directions flanges attached to the wall need not be used. Complete the installation by filling all edges and joints with THERMO-LAG 330-1 Subliming Material - Trowel Grade.





TYPICAL INSTALLATION DETAILS

TSI 2200 CASSENS DRIVE ST LOUIS, MISSOURI 63026		
NONE		
10-7-85		
THERMO-LAG 330 FIRE BARRIER SYSTEM PREFABRICAT PANEL DESIGN FOR JUNCTION BOXES WHICH ARE NOT SURFACE MOUNTED		FIGURE

FOR A JUNCTION BOX NOT SURFACE MOUNTED

3.1.6 Cut individual sections from a one hour fire rated Prefabricated Panel large enough to form the top, front and bottom panels of the fire barrier assembly. The width of the section shall be equal to the width of the junction box plus an additional 1/4 inch to provide for sufficient clearance when installed. The length shall be equal to the sum of the top, front and bottom of the junction box plus an additional 1/2 inch to provide sufficient clearance when installed. (Ref. Figure 4).

3.1.7 Cut another section from a one hour fire rated Prefabricated Panel large enough to form two sides and back of the fire barrier assembly. Cut holes for conduit penetrations in the side and back panels as required and then cut the panel or panels into two pieces to facilitate installation around the conduit.

3.1.8 Mount the fire barrier sections on the junction box and fasten the two sections together using .020" minimum X .500" minimum stainless steel banding.

3.1.9 Complete the installation by filling all edges and joints with THERMO-LAG 330-1 Subliming Material - Trowel Grade.

3.2 Installation of Three Hour Fire Barrier Design

3.2.1 Using a three hour fire rated Prefabricated Panel, form and mount a three hour fire barrier enclosure on the junction box following the procedures previously described in Steps 3.1.1 through 3.1.6 for surface mounted Junction Box or in steps 3.1.7 through 3.1.9 for a Junction Box not surfaced mounted.

4.0 PRESHAPED CONDUIT SECTION DESIGN FOR CONDUIT

Installation of the THERMO-LAG Preshaped Conduit Section Design on conduit, involves mounting two of the semi-circular preshaped conduit sections at a time, and fastening them together using .020" minimum X .500" minimum stainless steel banding. The sequential steps involved in installing this fire barrier design are described in the following paragraphs.

4.1 Installation of One Hour Fire Barrier Design

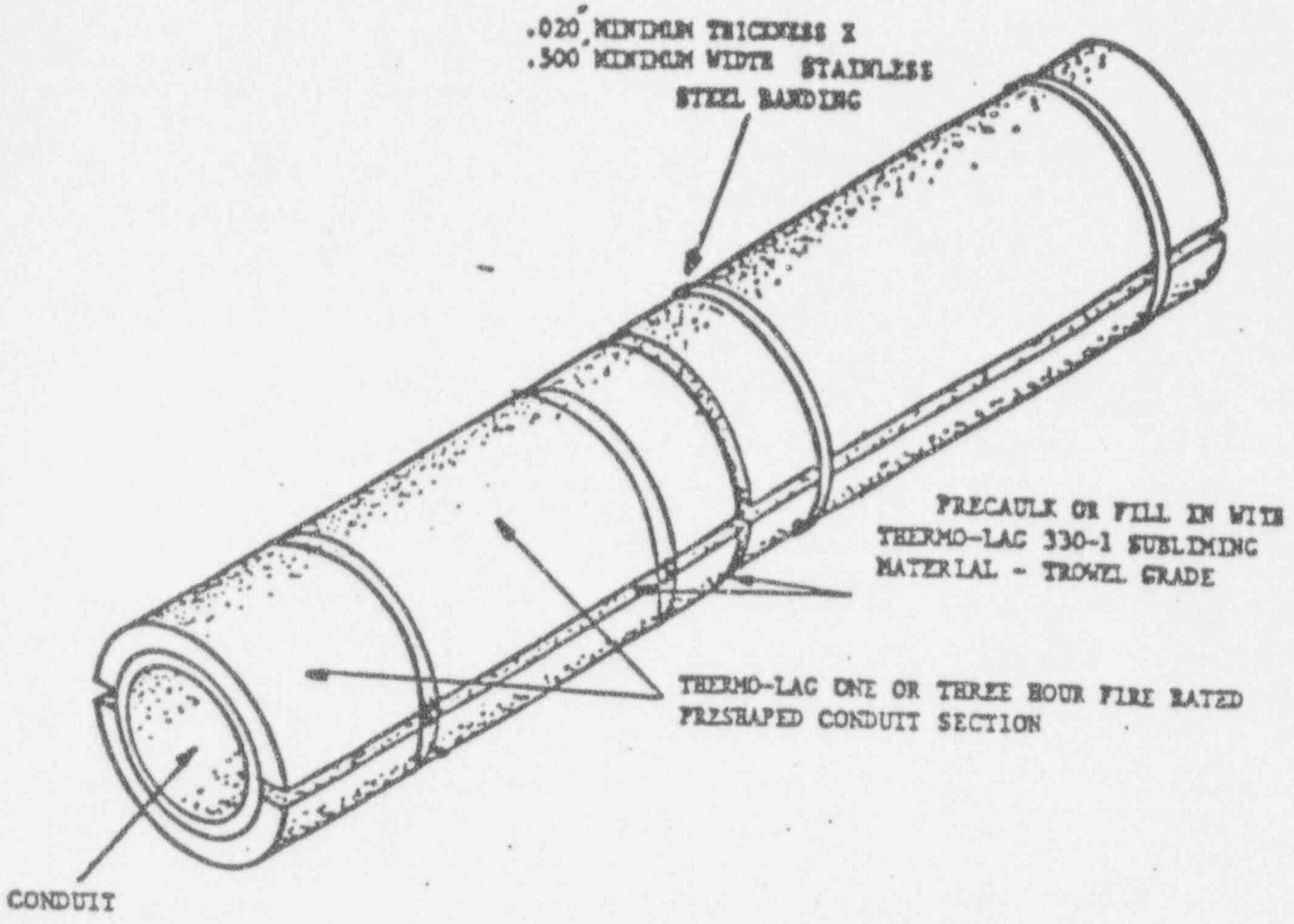
4.1.1 Precoat the edges on one of the one hour fire rated THERMO-LAG Preshaped Conduit sections with a one quarter to a one half inch bead of THERMO-LAG 330-1 Subliming Material - Trowel Grade.

4.1.2 Mount the coated section and one other one hour fire rated section on the conduit with the edges flush with each other to form a cylindrical section around the conduit. Fasten the two sections together using .020" minimum X .500" minimum stainless steel banding installed at 12 inch intervals, maximum, as shown in Figure 5.

4.1.3 Apply a one quarter to one half inch bead of THERMO-LAG 330-1 Subliming Material - Trowel Grade to the end of the installed section, and attach the next section making sure that the ends are butted and flush.

AS AN OPTION

4.1.4 Assemble two one hour Preshaped Conduit Sections on the conduit without preapplication of the THERMO-LAG 330-1 Subliming Material-Trowel Grade to the edges and end joints. After installation, fill in all gaps or openings at the edges or joints with THERMO-LAG 330-1 Subliming Material - Trowel Grade.



TYPICAL INSTALLATION

TSI, INC. 3260 BRANNON ST. LOUIS, MO. 63139.		
NONE		2 DWGS
2-7-84		
THERMO-LAG 330 FIRE BARRIER SYSTEM PRESHAPED CONDUIT DESIGN FOR CONDUITS (1 HOUR OR 3 HOUR)		FIGURE 5

4.2 Installation of Three Hour Fire Barrier Design

4.2.1 Using the three hour fire rated THERMO-LAG Preshaped Conduit Sections, install a three hour fire barrier on the conduit following the procedures previously described in Steps 4.1.1 through 4.1.3.

AS AN OPTION

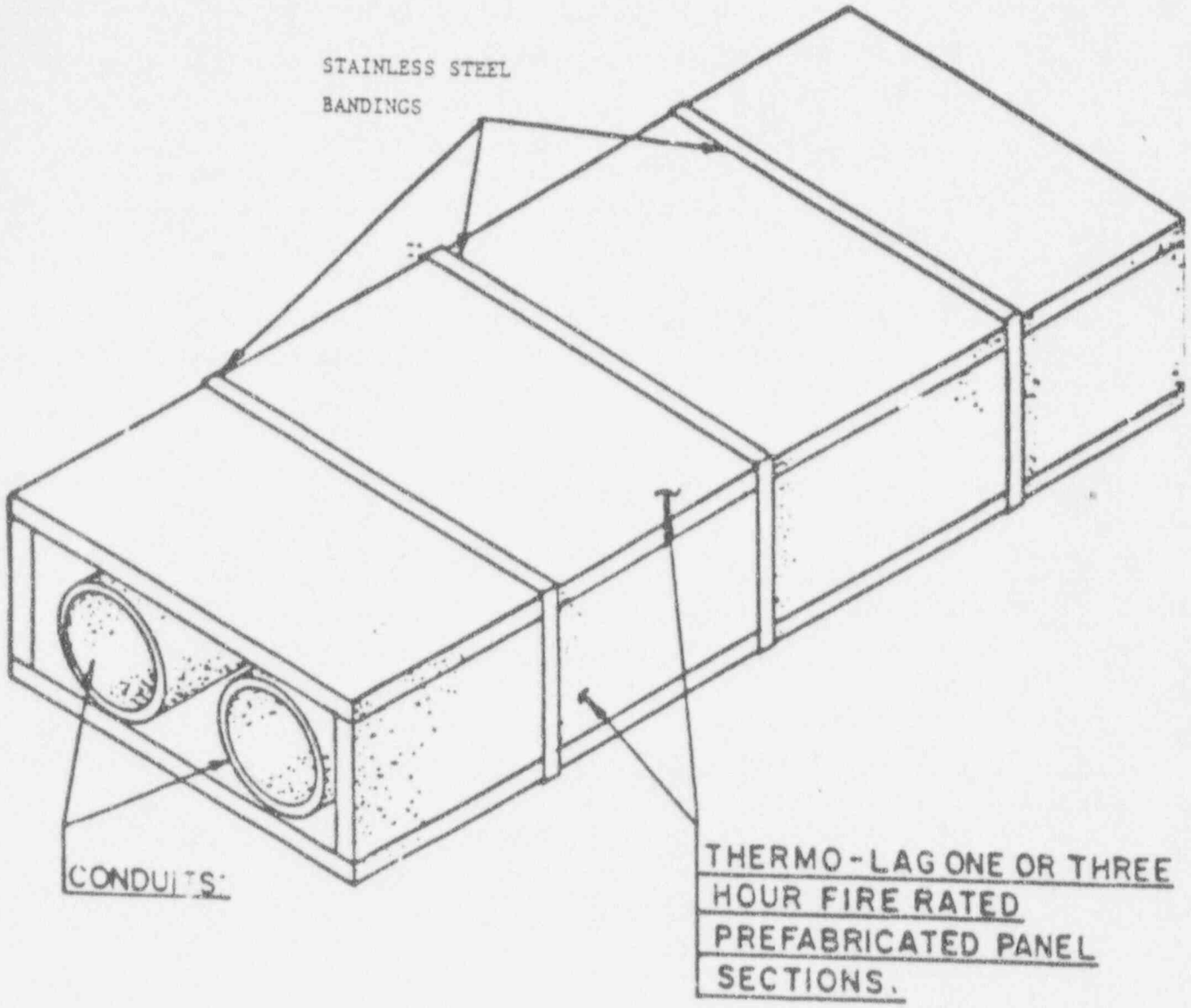
4.2.2 Using the three hour fire rated Preshaped Conduit Section, install a three hour fire barrier on conduit following the procedure described in Step 4.1.4.

5.0 PREFABRICATED PANEL DESIGN FOR TWO OR MORE CONDUITS

Installation of the Prefabricated Panel Design on two (2) or more conduits involved cutting and forming box sections from one hour or three hour fire rated THERMO-LAG Prefabricated Panels, and then mounting the sections on the conduits to be protected, using .020" minimum X .500" minimum stainless steel banding . The sequential steps involved in installing this fire barrier design are described in the following paragraphs.

5.1 Installation of One Hour Fire Barrier Design

5.1.1 Cut two equal sections from a one hour fire rated Prefabricated Panel which are large enough to enclose the conduits. The width of each section shall be equal to two times the outer diameter of the conduits. The length shall not exceed 6.5 feet since longer sections are unwieldy and more difficult to install.



TYPICAL INSTALLATION

TSI 2200 CASSENS DRIVE
ST LOUIS, MISSOURI 63026

NONE		
10-7-85		

THERMO-LAG 330 FIRE BARRIER SYSTEM PREFABRICAT PANEL DESIGN FOR 2 OR MORE CONDUITS (1 HOUR OR 3 HOUR)

FIGURE 6

2-13

5.1.2 Form the two sided bottom fire barrier section, with the Stress Skin side facing inward, by making a 90 degree bend at the middle of the first section.

5.1.3 Form the two sided top fire barrier section, with the Stress Skin side facing inward, by making a 90 degree bend at the middle of the first section.

5.1.4 Mount the top and bottom fire barrier sections on the conduits to form a box design and then fasten the two sections together, using .020" minimum x .500" minimum stainless steel banding as shown in Figure 6.

5.1.5 Attach addition top and bottom fire barrier sections to previously installed sections by butt joining them together at their ends.

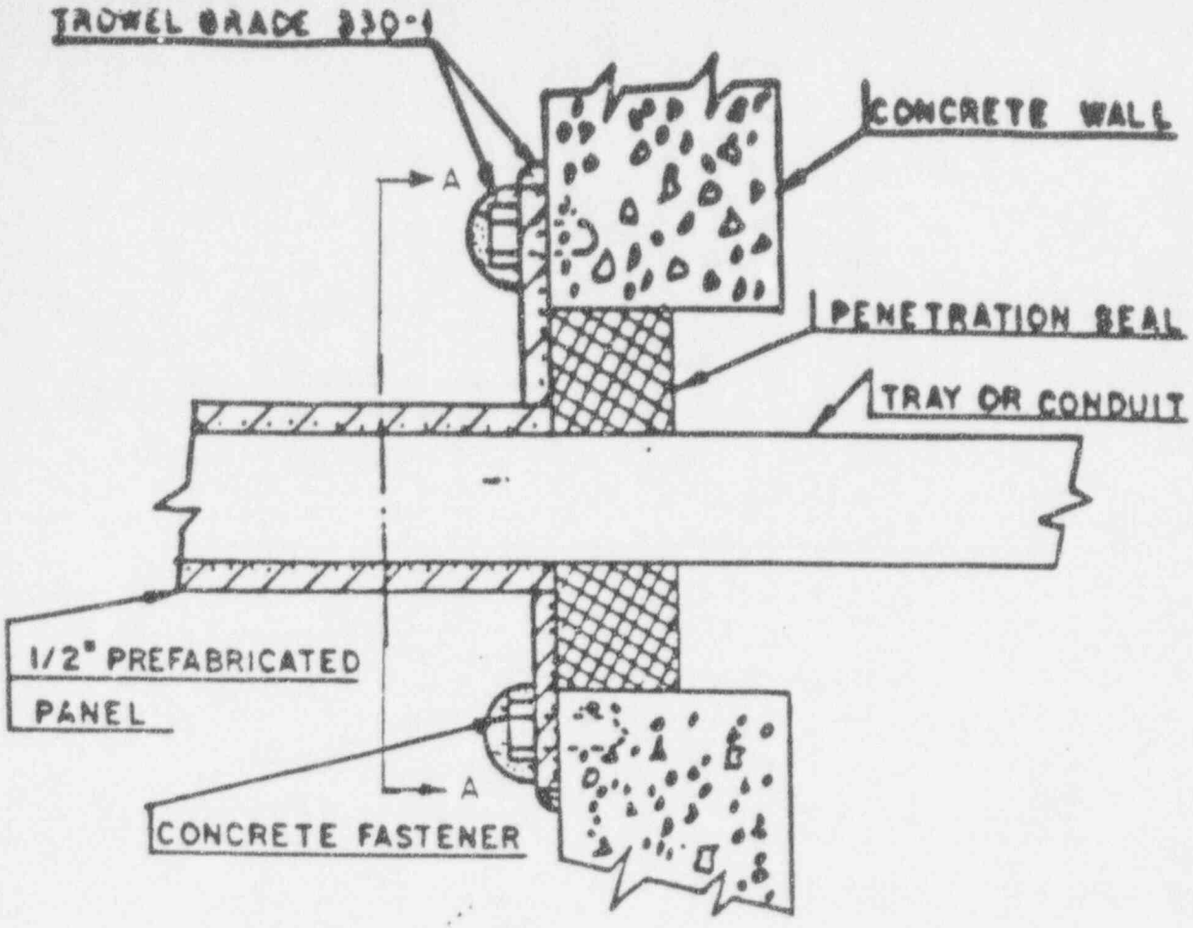
5.1.6 Complete the installation by filling in the edges and joints with THERMO-LAG 330-1 Subliming Material - Trowel Grade.

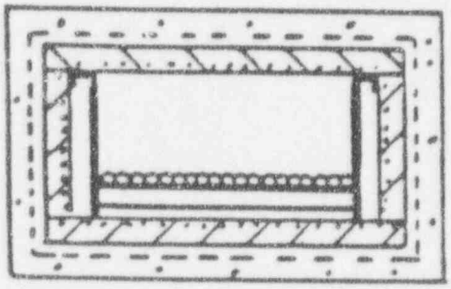
5.2 Installation of Three Hour Ready Access Fire Barrier Design

5.2.1 Using three hour fire rated Prefabricated Panels, form and mount a three hour fire barrier on conduits following the procedure previously described in Steps 5.1.1 through 5.1.6.

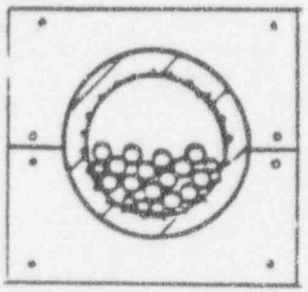
6.0 INTERFACES

Installation of cable tray and conduit interfaces with penetration seals, walls, ceilings, and other raceways is accomplished using either Prefabricated Panel or direct trowel on methods. Typical installations using these methods are briefly described and illustrated in the following paragraphs.



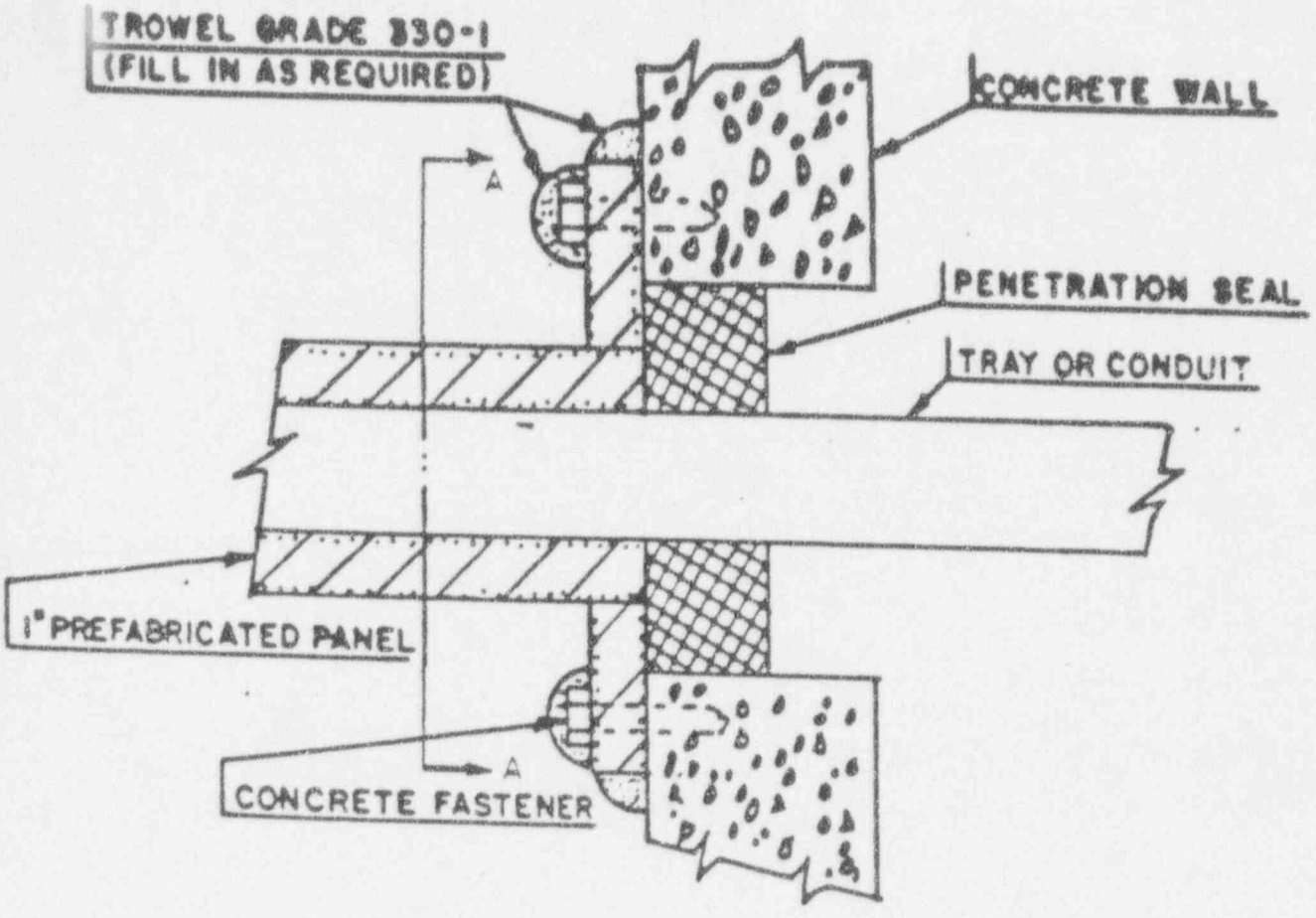


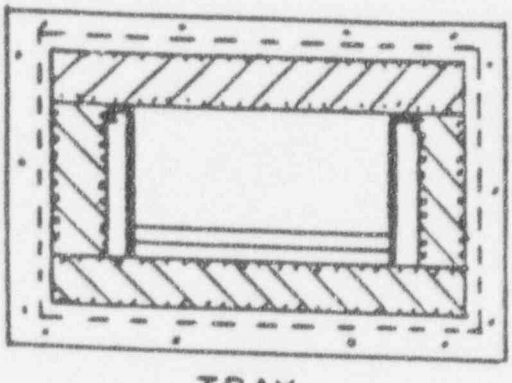
TRAY
SECTION A - A



TYPICAL INSTALLATION

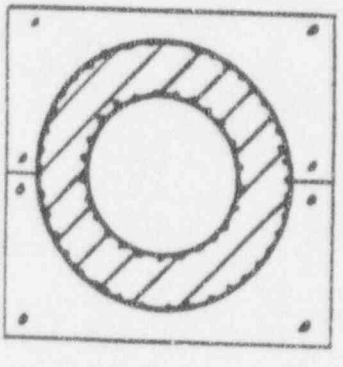
TSI TSI, Inc. 2200 CASSENS DRIVE ST LOUIS, MISSOURI 63026		
NONE		
10-7-85		
THERMO-LAG 330-1 FIRE BARRIER SYSTEM 1 HOUR ¼" MINIMUM PREFABRICATED PANEL-TYPICAL RACEWAY INTERFACING WITH PENETRATION SEAL		FIGURE 7





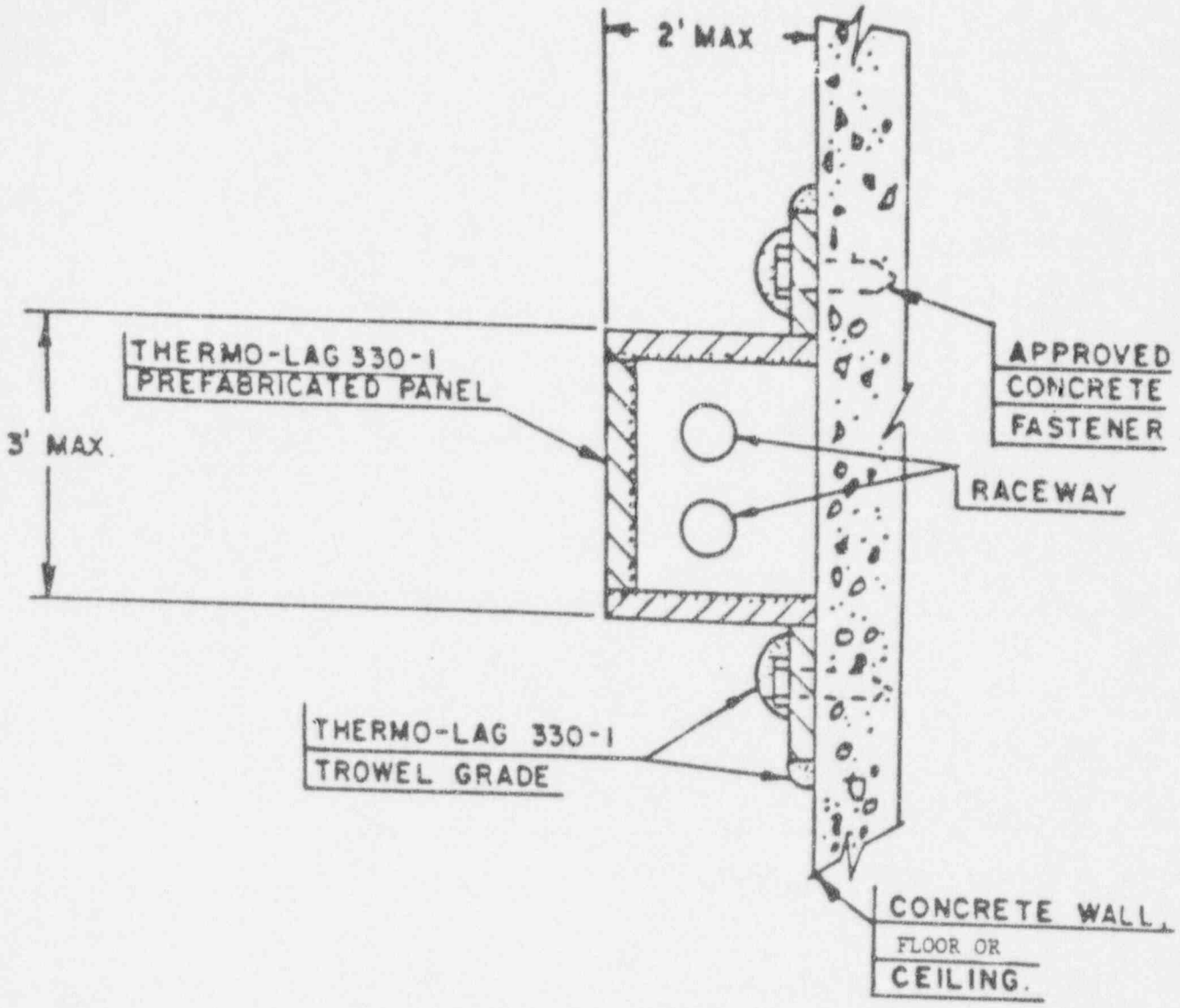
TRAY

SECTION A -- A



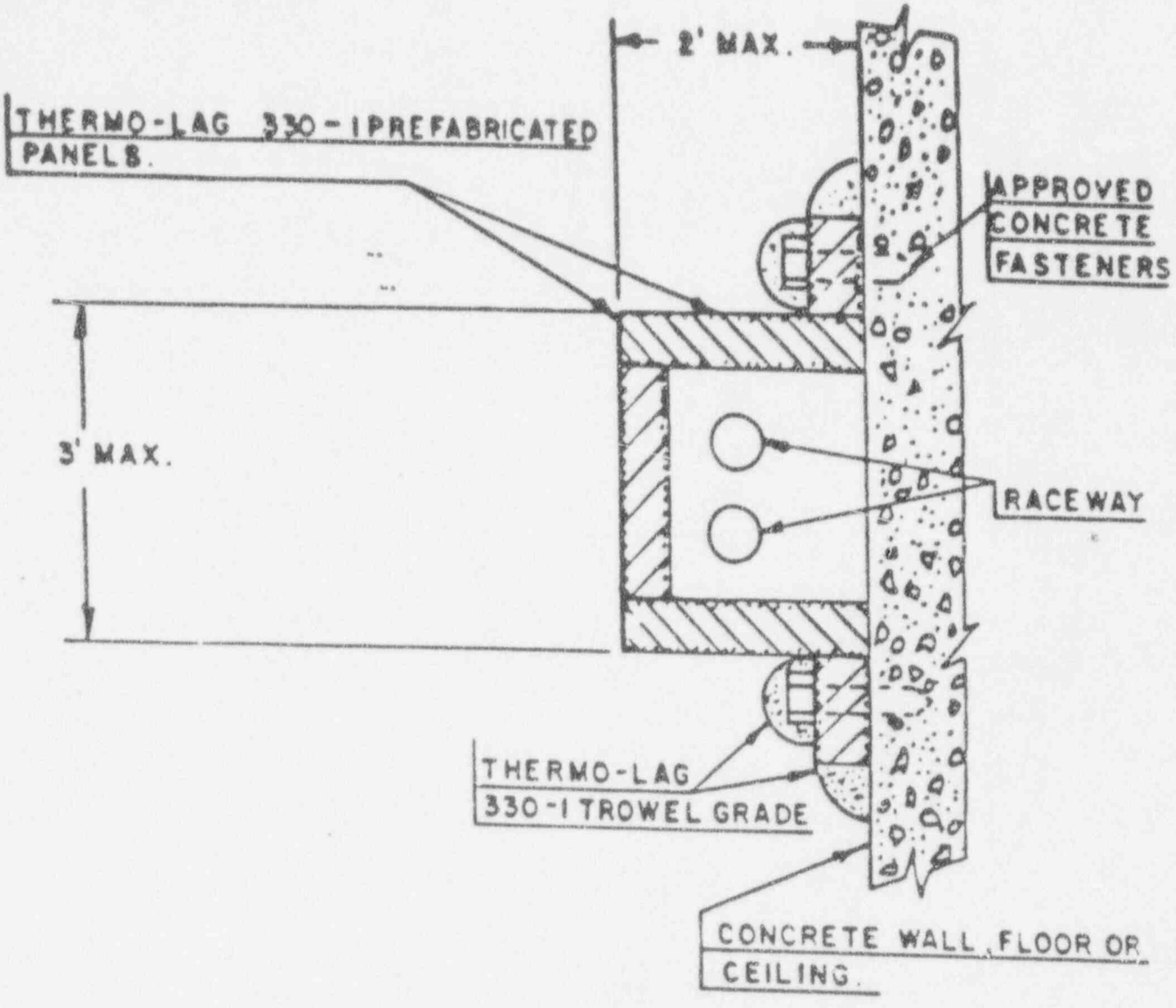
TYPICAL INSTALLATION

TSI	2200 CASSENS DRIVE ST LOUIS, MISSOURI 63026
NONE	
10-7-85	
THERMO-LAG 330-1 FIRE BARRIER SYSTEM -3 HOUR 1" MINIMUM PREFABRICATED PANEL-TYPICAL RACEWAY INTERFACING WITH PENETRATION SEAL	FIGURE 8



TYPICAL INSTALLATION

TSI 2200 CASSENS DRIVE ST LOUIS, MISSOURI 63026		
NONE		
10-7-85		
THERMO-LAG 330-1 FIRE BARRIER SYSTEM -1 HOUR ½" MINIMUM PREFABRICATED PANEL-SELF SUPPORTING SYSTEM FOR CONDUITS		FIGURE 9



TYPICAL INSTALLATION

TSI	2200 CASSENS DRIVE ST LOUIS, MISSOURI 63026
NONE	
10-7-85	
THERMO-LAG 330-1 FIRE BARRIER SYSTEM 3 HOUR 1" MINIMUM PREFABRICATED PANEL SEE SUPPORTING SYSTEM FOR CONDUITS	FIGURE 10

6.1 Installation of One or Three Hour Interfaces Between a Cable Tray or Conduit and a Penetration Seal

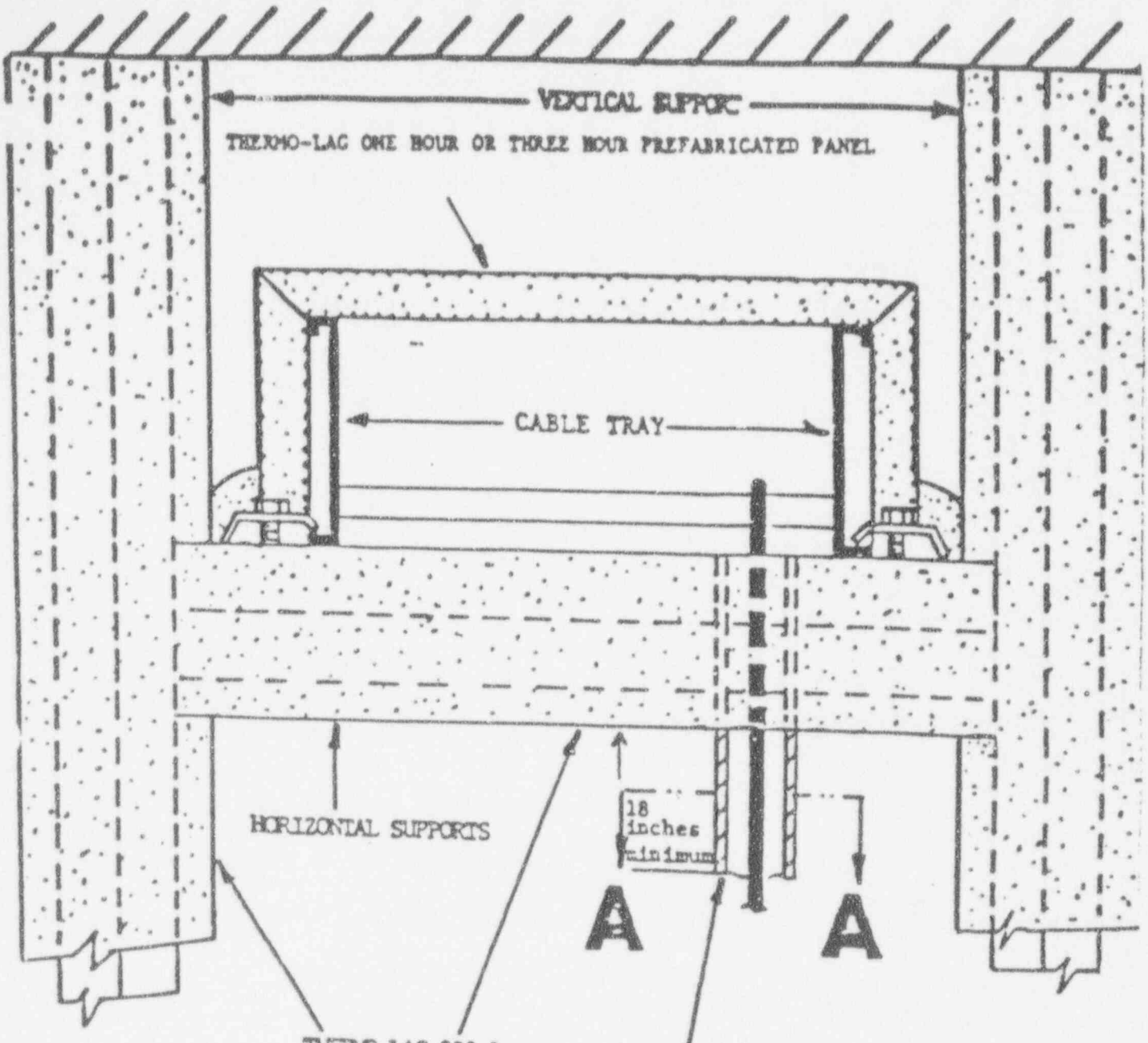
6.1.1 Cut and form a box shaped and flanged section from a one or three hour rated Prefabricated Panel as is shown in Figures 7 and 8. The minimum height of the flange shall be sufficient to cover the wall opening and accommodate approved concrete fasteners.

6.1.2 Mount the four sided and flanged section, installed at 12 inch intervals maximum between two fasteners and two per flange minimum, on the cable tray or conduit using approved concrete fasteners to fasten the section to the concrete wall. The concrete fasteners shall be site approved anchors of 1/4 inch diameter. All concrete anchors must conform to field construction procedures FCP-103 for installation. FCP should be reviewed to ensure that material will not be damaged. Use .020" minimum x .500" minimum stainless steel banding installed at 12 inch maximum intervals to secure the four sided section.

6.2 Installation of One or Three Hour Self Supporting Interface Between Conduit and a Wall or Ceiling

6.2.1 Cut and form a three sided and flanged section from a one or three hour rated prefabricated panel as shown in Figures 9 and 10. The minimum height of the flange shall be sufficient to provide for the concrete fasteners.

6.2.2 Mount the three sided and flanged section on the conduit using approved concrete fasteners to secure the section to the wall or ceiling. The fasteners should be installed at 12 inch maximum intervals with a minimum of 2 fasteners per flange. The concrete fasteners shall be site approved anchors of 1/4 inch diameter. All concrete anchors must conform to field construction procedures FCP-103 for installation. FCP should be reviewed to ensure that material will not be damaged.



SECTION **A-A**

TYPICAL INSTALLATION

TSI	3760 BRANNON AVENUE, ST LOUIS MISSOURI 6
NONE	
3-19-84	R. A. Lohman
THERMO-LAG 330-1 FIRE BARRIER SYSTEM 1 HOUR ½" MINIMUM PREFABRICATED PANEL OR 3 HOUR 1"	
MINIMUM PREFABRICATED PANEL-TYPICAL CABLE TRAY AND SUPPORT	FIGURE 1

6.2.3 Apply a coating of THERMO-LAG 330-1 Subliming Material - Trowel Grade in a nominal dry film thickness of 1/2" - 0 + 1/8" for one hour protection and 1" - 0 + 1/4" for three hour protection to the edges and joints of the installed section using a trowel or stiff bristle brush to fill in any gaps or holes.

6.3 Installation of One or Three Hour Interface Between a Cable Tray and a Rigid Conduit, Flex Conduit or Cable Drop

6.3.1 Install a one hour or three hour fire rated Prefabricated Panel Ready Access Design on the cable tray following the instructions given in Section 2.0 (Ref. Figure 11).

6.3.2 Install a one hour or three hour fire rated Preshaped Conduit section on a conduit penetrating a cable tray fire barrier for a minimum distance of eighteen inches from the point of penetration in accordance with Section I, 4.0.B.

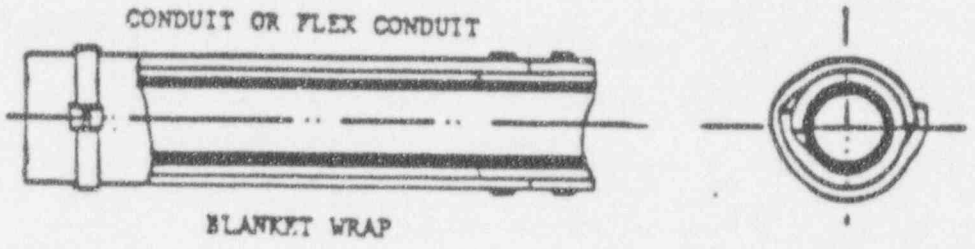
7.0 THERMO-LAG 330-660 FLEXI-BLANKET THERMAL BARRIER SYSTEM FOR FLEX CONDUIT OR CABLE DROPS

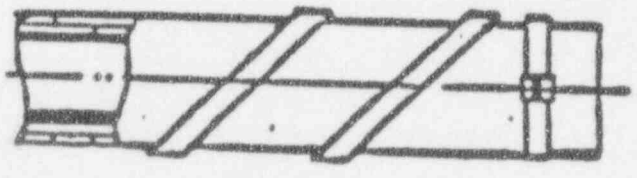
7.1 INTRODUCTION

This procedure sets forth the sequential steps involved in installing the one or three hour fire rated designs of the THERMO-LAG 330-660 Flexi-Blanket Thermal Barrier on flex conduit or cable drops.

7.2 Installation Of The One Hour Fire Rated Design

Installation of the one hour fire rated design of the THERMO-LAG 330-660 Flexi-Blanket Thermal Barrier System on conduit, flex conduit or cable drops is accomplished by using two (2) layers of the blanket or spiral wrap. Typical installations are briefly described and illustrated in the following paragraphs (Ref. Figure 12).





TYPICAL INSTALLATION

TSI 2200 CASSENS DRIVE ST. LOUIS, MISSOURI 63026		
NONE	L. J. McCue	6-85
2-28-85		
THERMO-LAG 330-660 FLEXI-BLANKET THERMAL BARRIER ONE HOUR DESIGN		
		FIGURE 12

7.2.1 Blanket Wrap Installation

7.2.1.1 Cut the first blanket wrap layer from a sheet of THERMO-LAG 330-660 Flexi-Blanket Thermal Barrier material in the width required to overlap the diameter of the flex conduit or cable drops by at least two (2) inches. The length of the first layer shall be sufficient to enclose the total or a portion of the total length of the flex conduit or cable drops.

7.2.1.2 Wrap the first layer of the Flexi-Blanket material around the flex conduit or cable drops taking care to overlap the material by at least two (2) inches.

7.2.1.3 Secure the first layer of the Flexi-Blanket material to the flex conduit or cable drops using 18 gauge minimum stainless steel wire installed at twelve (12) inch intervals.

7.2.1.4 Cut and install additional first layers of Flexi-Blanket material in the same manner as described in Steps 7.2.1.1 through 7.2.1.3, taking care to butt join the first layer pieces.

7.2.1.5 Cut the second blanket wrap layer from a sheet of THERMO-LAG 330-660 Flexi-Blanket Thermal Barrier material in the width required to overlap the installed first layer by at least two (2) inches and locate the overlap 180 degrees opposite from that of the first layer. The length of the second layer shall be at least four (4) inches less than the first layer to provide for an adequate overlap when installing an additional second layer over the first layer.

7.2.1.6 Wrap the second layer of the Flexi-Blanket material around the installed first layer taking care to overlap the material by at least two (2) inches, and locate the overlap 180 degrees opposite from that of the first layer.

7.2.1.7 Seal the overlapped seam using THERMO-LAG Fire Retardant Adhesive.

7.2.1.8 Secure the second layer of the Flexi-Blanket material around the first layer using .020" minimum X .500" minimum stainless steel banding material installed at twelve (12) inch intervals.

7.2.1.9 Cut and install additional second layers of Flexi-Blanket material in the same manner as described in Steps 7.2.1.5 through 7.2.1.7, taking care to butt join the second layer pieces and to secure the butt joint using .020" minimum X .500" minimum stainless steel banding.

7.2.1.10 Fill in any gaps and joints with the THERMO-LAG 330-660 Bulk Grade Material.

AS AN OPTION

7.2.2 Spiral Wrap Installation

7.2.2.1 Cut six inch (6") or wider strips from a sheet of THERMO-LAG 330-660 Flexi-Blanket Material. The number of six inch (6") or wider strips required shall be sufficient to completely double spiral wrap the conduit, flex conduit or cable drop.

7.2.2.2 Spiral wrap the six inch (6") or wider strips of Flexi-Blanket material around the conduit, flex conduit or cable drop taking care to overlap the seams by at least one (1) inch.

7.2.2.3 Seal the overlapped seams using THERMO-LAG Fire Retardant Adhesive.

7.2.2.4 Secure the installed first spiral wrapped layer using 18 gauge minimum stainless steel tie wire at twelve (12) inch intervals.

7.2.2.5 Continue the installation of the first spiral wrap layer of Flex-Blanket material as required following the procedures described in Steps 7.2.2.2 through 7.2.2.4.

7.2.2.6 Install the second spiral wrap layer of the THERMO-LAG 330-660 Flexi-Blanket Thermal Barrier material in the same manner as the first layer and oriented in the same direction.

7.2.2.7 Seal the overlapped seams of the second spiral wrapped layer using THERMO-LAG Fire Retardant Adhesive.

7.2.2.8 Secure the second spiral wrapped layer around the installed first spiral wrapped layer using 0.020" x 0.500" minimum stainless steel banding material at twelve (12) inch intervals.

7.2.2.9 Fill in any gaps and joints with THERMO-LAG 330-660 Grade Material.

7.3 Installation Of The Three Hour Fire Rated Design

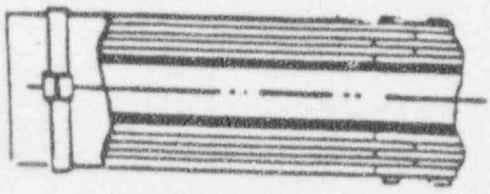
Installation of the three hour fire rated design of the THERMO-LAG 330-660 Flexi-Blanket Thermal Barrier System on flex conduit and cable drops is accomplished by using five (5) layers of the blanket or spiral wrap. Typical installations are briefly described and illustrated in the following paragraphs (Ref. Figure 13).

7.3.1 Blanket Wrap Installation

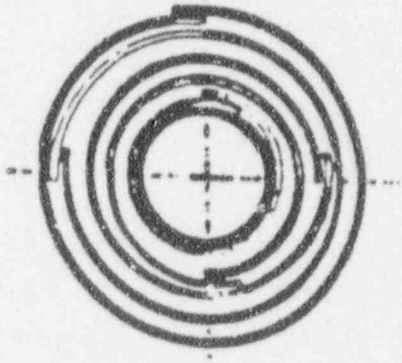
7.3.1.1 Cut the first blanket wrap layer from a sheet of THERMO-LAG 330-660 Flexi-Blanket Thermal Barrier material in the width required to overlap the diameter of the flex conduit or cable drop by at least two (2) inches. The length of the first layer shall be sufficient to enclose the total or a portion of the total length of the flex conduit or cable drop.

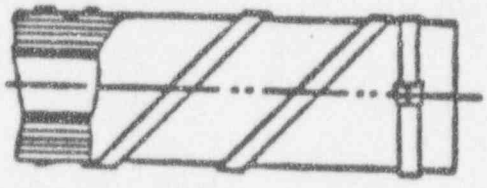
7.3.1.2 Install the first blanket wrap layer of Flexi-Blanket material in the same manner as described in Steps 7.2.1.2 through 7.2.1.3 for the one hour fire rated design.

CONDUIT OR FLEX CONDUIT



BLANKET WRAP





SPIRAL WRAP

TYPICAL INSTALLATION

TSI	2200 CESSEN DRIVE FENTON, MISSOURI 63	
NONE		
4-19-85		

THERMO-LAG 330-660 FLEXI BLANKET THERMAL BARRIE
THREE HOUR DESIGN

FIGURE 13

7.3.1.3 Cut the second blanket layer of Flexi-Blanket material in the width required to overlap the installed first layer by at least two (2) inches. The length of the second layer shall be at least four (4) inches less than the first layer to provide for an adequate overlap when installing an additional second layer over the first layer.

7.3.1.4 Install the second blanket wrap layer of Flexi-Blanket material in the same manner as the first layer described in Steps 7.2.1.5 through 7.2.1.8 except eliminating sealing the overlapped seams with the THERMO-LAG Fire Retardant Adhesive.

7.3.1.5 Install the third blanket wrap layer of Flexi-Blanket material in the same manner as the second layer described in Steps 7.2.1.5 through 7.2.1.8 except eliminating sealing the overlapped seams with the THERMO-LAG Fire Retardant Adhesive and positioning the overlap 90 degrees from that of the second layer.

7.3.1.6 Install the fourth blanket wrap layer of Flexi-Blanket material in the same manner as the second layer described in Steps 7.2.1.5 through 7.2.1.8 except eliminating sealing the overlapped seam with the THERMO-LAG Fire Retardant Adhesive and positioning the overlap 180 degrees from that of the third layer.

7.3.1.7 Install the fifth blanket wrap layer of Flexi-Blanket material in the same manner as the first layer described in Steps 7.2.1.1 through 7.2.1.3 of the one hour fire rated design except positioning the overlap 90 degrees from that of the fourth layer and sealing the overlapped seam with THERMO-LAG Fire Retardant Adhesive. Be sure that on .020" minimum X .500" minimum stainless steel banding is used to secure the installed five (5) layers at their butt joint junctions with adjoining layers.

7.3.1.8 Fill in any gaps and joints with the THERMO-LAG 330-660 Grade Material.

AS AN OPTION

7.3.2 Spiral Wrap Installation

7.3.2.1 Cut six inch (6") or wider strips from a sheet of THERMO-LAG 330-660 Flexi-Blanket Thermal Barrier material. The number of six inch (6") or wider strips required shall be sufficient to completely five (5) layer spiral wrap the conduit, flex conduit or cable drop.

7.3.2.2 Install the first spiral wrap layer of THERMO-LAG 330-660 Flexi-Blanket Thermal Barrier material following the procedures described for the first layer in Steps 7.2.2.2 through 7.2.2.5 of the one hour fire rated design.

7.3.2.3 Install the second, third and fourth spiral wrapped layers following the procedures described for the first layer in Steps 7.2.2.2 through 7.2.2.5 of the one hour fire rated design.

7.3.2.4 Install the fifth spiral wrapped layer following the procedures described for the second layer in Steps 7.2.2.6 through 7.2.2.8 of the one hour fire rated design.

7.3.2.5 Fill in any gaps and joints with the THERMO-LAG 330-660 Grade Material.

8.0 REPAIR PROCEDURES

The repair of a damaged section in a THERMO-LAG 330 Fire Barrier is easily accomplished by cutting out and removing the damaged material and then filling in the cut out section with new material.

The first step in this procedure is to remove the damaged and loose material using a knife and scraper. Care should be exercised that the damaged material is cut back until sound adhering material is reached.

The next step is to undercut the edges around the cut out section to form a beveled edge. All foreign matter is then removed from the exposed substrate surface in the cut out section.

Finally, the THERMO-LAG 330 Subliming Material is troweled into the cut out section. If necessary, several coats can be applied to achieve the desired film thickness. Care should be taken to allow for shrinkage of the repair patch by building up a slight dome shape on the surface of the patch. If the damage to the THERMO-LAG 330 Fire Barrier is significant, replace the entire damaged section with a new section using the related instructions outlined in this manual.

9.0 CABLE REPLACEMENT PROCEDURES

The replacement of a cable in a THERMO-LAG 330 Fire Barrier is accomplished by removing sections of the fire barrier, replacing the cable, and then reinstalling the sections

The first step in this procedure is to remove the required number of fire barrier sections by cutting away the material at the edges and the butt flanges.

Next, the .020" minimum X .500" minimum stainless steel banding are cut and the fire barrier section removed from the cable raceway.

After the defective cable has been replaced, the fire barrier sections are reinstalled using .020" minimum X .500" minimum stainless steel banding in accordance with the related instructions outlined in this manual. A coating of THERMO-LAG 330-1 Subliming Material - Trowel Grade is then applied in the specified wet thickness to the edges and joints of the reinstalled sections using a trowel or stiff bristle brush to fill in any uncoated areas.

10.0 POST APPLICATION PRACTICES

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

TSI TECHNICAL NOTE 20684-BV

THERMO-LAG 330 FIRE BARRIER SYSTEM

INSTALLATION PROCEDURES MANUAL

NUCLEAR PLANT APPLICATIONS

SECTION III

QUALITY CONTROL

REQUIRED ON SITE QUALITY

CONTROL PROCEDURE

The following is a required quality control procedure to be followed on site in the installation of the THERMO-LAG 330 Fire Barrier System.

RECEIVING PROCEDURES

1. Prefabricated Panels and Preshaped Conduit Sections

   a. Make a visual inspection for damage.

2. THERMO-LAG 330-1 Subliming Compound

   a. Make a visual inspection for damage.

   b. Read temperature recorder strip chart to verify that temperature limitations were not exceeded.

INSTALLATION PROCEDURES

1. Insure that the proper one hour or three hour fire barrier design has been installed.

2. Check to see that the protected entity is completely enveloped.
   Note: A concrete surface, such as a wall, ceiling or floor, can be a part of the envelope.

3. Check to see that the primary structural support of the protected entity is coated with the designated thickness to the point of attachment.

4. Insure that all seams and joints are filled and sealed with THERMO-LAG 330-1 Trowel Grade in order to prevent flame penetration into the envelope system.

5. Check to see that all fasteners, such as banding, nuts and bolts, and concrete fasteners are of the proper type and spacing.

6. Insure that all penetrations into the envelope are protected for a minimum of 18 inches from the envelope with the same fire rating as envelope.

ATTACHMENT 1

I.T.L. REPORT NO. 84-12-181

THREE HOUR FIRE ENDURANCE TEST

CONDUCTED ON A

LADDER CABLE TRAY WITH A P1000 UNISTRUT ATTACHMENT

AND TRANSITION SECTION

PROTECTED WITH THE THERMO-LAG 330 FIRE BARRIER SYSTEM

INDUSTRIAL TESTING LABORATORIES inc.

Chemists
Engineers
Metallurgists

2360 Seventh Blvd. • St. Louis, Missouri 63104 | 314/771-7111

I. T. L. REPORT NO. 84-12-181

THREE HOUR FIRE ENDURANCE TEST

CONDUCTED ON A

LADDER CABLE TRAY WITH A P1000 UNISTRUT ATTACHMENT

AND TRANSITION SECTION

PROTECTED WITH THE THERMO-LAG 330 FIRE BARRIER SYSTEM

DECEMBER 1984

REVISION 1: JANUARY 1985

I. T. L. REPORT NO. 84-12-181

TEST DATE: 13 DECEMBER 1984

TEST: THREE HOUR FIRE ENDURANCE TEST CONDUCTED ON A LADDER CABLE TRAY WITH A P1000 UNISTRUT ATTACHMENT AND TRANSITION SECTION PROTECTED WITH THE THERMO-LAG 330 FIRE BARRIER SYSTEM

LOCATION OF TEST: THERMAL SCIENCE, INC.
2200 CASSENS DRIVE
ST. LOUIS, MISSOURI 63026

WITNESSED BY
I.T.L. REPRESENTATIVE: CAMERON DUNCAN, P.E.

APPROVED: INDUSTRIAL TESTING LABORATORIES, INC.
2350 SOUTH SEVENTH BOULEVARD
ST. LOUIS, MISSOURI 63104

Allan M. Siegel

ALLAN M. SIEGEL, P.E.
DIRECTOR

DATE OF ISSUE: DECEMBER 1984

REVISION 1: JANUARY 1985

TEST ATTENDEES

Witnessing the test for Industrial Testing Laboratories, Inc.

Mr. C. Duncan

Witnessing the test for Thermal Science, Inc.

Mr. R. Feldman

Conducting the test:

Mr. W. Paddock

Operating TSI's ASTM E119 Furnace:

Mr. A. Thorpe

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THREE HOUR FIRE ENDURANCE TEST

CONDUCTED ON A

LADDER CABLE TRAY WITH A P1000 UNISTRUT ATTACHMENT

AND TRANSITION SECTION

PROTECTED WITH THE THERMO-LAG 330 FIRE BARRIER SYSTEM

1.0 INTRODUCTION AND SUMMARY

1.1 Introduction

This report presents and discusses the experimental test results obtained from performing a three hour ASTM E119 type fire endurance test, followed by a water hose stream test, on a modified ladder cable tray test assembly, protected with a one inch minimum thickness of the THERMO-LAG 330-1 Subliming Material.

The test assembly consisted of a ladder cable tray modified to include a P1000 unistrut section welded to one side of the cable tray.

An 18 inch long section of the unistrut, commencing from the point of penetration through the fire barrier and onto the fire zone, was covered with a uniform thickness of 1.2 inches of the THERMO-LAG 330-1 Subliming Material.

In addition, a flared transition design was installed on the upper leg of the cable tray at its junction with the penetration through the concrete slab, and a caulked-in flared transition design was installed on the lower leg at its penetration through the concrete slab.

THERMO-LAG 330 Prefabricated Panels, having a one inch minimum dry film thickness of the THERMO-LAG 330-1 Subliming Material, were installed on the cable tray test assembly. The panels were fastened by means of 18 ga. minimum stainless steel tie wire and 0.5" x 0.020" minimum stainless steel banding material, installed alternately at 12 inch intervals. The panel design included THERMO-LAG Stress Skin Type 330-69 on the fire and no fire sides.

A total of 142 generic power, control and instrumentation cables were installed in the cable tray test assembly, to simulate a typical power or cable tray filled to 100% of capacity (40% of cross-sectional area).

This test program was conducted in accordance with the methods and procedures set forth in American Nuclear Insurers' Bulletin #5(79) entitled: "ANI/MAERP Standard Fire Endurance Test Method To Qualify A Protective Envelope For Class 1E Electrical Circuits", and NFPA 251-1979 entitled: "Standard Methods Of Fire Tests of Building Construction and Materials."

All of the materials comprising the THERMO-LAG 330 Fire Barrier System were manufactured and applied in accordance with all applicable sections of Thermal Science's ("TSI") Nuclear Quality Assurance Program Manual/Quality Control Operating Procedures Manual, which has been previously accepted by the American Nuclear Insurers. The design configuration used in this test program is described in Section 7.0 of this test report.

1.2 Summary

Based on the results and observations of this test:

1) A P1000 unistrut, when uniformly protected with a 1.2 inch minimum dry film thickness (corresponding to limiting temperature prerequisites of ASTM E119 for structural members) of the THERMO-LAG 330-1 Subliming Material, at a span of 18 inches measured into the fire zone from the point of penetration through the fire barrier, did not degrade the integrity of the protected assembly.

2) A flared transition design comprised of a 1.00 inch minimum thickness of the THERMO-LAG 330 Fire Barrier System, used to join the protected tray to the concrete slab at its penetration junction, functioned satisfactorily, did not allow the penetration of flame, smoke or water and did not otherwise effect the integrity of the system.

3) A caulked-in flared transition design, which was applied at a 1.00 inch minimum thickness of the THERMO-LAG 330-1 Subliming Material, and used to join the protected tray to the concrete slab at its penetration junction, did function satisfactorily, did not allow the penetration of flame, smoke or water, and did not otherwise effect the integrity of the system.

4) The use of 12 inch spacing of mechanical ties comprised of 18 ga. minimum stainless steel tie wire and 0.5" x 0.020" minimum stainless banding performed satisfactory.

5) The Fire Barrier design met the applicable performance criteria of ANI's Bulletin #5(79).

These conclusions are supported by the following test results and observations.

1. The test assembly, as described in Section 1.1, was exposed to the standard time/temperature environment of ASTM E119 for 180 minutes, followed by a 2½ minute minimum water hose stream test. Following the test, the power, control and instrumentation cables were tested and found to function with no loss of circuit integrity.

2. The recorded cable surface temperatures in the test assembly during exposure to the 180 minute fire endurance test did not exceed:

   A) Average Cable Surface Temperature 191 F

   B) Maximum Individual Cable Surface Temperature 291 F

3. The recorded cable surface temperature of the 300 MCM cable adjoining the junction of the P1000 unistrut section and the cable tray during the three (3) hour exposure to the fire endurance test did not exceed:

   A) Average Cable Surface Temperature 276 F

   B) Maximum Individual Cable Surface Temperature 291 F

4. Both transition designs installed at the junction of the upper and lower legs of the cable tray and concrete access slab of the test furnace, functioned successfully as evidenced by the relative uniformity of temperature measurements at all locations in the test assembly. The recorded cable surface temperatures adjoining the junctions during the three (3) hour fire endurance test did not exceed:

   A) Average Cable Surface Temperature 190 F

   B) Maximum Individual Cable Surface Temperature 227 F

5. The 18 ga. minimum stainless steel tie wire and 0.5" x 0.020" minimum stainless steel banding material examined after the completion of the entire test, showed no evidence of deterioration or loss of properties other than discoloration.

These recorded temperatures were significantly below the 325F maximum established for the cable surface temperatures by the jurisdictional authorities.

2.0 PURPOSE

The purpose of this test was to:

1) Demonstrate by test that a P1000 unistrut, when uniformly protected with a 1.2 inch minimum dry film thickness (corresponding to limiting temperature prerequisites of ASTM E119 for structural members) of the THERMO-LAG 330-1 Subliming Material, along a span of 18 inches measured into the fire zone from the point of penetration through the fire barrier, will not degrade the integrity of the protected assembly.

2) Demonstrate that a flared transition design constructed from 1.00 inches minimum THERMO-LAG 330 Prefabricated Panel Sections used to join the fire protected tray to the concrete slab at its penetration junction will function satisfactorily, will not allow the penetration of flame, smoke or water and will not otherwise effect the integrity of the system.

3) Demonstrate that a caulked-in flared transition design, constructed of THERMO-LAG 330-1 Subliming Trowel Grade Material, at a minimum cross-sectional thickness of 1.00 inches dry, used to join the protected tray to the concrete slab will function satisfactorily, will not allow the penetration of flame, smoke or water, and will not otherwise effect the integrity of the system.

4) Demonstrate that the use of 12 inch spacing of mechanical ties comprised of either 18 ga minimum stainless steel tie wire or 0.5" x 0.020" minimum stainless banding will perform satisfactorily.

5) Demonstrate that the fire barrier design tested herein meets the applicable performance criteria of ANI's Bulletin #5(79), and the 325F cable surface temperature limitation imposed by jurisdictional authorities.

3.0 TEST LOCATION

The test was conducted on 13 December 1984 at the laboratory facilities of TSI in St. Louis, Mo., by its personnel and under the direct supervision and total control of Industrial Testing Laboratories, Inc. of St. Louis, Mo.

4.0 TEST PLAN STANDARDS AND REFERENCES

A) American Nuclear Insurer's Bulletin #5(79) entitled: "ANI/MAERP Standard Fire Endurance Test Method To Qualify a Protective Envelope For Class IE Electrical Circuits"

B) National Fire Protection Association (NFPA) Standard 251-1979 entitled: "Standard Method Of Fire Tests Of Building Construction and Materials"

C) American Society For Testing Materials (ASTM) "E119 Standard Method Of Fire Tests Of Building Construction and Materials"

D) A 325F Cable Surface Temperature limitation imposed by jurisdictional authorities.

4.1 ASTM E119 Fire Endurance Test

Paragraph 3.4.1 of ANI's Bulletin #5(79) states that "the protective envelope shall be exposed to the standard time/temperature curve found in ASTM E119-76 (revised to E119-81) for a minimum of one hour." In this test, the test assembly was exposed to the standard time/temperature environment presented in ASTM E119-76 (A2.1) for a minimum period of three (3) hours. The standard time/temperature curve is presented herein as Figure 1.

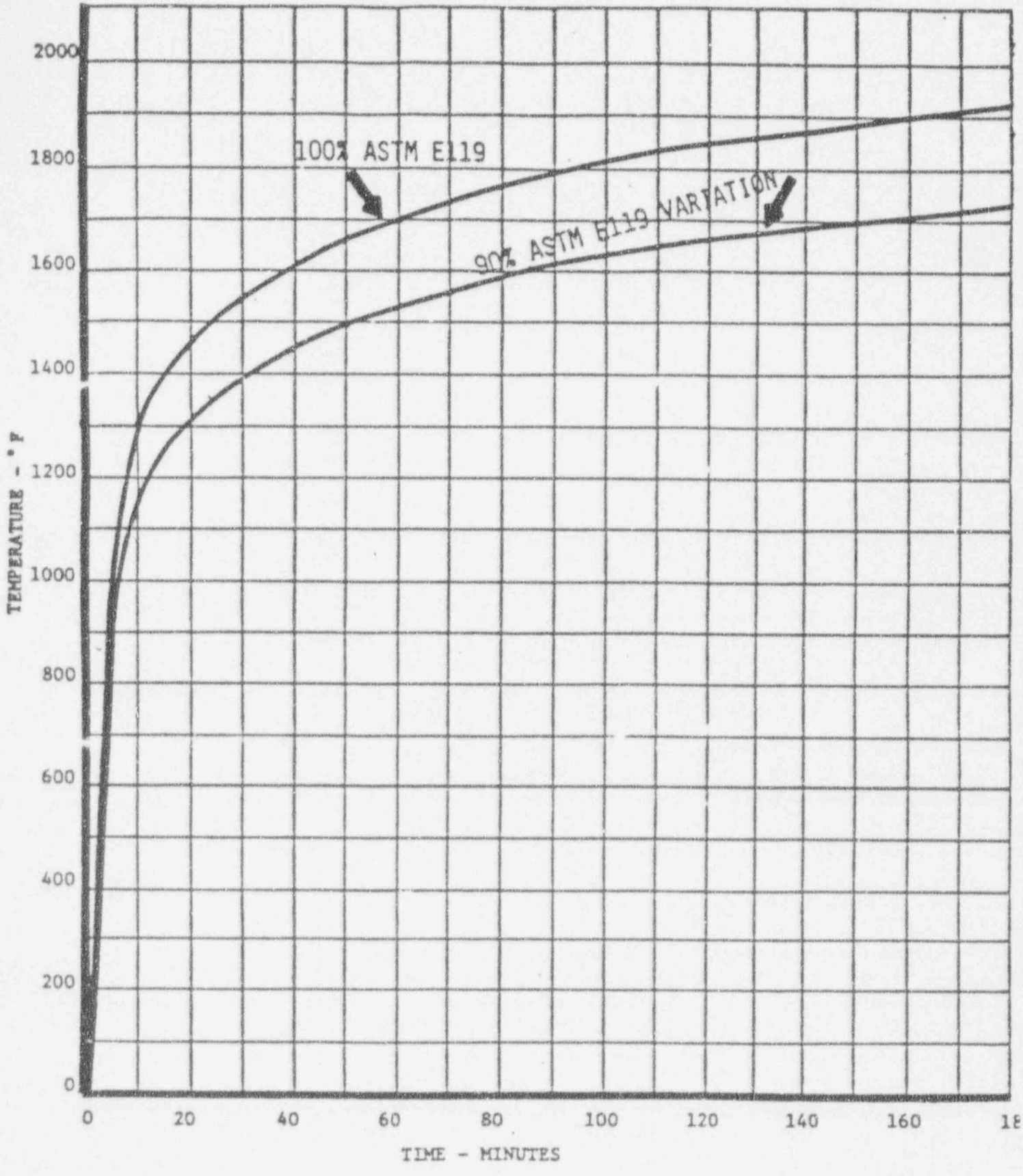
The required accuracy of the temperature control requirement under this test program is that the area under the test time/temperature curve shall be within ten percent (10%) of the corresponding area under the standard time/temperature curve.

NFPA Standard 251-1979 requires that the average cable surface temperature shall not exceed 250F above ambient and the highest individual temperature shall not exceed thirty percent (30%) above this temperature.

The authorities having jurisdiction over the fire safety and safe hot shutdown of nuclear power generating plants require that a limiting temperature of 325F, as measured on the surface of the protected power, control and instrumentation cables not be exceeded in the course of the fire exposure.

FIGURE 1

ASTM E119 TEST METHOD TIME/TEMPERATURE RELATIONSHIP



4.2 Water Hose Stream Test

In accordance with Paragraph 3.4.2(1) of ANI's Bulletin #5(79), the test assembly was exposed to a 2½ minute minimum water hose stream test, applied to the exposed surface of the test article, within three (3) minutes after the completion of the fire endurance test. A water pump was used to provide the water hose stream during the test. The hose was delivered through a 2½ inch national standard playpipe, equipped with a 1 1/8 inch type, at a nozzle pressure of 45 psi. The tip of the nozzle was held at a distance of 20 feet from the test assembly. The length of the hose was 50 feet.

4.3 Electrical Circuit Integrity Monitoring

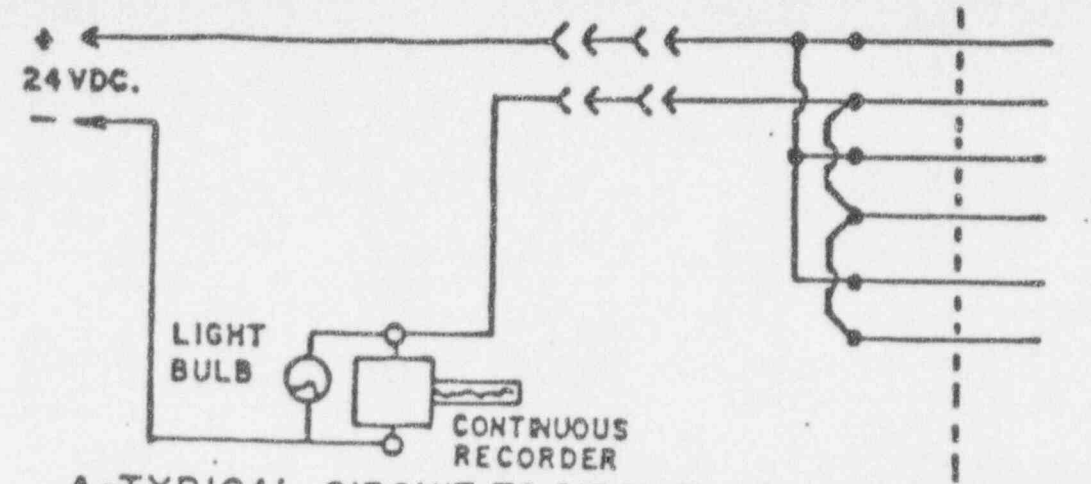
Paragraph 3.5 of ANI's Bulletin #5(79) requires that circuits contained in a test assembly do not de-energize during exposure to the fire endurance and water hose stream tests. A required test condition is to continuously monitor a sufficient number of electrical circuits in the test assembly to detect failure; circuit to circuit (conductor to conductor short circuits), circuit to system (conductor continuity), and circuit to ground (conductor to ground). A schematic diagram of the three monitoring channels utilized in this test program are shown in Figure 2. Since monitoring all of the conditions in the test assembly would be impractical, six cables in the test assembly were continuously monitored during the fire endurance and water hose stream test, using both a Multi-Light Display Panel and an Eight Channel Event Recorder as follows:

1) Power, control and/or instrumentation cables in the assembly were connected as a short circuit detection circuit as shown in Figure 2A;

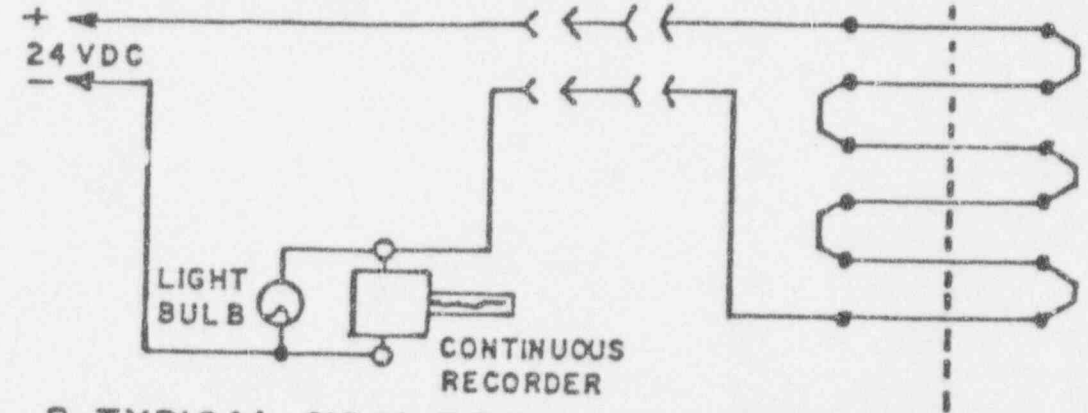
2) Power, control and/or instrumentation cables in the assembly were connected as a continuity monitoring circuit as shown in Figure 2B;

3) Power, control and/or instrumentation cables in the assembly were connected as a ground detection circuit as shown in Figure 2C.

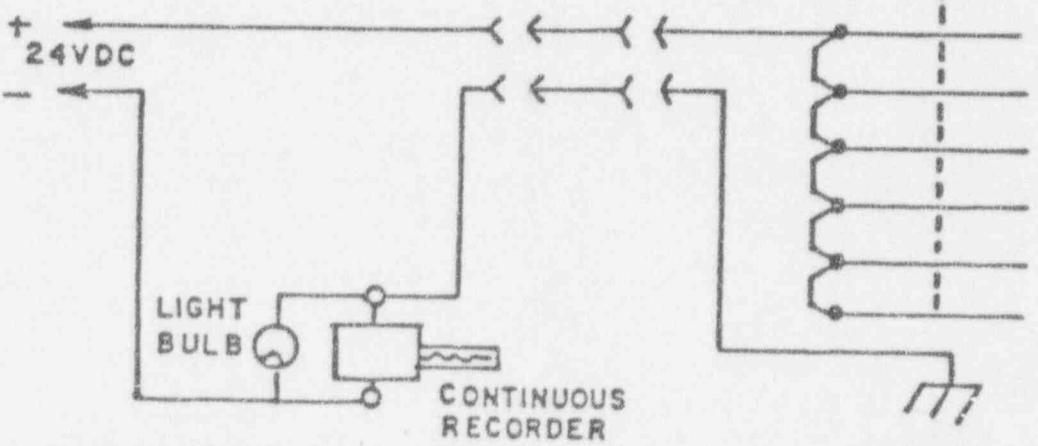
Cables selected for continuity monitoring were located in the center of the test assembly, with the exception of the circuit to ground cables which were located close to the side of the tray to insure that the most heat critical locations were being monitored. (Specific cables instrumented in each of these monitoring channels are shown in Table 1.)



A-TYPICAL CIRCUIT TO CIRCUIT MONITORING CHANNEL



B-TYPICAL CIRCUIT TO SYSTEM MONITORING CHANNEL



C-TYPICAL CIRCUIT TO GROUND MONITORING CHANNEL

FIGURE 2: CABLE INTEGRITY MONITORING CIRCUITS

TOLERANCES	REVISIONS		
DECIMAL ±	NO.	DATE	BY
FRACTIONAL ±			
ANGULAR ±			

ISI, INC. 3260 BRANNON AVE. ST. LOUIS, MO. 63139.

CABLE INTEGRITY MONITORING CIRCUITS

DRAWN J. DUMAIS	SCALE NONE	MATERIAL
CHKD TRACED	DATE 7-17-1982	DRAWING NO.
APP'D		

TABLE 1

THERMOCOUPLE CHANNEL ASSIGNMENT FOR

MONITORING ELECTRICAL CIRCUIT INTEGRITY

WITHIN THE TEST ASSEMBLY

FUNCTION LEGEND:

P = Power Cables
C = Control Cables
I = Instrumentation Cables

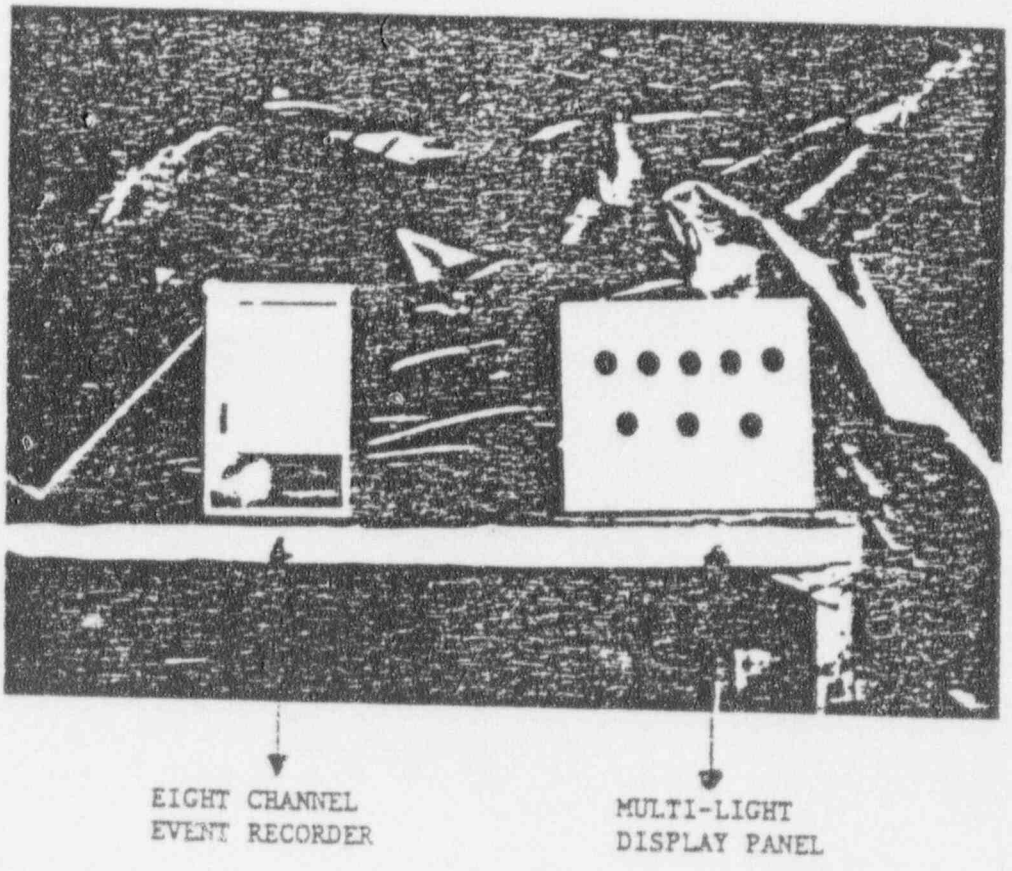
CHANNEL ASSIGNMENT	MONITORING CIRCUIT	CABLE TYPE	CABLE DESCRIPTION
1	Circuit to Ground	P	300 MCM
2	Circuit to Ground	C	12/7C XLP
3	Circuit to Ground	I	16/2C XLP
4	Circuit to System	I	16/2C XLP
6	Circuit to Circuit	P	300 MCM
7	Circuit to System	I	16/2C XLP

FIGURE 3

PHOTOGRAPH OF THE EIGHT-CHANNEL EVENT RECORDER

AND

THE MULTI-LIGHT DISPLAY PANEL



The Multi-Light Display Panel and Event Recorder were wired in such a manner that the monitored circuits were energized, and in the event of a test cable failure:

1) Circuit to Circuit: Light would go on and event recorder would indicate the condition;

2) Circuit to System: Light would go out and event recorder would indicate the condition;

3) Circuit to Ground: Light would go on and event recorder would indicate the condition.

The circuit to circuit and circuit to ground circuits were manually checked at the conclusion of the water hose stream test with a test lead to verify that the monitoring circuits were functioning during both the fire endurance and water hose stream tests.

Figure 3 shows a photograph of a typical Multi-Light Display Panel and an Eight Channel Event Recorder used to monitor circuit continuity.

5.0 DESCRIPTION OF TSI'S HIGH TEMPERATURE TEST FURNACE

TSI's ASTM E119 Fire Simulation Facility consists of a high temperature test furnace and a water hose stream test area located just outside the plant facilities. Upon completion of the fire endurance test, the test article was moved on the transfer cart to the water hose stream test area.

5.1 High Temperature Test Furnace

TSI's High Temperature Test Furnace is constructed of a steel plate lined with high temperature insulative material and has exterior dimensions of 49½ in width, 77" in depth and 66 3/4" in height. The bottom section of the furnace is made of 1/4" steel plate and is lined with a 5" layer of three (3) different types of Fiberfrax Durablanket.

The furnace interior is 36" wide by 71" deep by 50½" high. The bottom section is further insulated with approximately 5" of Monocast 50 in order to protect the test assembly from lower end temperature effects. The entire furnace is mounted on 4 inch "H" beam supports.

A total of eleven (11) burners are arranged in two groups of four on two opposite sides and one group of three at the joining wall. The burners are staggered to provide more uniform flaming in the proximity of the test article. A schematic of TSI's High Temperature Test Furnace is shown as Figure 4.

The furnace air temperature is monitored by eight (8) shielded chromel/alumel thermocouples. These eight (8) monitoring thermocouples, which are also shown in Figure 4, are located as follows:

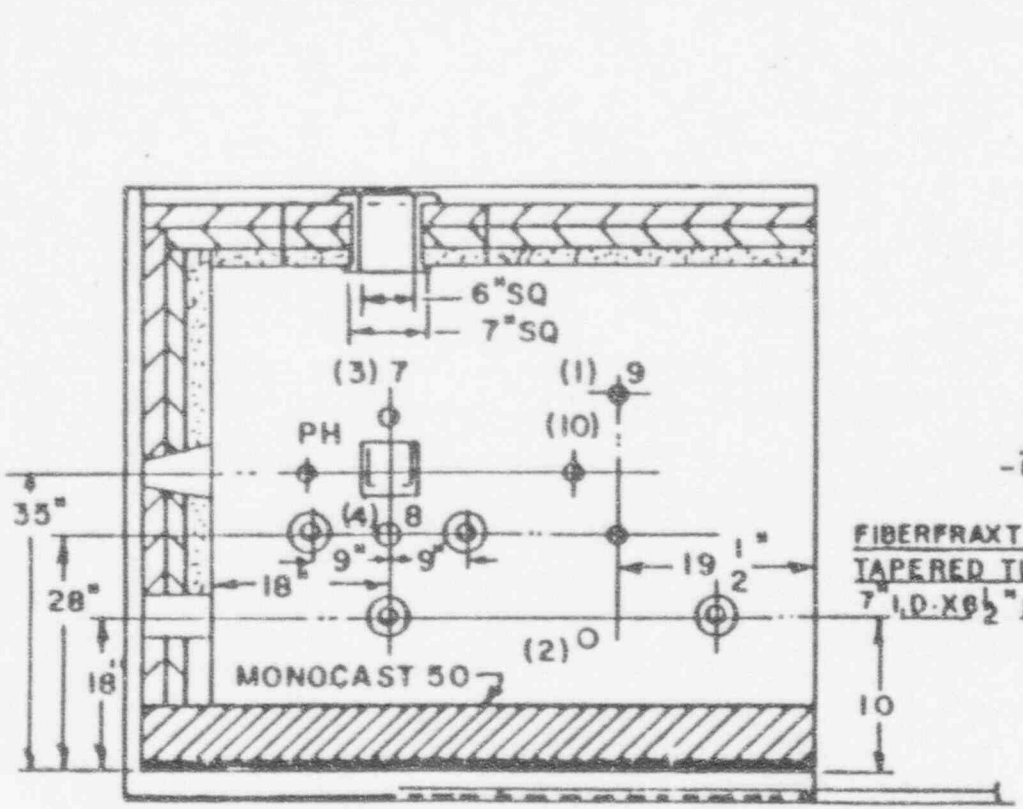
3 Thermocouples at the left wall
3 Thermocouples at the right wall
2 Thermocouples at the wall adjoining the two walls

In addition, two (2) informational thermocouples are located:

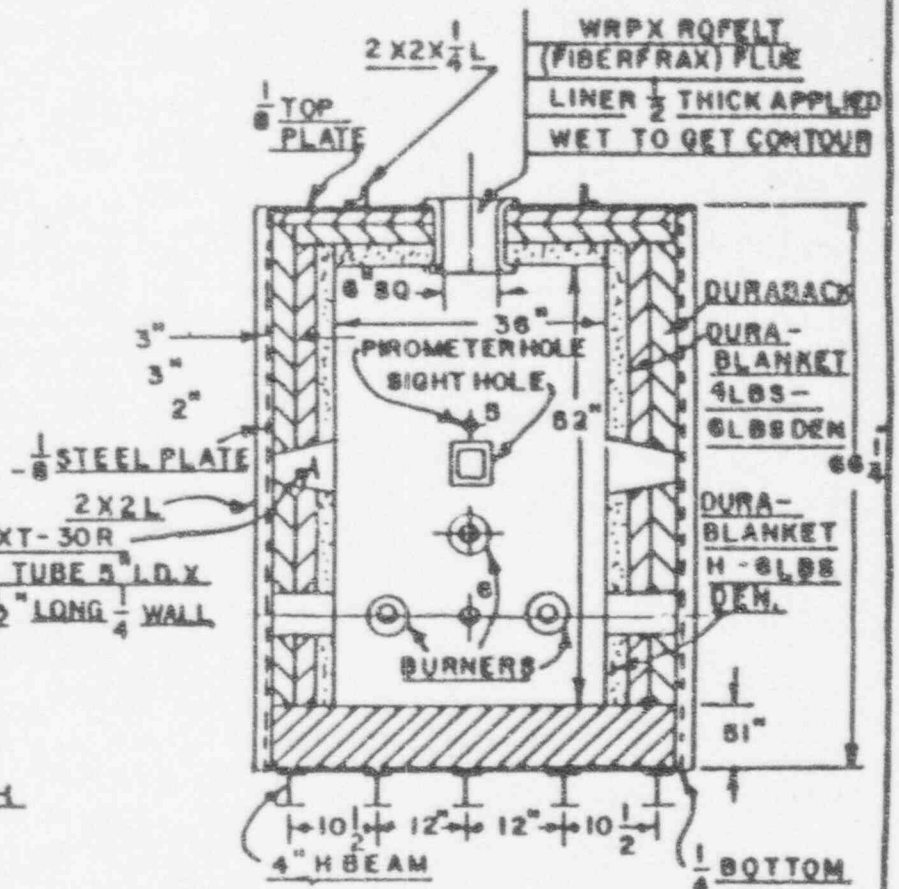
1 Thermocouple at the center of the plenum provided by the "U" cross-section of a typical test article

1 Thermocouple at approximately midway underneath the lower run of a typical test assembly

A general arrangement of a test article in the test furnace is shown as Figure 5.

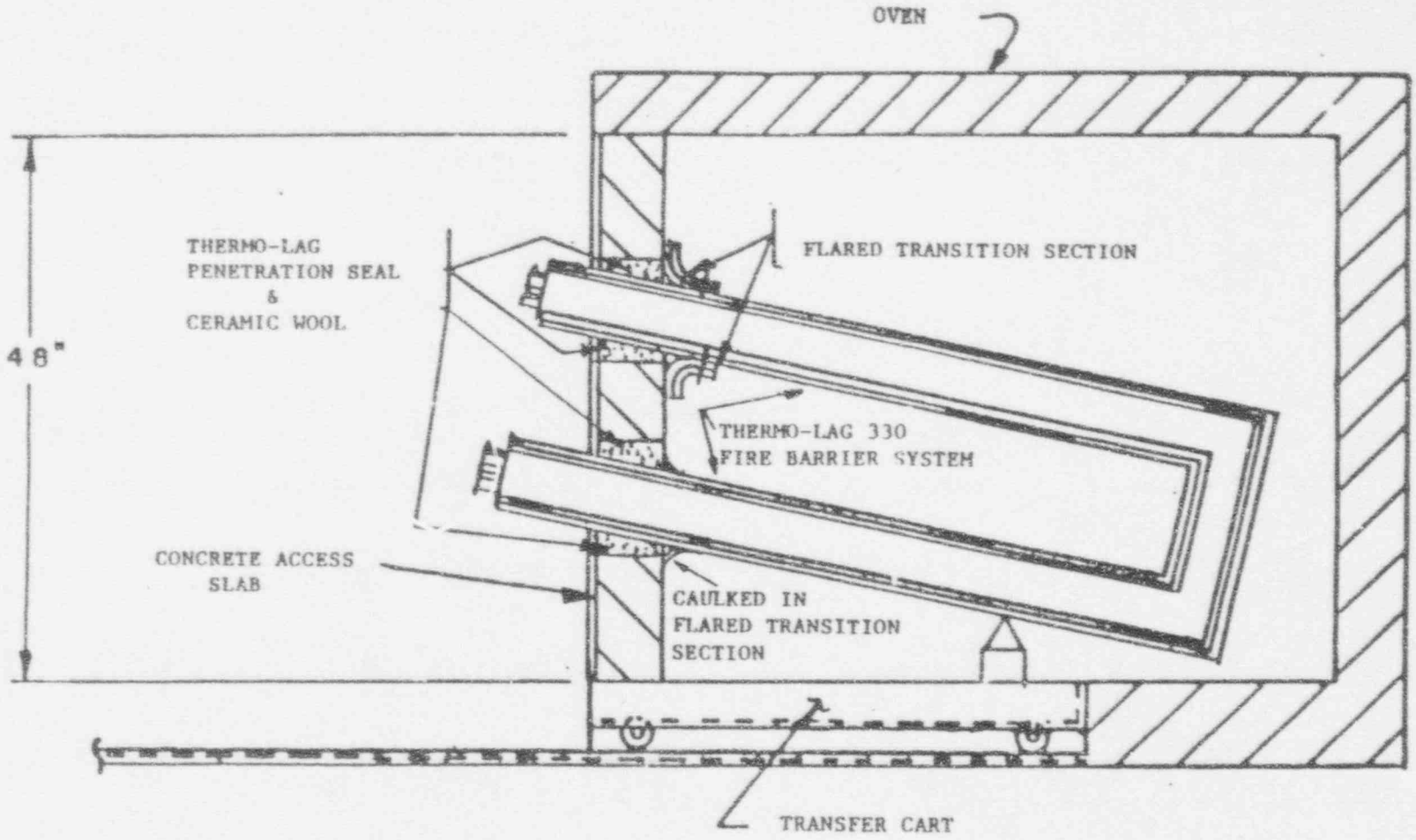


SECTION **A- A**



SECTION **B- B**

TSI TSI, Inc. CASSENS DRIVE ST LOUIS, MISSOURI 63026		
SCALE NONE	APPROVED BY P. J. McCue	DRAWN BY DUMPIE
DATE 12-14-84		REVISED
FIGURE 4: TSI'S HIGH TEMPERATURE TEST FURNACE		
		DRAWING NUMBER FIGURE 4



TSI TSI, Inc. CASSENS DRIVE ST. LOUIS, MISSOURI 63026

SCALE NONE | APPROVED BY L. D. McCue | DRAWN BY DUMPIS

DATE 12-14-84 | REVISED

FIGURE 5: GENERAL ARRANGEMENT OF A TEST ARTICLE IN THE TEST FURNACE

ARTICLE NUMBER FIGURE 5

Two exhaust blowers are provided to remove the flue gases and provide adequate furnace draft for efficient burner operations. In addition, outside air and cooling water are bled into the flue to facilitate draft and temperature control of the exhaust gases.

5.2 Transfer Cart

The transfer cart is used to move the test articles into the test furnace and then remove them upon completion of the fire test. It is also used to transport the test article from the test furnace to the water hose spray area. The transfer cart is approximately 50 inches long by 18 inches wide and has 4 inch diameter wheels. The transfer cart is attached to the access door which comprises one side of the test furnace. The door and transfer cart unit is rolled to the water hose spray booth on rails.

6.0 TEST ASSEMBLY

The test assembly was comprised of a 4 inch by 12 inch ladder cable tray section arranged in a block letter "U" configuration. The approximate length and height of the test assembly was 5 feet and 3 feet, for a total combined fire exposed length of 8 foot minimum.

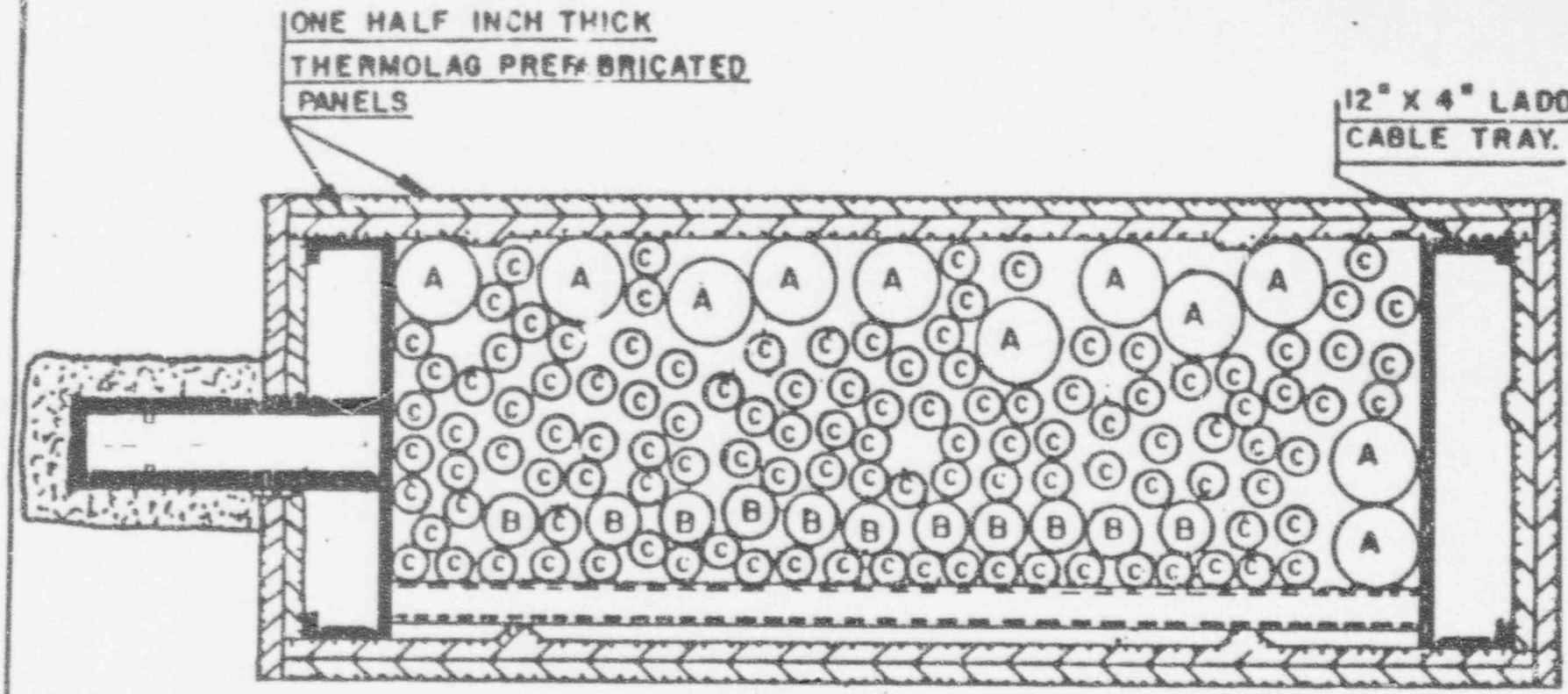
A P1000 unistrut section, having cross-sectional dimensions of 1 5/8" by 1 5/8", a weight per square foot of circa 3.51 lbs, with an overall length of 24", and an exposed length of 4 inches was welded to one side of the ladder cable tray.

6.1 Cable Installation

A total of 142 generic power, control and instrumentation cables were installed in the test assembly. These generic cables were:

Cable Description	Type	Quantity
300 MCM	Power	11
12/7C XLP	Control	12
16/2C XLP	Instrumentation	113

The location of each of these cables, identified by cable item number within the test article, is shown in Figure 6. The test assembly is representative of a typical power or control tray filled to 100% of capacity (40% cross-sectional area).



(A) = 300 mcm

(B) = 12/7C

(C) = 16/2C

TSI CASSENS DRIVE ST. LOUIS, MISSOURI 63026		
SCALE NONE	APPROVED BY L. J. McCue	DRAWING NO. Blank
DATE 12-13-84		REVISED

FIGURE 6: LOCATION OF CABLES WITHIN THE TEST ARTICLE

FIGURE 6

6.2 Opening Sealant

Fire stops comprised of 50% ceramic wool material and 50% THERMO-LAG 330-1 Subliming Trowel Grade Material were inserted in the upper and lower openings in the concrete slab between the cable tray penetrations and the cement slab. Those sections of the cable tray and their protruding cables located on the no-fire side of the test assembly were wrapped with 2 inches of ceramic blanket to minimize any major heat transfer with the ambient laboratory environment.

7.0 FIRE BARRIER SYSTEM

A three (3) hour fire rated design of the THERMO-LAG 330 Fire Barrier System was installed on the ladder cable tray test assembly using a Prefabricated Panel Ready Access Design to completely enclose that portion of the cable try located on the fire side of the test assembly. Prefabricated Panel Sections were also used to construct the flared transition design used to join the upper leg of the protected cable tray to the concrete slab at its upper penetration junction.

The Prefabricated Panels were fabricated from THERMO-LAG Stress Skin Type 330-69 and THERMO-LAG 330-1 Subliming Material.

The installation of the Prefabricated Panel Ready Access Design was accomplished by cutting the number of sections required to form the fire barrier from two (2) 0.500 inch minimum dry film thickness THERMO-LAG Prefabricated Panels, and then mounting the sections on the cable tray test assembly using 18 ga. minimum stainless steel tie wires and 0.5" x 0.020" minimum stainless steel banding material, installed alternately at 12 inch intervals.

The installation of the flared transition design was initiated by cutting four 6 inch wide pieces from two (2) 0.500 inch minimum dry film thickness THERMO-LAG Prefabricated Panels, and then forming each piece into a flanged section by making a 90 degree bend along the centerline of each piece. The length of two (2) of the flanged sections was 4 inches and the length of the other two (2) sections was 18 inches. Next, the 4 inch flanged sections were mounted on the two (2) sides of the cable tray, and the 18 inch flanged sections were mounted on the top and bottom of the cable tray at the intersection of the protected cable tray and concrete slab, using 18 ga. minimum stainless steel tie wires. The mounted four (4) flanged sections were then attached to the concrete slab using two (2) anchor bolts per flanged section.

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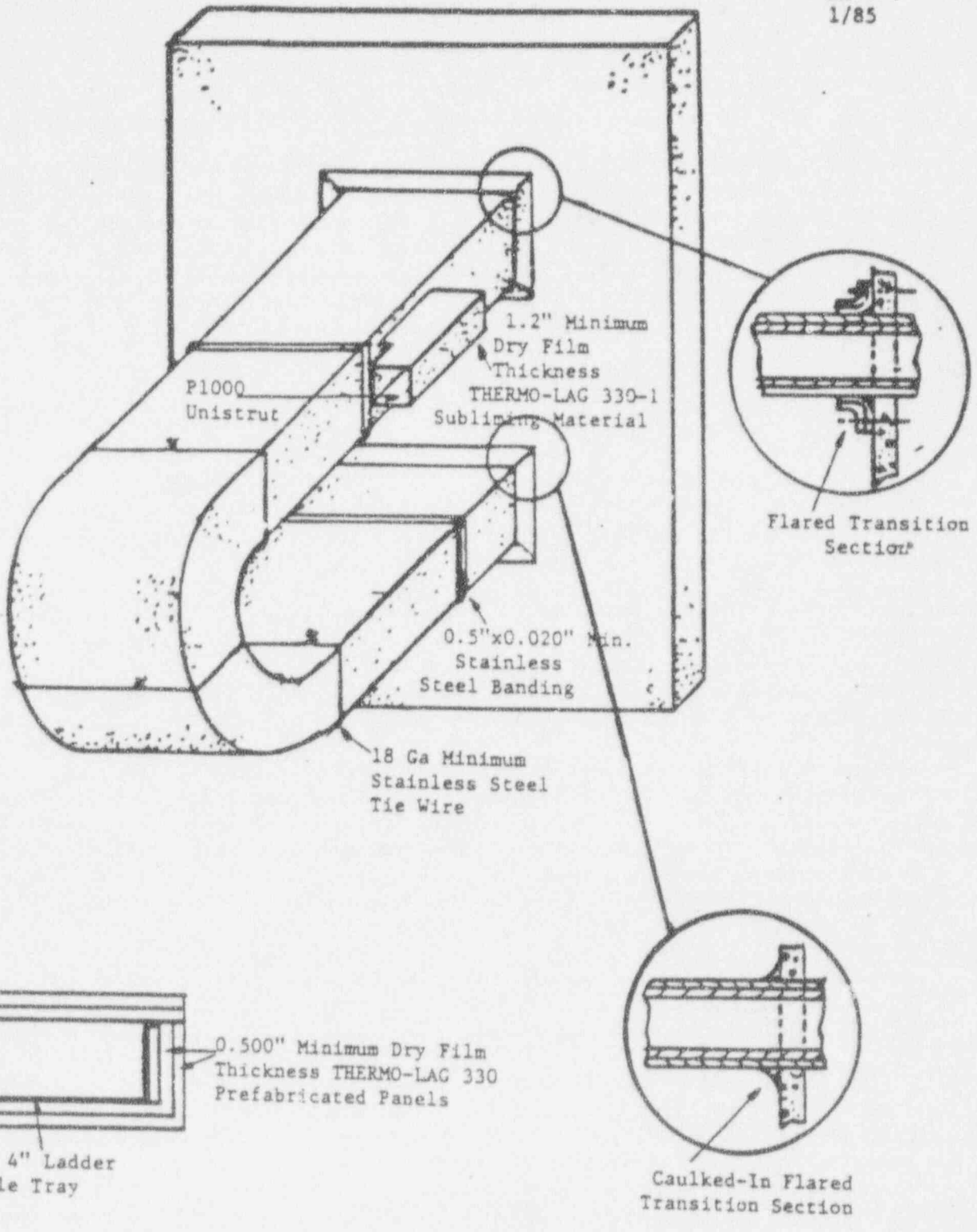


TSI 2200 CASSENS DRIVE ST LOUIS, MISSOURI 63026		
SCALE NONE	APPROVED BY	DRAWN BY DUMPLS
DATE 1-10-85		REVISED 1-31-85
FIGURE 7: SCHEMATIC OF THE THERMO-LAG 330 FIRE BARRIER PROTECTED TEST ARTICLE		
		DRAWING NUMBER FIGURE 7

THERMO-LAG 330-1 Subliming Trowel Grade Material was used to caulk the joints and edges of the installed Prefabricated Panel Sections and to provide a fire resistant coating of 1.2 inches minimum dry film thickness on the P1000 Unistrut. In addition, the THERMO-LAG 330-1 Subliming Trowel Grade Material was used to construct the caulked-in flared transition design used to joint the lower leg of the protected cable tray to the concrete slab at its lower penetration junction. The height of the caulked-in flared transition section was 3 inches, and the minimum cross-sectional thickness of the section was 1.0 inches.

The installation was performed in accordance with all applicable sections of TSI's Nuclear Quality Assurance Program Manual/Quality Control Operating Procedures Manual.

A schematic drawing of the three (3) hour fire rated THERMO-LAG 330 Fire Barrier Design, applied to the test assembly, is shown in Figure 7.

8.0 TEST MATERIALS

8.1 THERMO-LAG Stress Skin Type 330-69

This material provides a strong mechanical base for the THERMO-LAG 330-1 Subliming Material. It is an open weave, self stiffened steel mesh, having a 0.017 inch minimum strand diameter, 56 minimum mesh size and a weight per square yard of 1.75 pounds, minimum. This material was used in the fabricated of the THERMO-LAG 330 Prefabricated Panels.

8.2 THERMO-LAG 330-1 Subliming Material

This material provides the required level of fire resistance. It is a water based, subliming, thermally activated fire resistive coating which volatilizes at fixed temperatures, exhibits a volume increase through the formation of a multi-cellular matrix, and blocks heat to protect the substrate material to which it is applied. In addition to this material being used to fabricated the THERMO-LAG 330 Prefabricated Panels, it was also used in a Trowel Grade consistency to trowel and caulk areas where required.

8.3 THERMO-LAG 330 Prefabricated Panels

The THERMO-LAG 330 Prefabricated Panels were comprised of an initial layer of the THERMO-LAG Stress Skin Type 330-69, a minimum dry film thickness of 1.00 inches of the THERMO-LAG 330-1 Subliming Material, and an outer layer of the THERMO-LAG Stress Skin Type 330-69.

The above materials are rated as non-combustible with a flame spread, fuel contributed and smoke developed of less than 25.

9.0 TEST INSTRUMENTATION

The test instrumentation used to conduct this test program consisted of

One (1) twenty-four (24) point chart type thermocouple temperature recorder,
One (1) twelve (12) point chart type thermocouple temperature recorder,
One (1) digital temperature readout instrument,
One (1) multi-point display panel
One (1) eight channel event recorder

This instrumentation was calibrated in accordance with applicable sections of TSI's Nuclear Quality Assurance and Quality Control Operating Procedures Manual, and the calibration records are on file at the offices of TSI.

10.0 THERMOCOUPLES

Thermocouples used in this test program consisted of shielded and unshielded chromel/alumel thermocouples. Shielded 1/4" chromel thermocouples were used to record the air temperature inside the ASTM E119 high temperature test furnace. Unshielded thermocouples were used to record the cable surface temperature of the test article during the test.

10.1 High Temperature Test Furnace Thermocouples

A total of ten (10) shielded chromel/alumel thermocouples were used to monitor the furnace air temperature in the test program. These thermocouples, as shown in Figure 4, were located in the High Temperature Test Furnace as follows:

A) Three (3) thermocouples were located at the East Wall

B) Three (3) thermocouples were located at the West Wall

C) Two (2) thermocouples were located at the South Wall adjoining the two walls

D) One (1) thermocouple was located at the center of the plenum

E) One (1) thermocouple was located approximately midway underneath the test article

10.2 Test Assembly Thermocouples

Twenty-four (24) thermocouples were used to measure the cable surface temperatures in the test assembly. Twenty-one (21) of these thermocouples were located in seven (7) cross-sectional areas along the test assembly. The other three (3) were located along the 300 MCM cable immediately adjoining the junction of the partially protected P1000 unistrut section and the cable tray as shown in Figure 8.

11.0 TEST OBSERVATIONS

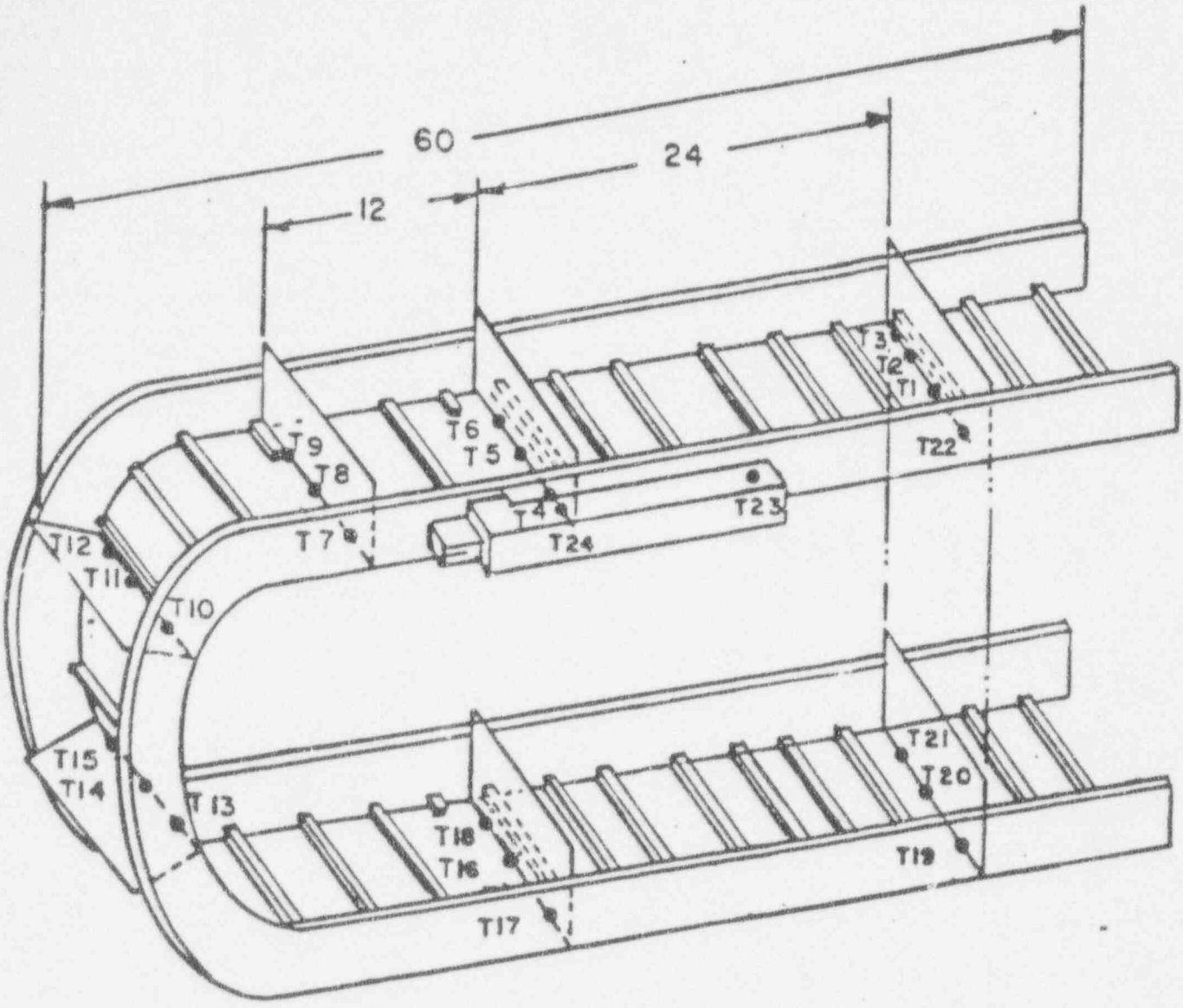
11.1 Details of the Three Hour Fire Endurance Test

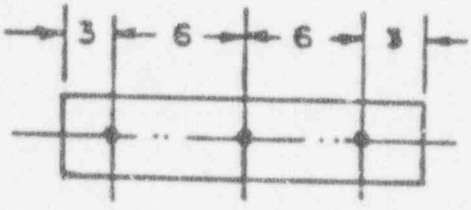
A. The total exposure to the ASTM E119 time/temperature environment for the three (3) hour fire endurance test was 180 minutes.

Electrical cable surface temperature measurements were recorded once every six (6) minutes, 5 seconds between individual thermocouple readings, using the 24 point chart type thermocouple temperature recorder.

B. Visual Observations

1. Only light volatiles were observed coming from within the test articles at any time during the three (3) hour fire exposure period.





TSI 2200 CASSENS DRIVE ST LOUIS, MISSOURI 63026		
SCALE NONE	DRAWN BY Lee J. McCue	DRAWING NO.
DATE 12-14-84		
FIGURE 8: LOCATION OF THERMOCOUPLES		
-22-		FIGURE 8

2. After a period of approximately 50 minutes into the fire exposure, a "slight" cracking was observed to have occurred in the outer layer of the THERMO-LAG 330 Fire Barrier System as it began to expand and form the char layer which continued throughout the remainder of the fire endurance test.

3. During the remainder of the fire endurance test, the protective coating continued to expand and form progressively greater char areas.

4. Examination of the test article after exposure to the fire endurance and water hose stream test showed that not all of the virgin material sublimed.

11.2 Details of the Water Hose Stream Test

A. As required by Paragraph 3.4.2(1) of ANI's Bulletin #5(79), a water hose stream test was conducted immediately following the fire endurance test.

1. A water pump was used to conduct the required water hose stream test.

2. A 2½ inch diameter national standard playpipe equipped with a 1 1/8 inch tip was used.

3. The nozzle discharge pressure during the water hose stream test exceeded the 30 psi minimum required in ANI's Bulletin #5(79). Prior to the test, the nozzle discharge pressure was tested and calibrated so that a predetermined 45 psi was applied to the test assembly during the water hose stream test.

4. The nozzle distance from the test article was maintained at a maximum of 20 feet.

5. The length of the water hose was 50 feet.

B. Visual Observations Made During The Water Hose Stream Test

1. The duration of the water hose stream test was 3 minutes, as compared to ANI's requirement of 2½ minute, minimum.

2. The virgin phase of the THERMO-LAG 330-1 Subliming Material remaining after the fire endurance test did not separate from the test article during the water hose stream test.

3. Examination of the cables after the completion of the test indicated that none of the electrical insulation of the cables were damaged. Further examination of the nylon tie wires used in retaining the cables within the test article showed no evidence of damage.

11.3 Details of the Electrical Circuit Integrity Monitoring

A. As required by Paragraph 3.5 of ANI's Bulletin #5(79), a sufficient number of electrical cables were monitored in the test article throughout the fire endurance and water hose stream tests. The purpose of this monitoring was to detect failure on a circuit to circuit, circuit to system and circuit to ground basis. All electrical cables, which were selected for circuit continuity monitoring, were located in thermally critical areas immediately adjacent to the walls of the test article.

B. Visual Observations Made During The Electrical Circuit Monitoring

1. An eight (8) channel event recorder and a multi-light display panel were used in parallel to conduct the circuit integrity monitoring.

2. Power, control and/or instrumentation cables in the test circuit of the test assembly were connected as a short circuit detection circuit. No failures were observed during either the fire endurance or water hose stream test.

3. Power, control and/or instrumentation cables in the test circuit of the test assembly were connected as continuity monitoring circuit. No failures were observed during either the fire endurance or water hose stream test.

4. Power, control and/or instrumentation cables in the test circuit of the test assembly were connected as ground short circuit detection circuit. No failures were observed during either the fire endurance or water hose stream test.

Specific cables in the test assembly instrumented for monitoring the cable integrity during the fire endurance and water hose stream test are shown in Table 1.

12.0 TEST RESULTS

The fire endurance and water hose stream tests conducted on the test assembly as described in Sections 1.1 and 7.0 of this test report, clearly demonstrate the capability of the system to meet the test criteria specified in ANI's Bulletin #5(79) for three hours fire resistance. These test results are as follows:

1. The test article contained generic power, control and instrumentation cables.

2. The test article was exposed to the standard ASTM E119 time/temperature environment for a minimum of three (3) hours, followed by a 3 minute water hose stream test.

3. Observations during exposure of the test assembly to the oriented and uniformly distributed water hose stream demonstrated its resistance to the penetration of water during the test.

4. Circuit integrity was continuously monitored during both the fire endurance and water hose stream test, with no loss of circuit integrity in any of the test circuits.

5. Cable surface temperatures recorded throughout the three hour fire endurance test exposure did not exceed:

   A. Highest Average Surface Temperature: 191 F

   B. Maximum Individual Thermocouple Surface Temperature: 291 F

6. The recorded cable surface temperature of the 300 MCM cable adjoining the junction of the P1000 unistrut section and the cable tray during the three hour exposure to the fire endurance test did not exceed:

   A. Average Cable Surface Temperature: 276 F

   B. Maximum Individual Cable Surface Temperature: 291 F

7. A P1000 unistrut, when uniformly protected with a 1.2 inch minimum dry film thickness (corresponding to limiting temperature prerequisites of ASTM E119 for structural members) of the THERMO-LAG 330-1 Subliming Material, along a span of 18 inches measured into the fire zone from the point of penetration through the fire barrier, did not degrade the integrity of the protected assembly.

8. The transition designs used to join the join the protected tray to the concrete slab at its penetration junction, functioned successfully as evidenced by the relative uniformity of temperature measurements at all locations in the test assembly, and its ability to resist the penetration of smoke, flames and water. The recorded cable surface temperatures at the junction during the three hour fire endurance test did not exceed:

   A. Average Cable Surface Temperature: 190 F

   B. Maximum Individual Cable Surface Temperature: 227 F

9. The 18 ga. minimum stainless steel tie wire and 0.5" x 0.020" minimum stainless steel banding material examined after the completion of the entire test, showed no evidence of deterioration or loss of properties other than discoloration, and did not allow any penetration of flame or water into the protected assembly.

10. The average and maximum of all cable surface temperatures recorded at six (6) minute intervals are shown in Table 2.

11. The average and maximum cable surface temperatures recorded at six (6) minute intervals during the fire endurance test are shown in Figure 9.

12. A comparison of the ASTM E119 test method time/temperature curve with the actual range of temperatures obtained during the test is shown in Figure 10.

13. For the comparison, the area under the test time/temperature was calculated by intergrating the time/temperature intervals under the curve. All integrated test areas were within 90% and 100% of the integrated standard area.

14. Throughout the fire endurance and water hose stream test, the Multi-light display panel remained in its prescribed lighted and non-lighted positions. The lights were energized in the circuit to system monitoring system, while the lights in the circuit to ground/circuit to circuit monitoring systems were not.

15. The eight (8) channel Event Recorder also indicated no circuit failures or faults during the fire endurance and/or water hose stream tests.

These test results clearly indicate that the THERMO-LAG 330 Fire Barrier System, as tested, met all of the prerequisites specified in ANI's Bulletin #5(79), and the cable surface temperature limitation established by the jurisdictional authorities.

TABLE 2

AVERAGE AND MAXIMUM OF ALL CABLE SURFACE TEMPERATURES

RECORDED THROUGHOUT THE THREE HOUR FIRE ENDURANCE TEST

TIME (Minutes)	AVERAGE TEMPERATURE (F)	MAXIMUM TEMPERATURE (F)
0	63	63
6	63	65
12	63	63
18	63	63
24	63	63
30	63	66
36	63	69
42	64	76
48	66	80
54	68	87
60 (One Hour)	70	93
66	72	101
72	79	116
78	92	129
84	98	140
90	104	149
96	109	159
102	116	166
108	122	171
114	127	176
120 (Two Hours)	133	181
126	138	189
132	143	196
138	148	204
144	154	215
150	161	226
156	166	235
162	172	247
168	178	258
174	184	272
180 (Three Hours)	191	291

FIGURE 9

AVERAGE AND MAXIMUM OF ALL CABLE SURFACE TEMPERATURES

RECORDED THROUGHOUT THE THREE HOUR FIRE ENDURANCE TEST

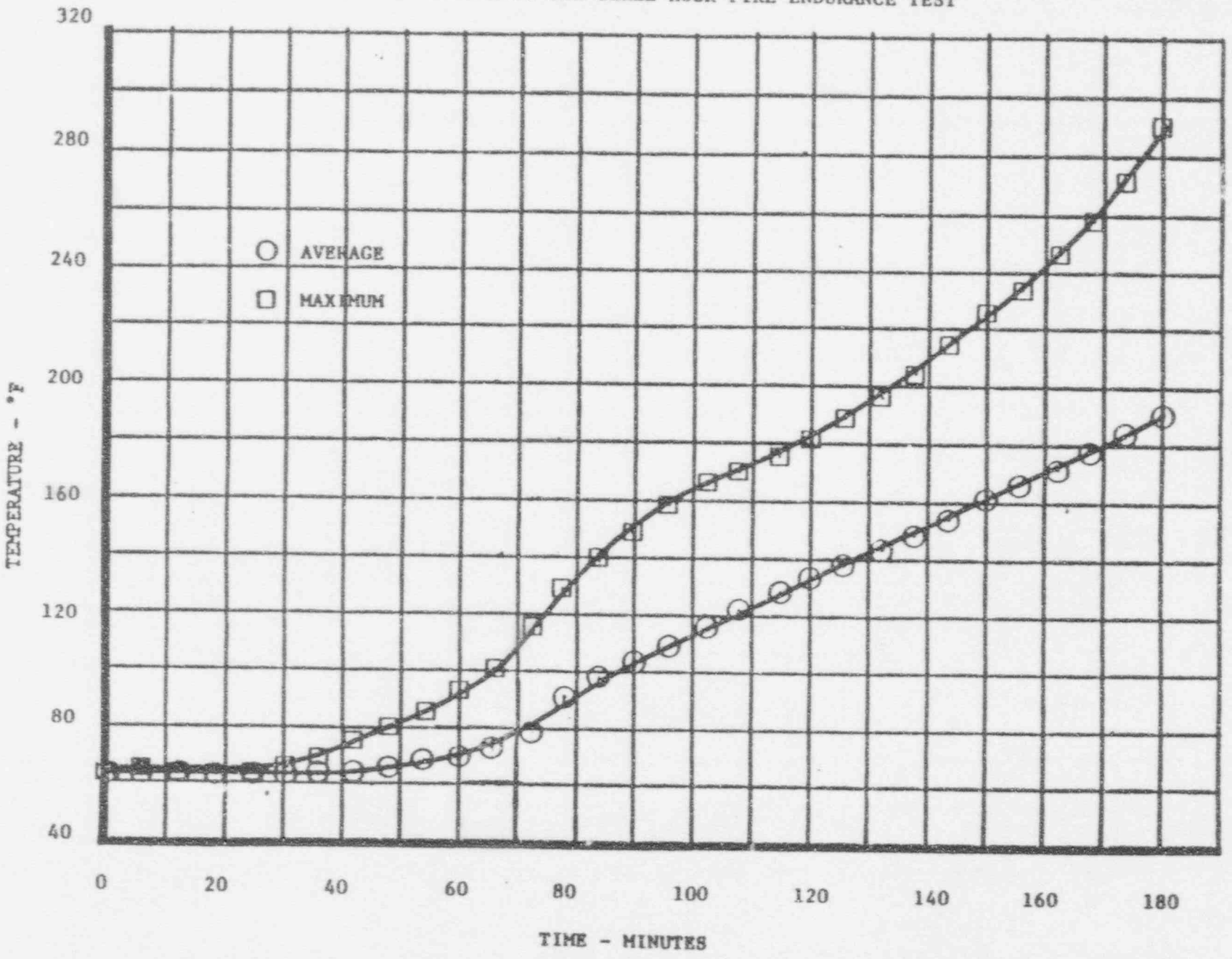
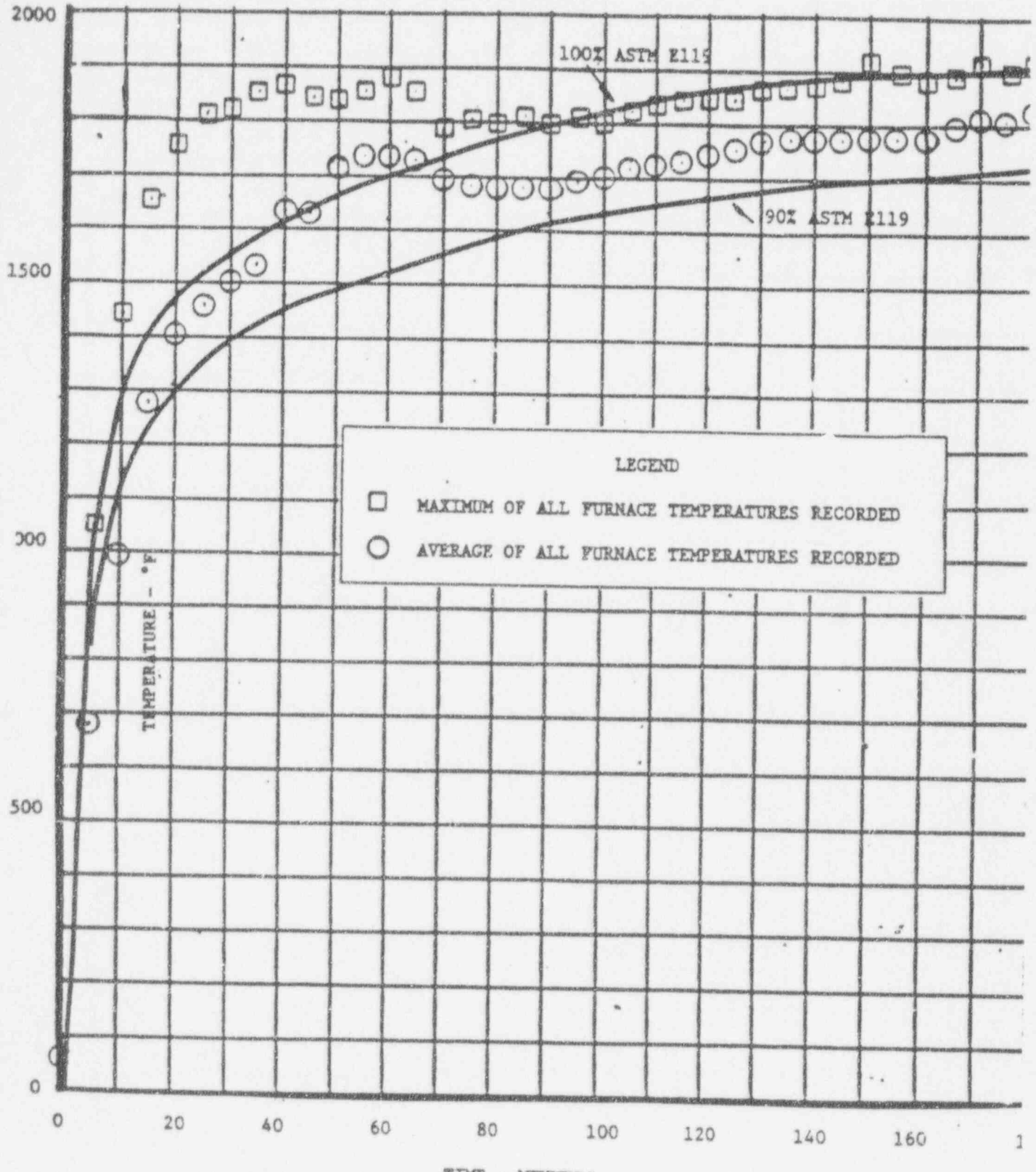


FIGURE 10

COMPARISON OF THE ASTM E119 TEST METHOD TIME/TEMPERATURE CURVE WITH THE ACTUAL RANGE OF TEMPERATURES RECORDED DURING THE THREE HOUR FIRE ENDURANCE TEST



ATTACHMENT 2

MATERIAL SAFETY DATA SHEET

DEPARTMENT OF LABOR AND INDUSTRIES
INDUSTRIAL HYGIENE SECTION

MATERIAL SAFETY DATA SHEET

SECTION I

MANUFACTURER'S NAME: TSI, Inc.	EMERGENCY TELEPHONE NO.: 314 352-8422
ADDRESS (Number, Street, City, State, and ZIP Code): 3260 Brannon Avenue, St. Louis, Mo. 63139	
CHEMICAL NAME AND SYNONYMS: Latex Mastic	TRADE NAME AND SYNONYMS: THERMO-LAG 330-1
CHEMICAL FAMILY: Fire Resistive Coating	FORMULA: Company Confidential

SECTION II HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS			BASE METAL		
See OSHA 29CFR 1910.1000 Table Z3			ALLOYS		
VEHICLE			METALLIC COATINGS		
SOLVENTS			FILLER METAL PLUS COATING OR CORE FLUX		
ADDITIVES	0.7%	25ppm			
OTHERS					

HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES	%	TLV (Units)

SECTION III PHYSICAL DATA

BOILING POINT (°F.)	CIRCA 220	SPECIFIC GRAVITY (H_2O=1)	1.25
VAPOR PRESSURE (mm Hg.)	Water	PERCENT VOLATILE BY VOLUME (%)	41
VAPOR DENSITY (AIR=1)	Water	EVAPORATION RATE (_____=1)	Water
SOLUBILITY IN WATER	Miscible		
APPEARANCE AND ODOR	White Mastic - No appreciable order		

SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used)	None TCC	FLAMMABLE LIMITS	Lel: N/A Uel:
EXTINGUISHING MEDIA	N/A		
SPECIAL FIRE FIGHTING PROCEDURES	Wear self contained breathing apparatus		
UNUSUAL FIRE AND EXPLOSION HAZARDS			

LI-413-7, Industrial Hygiene Section, Material Data Safety Sheet, Olympia 4/77

SECTION V HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE: None established - See OSHA 29CFR 1910.1000 Table Z3

EFFECTS OF OVEREXPOSURE

EMERGENCY AND FIRST AID PROCEDURES

EYE: Flush with water - call a Physician

INGESTION: Call a Physician

SECTION VI REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE	X	

INCOMPATABILITY (Materials to avoid)

HAZARDOUS DECOMPOSITION PRODUCTS

HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	X	

SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Shovel into container and flush surface with water.

WASTE DISPOSAL METHOD: Remove to landfill - dispose of in accordance with Federal, State and Local regulations regarding pollution.

SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type)
When spraying or sanding approved dust respirators should be worn.

VENTILATION	LOCAL EXHAUST: Normal ventilation.	SPECIAL
	MECHANICAL (General)	OTHER

PROTECTIVE GLOVES: Water impervious

EYE PROTECTION: Splash goggles.

OTHER PROTECTIVE EQUIPMENT

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

Close containers after using. Store above 32°F and Below 100°F.

OTHER PRECAUTIONS

Do Not Take Internally.