July 23, 1991

MEMORANDUM FOR: Carl Berlinger, Chief
Generic Communications Branch
Division of Operational Events Assessment

FROM: Conrad E. McCracken, Chief
Plant Systems Branch
Division of Systems Technology

SUBJECT: PROPOSED INFORMATION NOTICE ON THERMOLAG FIRE RETARDANT MATERIAL

Enclosed is a proposed information notice concerning possible deficiencies in fire barriers for safe shutdown components constructed of Thermolag, a fire retardant material manufactured by Thermal Science, Inc. of St. Louis, Missouri.

River Bend Station (RBS) began experiencing degradation of their Thermolag fire barriers since about 1987. In order to resolve certain questions concerning the fire retardant qualities of the Thermolag barriers as constructed at RBS, they embarked on a full scale fire testing program in 1989. A Thermolag protected tray did not survive one of the tests conducted for RBS by Southwest Research Institute. This Information Notice describes that failure. Because of the generic implications to both PWR and BWR plants, the Plant Systems Branch believes the proposed information notice should be issued promptly to notify other licensees of the problems.

Original signed by

Conrad E. McCracken, Chief
Plant Systems Branch
Division of Systems Technology

Enclosure:
Proposed Information Notice

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RArchitzel
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UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

July , 1991

NRC INFORMATION NOTICE NO. 91- : FAILURE OF THERMOLAG FIRE BARRIER MATERIAL TO PASS 3-HOUR FIRE ENDURANCE TEST

Addressees:

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose:

This information notice is intended to alert addressees to problems that could result from use of Thermolag material to satisfy the electrical raceway fire protection requirements for safe shutdown components specified in Section III.G.2 of Appendix R to Part 50 of Title 10 of the Code of Federal Regulations (10 CFR Part 50). It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice do not constitute U.S. Nuclear Regulatory Commission (NRC) requirements; therefore, no specific action or written response is required.

Description of Circumstances:

The Gulf States Utilities Company, the licensee for the River Bend Station (RBS) submitted Licensee Event Reports (LERs) 87-005, 89-009, and 90-003 to the NRC. The NRC staff reviewed test reports and associated documents regarding the RBS electrical raceway fire barriers to determine if the problems identified in the LERs could affect other NRC licensees. The electrical raceway fire barrier material used at RBS is Thermolag, a product manufactured and supplied by Thermal Science, Incorporated, (TSI), of St. Louis, Missouri. TSI provides Thermolag in thicknesses rated as providing 1-hour and 3-hour protection.

The NRC staff identified two relevant fire test reports regarding the 3-hour rated Thermolag material covering test configurations of the 30-inch aluminum electrical cable tray. The first set of tests was performed in April 1989 at the Chicago Construction Technologies Laboratory (CCTL) and documented in CCTL Report 240056. RBS personnel witnessed this test, in which the Thermolag material passed the 3-hour fire endurance test and the hose stream test. The RBS personnel questioned the validity of the test since an additional layer of what appeared to be trowel-grade Thermolag had been added to the entire bottom surface of the test specimen. The NRC reviewed CCTL Report 240056 and found no reference to an additional layer of Thermolag or consideration of additional thermal protection that may have been added to the test specimen as a result.

The second test was performed in October 1989 at the Southwest Research Institute (SwRI), SwRI Report 01-2702. This test showed high temperature anomalies within 45 minutes in the center of the cable tray with castrophic failure and collapse of the tray within 1½ hours. The failure of this second test raised questions regarding the validity of CCTL Test Report 240056 and of the Thermolag material when used to protect any 30-inch aluminum or steel cable trays. The NRC staff has not reviewed other tested configurations of TSI Thermolag.

Discussion:

The Gulf States Utilities Company has extensively used Thermolag to protect raceways and components throughout RBS that are related to safe shutdown. At least 40 NRC licensed facilities use Thermolag to construct fire barrier assemblies with 3-hour and 1-hour ratings to enclose electrical raceways and other safe shutdown components.

During routine walkdown inspections, RBS fire protection personnel began noticing degradation of the Thermolag 1-hour and 3-hour rated fire barriers in about 1987. The large number of observed deficiencies prompted the licensee to expand these walkdown inspections to include all Thermolag barriers.

The subcontractor who installed the Thermolag fire barriers at RBS was approved by TSI as a qualified installer. However, during the installation at RBS, the subcontractor removed a factory-installed component of the Thermolag called "Stress Skin." Stress skin is a wire mesh fabric component of Thermolag built on one side of the 1-hour fire-rated board and both sides of the 3-hour fire-rated board. This component is critical to the structural stability of the product during fire exposure according to TSI.

The RBS fire protection personnel assumed that all barriers were degraded because their staff had found that many sections of the inside layer of the stress skin had been removed during initial installation at RBS. Additionally, the licensee was concerned about Thermolag installations covering large cable trays. The licensee uses Thermolag to protect 30-inch wide cable trays. However, the largest cable trays known by RBS personnel to have been tested by

TSI were 18 inches wide. The licensee questioned the validity of extrapolating results from the 18 inch wide tray tests to its 30-inch wide trays. Therefore, the licensee decided to conduct full scale fire tests using 30-inch wide trays to validate the protection of these trays as installed.

In October 1989, SwRI tested two U-shaped 30-inch wide aluminum ladderback cable trays and several other penetrations constructed in the same test slab. One of the cable trays was enclosed in a 3-hour fire-rated barrier constructed of Thermolag material in accordance with TSI's published installation instructions. The other cable tray was enclosed in a 3-hour rated fire barrier constructed of a different material in accordance with that manufacturer's published installation instructions. RBS personnel constructed the twin cable tray fire barrier test set up at the SwRI test facility.

The specimen was considered to have failed when the internal temperature reached 400°F. All 44 thermocouples inside the Thermolag-protected tray reached failure temperatures in times ranging from approximately 45 minutes to 85 minutes. Conductor-to-ground failure occurred in the power cable at 60 minutes. The Thermolag enclosure had totally disintegrated at 77 minutes, and the cable tray collapsed at 82 minutes. None of the thermocouples in the tray protected with the other fire retardant material registered temperature above 400°F and no electrical failure occurred in the cables in that tray over the full 3-hour test.

The SwRI test results and the as-installed Thermolag configuration prompted RBS to institute a 1-hour fire watch patrol in all areas that depend on Thermolag barriers for protection of safe shutdown capability. The licensee is evaluating various repair procedures to resolve this problem at RBS. NRC Information Notice 88-04, "Inadequate Qualification and Documentation of Fire Barrier Penetration Seals," provides additional discussion and considerations regarding qualification of installed fire barriers.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contact: Ralph Architzel
301-492-0804

Attachment: List of Recently Issued NRC Information Notices

*Transmitted by dated ____________________

Document Name: INFO NOTICE - NOTLEY

SPLB:DST
DNotley;drl**
7/2/91

SPLB:DST
RArchitzel**
7/2/91

SPLB:DST
CMcCracken
7/16/91

RVIB:DRIS
JPetrosino**
7/3/91

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RPB:ADM
TechEd**
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***D/OI
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***C/OGCB:DOEA:NRR
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**See previous concurrences.

***Delete from concurrence

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Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contact: David Notley
301-492-0831

Joseph Petrosino
301-492-0979

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*Transmitted by dated ____________________

Document Name: INFO NOTICE - NOTLEY

C.R.

SPLB:DST	SPLB:DST	SPLB:DST	RVIB:DRIS
DNotley;drl**	RArchitzel**	CMcCracken	JPetrosino**
7/2/91	7/2/91	7/16/91	7/3/91

OGCB:DOEA:NRR	RPB:ADM	D/OI	D/OIG	C/OGCB:DOEA:NRR
	TechEd**			CHBerlinger
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		C.R.	C.R.	

D/DOEA:NRR
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**See previous concurrences.

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Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

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301-492-0831

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7/2/91	7/2/91	/ /91	7/3/91

OGCB:DOEA:NRR	RPB:ADM	D/OI	D/OIG	C/OGCB:DOEA:NRR
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TSI

RECEIVED AUG 2 7 1991

23 August 1991

Mr. Frank Garrett
Arizona Public Services
P O Box 52034
Phoenix, Arizona 85072-2034

Subject: TSI's Response To The NRC Information Notice No. 91-47 "Failure of THERMO-LAG Fire Barrier Material To Pass Fire Endurance Test"

Dear Mr. Garrett:

We have reviewed the content of the above referenced Notice. As we understand, the NRC is addressing the following:

(a) Removal of Stress Skin from the THERMO-LAG 330 Prefabricated/Preshaped Items. The NRC, very correctly, condemned that action. In essence, the Notice concludes that the removal of the Stress Skin from the prefabricated panels and preshaped conduit sections substantially reduced the structural and fire resistive properties of the THERMO-LAG 330 Fire Barrier System.

(b) Lack of documentation and qualification tests of THERMO-LAG applicable to large cable trays. The Licensee questions the validity of extrapolating results from small cable trays to 30 inch wide cable trays.

(c) A test failure involving the THERMO-LAG 330 Fire Barrier System, when installed on a 30 inch aluminum electrical cable tray, performed in October 1989 at Southwest Research Institute.

(d) Lack of documentation of qualification tests which demonstrate that aluminum conduits penetrating the THERMO-LAG 330 Fire Barrier System have been tested.

(e) Lack of documentation and qualification tests for joint installations that demonstrate that dry fitting methods are qualified.

The supplementary information presented herein should clarify these issues.

L/114

(a) Removal of Stress Skin from the
THERMO-LAG 330 Prefabricated/Preshaped Items

The Stress Skin element comprises a critical component of the THERMO-LAG Prefabricated Panels and THERMO-LAG Preshaped Conduit Section Designs. In essence, the Stress Skin is the skeleton of the System, and its removal greatly reduces the physical properties (fire resistance, structural integrity, etc.).

Subsequent tests performed at the Fire Research Facilities of Thermal Science, Inc. and Southwest Research Institute demonstrated that a substantial reduction in the fire resistance capability of the THERMO-LAG 330 Prefabricated/Preshaped Fire Barrier System resulted from this action.

(b) Tests on 30 inch Aluminum Cable Trays

Two successful full scale fire endurance tests on 30 inch wide aluminum ladder back trays were conducted at the facilities of Construction Technology Laboratories in Skokie, Illinois. The tests followed the prerequisites of ANI Bulletin #5. The performance of the tests was under total control of the test laboratory. The manufacturing process was carefully recorded and monitored by both TSI's Quality Assurance Department and Construction Technology Laboratories.

The cable trays were protected with the THERMO-LAG 330 Prefabricated Panel Fire Barrier Design.

The tests were performed in April and May, 1989. The cables were generic. Also, one bare copper wire was run in the entire length of each cable tray. The data acquisition for both cable trays followed the same prerequisites.

The data acquisition was comprised of continuous temperature and electrical integrity measurements. The electrical integrity measurements were continuously monitored during both the ASTM E119 fire endurance test and water hose stream exposure.

Both test reports were published by Construction Technology Laboratories, Inc. in October 1989, and are as follows:

CTL Report No. 240056 824-63
"Fire Test On Aluminum Ladder Back Cable Tray Protected By THERMO-LAG Prefabricated Panels In A Steel Bulkhead October 1989 - Revision 1"

CTL Report No. 240056-824 824-59
"Fire Test On Aluminum Ladder Back Cable Tray Protected By THERMO-LAG Prefabricated Panels For Gulf States Utilities October 1989 - Revision 1"

Complete copies of the test results, including pertinent QA documentation, are available upon written request.

(c) Southwest Research Institute Test

The referenced test was conducted at the facilities of SWRI in October 1989. TSI does not have a copy of this test report. We did, however, receive a certain amount of written and verbally transmitted information from GSU personnel who were involved in the performance of the test. TSI's personnel did not participate in the installation of the THERMO-LAG Fire Barrier Materials to the cable tray nor did they witness the actual test.

It is significant that two test articles, composed of dissimilar materials, were installed on a common steel support. One of these entities was a 30 inch aluminum cable tray protected with the THERMO-LAG 330 Fire Barrier System. The other entity employed a "ceramic" material which, in accord with the manufacturer's data, has a negative coefficient of thermal expansion. It shrinks when heated. The THERMO-LAG protected cable tray and the "ceramic" entity were in intimate contact with each other at the base comprised of a 4 inch tubular support.

Further, it appeared that the THERMO-LAG material was installed on the steel support using 18 gauge wire which was wrapped around the steel support itself and anchored to the cable tray prior to the installation of the THERMO-LAG material.

We believe that upon commencement of fire, the ceramic material started to shrink and recede from its interface with THERMO-LAG, exposing the steel of the common support to the flames. This, in turn, promoted a very rapid rate of heat transfer under the THERMO-LAG barrier and into the cable tray itself.

GSU personnel informed TSI that at approximately 42 minutes into the test, the bottom of the tray support fell off and, at 47 minutes, the integrity of the system was lost.

The initial separation of THERMO-LAG segments from the tubular steel and their subsequent drop from the bottom of the structural support, allowed for direct contact of the steel with the flames and subsequent flame penetration onto the exposed steel and into the cable tray. As a result, the aluminum tray, resting on the tubular steel, was abnormally heated. The aluminum tray, for practical purposes, was now void of thermal protection.

TSI's conclusion is that the manner in which the THERMO-LAG 330 Fire Barrier System was installed at the cable tray/tubular steel support interface, was a cause of the breach of the integrity of the thermal protective system.

TSI also observed that the three hour THERMO-LAG 330 Prefabricated Panel was "V" grooved on the fireside, for convenience in forming contour surfaces such as the transition section from vertical to horizontal. The THERMO-LAG Stress Skin Type 330-69 was therefore cut, providing a gap in substantial excess of 1/4 inch, probably more than 1 inch. That void was filled with the THERMO-LAG 330-1 Subliming Trowel Grade Material. The Stress Skin, at this separation, was not replaced. The above method of installation is not acceptable. In order to have a valid test, a continuous layer of THERMO-LAG Stress Skin Type 330-69 is required.

For the foregoing reasons, it is TSI's conclusion that the test performed on October 26, 1989 at the facilities of Southwest Research Institute, was not a valid test.

(d) Aluminum Conduits Penetrating the THERMO-LAG Fire Barrier System

Under a GSU contracted test program, one and three hour fire endurance and water hose stream tests were performed on a 30 inch aluminum cable tray with a 4 inch aluminum conduit penetrant - partially enclosed with the THERMO-LAG 330 Fire Barrier System. These tests were successfully completed in November and December 1990.

(e) Dry fitting joints, etc.

These are not allowed under TSI procedures.

We hope that the foregoing comments will be helpful to you.

Yours truly,

R A Lohman
Richard A. Lohman
Assistant to the President

RAL/mm

?0407-M301-16-1 000

TSI

DISTRIBUTION TO: FOR:	REVIEW	INFO.
• MECHANICAL	✓	
BALANCE OF PLANT		
BOILER/NSSS		
PLANT UTILITIES		
• PLANT DESIGN		
• CONTROL SYSTEMS		
• ELECTRICAL	✓	
WIRING		
CONDUIT		
• MQS		
• PAINTING & COATINGS		
• CIVIL/STRUCTURAL		
• NUCLEAR		
• STRESS		
• ARCHITECTURAL		
• STARTUP		
• CONSTRUCTION		
• NOT REQ'D BY ENGRG		
• CLIENT		
R. CHATFIELD		✓

IDENTIFYING TITLE OF THIS DOCUMENT: THERMAL-LAG DATA SHEETS AND TEST REPORTS

FOR INFORMATION ONLY

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DATA CODE 17.0
ACTIVITY PKG NO. NA
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IMPORTANT

Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligations.

DATE RECEIVED 12-6-82

SIGNED [signature]

DOCUMENT STATUS

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2 ☐ REVISE AND RESUBMIT. WORK MAY PROCEED SUBJECT TO INCORPORATION OF CHANGES INDICATED.
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4 ☐ INFORMATION ONLY. DISTRIBUTION REQ'D? ☐ YES

DATE 2/7/83

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THERMO-LAG 330-1 SUBLIMING COMPOUND

Index

TSI

THERMO-LAG 330-1 SUBLIMING COMPOUND

DATA SHEET

PRODUCT DESCRIPTION:	THERMO-LAG 330-1 is a water based, fireproofing, thermally activated, subliming and insulative coating. When exposed to flame, the material volatizes at fixed temperatures; exhibits a small volume increase through formation of a multi-cellular matrix; absorbs and blocks heat to protect the substrate material.
TYPE:	THERMO-LAG 330-1 Subliming Compound
COLOR:	Antique White
FINISH:	Textured
OUTSTANDING FEATURES:	Ease of Application Excellent exterior and interior durability No flash point or fire hazard Chemical Resistance No asbestos Rugged

COMPOSITION AND PHYSICAL PROPERTIES:

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

TSI, INC. • 3260 BRANNON AVE. • ST. LOUIS, MO. 63139 • (314) 352-8422 • Telex: 44-2384

THERMO-LAG 330-1 SUBLIMING COMPOUND

DATA SHEET CONTINUED

BASIC USE: THERMO-LAG 330-1 is applied to cable trays, cable drop and junction box assemblies, structural steel, support structures, containment vessels, tank cars, and other similiar entities. THERMO-LAG 330-1 is applied to protect the substrate against loss of structural stength and accessing temperatures during exposure to fire. One and multiple hour fire ratings can be provided as determined by test utilizing the ASTM E-119 time - temperature environment, hydrocarbon or chemical fire environments.

THERMO-LAG 330-1 Subliming Compound has also been tested per ASTM E84 Standards by an independent testing laboratory with the following results:

Flame Spread	5
Fuel Contributed	0
Smoke Developed	15

COATING THICKNESS: The coating thickness is a function of the specific weight of the steel to be protected. The heavier the steel, the thinner the coating required for a given fire endurance rating. (Specific film thicknesses are specified by the owner or his duly authorized representative.)

PACKAGED: 55 gallon drums approximately 500 net lbs. THERMO-LAG 330-1 Subliming Compound is supplied in containers bearing Underwriters Laboratories labels.

STORAGE CONDITIONS: Store above 32°F and below 100°F.

THERMO-LAG 330-1 SUBLIMING COMPOUND

DATA SHEET CONTINUED

SURFACE PREPARATION:	1. Surface must be clean, dry and free from contaminants including oil, grease and scale prior to application. 2. THERMO-LAG 351 Primer should be used as and where required.
MIXING:	Material should be stirred to a homogeneous consistency prior to application.
TEMPERATURE/HUMIDITY:	THERMO-LAG 330-1 Subliming Compound shall be applied in conformance with good painting practices. The surface shall be dry, above 40°F and below the dew point.
METHOD OF APPLICATION:	May be applied by airless spray, air atomizing spray, brushing, rolling or caulking gun.
RECOMMENDED SPRAY EQUIPMENT:	For spray application direct from the shipping container, air-ram (45:1 & 10:1 compression ratio) extrusion pump, airless spray or air atomizing spray equipment should be used.

TSI

THERMO-LAG 350

TWO PART SPILL RESISTANCE TOPCOAT

DATA SHEET

PRODUCT DESCRIPTION:	THERMO-LAG 350 is a two part spill resistant topcoat with a formulation designed to provide chemical and corrosion resistance to protect against abrasion, moisture, corrosive fumes and chemical contact.

PHYSICAL PROPERTIES:

Color:	White
Finish:	Gloss
Solids by Volume:	34.0 ± 1.0% Mixed
Theoretical Coverage:	50 Sq. Ft Per Gallon
Mixing Ratio By Volume:	Part A - 4 To Part B - 1
Net Weight Per Gallon:	10.93 ± 0.20 lbs (Mixed)
Storage Temperature:	Minimum - 35°F Maximum - 120°F Protect from freezing. In cold weather, store materials inside above 60°F until use.
Shelf Life:	6 Months at recommended storage temperatures.
Flash Point:	Above 135°F
Pot Life:	10 hours at 60°F 8 hours at 77°F 4 hours at 100°F
Surface Temperature:	Minimum - 40°F Maximum - 120°F
Thinning:	Use clean water. For air spray thin up to 10%; airless spray, brush or roller, up to 5%.

THERMO-LAG 350

TWO PART SPILL RESISTANCE TOPCOAT

DATA SHEET CONTINUED

CHEMICAL RESISTANCE:

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

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

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

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

THERMO-LAG 350

TWO PART SPILL RESISTANT TOPCOAT

DATA SHEET CONTINUED

SURFACE PREPARATION: The surface should be clean, free of loose and foreign contaminants and dry: at least 5°F above the dew point.

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

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

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

APPLICATION EQUIPMENT:

Brush: Use Nylon or synethetic bristle brushes.

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

THERMO-LAG 350

TWO PART SPILL RESISTANT TOPCOAT

DATA SHEET CONTINUED

APPLICATION EQUIPMENT:

For Air Spray:

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

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

For Airless Spray:

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

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

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

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

THERMO-LAG STRESS SKIN TYPE 330-69

DATA SHEET

PRODUCT DESCRIPTION:

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

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

PHYSICAL PROPERTIES:

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

Strand Diameter:	0.019 Minimum
Mesh Size:	64 Minimum
Weight/Sq. Yd:	1.75 Minimum

Type "V" Stiffeners dimensions:

Height:	.29 ± 0.04 Inches
base:	.29 ± 0.04 Inches
Distance Between:	6 ± 1 Inches

CHEMICAL PROPERTIES:

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

THERMO-LAG STRESS SKIN TYPE 330-69

DATA SHEET CONTINUED

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

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

METHOD OF APPLICATION: Best results are obtained if each individual length of each individual section does not exceed 10 feet. Each section should overlap each preceding section by at least 6 inches or fastened to the preceding and following section by a flange facsimile having a 1 inch lip, minimum. Circumferentially, two sections are preferred. The skin shall be tight and all flanges and butt joints properly fastened. The sections should be secured to each other by using approved mechanical fasteners. The maximum distance between fasteners should be 6 inches.

TSI

THERMO-LAG 330-70 CONFORMABLE CERAMIC INSULATOR

DATA SHEET

PRODUCT DESCRIPTION:

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

PHYSICAL PROPERTIES:

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

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

TSI, INC. • 3260 BRANNON AVE. • ST. LOUIS, MO. 63139 • (314) 352-8422 • Telex: 44-2384

THERMO-LAG 330-70 CONFORMABLE CERAMIC INSULATOR

DATA SHEET CONTINUED

CHEMICAL PROPERTIES:

Aluminum Oxide:	48.0%	Silicone Dioxide:	51.8%
Iron Oxide:	0.04%	Titanium Dioxide:	0.002%
Magnesium Oxide:	0.01%	Calcium Oxide:	0.02%
Sodium Oxide:	0.1%		
Leachable Chlorides:	Less Than 10 ppm		

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

SURFACE PREPARATION: No special surface preparation is required.

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

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

TSI

FIBERGLASS ARMORING

DATA SHEET

PRODUCT DESCRIPTION:	The Fiberglass Armoring is a light weight, electrical glass armoring fabric for use with the THERMO-LAG 330-1 Subliming Material System.

PHYSICAL PROPERTIES:

Color:	White	
Finish:	Matte	
Type:	"E" Type Fiberglass Fabric	
Ounce/Sq. Yd.	1.0 ± 0.2	
Thickness (Inches):	0.005 ± 0.001	
*Tensile Strength (lbs/in):	Warp: 75	Fill: 60
Yarn:	Warp: 150-1/0	Fill: 150-1/0
Knit:	Weave Type	
Temperature of Decomposition:	circa 1600°F	

*Minimum average breaking strength pounds per inch (ASTM Method 578-49).

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

TSI, INC. • 3260 BRANNON AVE. • ST. LOUIS, MO. 63139 • (314) 352-8422 • Telex: 44-2384

GENERAL METHOD OF OPERATION

THERMO-LAG compounds provide a highly effective heat blocking function, primarily through the mechanism of sublimation. Upon exposure to heat, as the temperature of sublimation is attained, a transition from the solid phase to a vapor phase takes place. This is associated with the absorption of approximately 750 Btu's per pound. The sublimate vapors are subjected to further energy absorbing reactions through endothermic decomposition. The endothermic decompostion reactions can absorb as much as 6000 Btu's per pound. During pyrolysis of the binder system, a char layer is formed which is made to expand by action of the sublimate gases.

Since the char layer is composed of small interconnecting cells having a large surface area, it functions as an efficient heat exchanger. With expansion of the char layer, the path followed by the sublimate gases is lengthened and the time of contact between the sublimate gases and the high temperature cellular structure is increased.

The combined effects result in increased efficiency of the endothermic decomposition mechanism. The ability of the char layer to attain high temperatures further results in significant re-radiation of energy and a reduced heat transfer coefficient. The low conductivity of the light cellular char structure also performs an insulative function.

ENGINEERING REPORT

ON

ONE - HOUR ASTM-E-119 FIRE SIMULATION FACILITY FIRE TEST FOLLOWED BY A SHORT TERM WATER HOSE STREAM IMPACT TEST ON A NUCLEAR FACILITY CLASS 1E CABLE TRAY, CONDUITS AND AIR DROP ASSEMBLY

Prepared

for

TSI, INC.

3260 BRANNON AVENUE

ST. LOUIS, MO 63139

By

Wesson And Associates, Inc.
P. O. Box 1082
Norman, Oklahoma 73070
(August 1981)

405 364-8077

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ON

ONE - HOUR ASTM-E-119 FIRE SIMULATION FACILITY FIRE TEST FOLLOWED BY A SHORT TERM WATER HOSE STREAM IMPACT TEST ON A NUCLEAR FACILITY CLASS 1E CABLE TRAY, CONDUITS AND AIR DROP ASSEMBLY

I. INTRODUCTION

The basic purposes of this Engineering Test Report are to present and discuss the experimental results obtained from a 'One-Hour' ASTM-E-119 Fire Test and Water Hose Stream Impact Test on a Thermo-Lag 330-1 Subliming Coating Envelope System for a Nuclear Plant Class 1E electrical circuits installed in a Ladder Back Cable Tray and Air Drop Assembly.

According to the manufacturer (TSI, Inc.), all of the fire and water hose stream tested Thermo-Lag 330-1 Subliming Coating Envelope System materials were manufactured and produced in strict accordance with all of the applicable Quality Control and Quality Assurance Requirements presented in Appendix 'B' to BTP-9.5-1, NRC Supplemental Guidance, Nuclear Plant Fire Protection Functional Responsibilities, Administrative Controls and Quality Assurance (see Reference '1').

Also, according to the manufacturer of the Thermo-Lag 330-1 Subliming Coating Envelope System (TSI, Inc.), the Envelope System utilized for the testing as reported herein was prepared in strict compliance with the Application Procedures as presented in Exhibit '1' to this Engineering Test Report.

The Nuclear Plant Class 1 E Cable Tray, Conduit and Air Drop Assembly successfully passed all of the applicable Design, Performance and Operational Criteria specifed in the applicable sections of ANI/MAERP Standard Fire Endurance Test Method to Qualify a Protective for Class 1E Electrical Circuits and the Nuclear Regulatory Commission, 10 CFR Part 50 (Fire Protection Program for Operating Nuclear Power Plants, dated 19 November 1980) Final Rule.

II. TEST PROCEDURES

The Test Procedures involved in the Test Program reported herein specified the use of 'Specific' Procedures for the One-Hour Fire Test, the Water Hose Stream Test and the Cable Tray Assembly Electrical Circuitry Continuity Tests. Each of these three (3) separate Test Procedures are summarized in the following subsections.

A. One-Hour Fire Test:

The Fire Testing Procedures are specified in Paragraph 3.4.1 of ANI/MAERP Standard Fire Endurance Test Method to Qualify a Protective Envelope for Class 1E Electrical Circuits (see Exhibit 2 to this report). Basically this one-hour Fire Test is a one hour exposure to the temperature-time curve of ASTM-E-119-76 (ANSI A2.1). For ease of reference, Figure 1 presents this ASTM-E-119-76 Time-Temperature Curve for the exposure period of interest.

As shown in Figure 1, the Test Set-Up Internal Air Temperature starts at the prevailing ambient air temperature (Test Room Temperature), reaches a temperature of about 1000 °F after five (5) minutes, a temperature of about 1550 °F after 30 minutes and a temperature of 1700 °F after one-hour. Based upon widely accepted crtieria, this variation in the time-temperature curve also means a variation in the Incident Heat Flux upon any 'Target' exposed to the this time-temperature relationship. It is commonly accepted that the One-Hour ASTM-E-119 Test Method produces a 'Time Averaged Incident Heat Flux' of about 24,500 BTU/HR-FT^2 for one-hour's exposure, 34,500 BTU/hr-ft^2 for two hours exposure, and 42,000 BTU/hr-ft^2 for three hours exposure, as is shown in Figure 2. It is also important to note, for subsequent experimental data analyses, that in the ASTM-E-119 Test Method about 20 percent of the heat transfer is by convection and about 80 percent is by radiation. Thus, the actual amount of the 80 percent radiant heat that will be 'absorbed' by the 'Target' is strongly dependent upon the Target's Radiation View Factor, the spectral emissive properties of the natural gas flames and the spectral reflectance properties of the Thermo-Lag 330-1 Subliming Coating Envelope System external surface.

B. Water Hose Stream Test:

The Water Hose Stream Test Procedures are specified in Paragraph 3.4.2 of ANI/MAERP Standard Fire Endurance Test Method to Qualify a Protective Envelope

FIGURE 1

ASTM-E-119 TEST METHOD TIME-TEMPERATURE RELATIONSHIP

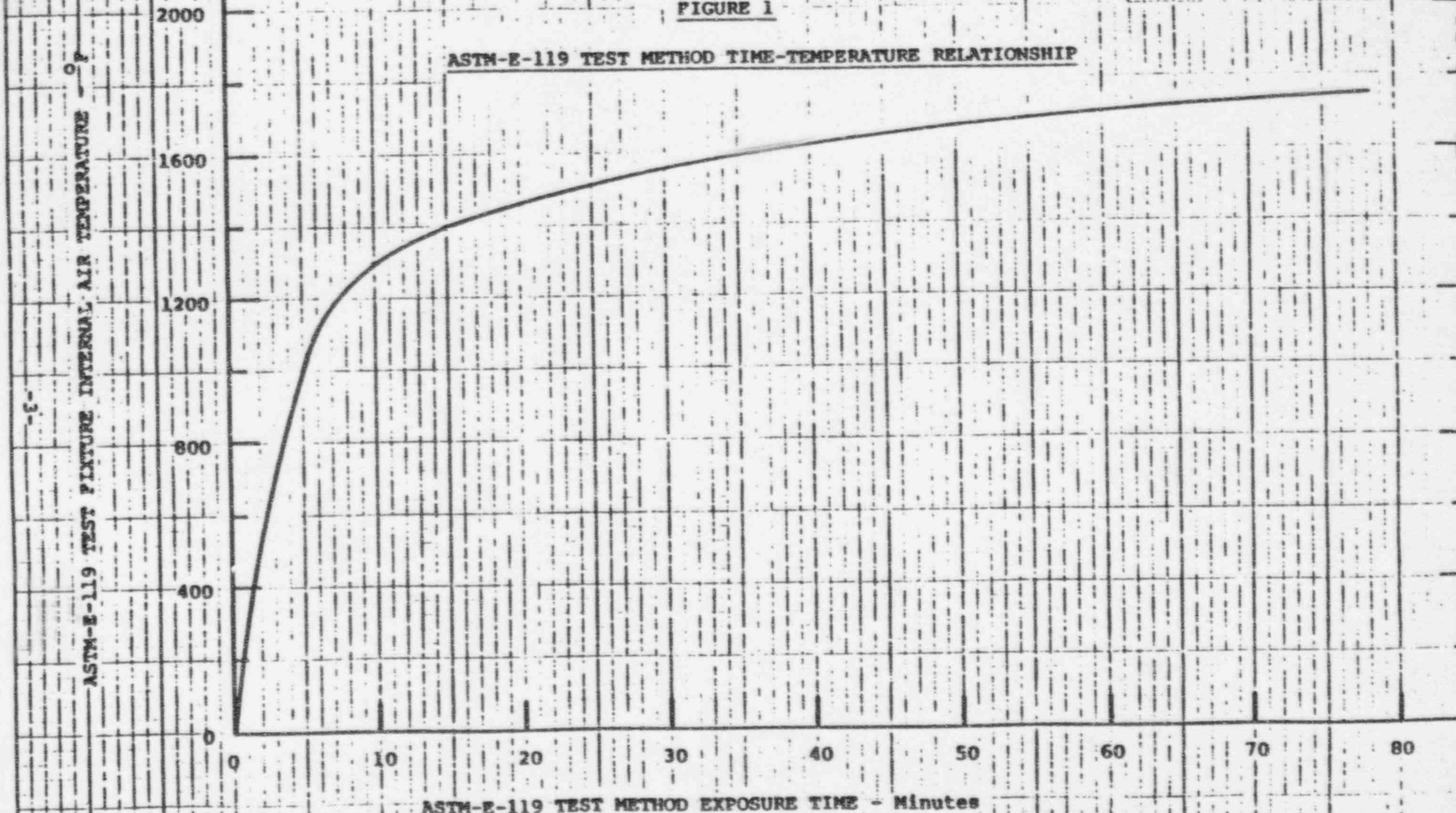
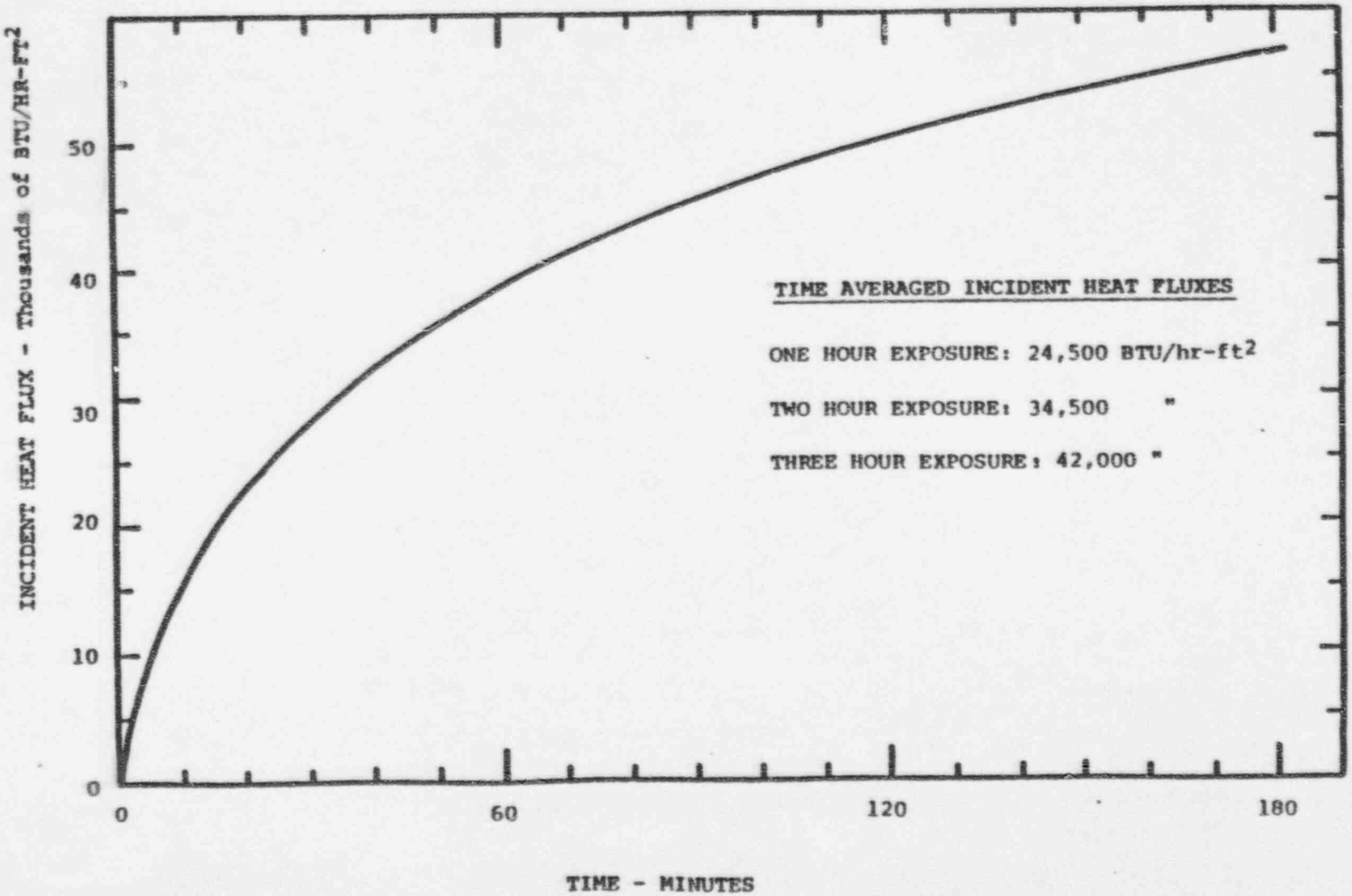


FIGURE 2: ASTM -E -119 TEST METHOD FIRE TEST SET-UP INCIDENT HEAT FLUX LEVEL AS A FUNCTION OF FIRE DURATION/EXPOSURE TIME



for Class 1E Electrical Circuits (see Exhibit 2 to this report). This Exhibit permits the use of 'one' of 'three' specific Test Procedures. In the Water Hose Stream Test reported herein, the Test Procedures specifiec by Paragraph 3.4.2 (3) was utilized. This procadures is as follows:

"The stream shall be delivered through a 1½ inch nozzle set at a discharge angle of 15° with a nozzle pressure of 75 psi and a minimum discharge of 75 gpm with the tip of the nozzle a maximum of 10 feet from the system."

This procedure also requires that the hose stream be applied (to the system) for a minimum of 2½ minutes.

C. Electrical Circuitry Continuity Tests:

Paragraph 3.5 of ANI/MAERP Standard Fire Endurance Test Method to Qualify a Protective Envelope for Class 1E Electrical Circuits (see Exhibit 2 to this report) requires the following Criteria be meet for the one-hour Fire Test:

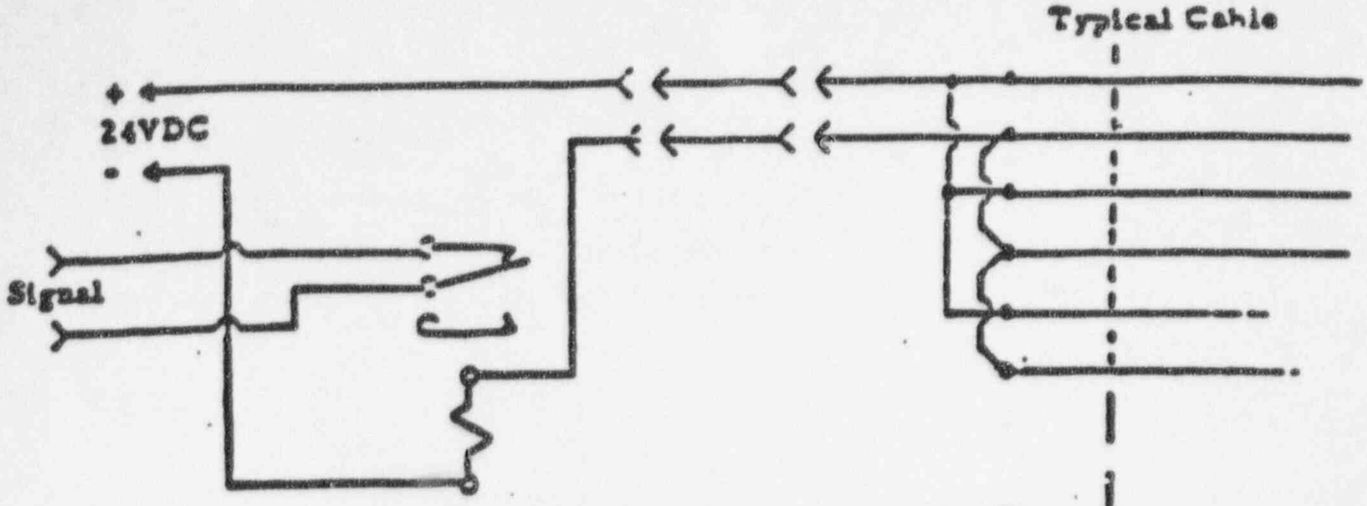
"3.5 The tests shall be constituted a failure if any of the following occur:

1. Circuits fail or fault during the fire test as required in Test 1 (ASTM-E-119-76 one-hour exposure test) or fail during the hose stream test."

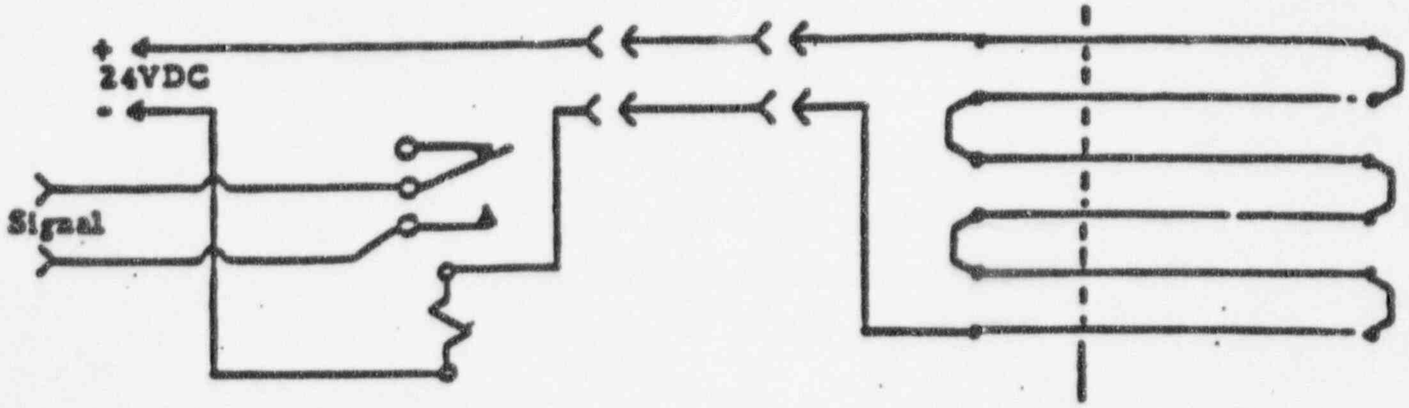
Thus, one of the required test conditions is to continuously monitor a sufficient number of electrical circuits in the Test Specimen to detect failure circuit to circuit (conductor to conductor short circuits); circuit to system (conductor continuity); and circuit to ground (short circuits, conductors to ground). Monitoring all of the conductors in the Cable Tray, Conduit and Air Drop Test Assembly would be a very arduous, if not impractical, task. Therefore, selected cables in the Test Specimen Cable Tray Assembly were instrumented to monitor each of the following three parameters:

1. Two cables, one power and one control cable in the Test Speciman Cable Tray Assembly was connected to a short circuit detection circuit as shown in Figure 3-A.
2. Two cables, as identified in C.1 above, was also connected to a continuity monitoring circuit as shown in Figure 3-B.
3. Two cables, as identified in C.1 above, was connected to a ground short circuit detection circuit as shown in Figure 3-C.

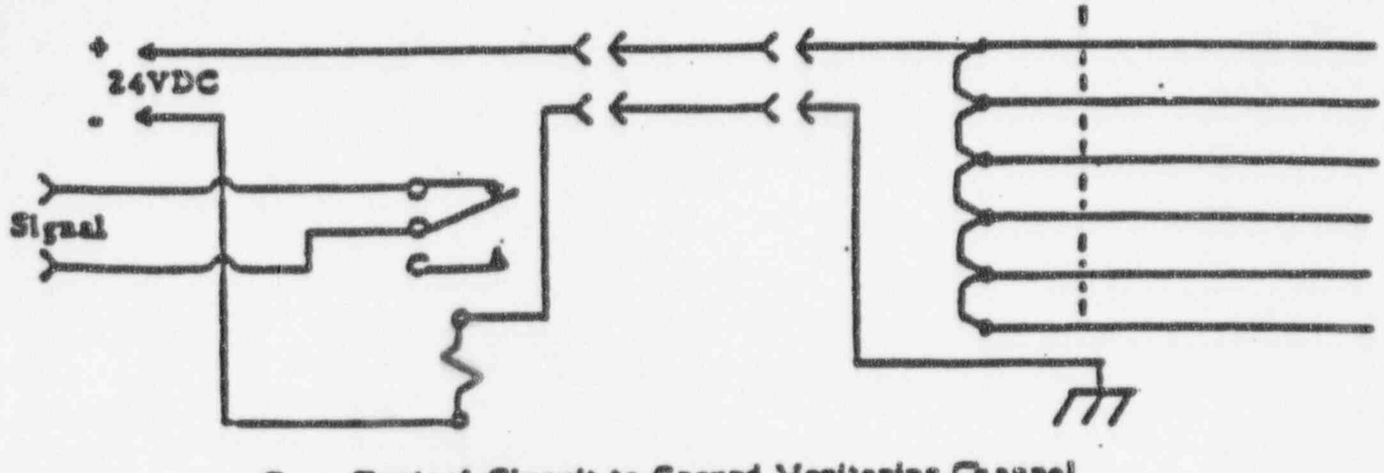
This procedure gives a total of six (6) instrumented cables in the Test Specimen Cable Tray Assembly for monitroing of cable integrity during both the one-hour Fire Test and the subsequent Water Hose Stream Test.



A - Typical Circuit to Circuit Monitoring Channel



B - Typical Circuit to System Monitoring Channel



C - Typical Circuit to Ground Monitoring Channel

FIGURE 3: Test Specimen Cable Tray Assembly Cable Integrity Monitoring Circuits

III. TEST SPECIMEN

A. Preparation of Test Specimen Protective Envelope:

Suggested Test Specimen Layouts are presented in ANI/MAERP Standard Fire Endurance Test Method to Qualify a Protective Envelope for Class 1E Electrical Circuits (see Exhibit 2 to this report). In this section of the Test Report, we will summarize the manufacturer's preparation of the Cable Tray, Conduit and Air Drop Assembly Thermo-Lag 330-1 Subliming Coating Envelope System.

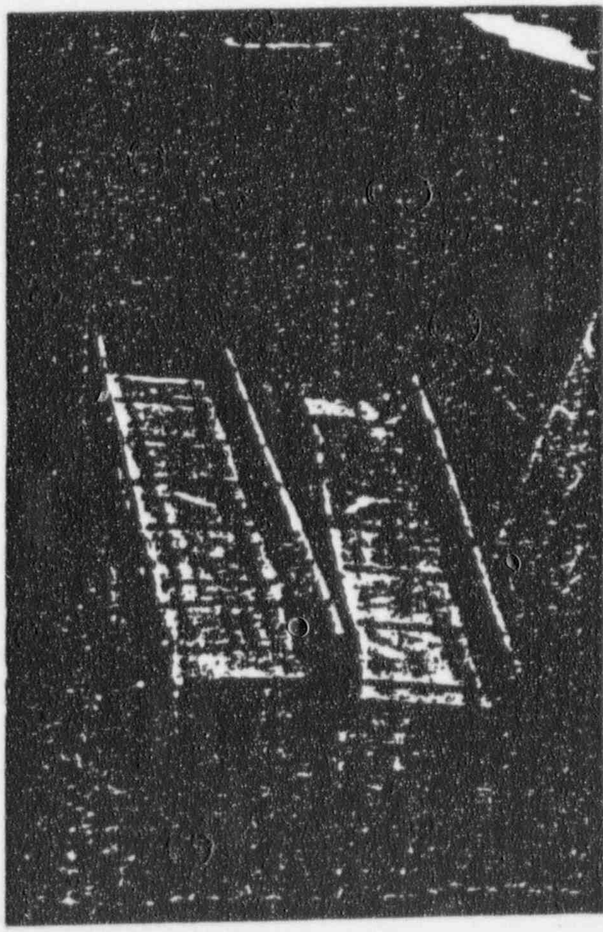
As explained in detail in Exhibit 1 to this report, the protective envelope consists of 'clam shell arrangement' which fits all-around the Test Specimen Cable Tray Assembly. This envelope consists of an inner layer of Thermo-Lag Stress Skin Type 330-69, a 0.625 inch wet (0.469 inch dry, 25 percent shrinkage in airless sprayed wet Thermo-Lag 330-1 coating) covering of Thermo-Lag 330-1 Subliming Coating material, a outer covering of light weight Fiberglass Cloth Armoring and a thin top coat of Thermo-Lag 330-1 Subliming Coating material of sufficient thickness to just cover the Fiberglass Armoring. The detail preparation and Thermo-Lag 330-1 Subliming Coating material Application Procedures are presented in Exhibit 1 to this report. A typical clam shell section of the Thermo-Lag 330-1 Subliming Coating Envelope System, prior to installation around the Test Specimen Cable Tray Assembly is shown in Figure 4.

B. Test Specimen Physical Details:

As shown by Figure 5, the Test Specimen Cable Tray is a standard 14 inch wide by 4½ inch high Ladder Back Electrical Cable Tray fabricated in the form of a U-Bend, with the dimensions being 36 inches long by 32 inches high. A single cable 'air drop' is also incorporated in the Test Specimen. A total of 27 cables are installed in the Test Specimen Cable Tray Assembly (see Table I for individual electrical cable indentification).

Figure 6 presents a photograph of the Test Specimen Cable Tray Assembly with the Thermo-Lag 330-1 Subliming Coating Envelope System installed on all portions of the Cable Tray with the exception of the 'air drop' cable. Figure 6 also shows the leads of the thermocouples installed within the Test Specimen Cable Tray Assembly for monitoring of various items during the one-hour Fire Test. A photograph of the completed Test Specimen, mounted for insertion into the TSI ASTM-E-119 Fire Simulation Facility is presented in Figure 7. In this photograph, the 'air drop' cable has had the Thermo-Lag 330-1 Subliming Coating Envelope System added to the air drop cable.

NOTE: THERMO-LAG STRESS SKIN TYPE 330-69 IS PLACED NEXT TO CABLE TRAY (NON-FIRE EXPOSED SIDE)



THERMO-LAG STRESS SKIN TYPE 330-69

THERMO-LAG 330-1 SUBLIMING COATING

FIGURE 4: TYPICAL SAMPLE OF THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM FOR CABLE TRAY PROTECTION BEFORE INSTALLATION AROUND CABLE TRAY

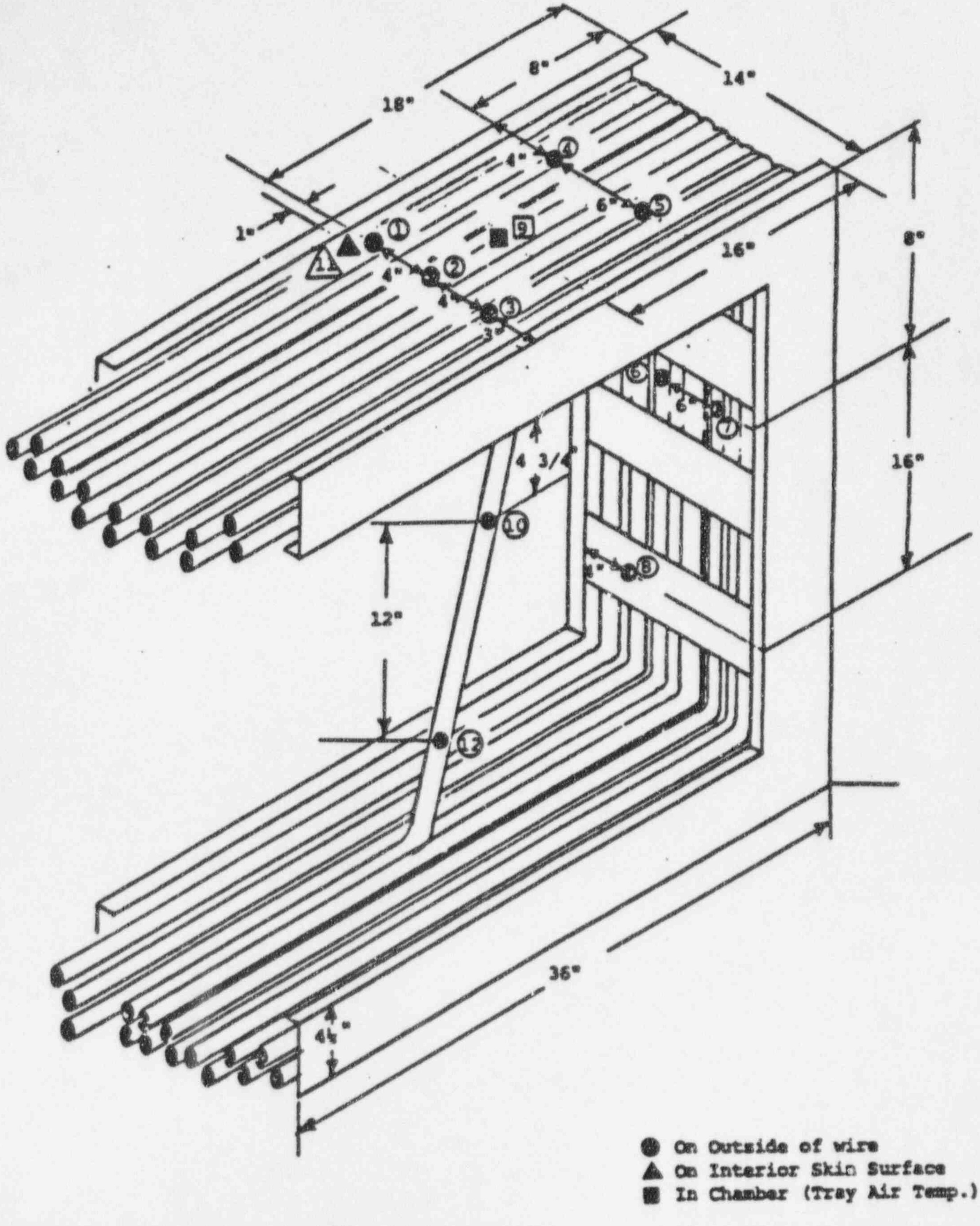


FIGURE 5: SCHEMATIC ILLUSTRATION OF THE TEST SPECIMEN CABLE TRAY ASSEMBLY BEFORE INSTALLATION OF THE THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM (FOR CLARITY, ALL CABLES ARE NOT SHOWN)

TABLE I

IDENTIFICATION OF CABLES IN CABLE TRAY AND AIR DROP ASSEMBLY

TEST SPECIMEN

CABLE NUMBER	ELECTRICAL CABLE IDENTIFICATION
1	3C - W023.5 ADD7530 - ADD 7438
2	"
3	"
4	"
5	"
6	"
7	"
8	3C - 8AW6 ITT TYPE W 90°C P122 - MSHA
9	"
10	"
11	2C - W-121 .0000078 - 0000228
12	"
13	"
14	2C - 6AW6 PR MAGENT CRANE CABLE
15	"
16	"
17	"
18	12C - W-045-15 07054 - 07004
19	"
20	"
21	"
22	"
23	"
24	"
25	"
26	"
27	"

SUMMARY: 7 Size 2C Cables
10 Size 12C Cables
10 Size 3C Cables
TOTAL: 27 Electrical Cables in Ladder Back Cable Tray

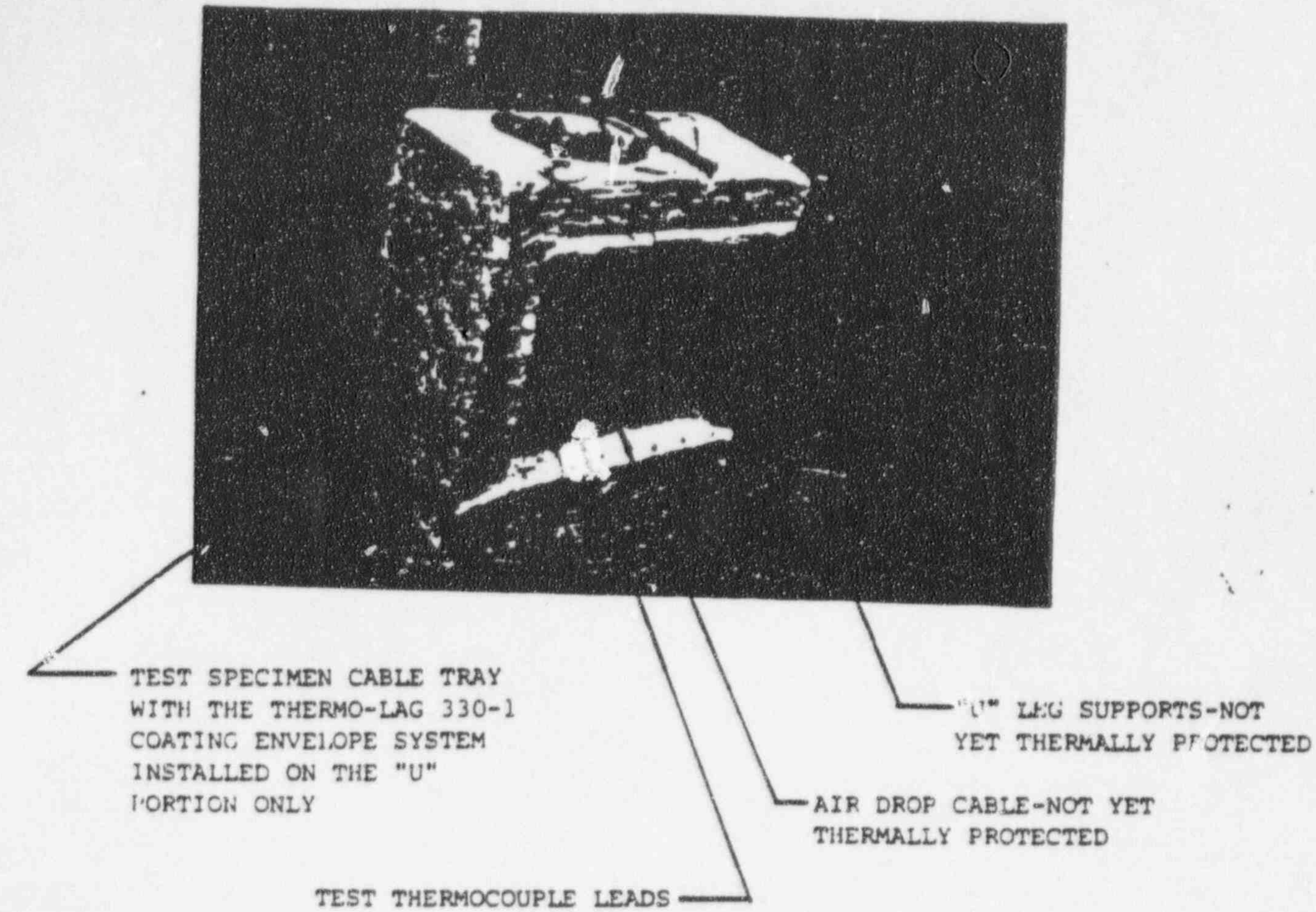


FIGURE 6: PHOTOGRPAH OF THE TEST SPECIMEN CABLE TRAY ASSEMBLY WITH THE THERMO-LAG 330-1 COATING ENVELOPE SYSTEM INSTALLED EXCEPT FOR THE AIR DROP CABLE

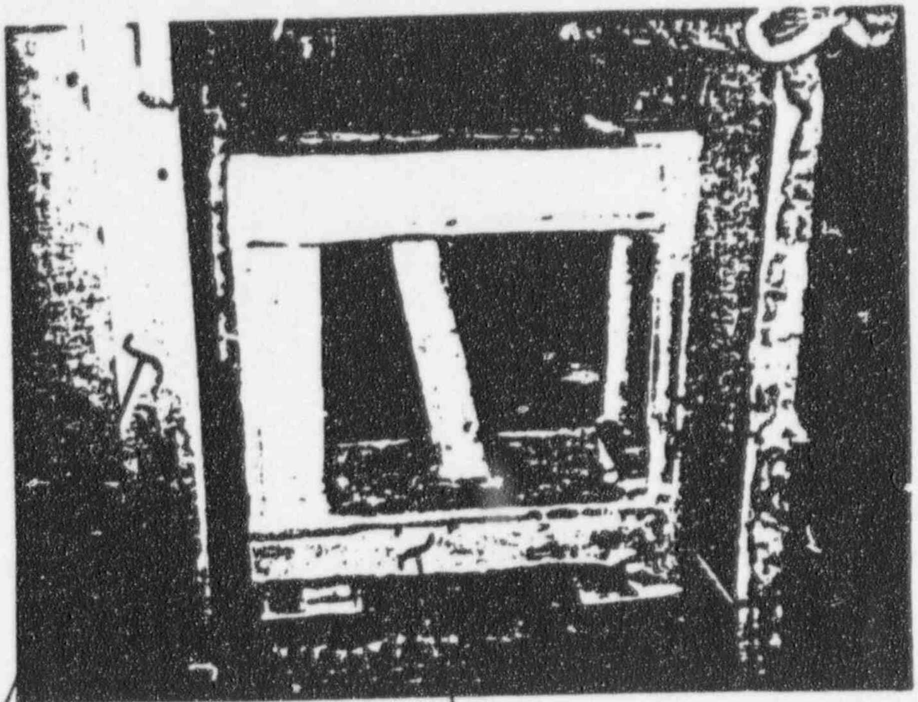


FIGURE 7: PHOTOGRAPH OF TEST SPECIMEN CABLE TRAY AND AIR DROP ASSEMBLE FULLY PROTECTED WITH THE THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM

C. Verification of Subliming Coating Envelope Thickness:

Using a sharp point 'penetration type" metallic gauge, the Author verified that the Thermo-Lag 330-1 Subliming Coating Envelope System varied in thickness (dry film thickness) from a low of 0.460 inches to a high of 0.475 inches. This is well within the commercially accepted dry film thickness meaurements of ± 5 percent of the nominal thickness for airless spraying techniques. In the specific case of the Test Speciment, the 'nominal dry film thickness' should be 0.469 inches for a 'wet film thickness' of 0.625 inches.

The Author also verified that the cured surface of the Thermo-Lag 330-1 Subliming Coating Envelope System had not cracked, spalled or flaked and that it appeared to be a conventional finish for this type fireproofing material.

IV. TEST INSTRUMENTATION

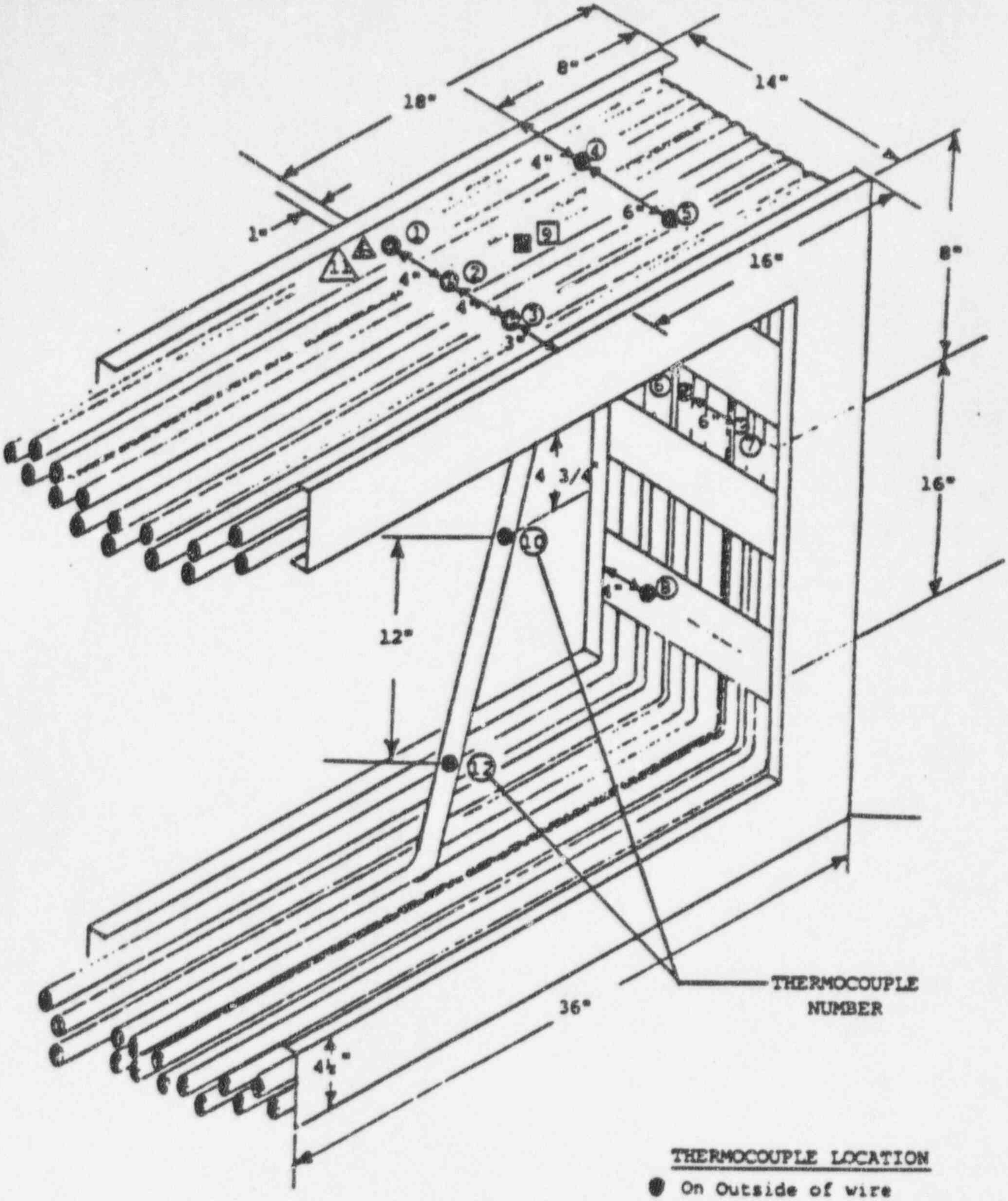
The Test Instrumentation consisted of the following:

A. Twelve (12) Chromel/Alumel Thermocouples for measurement of cable surface temperatures, Ladder Back Cable Tray interior surface temperature and Cable Tray ambient air temperature beneath the protective envelope. The locations of the thermocouples are shown schematically in Figure 8. Table II presents a listing of the temperature measurement for each of the twelve (12) Test Thermocouples.

B. Six (6) Chromel/Alumel Thermocouples were used for air temperature measurements inside the TSI ASTM-E-119 Fire Simulation Facility.

C. The twelve Test Specimen Thermouple readings were recorded on a Honeywell-Brown Electronic Chart Type Recorder. This recorder has an automatic cold reference incorporated in the recorder mechanism. Exhibit 3 presents a copy of the original temperature readings for these thermocouples. Figure 9 presents a comparison of the ASTM-E-119 Test Method required Time-Temperature Curve with the 'maximum thermocouple reading' and the overall average of the thermocouple reading in the area of the Test Specimen within the Test Facility. As shown, the actual ASTM-E-119 Fire Simulation Facility Time-Temperature curve very slightly exceeds the requirements of the ASTM-E-119 Test Method.

For manual control of the ASTM-E-119 Fire Simulation Facility time-temperature relationship two Omega Digital Temperature Recorders, Model 175 and 179, were also used. A manual reading was taken every five (5) minutes from these visual Recorders for use in the ASTM-E-119 Fire Simulation Facility temperature control



THERMOCOUPLE LOCATION

- ● On Outside of wire
- ▲ On Interior Skin Surface
- ■ In Chamber (Tray Air Temp.)

FIGURE 8: LOCATION OF TEST THERMOCOUPLES IN THE CABLE TRAY AND AIR DROP TEST ASSEMBLY

(FOR CLARITY, ALL CABLES ARE NOT SHOWN)

TABLE II

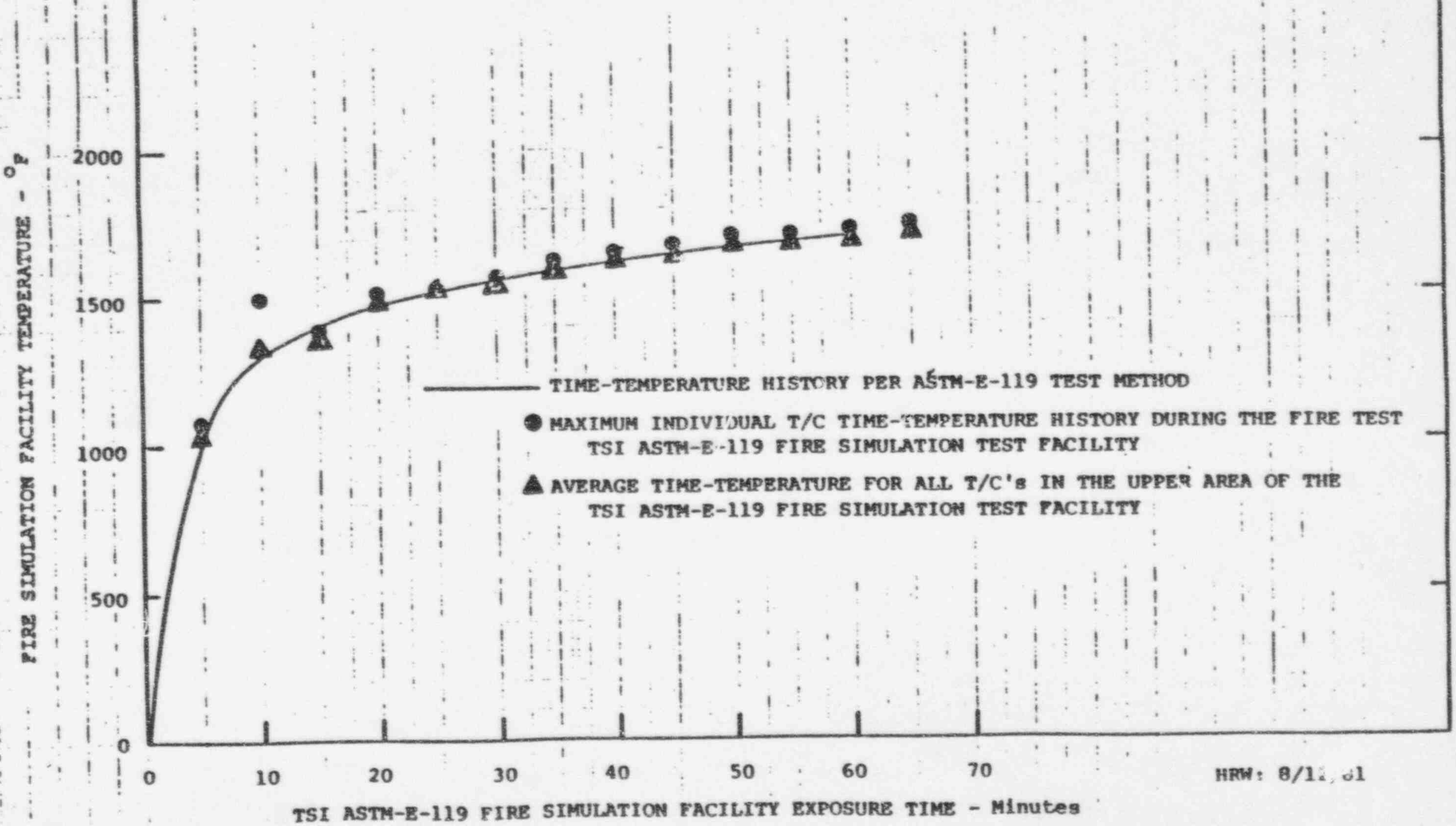
LOCATION OF TEST THERMOCOUPLES

THERMOCOUPLE NUMBER	THERMOCOUPLE LOCATION
1	3C - W023.5 ADD7530 - ADD7438 Electrical Cable
2	2C - 8AW6 FR Magent Crane Cable
3	2C - W-121 0000078 - 0000228 Electrical Cable
4	12C - W-023-5 ADD7530 - ADD7438 Electrical Cable
5	3C - W023.5 ADD7530 - ADD7438 Electrical Cable
6	3C - W023.5 ADD 7530 - ADD7438 Electrical Cable
7	3C - 8AW6 ITT TYPE 90°C P122 - MSHA Electrical Cable
8	3C - W023.5 ADD7530 - ADD7438 Electrical Cable
9	Cable Tray Interior Air Temperature
10	3C - W023.5 ADD7530 - ADD7438 Air Drop Electrical Cable
11	Ladder Back Cable Tray Interior Surface Temperature
12	3C - W023.5 ADD7530 - ADD7438 Air Drop Electrical Cable

NOTE: SEE FIGURE 8 FOR PHYSICAL LOCATION OF TEST THERMOCOUPLES

FIGURE 9

COMPARISON OF THE REQUIRED ASTM-E-119 TEST METHOD TIME-TEMPERATURE HISTORY WITH ACTUAL MEASUREMENTS DURING THE ONE HOUR ASTM-E-199 TEST ON THE THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM FOR A CABLE TRAY-CONDUIT AND AIR DROP ASSEMBLY



HRW: 8/12/81

Figure 9a presents a photograph of the Cable Tray and Air Drop Test Assembly thermocouple, cable intergrity monitoring and temperature measurement recording arrangement with the Test Specimen in place in the TSI ASTM-E-119 Fire Simulation Facility during the course of the one-hour Fire Test.

V. FIRE TEST OBSERVATIONS

A. Details of the Fire Test:

The Fire Test required by Exhibit 2 to this report, was conducted on 6 August 1981. The Fire Test was started at 12:20 PM and was concluded at 1:25 PM. The actual Fire Test Duration was One-Hour and Five (5) Minutes with exposure to the ASTM-E-119 Test Method Time-Temperature relationship in the TSI ASTM-E-119 Fire Simulation Facility.

The twelve (12) thermocouples used for the various electrical cable, tray surface and tray air temperature measurements were recorded once every 3 minutes (15 seconds between individual thermocouple readings).

B. The Author made the following visual observations during the course of the Fire Test:

1. The temperature recorders, charts and visual, were checked not less than once every five minutes.
2. After approximately 30-minutes of fire exposure, a slight yellowish smoke observed to be escaping from around the upper horizontal leg entry of the Test Cable Tray Assembly. The location of the escaping smoke and the color of the smoke indicates that some decomposition was occurring in electrical cable coverings. However, a survey of all of the electrical cable temperatures being measured would indicate that the cable coverings are 'below' the expected decomposition temperature. It was temporarily concluded, based upon existing cable integrity and lack of short circuits as well as the cable covering temperature measurements, that if the yellowish smoke was due to cable decomposition, then it must be occurring from some cable in direct contact with the Ladder Back Cable Tray metallic surface near the upper leg connection to the ASTM-E-119 Fire Simulation Facility front face.
3. After 45 minutes of fire exposure, slight 'cracking' was observed in the Thermo-Lag 330-1 Subliming Coating Envelope System "CHAR FORMATION" on the air drop envelope and the upper horizontal leg envelope. These observations were made through the viewing windows of the Test Facility. Such cracking in the char formation is normal and has been repeatedly observed by the Author in other Thermo-Lag 330-1 Subliming Coating fire tests on Plates, Beams, etc.

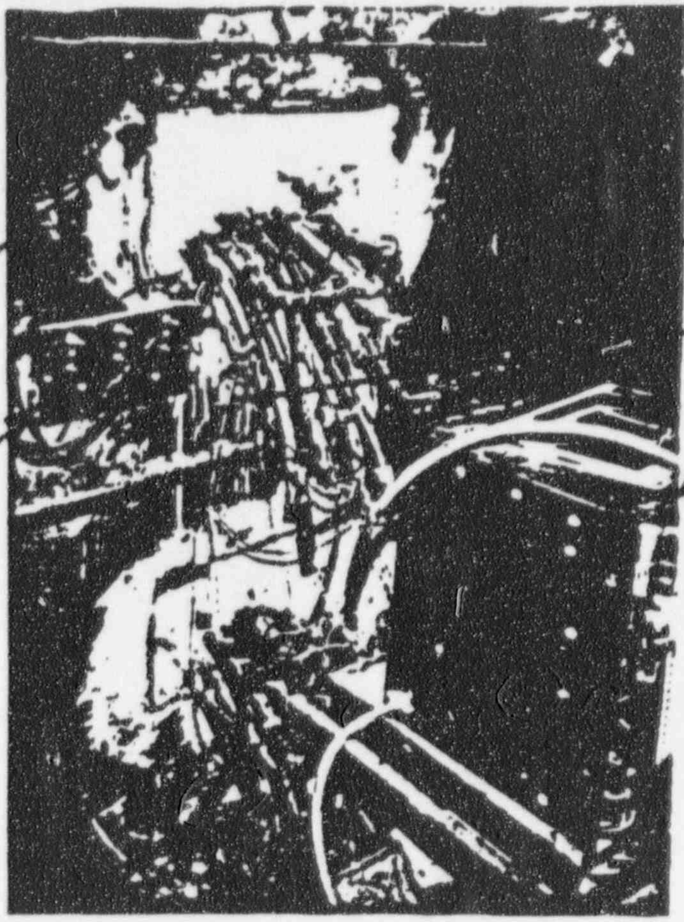


FIGURE 9a: PHOTOGRAPH OF TEST CABLE TRAY AND AIR DROP ASSEMBLY AND TEST INSTRUMENTATION CONFIGURATION

Such char formation cracking usually occurs long after sublimation of the coating and is felt to be due to continued heating of the char and the resultant expansion of the char, a normally expected sequence of events. Figure 10 presents a photograph of the Cable Tray Test Specimen after the removal from the ASTM-E-119 Fire Simulation Facility. The char formation cracking, or checking, can be observed in the outer areas of the Thermo-Lag 330-1 Subliming Coating Envelope. Howarver, it is important to note that the depth of this cracking or checking is limited to the char. This cracking or checking does not penetrate into the un-sublimed lower layers of the envelope system, as wall be shown later in this report.

C. Details of the Water Hose Stream Test:

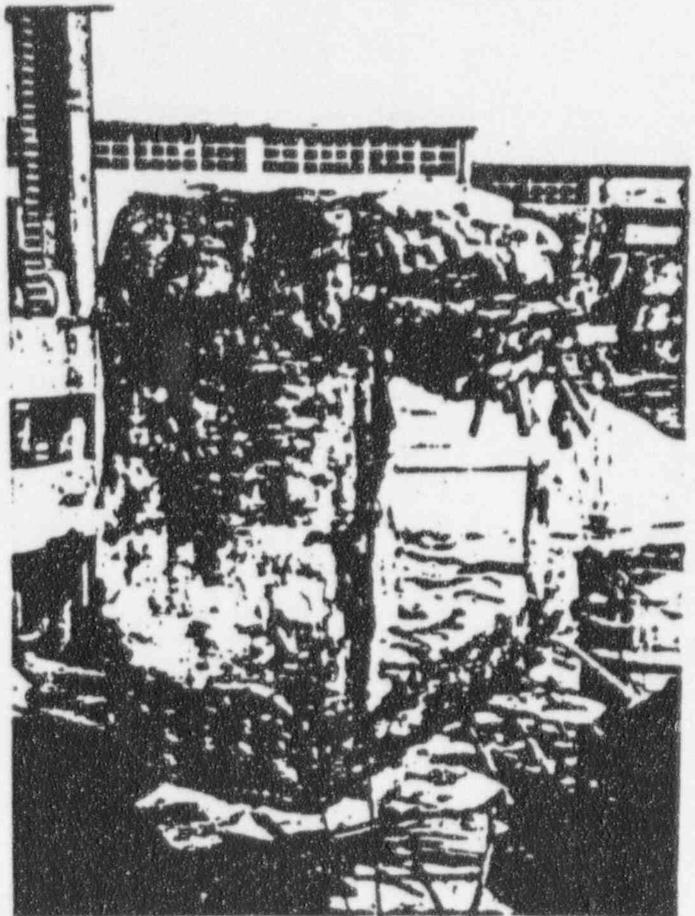
Due to the previously noted Test Requirements for a 1½ inch fire hose for conducting the Water Hose Stream Test, arrangements were made with the City of St. Louis, MO Fire Department for the use of one of their Class "A" Fire Pumpers for conducting the required test. Figure 11 presents a photograph of the Fire Apparatus used for the Water Hose Stream Tests on the Cable Tray and and Air Drop Assembly following the one hour Fire Test in the TSI ASTM-E-119 Fire Simulation Facility (Figure 10 presents a photograph of this Test Specimen being taken outside the TSI Buildings for this water hose test).

For the Water Hose Stream Test, as required by Exhibit 2 to this report, the following conditions were used:

1. Pump discharge setting: 90 psig
2. 100 feet of 1½ inch diameter fire hose with a 1½ inch Akron Brass Adjustable stream nozzle. Nozzle set at 15 degrees angle for the test with the nozzle operator (a Fire Department employee) set at 10 feet from the Fire Exposed Test Specimen.
3. The pump discharge setting, the 100 feet of 1½ inch diameter fire hose and the 1½ inch diameter discharge nozzle resulted in a water flow rate and stream angle which exceeds the minimum requirements of the Water Hose Stream Test (required water flow rate is only 75 GPM, the actual test water flow rate was close to 95 GPM).

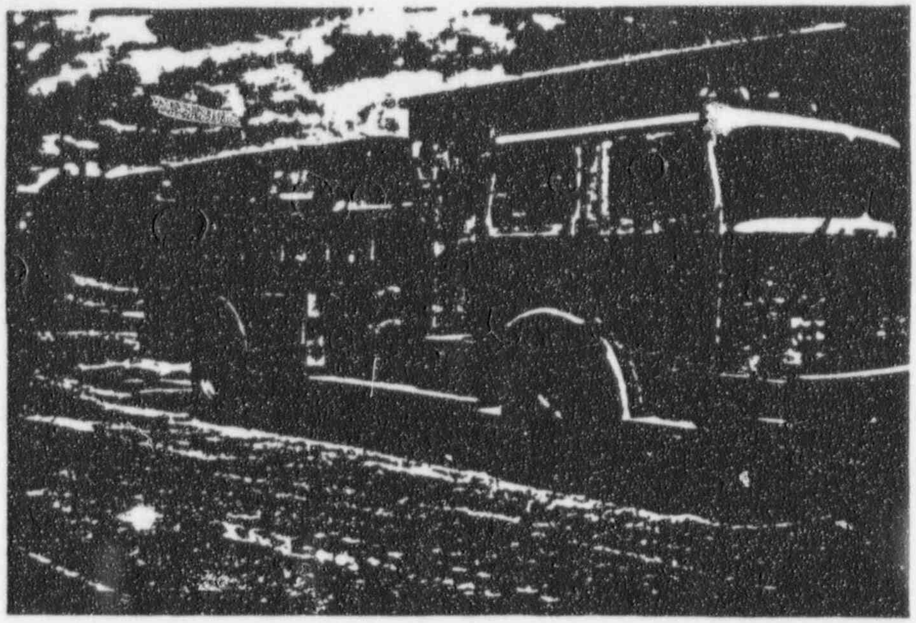
D. Visual Observations Made During the Water Hose Stream Test:

1. The Water Hose Stream Test was conducted on 7 August 1981. The actual water stream impact test was started at 2:30 PM and was stopped at 2:33 PM. The Water Stream Test duration was 3 minutes, as compared to the required 2½ minute minimum.



CRACKING IN CHAR FORMATION

FIGURE 10: PHOTOGRAPH OF CABLE TRAY AND AIR DROP TEST ASSEMBLY AFTER 65-MINUTES OF EXPOSURE TO THE TSI ASTM-E-119 FIRE SIMULATION FACILITY



1250 GPM, CLASS "A" PUMPER: 500 GALLON WATER BOOSTER TANK

FIGURE 11: PHOTOGRAPH OF CLASS "A" 1250 GPM WATER PUMPER USED FOR THE WATER HOSE STREAM TEST ON THE FIRE EXPOSED

CABLE TRAY TEST SPECIMEN

2. The 15 degree dispersed water stream did not have any 'material' effect upon the physical integrity of the Thermo-Lag 330-1 Subliming Coating Envelope System or its char formation. In fact to dislodge the char formation, it was necessary to use a high velocity solid cone straight stream water hose pattern. Although this solid cone water stream did dislodge some of the char formation, it did not adversely effect the unsublimed coating layers.

VI. RESULTS OF FIRE TEST

According to the requirements of Exhibit 2 to this report, the Pass-Fail Criteria for the Fire Test is as follows:

"3.4.2 Hose Stream Test - Immediately following Test I (the one-hour Fire Test), accessible surfaces of the Protective Envelope shall be subjected to one of the following hose stream tests. The hose stream shall be applied for a minimum of 2½ minutes, without de-energizing the circuits. .....

3.5 The tests shall be constituted a failure if any of the following occur:

1. Circuits fail or fault during the fire test as required in Test I or fail during the hose stream test."

On the basis of this cable integrity, as shown by the Figure 3 Monitoring Circuits, the Cable Tray, Conduits and Air Drop Test Assembly PASSED all of the One Hour Fire Test Requirements. However, to provide additional test data for interpretation of the test results, a number of cable surface temperature measurements must also be recored and reported in the Test Report. The 'usual' temperature limits associated with cable surface temperatures are as follows:

1. 400 °F for cable in the cable tray.
2. 700 °F for cables in the air drops.

As previously stated, Exhibit 3 presents a copy of the actual Honeywell Chart recordings for all twelve (12) thermocouples used in the Fire Test. Figures 12, 13 and 14 present plots of the measured electrical cable surface temperatures in the Ladder Back Cable Tray. As shown, a maximum electrical cable surface temperature of 315 °F was recorded after a one hour exposure time to the TSI ASTM-E-119 Fire Simulation Facility environment. At the end of one hour's exposure to this fire environment, the electrical cable surface temperatures, for the cables in the cable tray, ranged from a low of 190 °F to a high of 315 °F, well below the commonly used maximum electrical cable surface temperature of 400 °F for cables installed in cable trays.

FIGURE 12

TSI ASTM-E-119 FIRE SIMULATION FACILITY: ONE HOUR FIRE TEST ON THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM FOR A CABLE TRAY CONDUITS AND AIR DROP ASSEMBLY: RESPONSE CHARACTERISTICS OF ELECTRICAL CABLE COVERINGS

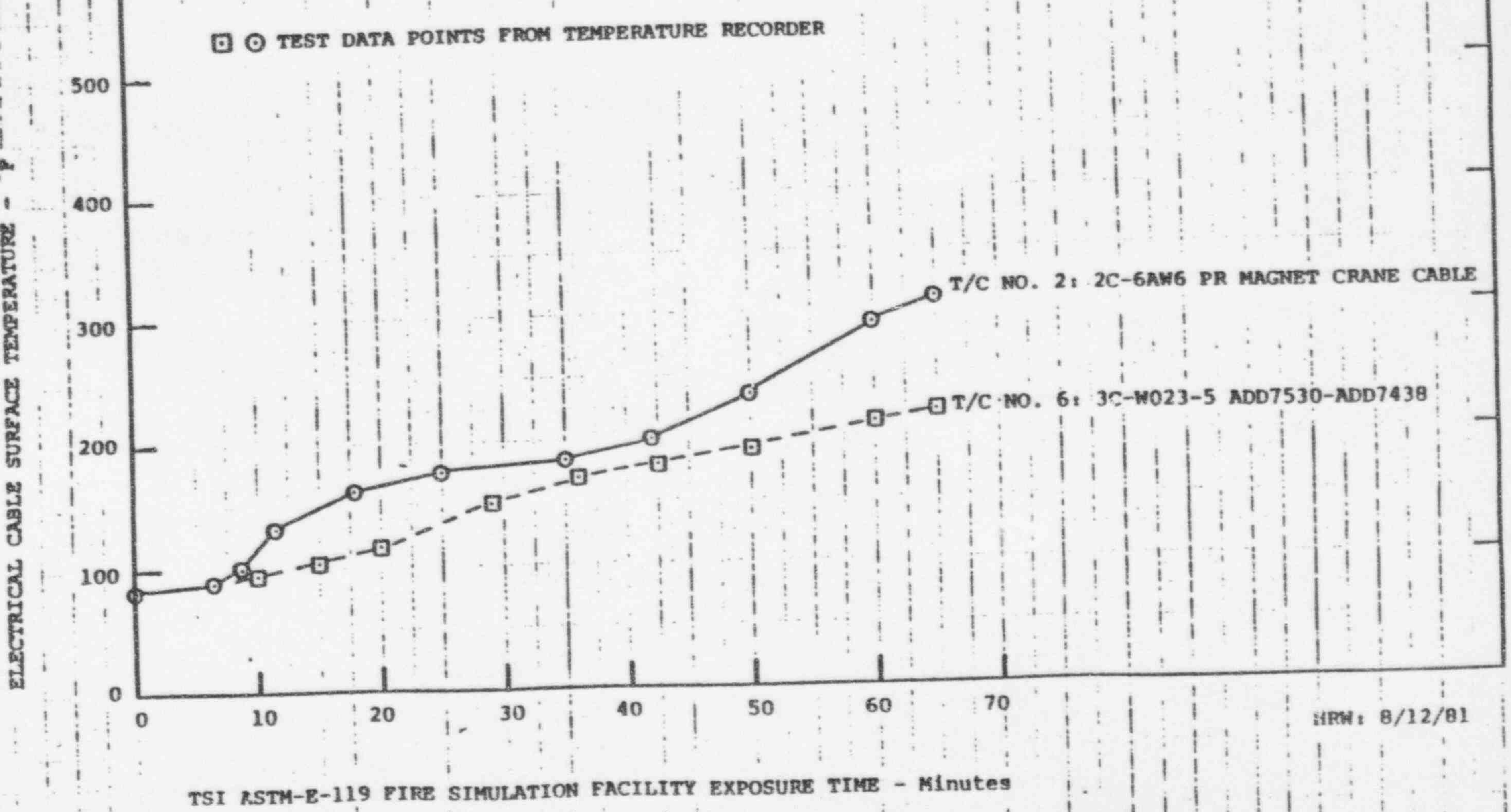
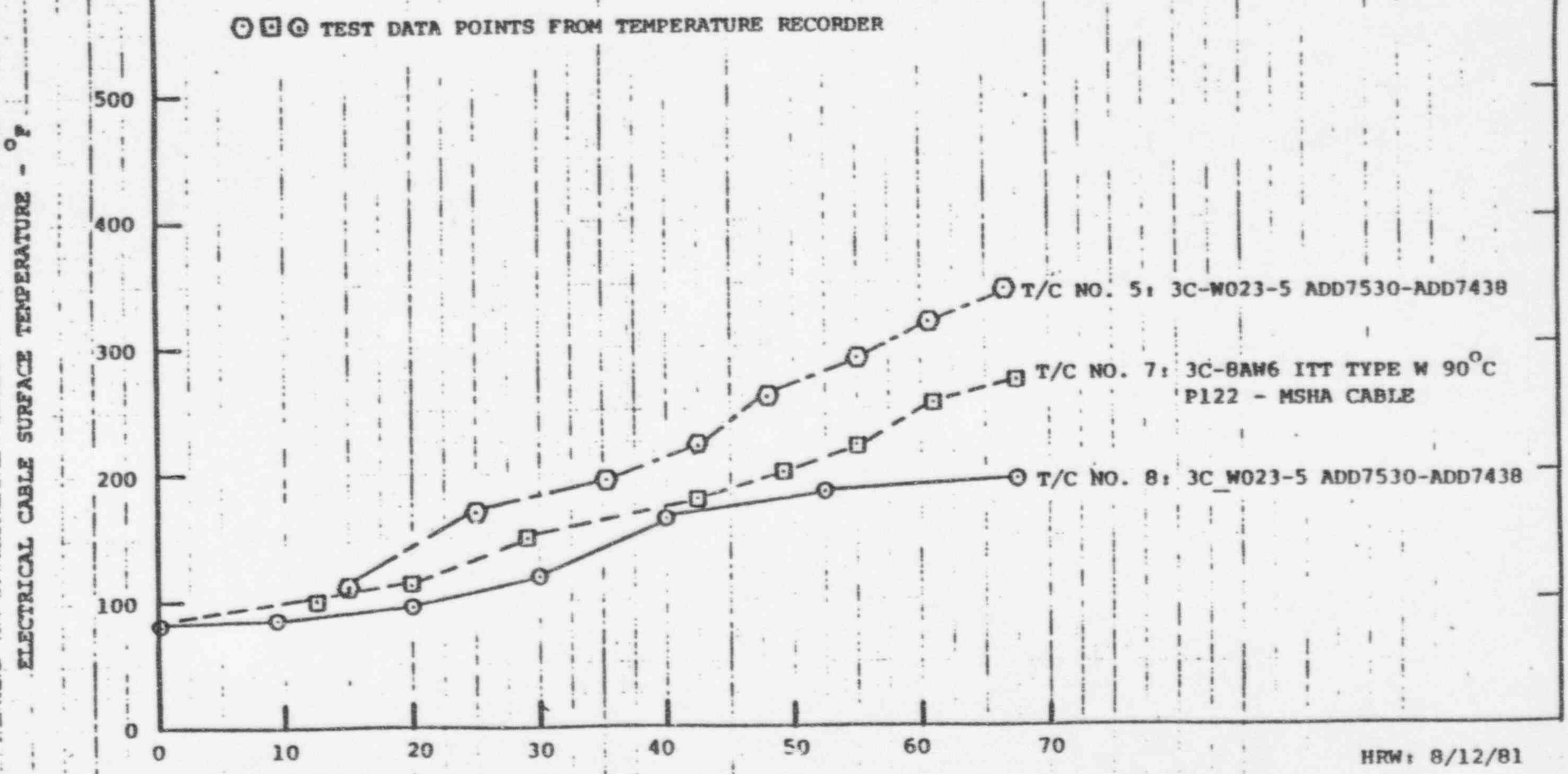


FIGURE 13

TSI ASTM-E-119 FIRE SIMULATION FACILITY: ONE HOUR FIRE TEST ON THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM FOR A CABLE TRAY-CONDUITS AND AIR DROP ASSEMBLY: RESPONSE CHARACTERISTICS OF ELECTRICAL CABLE COVERINGS



TSI ASTM-E-119 FIRE SIMULATION FACILITY EXPOSURE TIME - Minutes

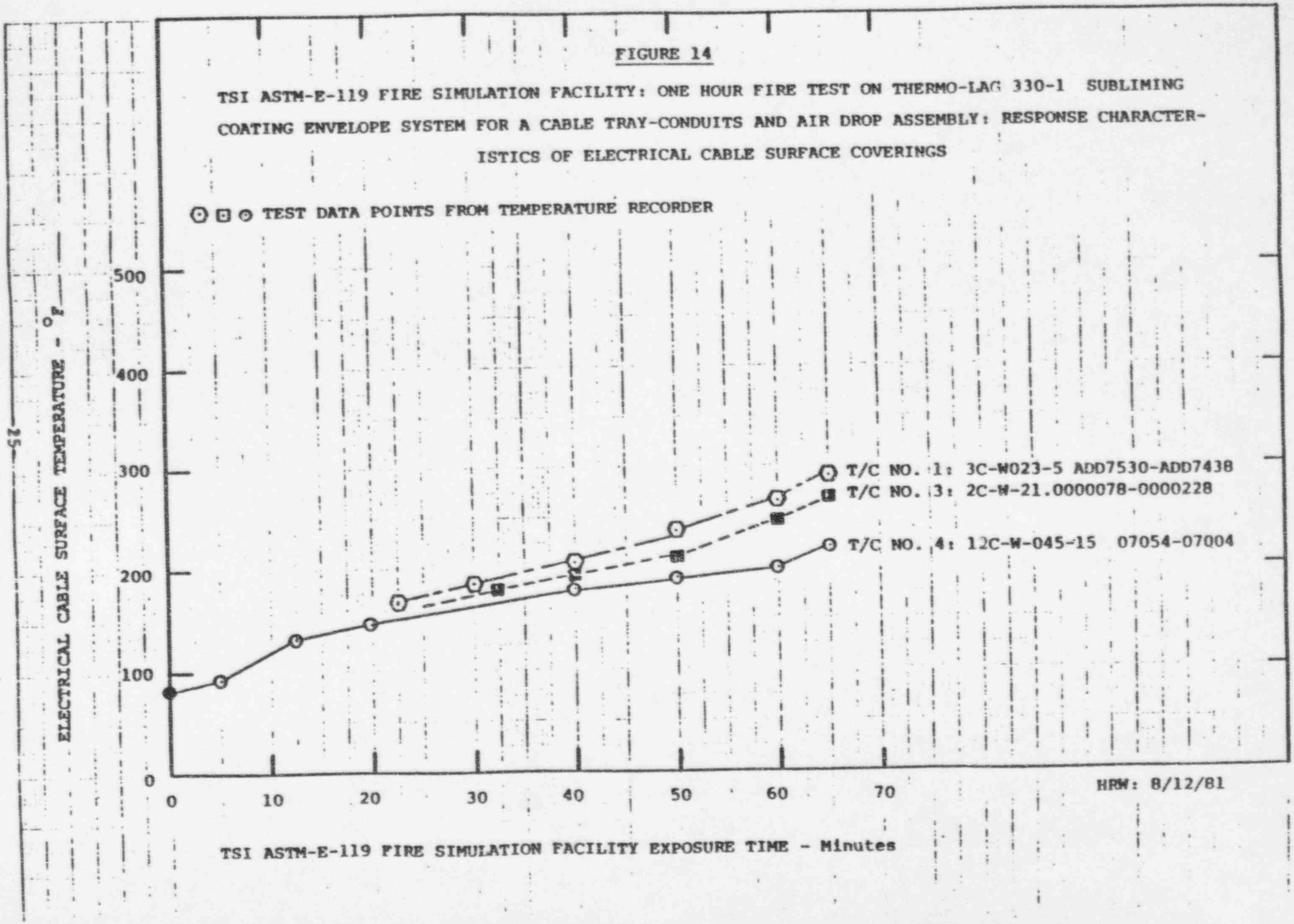


FIGURE 14

TSI ASTM-E-119 FIRE SIMULATION FACILITY: ONE HOUR FIRE TEST ON THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM FOR A CABLE TRAY-CONDUITS AND AIR DROP ASSEMBLY: RESPONSE CHARACTERISTICS OF ELECTRICAL CABLE SURFACE COVERINGS

Figure 15 presents the Time-Temperature measurements for the electrical cable installed in the 'Air Drop' portion of the Test Specimen. As shown, at the end of the one-hour fire exposure, the cable surface temperature was recorded as 450 $^{\circ}$F, well below the commonly accepted limitation of 700 $^{\circ}$F for electrical cables in air drops. The Time-Temperature measurements for the surface temperature of the Ladder Back Cable Tray (measurement made in the upper leg of the Test Specimen as is shown in Figure 8) and the air temperature inside the upper leg of the Test Specimen (see Figure 8) are presented in Figure 16. As shown, the end of one-hour's fire exposure, the Ladder Back Cable Tray reached a metal surface temperature of 450 $^{\circ}$F and an air temperature of about 315 $^{\circ}$F just above the electrical cables.

VII. RESULTS OF WATER HOSE STREAM TEST

Figures 17 and 18 present photographs of the 1½ inch diametr water hose stream being applied to the fire tested Cable Tray, Conduits and Air Drop Test Assembly. As shown, the water stream has a high impact upon the fire tested Test Specimen and is a relative compact water stream which covers the entire Test Specimen. This hose stream and its point of discharge with respect to the Test Specimen meets the criteria presented in Exhibit 2 to this report (ANI/MAERP Requirements).

Figure 19 presents a close-up of the Cable Integrity Monitoring Panel immediately following 3-minutes of water hose stream application to the fire tested Cable Tray, Conduits and Air Drop Test Assembly. AS shown by the lighted bulb and the two non-lighted bulbs, electrical circuit continuity was maintained throughout the fire test and water hose stream test and that no faults, or short circuits occurred during either tests. This means that the Test Specimen meets the specified Cable Integrity Requirements specified in Exhibit 2 to this report (ANI/MAERP Requirements for Class 1E Electrical Circuit Protective Enclosures).

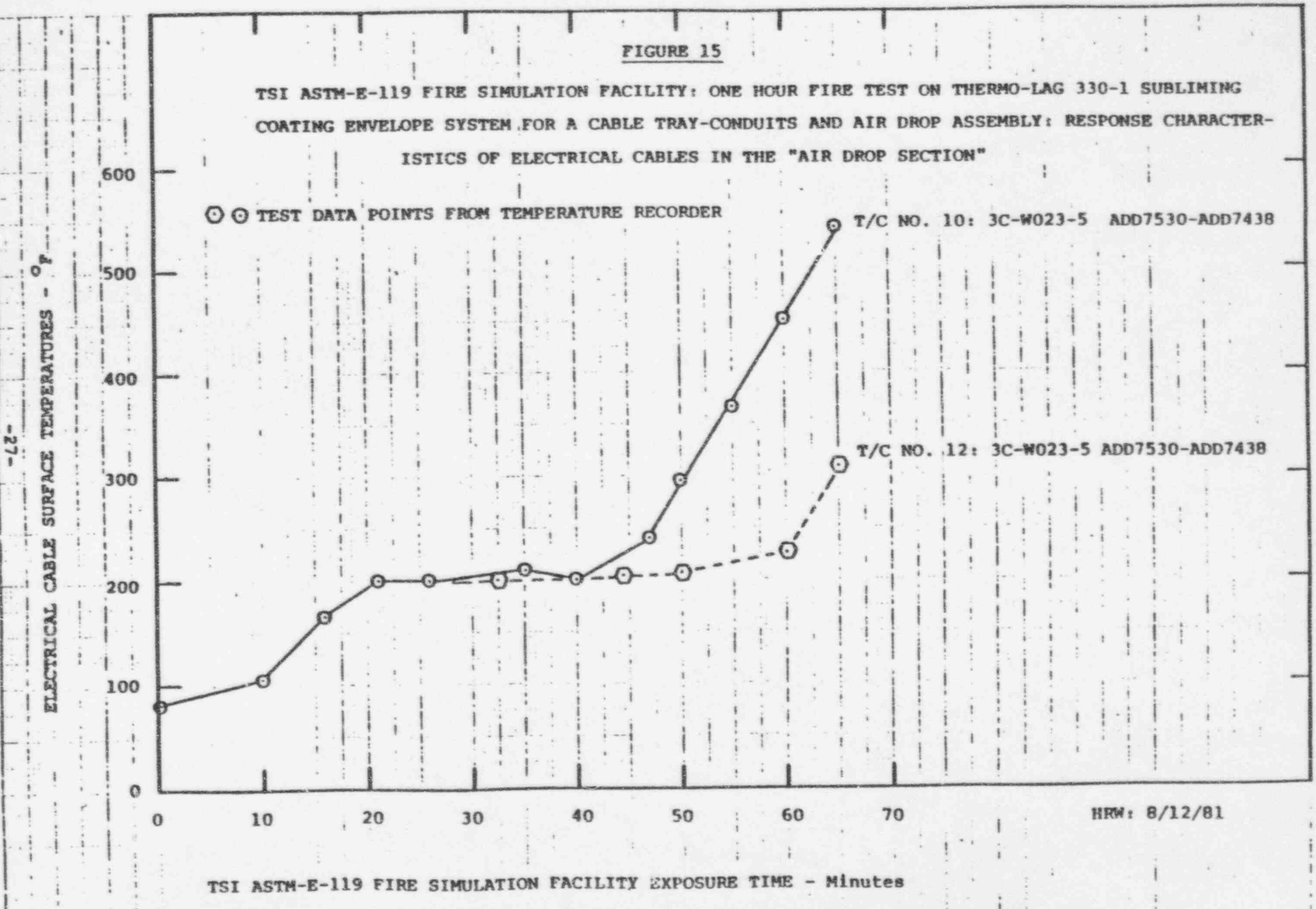
VIII. CONCLUSIONS AND OBSERVATIONS

Based upon the tests results and experimental data presented herein, as well as detail visual inspections of the Cable Tray, Conduits and Air Drop Test Assembly before the start of testing and after both the One Hour Fire Test and the Water Hose Stream Test, the following Conclusions and Observations are presented for consideration and evlauation purposes:

1. Based upon the requirements for maintaining cable circuit integrity, as specified

FIGURE 15

TSI ASTM-E-119 FIRE SIMULATION FACILITY: ONE HOUR FIRE TEST ON THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM FOR A CABLE TRAY-CONDUITS AND AIR DROP ASSEMBLY: RESPONSE CHARACTERISTICS OF ELECTRICAL CABLES IN THE "AIR DROP SECTION"



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-27-

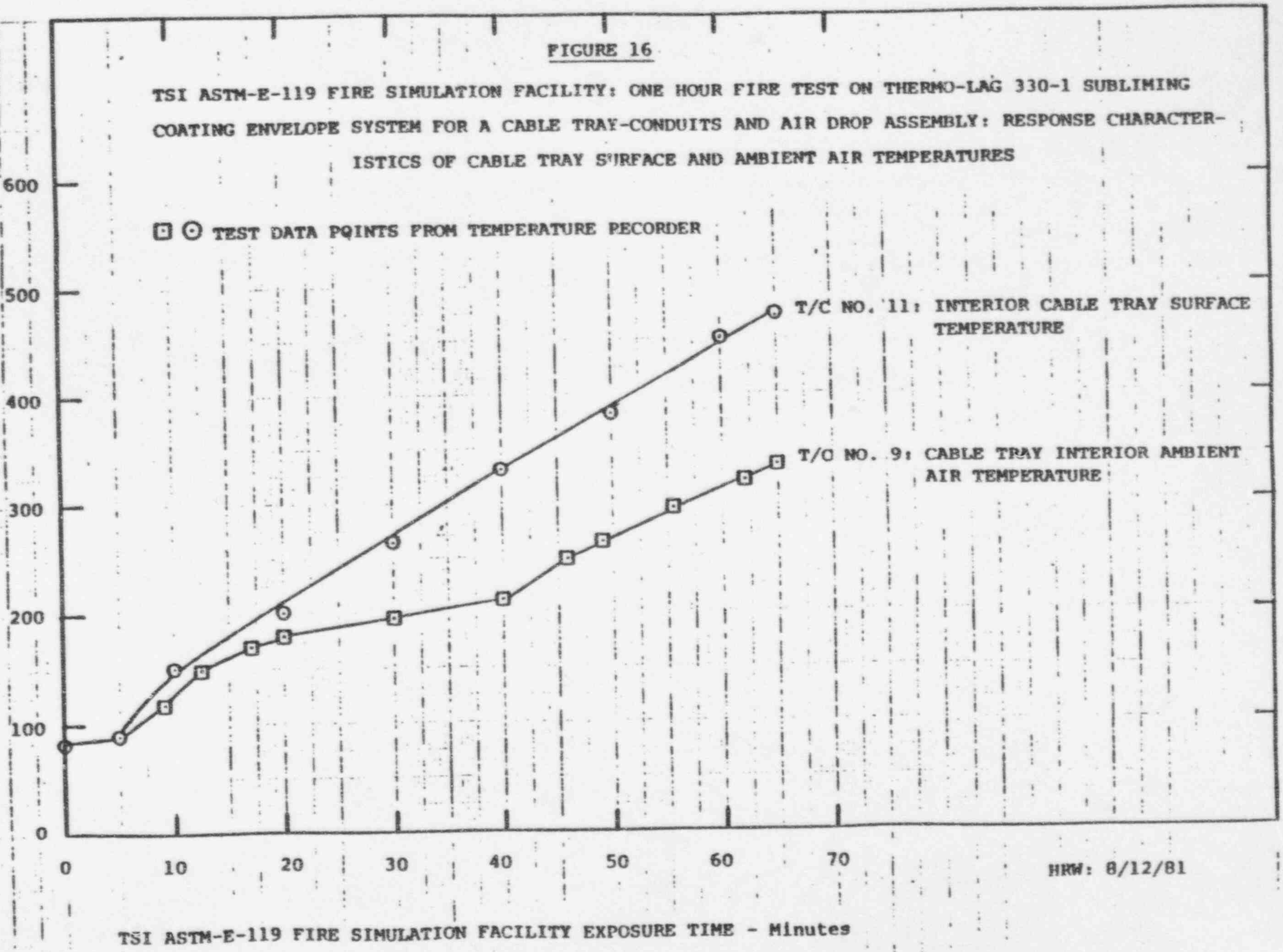


FIGURE 16
TSI ASTM-E-119 FIRE SIMULATION FACILITY: ONE HOUR FIRE TEST ON THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM FOR A CABLE TRAY-CONDUITS AND AIR DROP ASSEMBLY: RESPONSE CHARACTERISTICS OF CABLE TRAY SURFACE AND AMBIENT AIR TEMPERATURES
TEST DATA POINTS FROM TEMPERATURE RECORDER
T/C NO. 11: INTERIOR CABLE TRAY SURFACE TEMPERATURE
T/C NO. 9: CABLE TRAY INTERIOR AMBIENT AIR TEMPERATURE
TEMPERATURE - °C
600
500
400
300
200
100
0
0
10
20
30
40
50
60
70
HRW: 8/12/81
TSI ASTM-E-119 FIRE SIMULATION FACILITY EXPOSURE TIME - Minutes

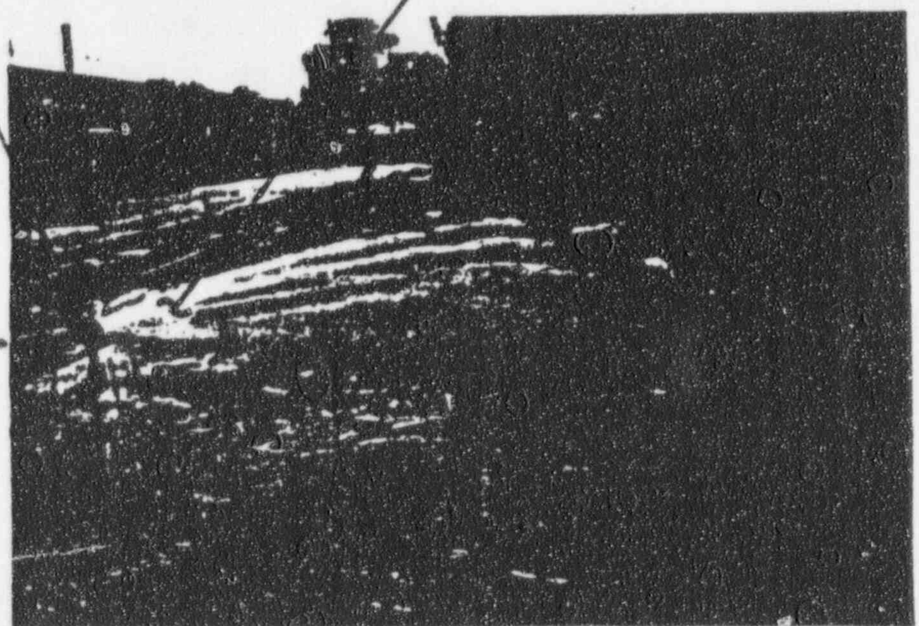


FIGURE 17: PHOTOGRAPH OF WATER STREAM BEING APPLIED TO THE CABLE TRAY, CONDUITS AND AIR DROP ASSEMBLY AFTER EXPOSURE TO THE ONE HOUR FIRE TEST WITH A 1½ INCH DIAMETER HOSE LINE FROM A CLASS A 1250 GPM PUMPER TRUCK

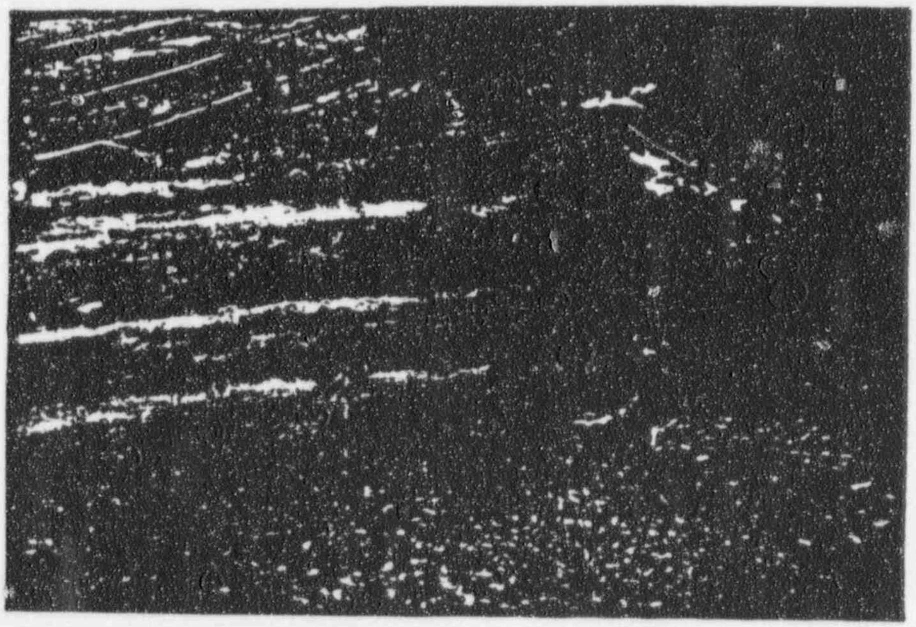


FIGURE 1[illegible]: CLOSE-UP OF THE CONTACT OF THE 1½ INCH DIAMETER 15 DEGREE ANGLE DISPERSED WATER STREAM WITH THE CABLE TRAY, CONDUIT AND AIR DROP ASSEMBLY TEST SPECIMEN

NOTES: 1. THE LIGHTED "BULB" IS THE "CIRCUIT TO SYSTEM " MONITORING CHANNEL (LIGHTED MEANS CABLE INTEGRITY)

2. The NON-LIGHTED Bulbs are for the "Circuit to Circuit" and "Circuit to Ground" Monitoring Channels. A LIGHTED BULB here means the presence of a fault or short.

FIGURE 19: CLOSE-UP OF ENERGIZED CABLE INTEGRITY MONITORING CIRCUIT DISPLAY PANEL IMMEDIALTELY FOLLOWING THE WATER HOSE TEST ON A FIRE TESTED CABLE TRAY, CONDUITS AND AIR DROP ASSEMBLY

in Paragraphs 3.4.1, 3.4.2 (3) and 3.5 (1) of ANI/MAERP Standard Fire Endurance Test Method to Qualify A Protective Envelope for Class 1E Electrical Circuits (see Exhibit 2 to this report), the TSI Cable Tray, Conduits and Air Drop Thermo-Lag 330-1 Subliming Coating System PASSES both the Fire Test and the Water Hose Stream Test Requirements in all aspectes.

2. The recorded cable surface temperature measurements at the conclusion of the One-Hour Fire Test shows that the electrical cable surface temperature are well below commonly accepted industrial standard limitations.

3. A Post Fire Test and Water Hose Stream Impingement Test detail visual inspection of the Cable Tray, Conduits and Air Drop Test Assembly showed the following:

   a. Figure 20 presents a photograph of the TSI Cable Tray, Conduits and Air Drop Test Specimen immediately following the One Hour Fire Test and the Water Hose Stream Impingement Test. Figure 21 presents the same Test Specimen with portions of the Thermo-Lag 330-1 Subliming Coating Envelope System removed from the cable tray assembly. As shown, in Figure 21 'one' of the electrical cables in direct contact with the metal cable tray under went a slight decomposition and bubbling in the cable covering. This would account for the slight amount yellowish smoke that was observed to issue from within the cable tray opening after about 30 minutes of fire exposure. Cutting open the cable jacket bubbled area showed NO damage to the cables themselves, in so far as heat or fire damage is concerned.

   b. Figure 22 presents a photograph of the interior surface of the Thermo-Lag 330-1 Subliming Coating Envelope System after the One Hour Fire Test and the Water Hose Stream Test (a solid cone water discharge from 10 feet was also used on this portion of the protective covering). As shown, the Thermo-Lag 330-1 Subliming Coating has not fully sublimed all the way through the original 0.469 dry film thickness and has not been damaged by the Water Hose Stream Test. No actual measurements were made of the unsublimted thickness. Essentially all of the dry film thickness was sublimed along the upper leg of the test specimen. Since the air temperature around the test specimen and the measured thickness of the protected envelope were essentially the same, the differences in convection heating would account for the unsublimed coating.

   c. Figure 23 shows a section of electrical cable being removed from the Test Specimen for a detail inspection of the interior cables. Figure 24 shows the actual physical condition of the cabling inside the section of removed cable. As far as a visual inspection is concerned, NO damage at all resulted to any

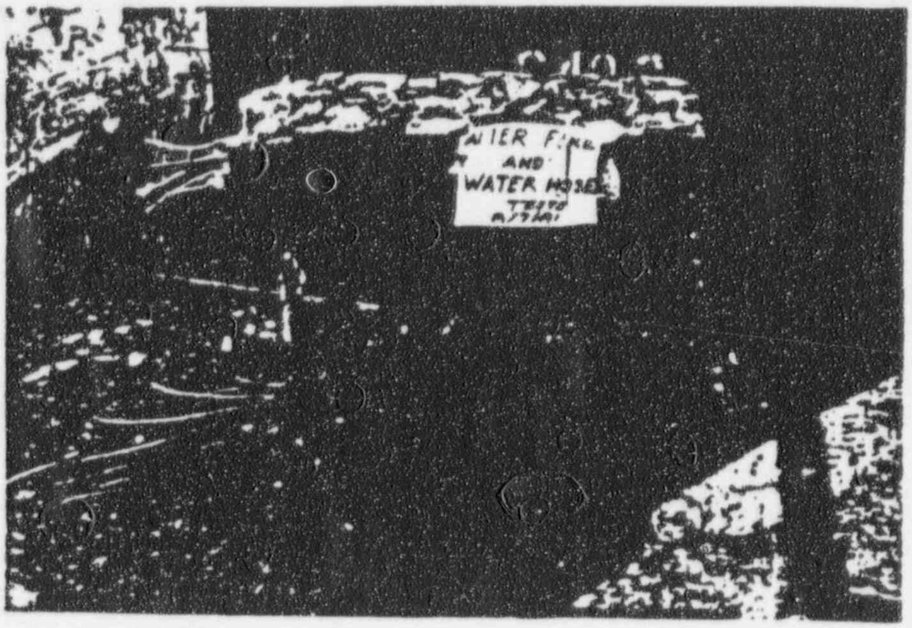


FIGURE 20: PHOTOGRPAH OF THE THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM PROTECTED CABLE TRAY, CONDUITS AND AIR DROP TEST ASSEMBLY FOLLOWING THE ONE HOUR FIRE TEST AND WATER HOSE STREAM TEST

BUBBLING OF CABLE SURFACE COVERING (CABLE IN DIRECT CONTACT WITH CABLE TRAY METAL SURFACE)

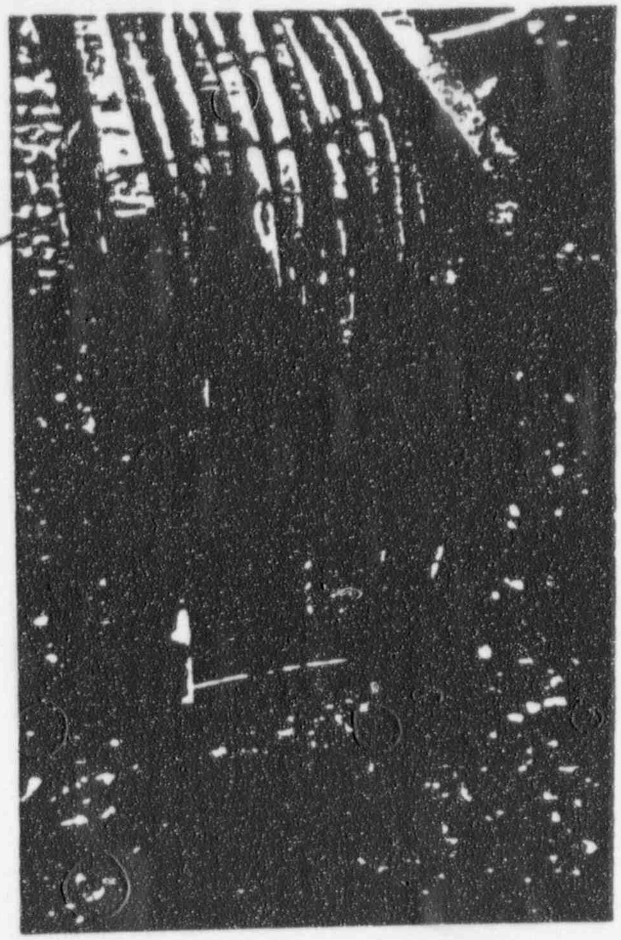


FIGURE 21: PHOTOGRPAH OF THE TSI CABLE TRAY, CONDUITS AND AIR DROP TEST SPECIMEN WITH PORTIONS OF THE PROTECTIVE COVERING REMOVED

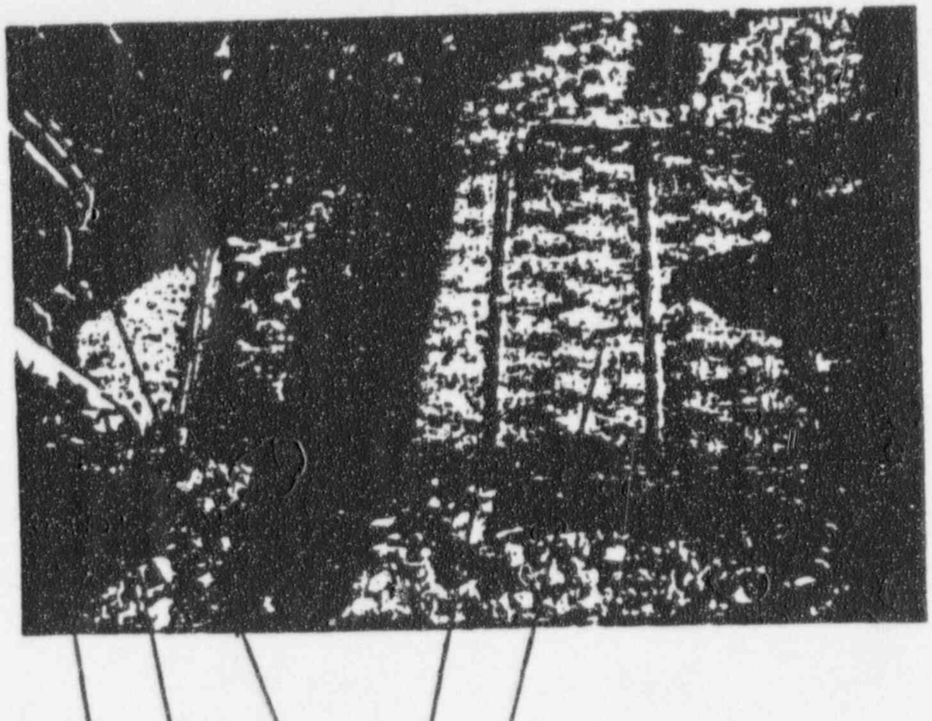


FIGURE 22: PHOTOGRPAH OF THE INTERIOR SURFACE OF THE CABLE TRAY, CONDUIT AND AIR DROP TEST SPECIMEN THERMO-LAG 330-1 SUBLIMING COATING ENVELOPE SYSTEM AFTER THE ONE HOUR FIRE TEST AND WATER HOSE STREAM TEST

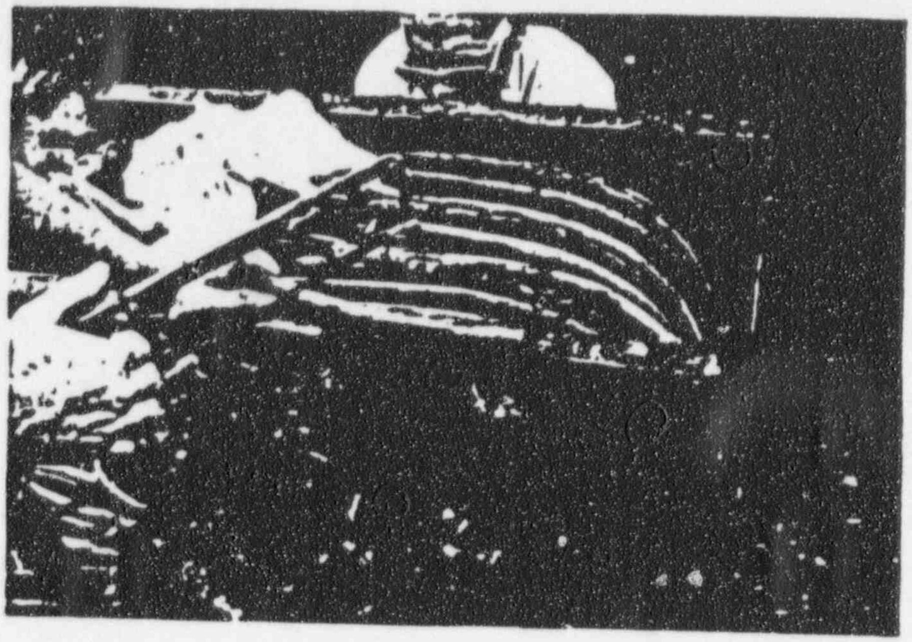


FIGURE 23: PHOTOGPPAH OF A SECTION OF ELECTRICAL CABLE BEING REMOVED FROM A CABLE BUNDLE IN THE TSI CABLE TRAY, CONDUIT AND AIR DROP TEST SPECIMEN AFTER A ONE HOUR FIRE TEST AND A WATER HOSE STREAM IMPINGEMENT TEST

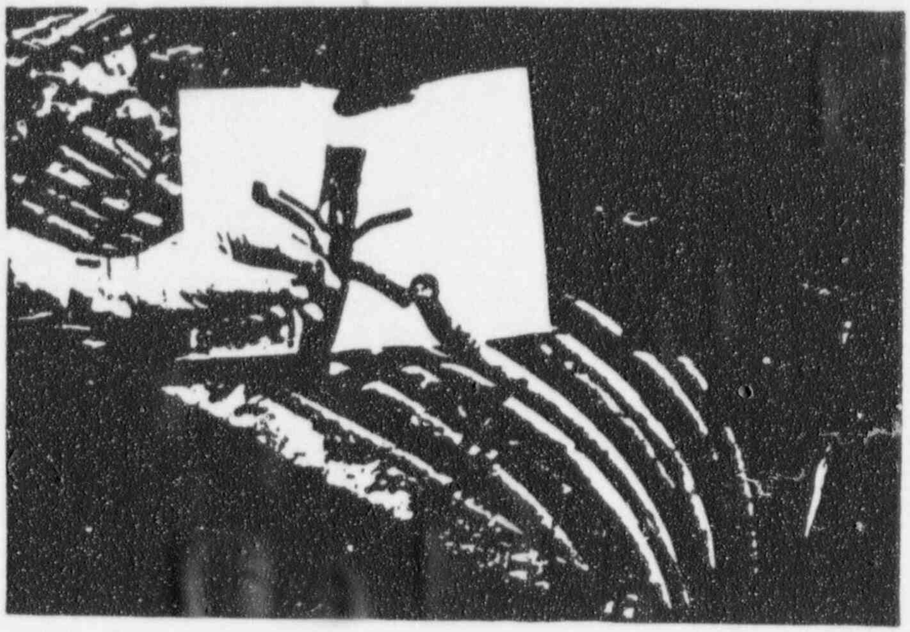


FIGURE 24: PHOTOGRPAH OF THE INTERIOR OF AN ELECTRICAL CABLE IN THE TSI CABLE TRAY, CONDUITS AND AIR DROP TEST SPECIMEN AFTER THE ONE HOUR FIRE TEST AND WATER HOSE STREAM IMPINGEMENT TEST

of the individual wires or cables. Even the paper lining on the cable covering was NOT scorched or burnt.

d. On the basis of the Cable Integrity Monitoring Requirements and the detail visual inspection of the Test Specimen after the One Hour Fire Test and the Water Hose Stream Test, it can be safely concluded that the Thermo-Lag 330-1 Subliming Coating Envelope System, as tested and reported upon herein, more than meets all the specified Performance Critaria and will provide more than the required One Hour of thermal protection against an ASTM-E-119 Test Method fire environment (actual test period was 65 minutes).

IX. REFERENCES

1. TSI Nuclear Quality Assurance Program Manual and TSI Quality Operating Procedures Manual (Copy No. 014 to Dr. H. R. Wesson, Wesson and Associates, Inc., P. O. Box 1082, Norman, OK 73070: Transmittal date of 7 August 1981).

Report Prepared By: H. R. Wesson

Dr. Harold R. Wesson, PE
State of Oklahoma Registration No. 8591, 19 June 1970
State of Texas Registration No. 17430, 17 April 1959
President
WESSON AND ASSOCIATES, INC.
P. O. BOX NO. 1082
NORMAN, OK 73070

H. R. Wesson

TSI

" EXHIBIT 1 "

SEE SECTION FOR A COMPLETE

TSI TECHNICAL NOTE 80181

THERMO-LAG 330-1

SUBLIMING COATING ENVELOPE SYSTEM

APPLICATION PROCEDURES

AMERICAN NUCLEAR INSURERS

EXHIBIT "2"

PROPERTY ENGINEERING DEPARTMENT

BURT C. PROOM, CPCU
President

ANI/MAERP STANDARD FIRE ENDURANCE TEST METHOD TO QUALIFY A PROTECTIVE ENVELOPE FOR CLASS 1E ELECTRICAL CIRCUITS

1.0 INTRODUCTION

The ANI/MAERP "Basic Fire Protection Guidelines" (April, 1976) recommend that redundant safety circuits be cut-off from each other by standard fire walls and floors (Item I, E-6). It has been our experience, that in new designs, this feature is "built-in". However, for operating plants, and some plants nearing completion, the provision of standard, rated, fire barriers may not be practical. When this condition exists, the options are to relocate the vital circuit to another fire area, or protect them in place. "Protecting-in-place" is defined as the ability to maintain the circuit's function during a standard exposure fire by use of a Protective Envelope.

In an effort to provide, for insurance purposes only, a reasonable and reliable means of "protecting-in-place" these vital circuits, without limiting our Insureds to conventional methods, and giving them the option of using products/materials not normally seen in this type of application, we have developed this test method. In this manner evaluations of different products/materials can be made, using a standard test approach.

In developing this Standard Test Method, the need to maintain circuit integrity during a standard "temperature-time" fire exposure was the prime consideration. In addition, the ability of the Protective Envelope to contain an internal fire exposure, was also considered important.

It should be emphasized that this Standard Test Method in no way decreases our requirements for fixed automatic fire suppression systems nor will it be considered the equivalent of rated fire barriers, where required. Its intent is to provide a means for "protecting-in-place" redundant cable systems in existing plants, or unusual situations in new designs.

2.1 SCOPE & PURPOSE

2.1 The purpose of this test is to qualify for insurance purposes a Protective Envelope for Redundant Class 1E Cables in Nuclear Power Plants when located in the same fire area. (A fire area is defined as that portion of a building that is encompassed by rated fire walls, ceilings and floors.) The maintenance of circuit integrity in these Class 1E safety circuits during a postulated fire is of prime importance.

2.2 The intent of this Test Method is to establish a protective envelope that maintains circuit integrity for safety circuits when:

---Redundant safety circuits, located in the same fire area, are exposed to a fire outside of the cable system, or

---Redundant safety circuits, located in the same fire area, are exposed by a fire originating in an adjacent "protected-in-place" cable system, or

---Redundant safety circuits, located in the same fire area, are subjected to mechanical impact damage as simulated by a hose stream, or other impact test.

3.0 ACCEPTANCE CRITERIA

ANI/MAERP Acceptance will be based on the completion and review of all of the following:

3.1 Successful passage of fire tests, as outlined in Section 3.4 of this test method, and submittal of necessary test documentation as prepared by a recognized testing laboratory or consultant.

3.2 A Quality Control/Quality Assurance Program for the system/design should be submitted for review. Complete details covering installation procedures, physical characteristics, identification methods, sample forms for third party sign-off, etc. should be included.

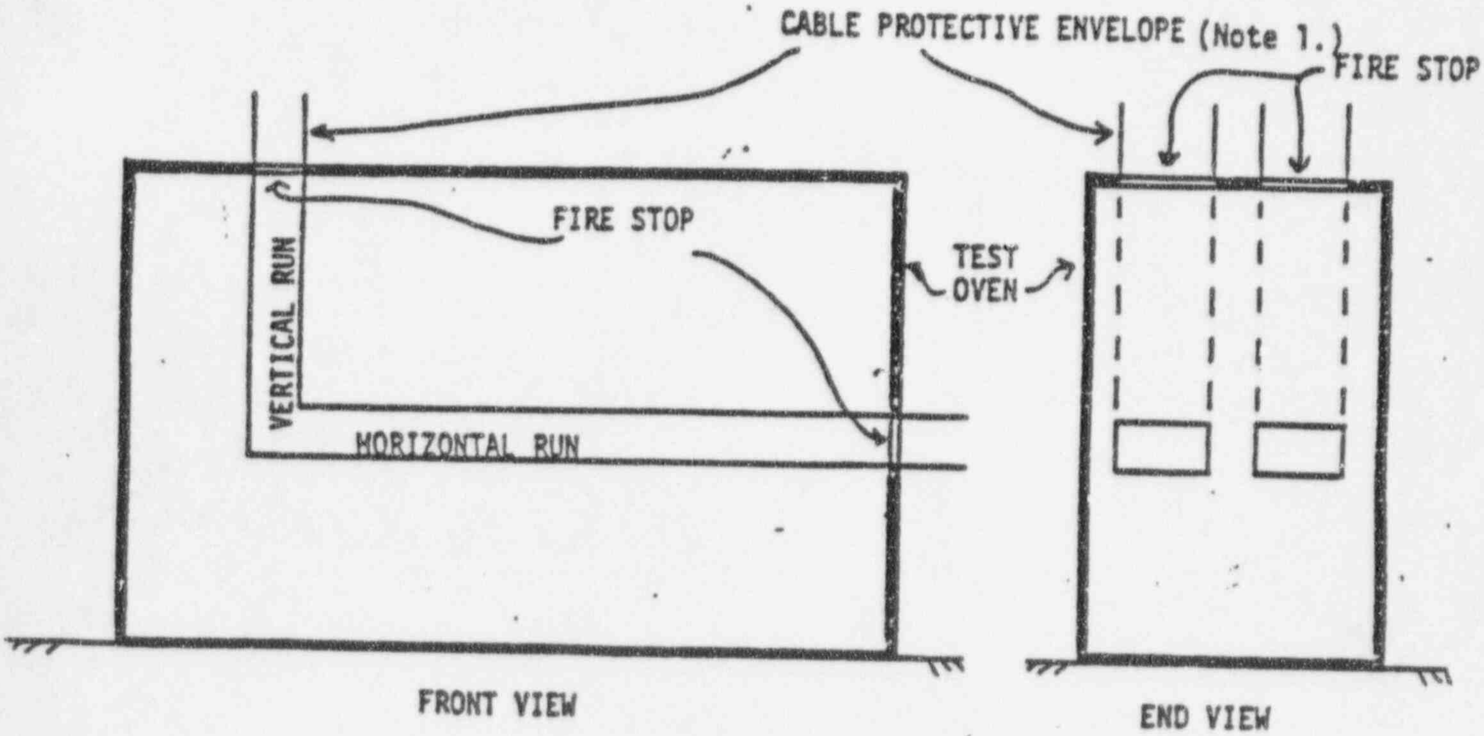
The QC/QA Program is considered an integral part of the acceptance process and variations between the QC/QA Program for the test and the program developed for the actual installation will not be acceptable.

3.3 All materials and components in the completed system, with the exception of the cable, shall be rated as non-combustible i.e., Flame Spread, Fuel Contributed, and Smoke Developed ratings of 25 or less.

Materials or components that are combustible or hazardous during the installation phase, should have a material hazard analysis performed with procedures developed for quantities on hand, storage practices, and precautions to be taken during installation.

SUGGESTED TEST LAYOUT - TEST METHOD 1

EXPOSURE FIRE TEST



(NO SCALE)

NOTE 1: TWO PROTECTIVE ENVELOPES TO BE TESTED. ONE LOADED TO MAXIMUM (40%) DESIGN AND ONE LIGHTLY LOADED.(ONE LAYER).

SUFFICIENT CIRCUITS TO BE MONITORED TO DETECT FAILURE; CIRCUIT TO CIRCUIT, CIRCUIT TO SYSTEM, OR CIRCUIT TO GROUND.

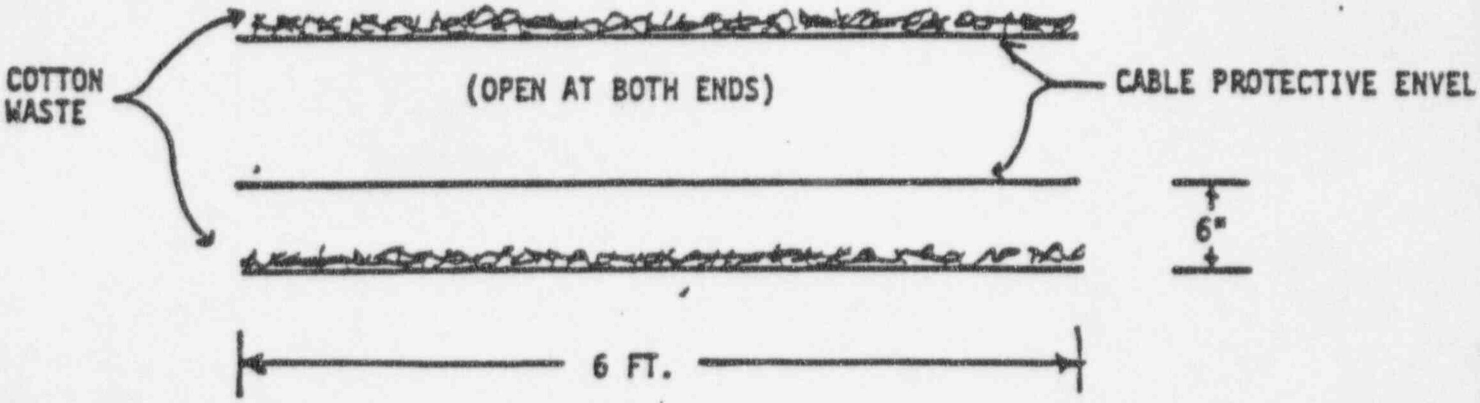
VARIOUS TYPES OF CABLE; SUCH AS POWER, CONTROL AND INSTRUMENTATION.

CABLE SHOULD NOT EXTEND MORE THAN THREE FEET OUTSIDE THE TEST OVEN.

NOTE 2: DUE TO FURNACE DESIGN, IT MAY BE NECESSARY TO ENTER AND EXIT THE FURNACE ON THE TOP OR THE SIDE.

SUGGESTED TEST LAYOUT - TEST METHOD 2

INTERNAL FIRE TEST



NOTE 1: COTTON WASTE SHALL BE PLACED OVER THE ENTIRE TOP SURFACE OF THE TEST SYSTEM AND A SAMPLE SYSTEM 6 INCHES BELOW THE TEST SYSTEM.

NOTE 2: THE CABLES USED IN THE TEST SHALL BE REPRESENTATIVE OF THE CABLE USED AT THE SITE. LOADINGS SHOULD BE 20% FILL WITH RANDOM LAY.

THE CABLES IN THE TRAY SHALL BE IGNITED USING THE "OIL SOAKED BURLAP" METHOD AS OUTLINED IN IEEE/ICC/WG 12-32, DATED 6/27/73, OR OTHER ACCEPTABLE "FLAME SOURCE", DEPENDING ON DESIGN AND OPERATING CONDITIONS OF THE COATING. THE FLAME SOURCE SHALL BE LOCATED AT THE MID-POINT OF THE CABLE SYSTEM. THE INTENT BEING TO PROVIDE AN IGNITION/FLAME SOURCE THAT IS DESIGNED TO LAST APPROXIMATELY 20 MINUTES AND ACTIVATE THE PROTECTIVE ENVELOPE.

OBSERVATIONS AND THERMOCOUPLE READINGS SHALL BE MAINTAINED FOR ONE HOUR FROM THE POINT OF IGNITION OF THE "FLAME SOURCE".

3.4 The Cable Protective Envelope shall be exposed to the following fire endurance and hose stream tests. Test configuration and details should be submitted for review and comment prior to test.

3.4.1 Test I - Exposure Fire - The Protective Envelope shall be exposed to the standard temperature-time curve found in ASTM E-119-76 (ANSI A2.1) for a minimum of one hour. Sketch #1 outlines a suggested test configuration.

3.4.2 Hose Stream Test - Immediately following Test I, accessible surfaces of the Protective Envelope shall be subjected to one of the following hose stream tests. The hose stream shall be applied for a minimum of 2 1/2 minutes, without de-energizing the circuits. PROPER SAFETY PRECAUTIONS SHALL BE EXERCISED. One of the following tests shall be used:

1. The stream shall be delivered through a 2 1/2 inch national standard playpipe equipped with 1 1/8 inch tip, nozzle pressure of 30 psi, located 20 feet from the system.

or

2. The stream shall be delivered through a 1 1/2 inch nozzle set at a discharge angle of 30° with a nozzle pressure of 75 psi and a minimum discharge of 75 gpm with the tip of the nozzle a maximum of 5 ft. from the system.

or

3. The stream shall be delivered through a 1 1/2 inch nozzle set at a discharge angle of 15° with a nozzle pressure of 75 psi and a minimum discharge of 75 gpm with the tip of the nozzle a maximum of 10 ft. from the system.

NOTE: #1 is the preferred test.

3.4.3 Test II - Internal Fire - For systems/designs that require heat to activate the Protective Envelope, the system shall also be subjected to Test II - Internal Fire. Sketch #2 outlines a suggested test configuration.

3.4.4 Cable Construction & Test Details

3.4.4.1 Cables shall be energized for circuit monitoring during Test Method I. For the purpose of this test method, "energized" means sufficient current to monitor failure.

3.4.4.2 Cable constructions shall be representative of cable used at the site. Cable tray loadings shall be in accordance with suggested test layouts.

3.4.4.3 In both test methods, cable tray construction shall be representative of actual site conditions, where applicable.

3.4.4.4 Cable system supports shall be those currently found in nuclear power plants and follow accepted installation procedures. Care should be exercised in using only supports that are necessary for the test. Supports that are used for the Protective Envelope shall be part of the final installed design.

3.4.4.5 Thermocouples shall be located strategically on the surface and at one foot intervals in the cable system and temperatures recorded throughout the test.

3.4.4.6 Fire stops or breaks, if used, shall be acceptable to American Nuclear Insurers. Failure of the fire stop or break shall not necessarily constitute a failure of the the Protective Envelope.

3.5 The tests shall be constituted a failure if any of the following occur:

1. Circuits fail or fault during the fire test as required in Test I or fail during the hose stream test.

2. Cotton waste in Test II ignites during the test period.

3.6 The minimum fire endurance rating acceptable for Test I shall be one hour. If longer ratings are desired, they shall be in one hour increments, such as 2 hr. and 3 hr. ratings.

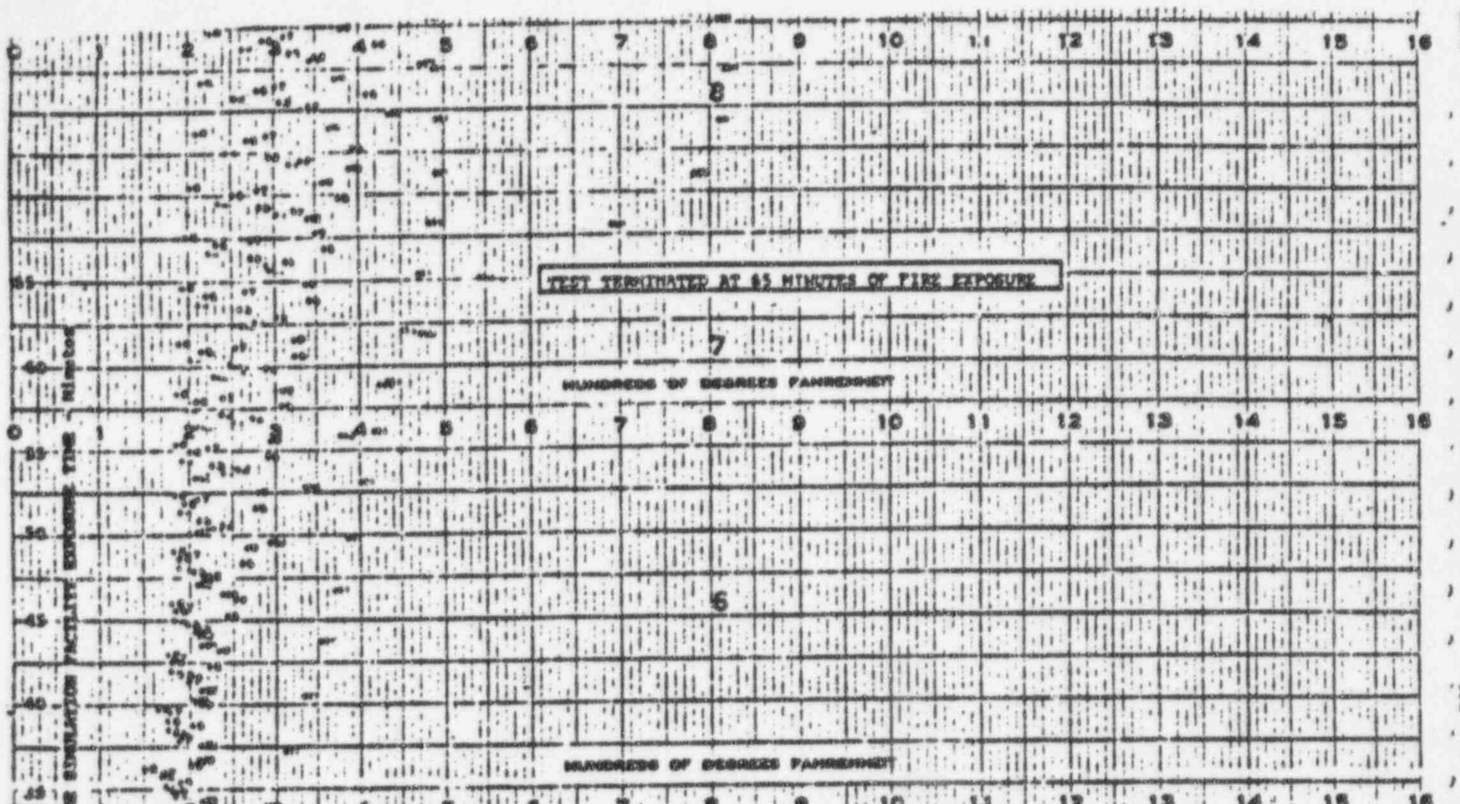
4.0 FINAL ACCEPTANCE

Prior to any installation at plants insured by American Nuclear Insurers, or Mutual Atomic Energy Reinsurance Pool, complete plans outlining system to be installed, location, etc. shall be submitted for review and acceptance.

JULY, 1979

FOR INFORMATION ONLY

EXHIBIT "3"



TU ELECTRIC

Log # TXX-89737
File # 10110
909.5
Ref. # 10CFR50.55(e)

October 12, 1989

William J. Cahill, Jr.
Executive Vice President

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION (CPSES)
DOCKET NOS. 50-445 AND 50-446
SITE FABRICATED THERMO-LAG PANELS
SDAR: CP-89-025 (FINAL REPORT)

Gentlemen:

On September 15, 1989, TU Electric verbally notified the NRC of a deficiency that it had identified involving inadequacies in site fabricated one hour fire barrier thermo-lag panels. After further evaluation, we have concluded this deficiency is reportable pursuant to 10CFR50.55(e). The required information follows.

Description

Site fabricated thermo-lag panels have localized dry film thickness (DFT) of less than the 1/2" requirement of the design specification. This deficiency impacts approximately 2,000 square feet of thermo-lag installed in the plant and 11,000 square feet in the warehouse.

Additionally, during the removal of site fabricated panels from the plant, panels were observed which violated the requirements of the installation specification. Thermo-lag panels were less than 1/2" thick in areas of seams, joints, edges and bolting. Also, some panels removed were found to have been modified to accommodate protrusions without compensating for the reduced material thickness. This problem impacts approximately 12,000 square feet of installed thermo-lag.

The causes of these deficiencies are attributed to an inadequate onsite fabrication process for the site fabricated thermo-lag, failure to identify deficiencies in the site fabricated panels, failure to comply with installation specifications in certain applications, and failure to detect the nonconforming finish conditions. The failure to detect nonconforming conditions was attributed to inadequate change/revision to the specification and the corresponding inspection criteria.

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IE27

The generic implications of the deficiency extend to the adequacy of one hour barrier thermo-lag fabricated and/or installed in accordance with the CPSES specification.

Safety Significance

The design and installation specification and procedures were found to be inadequate to assure the required one hour fire-barrier. Had these deficiencies remained uncorrected, the potential existed that a fire could have breached the barrier and adversely affected the ability to safely shutdown the plant; therefore, the deficiencies are reportable pursuant to 10CFR50.55(e).

Corrective Action

A corrective action request has been initiated to track this deficiency and ensure that it is corrected and that the thermo-lag is installed in accordance with the appropriate specifications. Corrective and preventive action has been outlined as described below.

A nonconformance report (NCR) was initiated to require inspection of the site . fabricated thermo-lag panels in the warehouse. Many of these panels were found to be sub-standard or suspect. To prevent the use of these site fabricated thermo-lag panels, this NCR has been dispositioned to scrap the site fabricated panels stored in the warehouse.

A design change authorization has been issued to revise the design and installation specification to eliminate the fabrication of thermo-lag panels on-site, to recognize only vendor fabricated panels, and to clarify inspection requirements.

Site fabricated thermo-lag panels installed in the plant prior to September 6, 1989, are being identified by engineering inspection. Thermo-lag determined by these inspections to be site fabricated will be removed and scrapped. Panels which cannot be identified as vendor fabricated (acceptable) or site fabricated (unacceptable) are being treated as site fabricated panels and will be removed and scrapped.

In addition to the removal and scrapping of site fabricated thermo-lag, installed vendor supplied panels will be inspected to assure that there are no improper modifications to accommodate surface protrusions and to assure that the 1/2" criteria was not violated in the areas of seams, joints, edges and bolting. Deficient installations will be repaired or removed and scrapped.

Formal re-training sessions have been provided to craft by qualified vendor personnel to prevent recurrence.

Completion schedule of rework for Unit 1 will be prior to Unit 1 fuel load. Thermo-lag has not been installed in Unit 2, hence rework for Unit 2 is not required.

Sincerely,

William J. Cahill, Jr.

JTB/vld

c - Mr. R. D. Martin, Region IV
Resident Inspectors, CPSES (3)

Report to

THERMAL SCIENCE, INC.
2200 Cassens Drive
St. Louis, MO 63026

FIRE TEST ON ALUMINUM LADDER BACK CABLE TRAY PROTECTED BY THERMO-LAG PREFABRICATED PANELS

by

G. Russell Hall

Submitted by

CONSTRUCTION TECHNOLOGY LABORATORIES, INC.
5420 Old Orchard Road
Skokie, Illinois 60077

November 1989

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TABLE OF CONTENTS

FIRE TEST ON ALUMINUM LADDER BACK CABLE TRAY PROTECTED BY THERMO-LAG PREFABRICATED PANELS

by

G. Russell Hall*

INTRODUCTION

At the request of Thermal Science, Inc. (TSI) and as authorized by Purchase Order 6652, Construction Technology Laboratories, Inc. (CTL) performed fire and hose stream tests on an electrical protective envelope system containing an aluminum ladder back cable tray all supplied by Thermal Science Inc.

The objective of the test was to develop fire test data on the performance of THERMO-LAG 330-1 Prefabricated Panels comprising the electrical protective envelope system for a 30-inch wide aluminum ladder back cable tray with one layer of various cable conductors. Although other systems were tested simultaneously, they are proprietary and are not covered in this report.

The electrical protective envelope system was supported by a 213-1/2x131x12-in. thick concrete slab. Cable tray construction, cable installation, cable instrumentation, and protective envelope system installation were performed by TSI personnel. CTL personnel witnessed the installation of the THERMO-LAG Prefabricated Panels comprising the protective envelope system. CTL provided the concrete test slab and performed the fire and hose stream testing.

Fire and hose stream tests were performed at the fire and thermal testing facilities of CTL on May 5, 1989. The concrete slab supporting the electrical

*Materials Technologist, Fire/Thermal Technology Section, Construction Technology Laboratories, Inc., 5420 Old Orchard Road, Skokie, Illinois 60077.

protective envelope system was subjected to a 3-hr fire exposure in accordance with provisions of ASTM Designation: E119, "Standard Method of Fire Tests of Building Construction and Materials,"(1)* and ANI's Bulletin #5,(79) "ANI/MAERP Standard Fire Endurance Test Method to Qualify a Protective Envelope for Class 1E Electrical Circuits."(2) A copy of ANI's Bulletin #5(79) is provided in Appendix A. Immediately after fire testing, the test assembly was removed from the floor furnace and subjected to a hose stream test in accordance with ASTM Designation: E119 and ANI's Bulletin #5(79). The electrical circuitry was checked for integrity, as outlined in Paragraph 3.5 of ANI's Bulletin #5(79) before, during, and after fire endurance testing, as well as before and after the water hose stream test.

SUMMARY OF RESULTS

The test assembly containing the protective envelope system was subjected to a 3-hr fire test and subsequent water hose stream test. Before, during and after the fire test, as well as before and after water hose stream tests, the electrical protective envelope system was monitored for integrity of electrical circuits. The following are significant test results:

1. The protective envelope system remained in place during the 3-hr fire exposure.
2. Circuit integrity was maintained by the protective envelope system. Circuit integrity was tested at the following stages:
   (i) Before fire testing
   (ii) During fire testing
   (iii) After fire testing and before hose stream testing
   (iv) After hose stream testing

*Numbers in parentheses designate references at end of report.

3. The average of all cable temperatures measured during the 3-hr fire exposure was 271°F.

4. The maximum cable temperature measured during the 3-hr fire exposure was 331°F by Thermocouple No. 45.

TEST ASSEMBLY

A concrete test slab was designed by CTL personnel for testing in a horizontal position in CTL's floor furnace, as shown in Figs. 1 through 3.

Installation of block-outs and reinforcing steel rebar was provided by CTL personnel.

Concrete used for the test slab was obtained from a local ready-mix supplier. It was a six-bag normal weight concrete mix using a carbonate coarse aggregate.

Air content, unit weight, and slump of fresh concrete were determined during casting. Cylinders were cast for determination of compressive strength of hardened concrete at seven days. Properties of fresh concrete and seven day compressive strength of hardened concrete are presented in Table 1.

TABLE 1 - MEASURED PROPERTIES OF CONCRETE

Date of Casting	2/24/89
Air Content (%)	5.6
Unit Weight (pcf)	147.3
Slump (in.)	3-3/4
Avg. Compressive Strength (psi) at 7 Days	3960

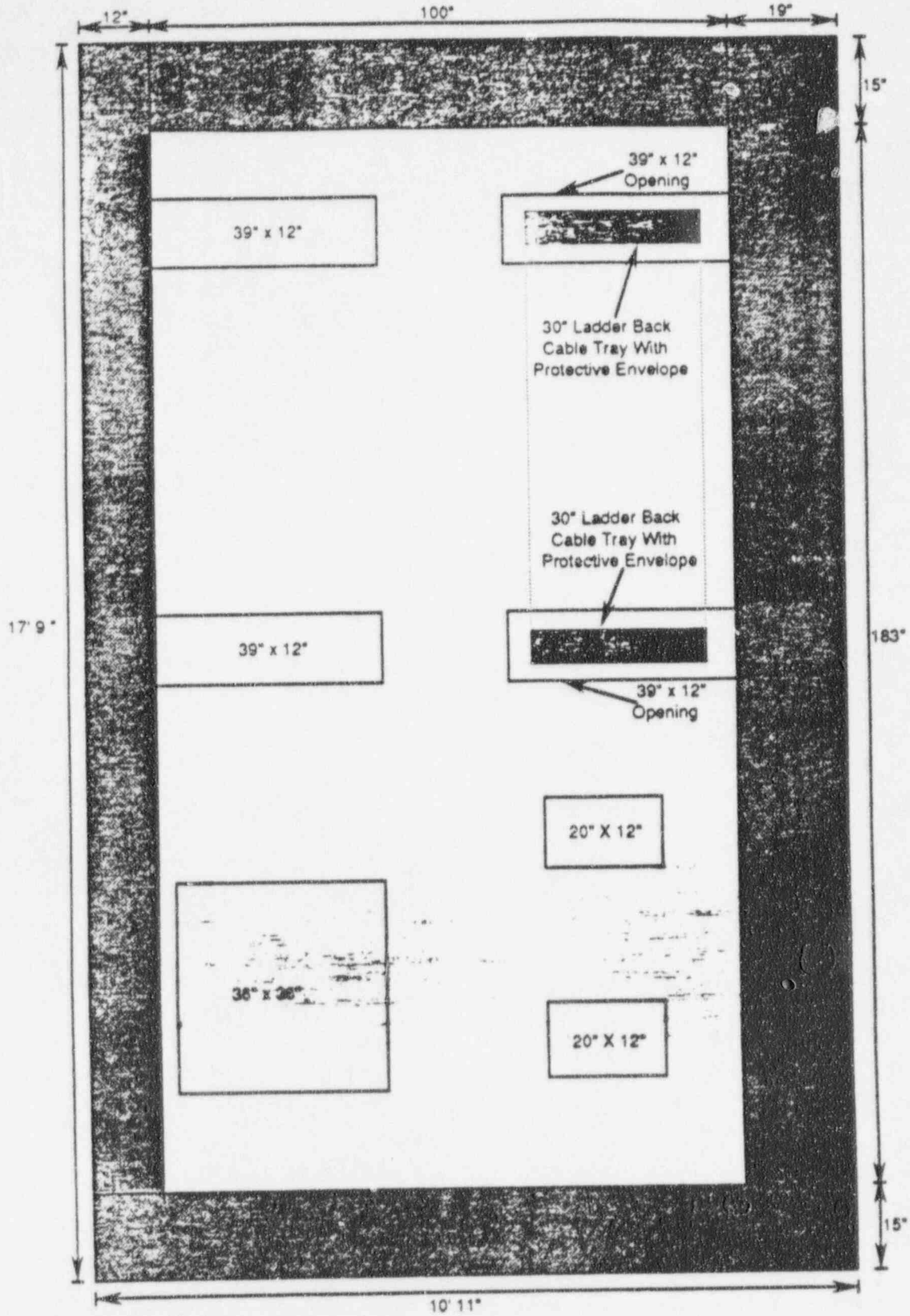


Fig. 1 Concrete Slab Layout

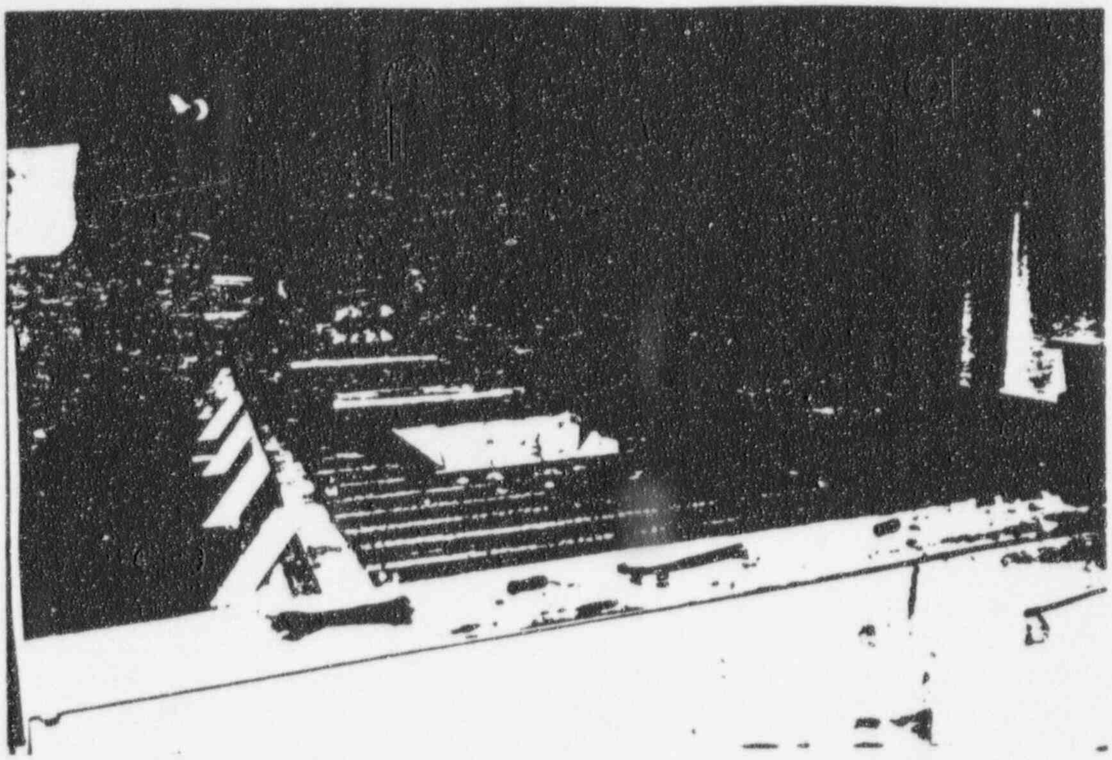


Fig. 2 View of Formwork and Reinforcing Steel (240056 - 2/24/89)

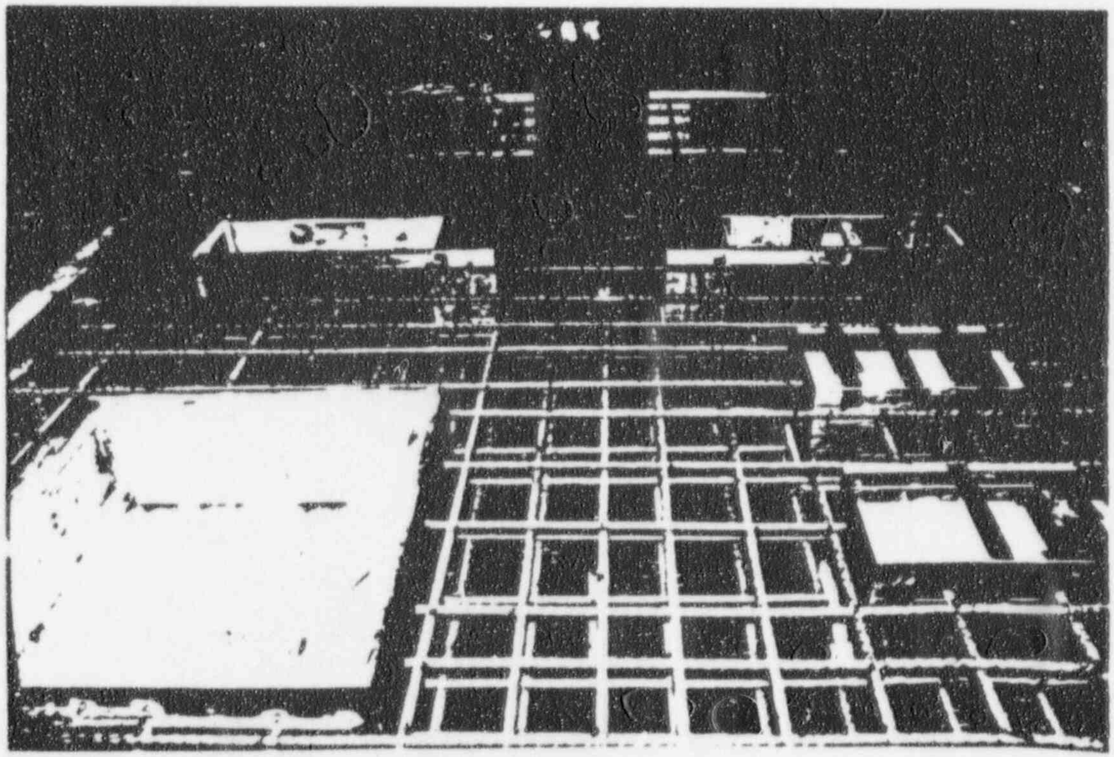


Fig. 3 Close-up View of Blockouts and Reinforcing Steel (240056 - 2/24/89)

After consolidation of concrete with internal vibrators, the slab surface was screeded and finished by CTL personnel. The slab was cured in the form under damp burlap for 7 days. After 7 days, forms were stripped and the slab placed inside the floor furnace. The slab was dried at 400-450°F for 10 days to remove free moisture.

The completed electrical protective envelope system was delivered to CTL from TSI's facilities for installation. The electrical protective envelope system was installated by TSI personnel with construction assistance provided by CTL personnel. Fire barrier penetration materials used to fill void areas after installation of the electrical protective envelope system were installed by TSI personnel and are not considered as part of the test assembly.

CABLE TRAY

A 30-in. wide aluminum ladder back cable tray was used in the performance of this test program. The cable tray was supplied by Gulf States Utilities. TSI personnel installed the THERMO-LAG Prefabricated Panels on the aluminum ladder back cable tray.

Cable Conductors

Cable conductors were installed by TSI personnel. The length of the cable conductors was reported to be 16 ft 7 in. The conductors were procured by TSI from Melville B. Hall, Inc., 3001 Spruce St., St. Louis, MO 63103. Data on cable conductors were reported as follows:

1.	Power Cables	300 MCM
2.	Control Cables	#12-7/conductor
3.	Instrumentation Cables	#14-2/conductor
4.	Bare Copper Cable (Temperature Reference)	#6-7/strand

Quality control documentation, including a schematic showing the location of the cables within the test assembly, are in Appendix C.

INSTALLATION OF THERMO-LAG PREFABRICATED PANELS

The following section provides information concerning the installation of THERMO-LAG Prefabricated Panels used to complete the electrical protective envelope system.

After instrumentation of the cable conductors was completed, representatives of TSI installed the electrical protective envelope system. The installation was performed on April 19 & 20, 1989 at TSI's facilities in St. Louis, MO. The installation was witnessed by CTL personnel. The electrical protective envelope system consisted of THERMO-LAG Prefabricated Panels. Thickness ranged from a 1 in. minimum to a 1-1/2 in. maximum. Panels were cut to size and attached to the aluminum ladder back cable tray by means of stainless steel bands, as shown in Figs. 4 through 7. The installation was performed in accordance with applicable procedures outlined in Sections II and IV of TSI's Technical Note, Revision V, entitled: "THERMO-LAG 330 Fire Barrier System Installation Procedures Manual, Power Generating Plant Applications." A copy of the procedure is included in Appendix B. Also included in Appendix B is a listing of materials used in the electrical protective envelope system, their sizes, location, instrumentation, quality control records, and qualification certificates for TSI personnel who installed the system.

INSTALLATION OF CABLE TRAY WITH PROTECTIVE ENVELOPE SYSTEM

After installation of the THERMO-LAG Prefabricated Panel electrical protective envelope system and transportation to CTL's fire and thermal test

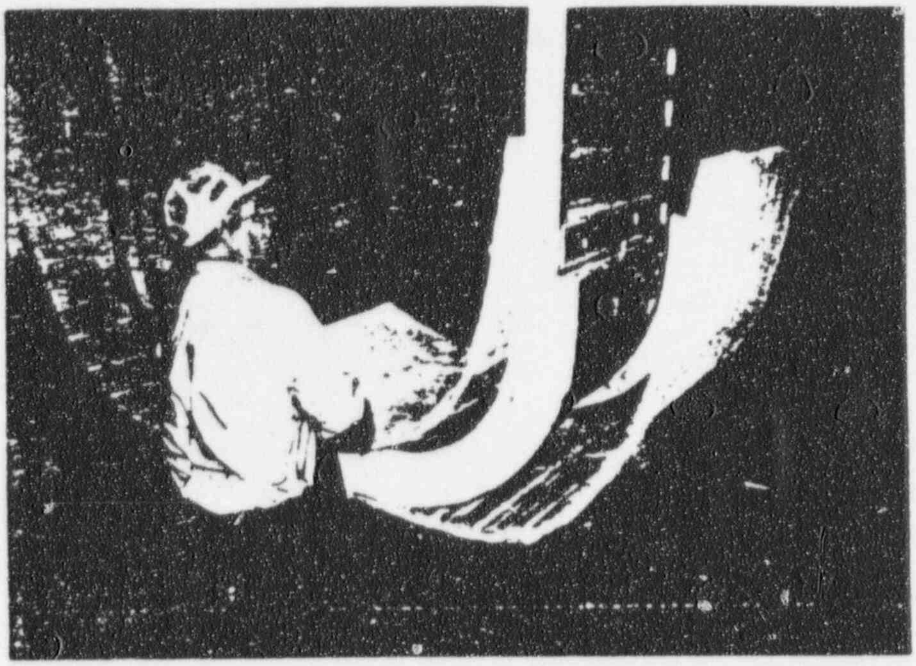


Fig. 4 Outside Edge Section Being Positioned

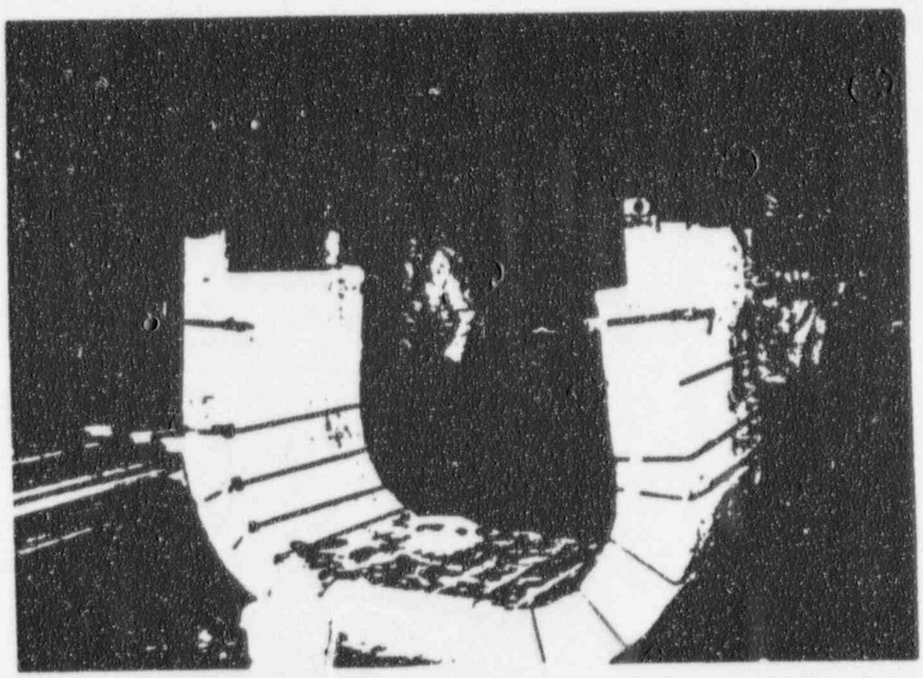


Fig. 5 Prefabricated Thermo-Lag Panels Being Positioned and Secured by Stainless Steel Banding

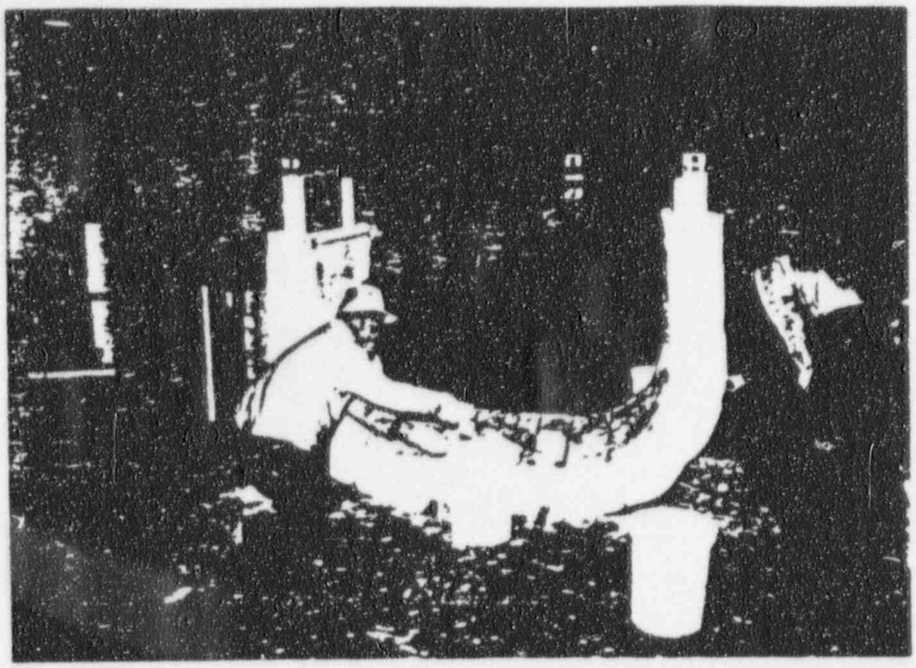


Fig. 6 Filling in Edges and Joints with Thermo-Lag Trowel Grade Material

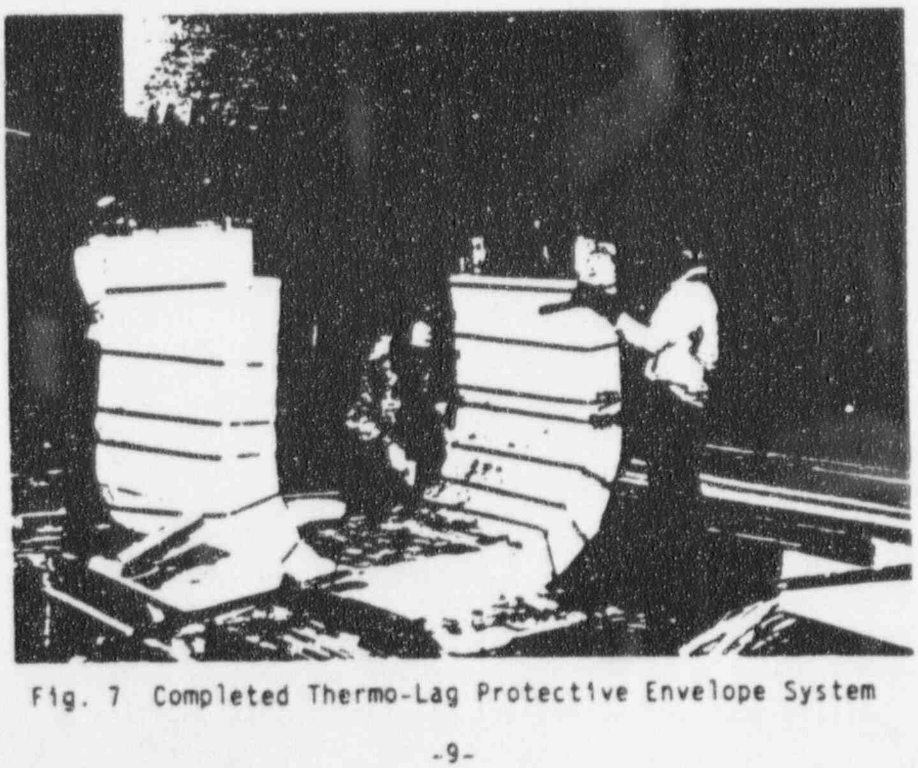


Fig. 7 Completed Thermo-Lag Protective Envelope System

facilities were completed, TSI personnel attached the test article with Unistrut sections to the bottom (exposed side) of the (concrete) test assembly, as shown in Fig. 8. The Unistrut support sections were protected with the THERMO-LAG Prefabricated Panels. Support on the unexposed side was provided by bolting horizontal 3x3-in. angle with feet to the cable tray and bolting the feet of the support angle to the concrete test slab.

After installation of the protective envelope system was complete, a 3-hr fire barrier system was installed to protect openings through the concrete test slab at the cable tray protective envelope. Installation was performed in accordance with procedures outlined in TSI's Technical Note 20684, Revision V, Section VI. Figure 9 shows the protective fire barrier interface and exposed side of the completed test assembly.

TEST EQUIPMENT AND PROCEDURES

The following sections briefly describe equipment and procedures used to conduct the fire and hose stream tests on the test assembly containing the electrical protective envelope system.

Furnace

The test assembly was subjected to a 3-hr fire exposure in the floor furnace at CTL's Fire/Thermal Technology Laboratory. This furnace tests specimens in a horizontal position. The approximate area of fire exposure was 214x132 in.

Furnace atmosphere temperatures were monitored by nine Type K Chromel/Alumel protected thermocouples, located 12 in. below the exposed face

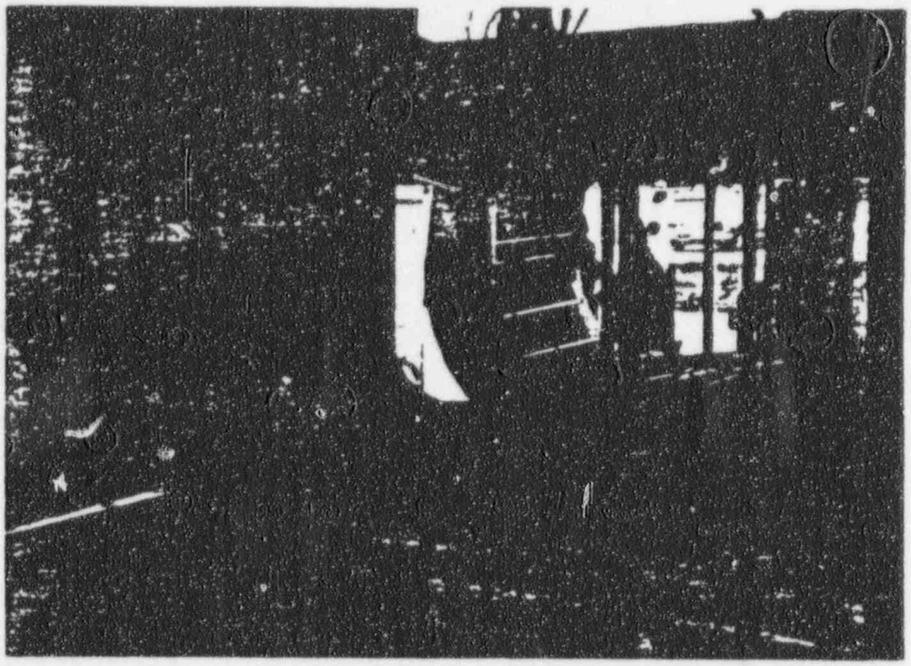


Fig. 8 Exposed Side Unistrut Support Sections Prior to Installation of Thermo-Lag Protection

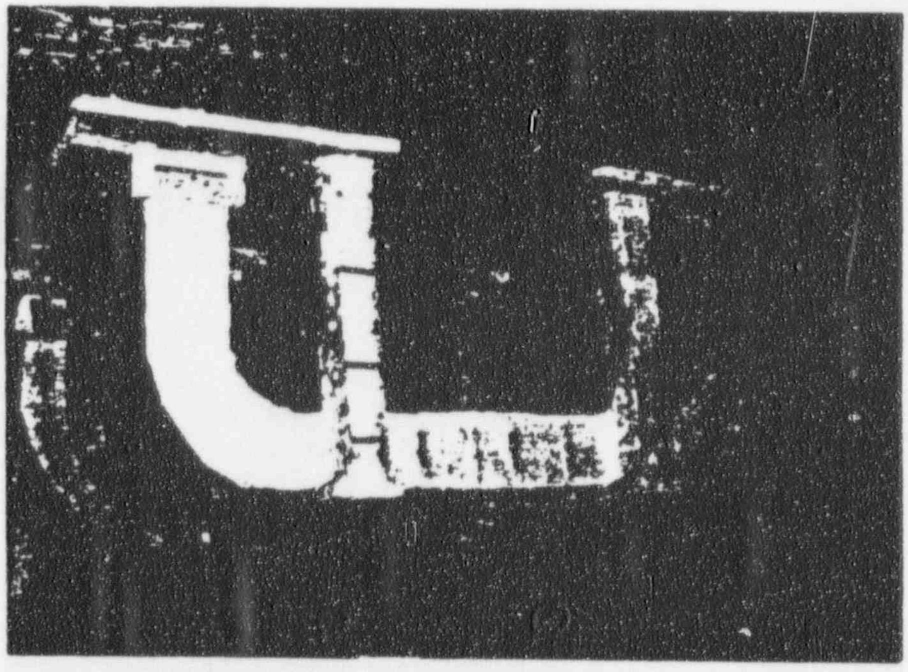


Fig. 9 View of Completed Installation

of the concrete test assembly and the test article. The fire exposure was monitored by these nine thermocouples. The time/temperature relationship followed that prescribed by ASTM Designation: E119. The furnace temperatures recorded during the test are tabulated in Appendix C.

Furnace atmosphere pressure was maintained close to ambient laboratory air pressure or slightly negative (-0.01 to -0.08 in. of water). For this test, the average pressure was -0.03 in. of water.

Specimen Instrumentation

Fifty (50) thermocouples were used for measuring the temperatures on the test article at locations shown in Appendix C. Location of thermocouples are detailed in Appendix C. Appendix D contains calibration certificates for equipment and personnel qualifications.

Data Acquisition

Furnace atmosphere and specimen temperatures were monitored at 5 minute intervals throughout the 3-hr fire test. The automated data acquisition system consisted of a Hewlett-Packard HP34455A digital voltmeter and a series of HP3495A data scanners. The data acquisition system controller was an HP9845B desk top computer. Calibration certificates for test equipment are provided in Appendix D.

Electrical Circuit Integrity Tests

Cable integrity was monitored before, during, and after the fire endurance test, and before and after the water hose stream testing. Paragraph 3.5 of ANI's Bulletin #5(79) requires that circuits contained in a test article do not de-energize during exposure to the fire endurance or hose stream test. Circuits were tested, as applicable, to detect failure; circuit to circuit (conductor to conductor short circuits), circuit to system (conductor continuity), and circuit to ground (conductor to ground). Schematic diagrams of these monitoring circuits are shown in Figs. 10 and 11.

Hose Stream Test

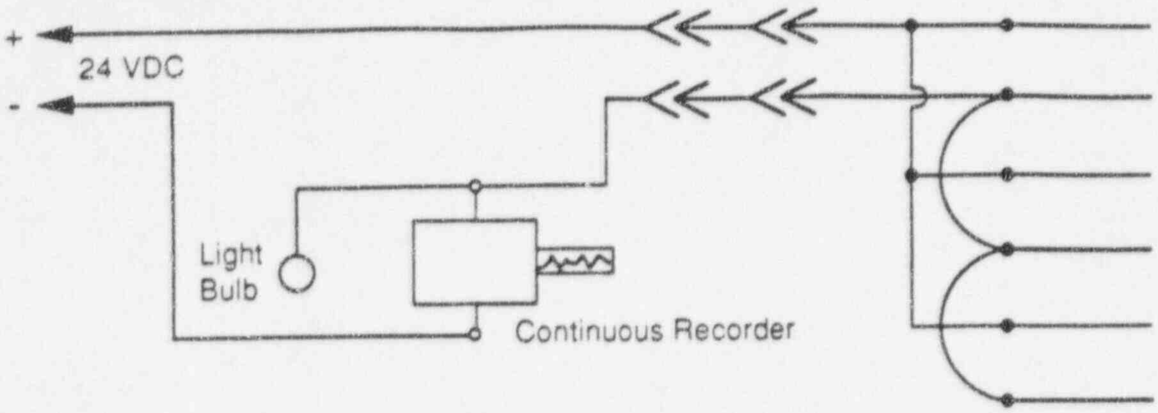
A hose stream test was conducted at the conclusion of the fire test. Hose stream test procedures followed those described in ASTM Designation: E119 and in ANI's Bulletin #5(79). Equipment and procedures for the test are as follows:

> A 30 psi solid stream of water is delivered from a distance of 20 ft (minus 1 ft from the 20 ft for each 10° of variation) through a 2-1/2-in.-diameter hose equipped with a National Standard Playpipe with a 1-1/8-in.-diameter discharge tip. The stream was delivered over an exposed area of 214x132 in. for 4 min 56 sec at a distance of 17 ft.

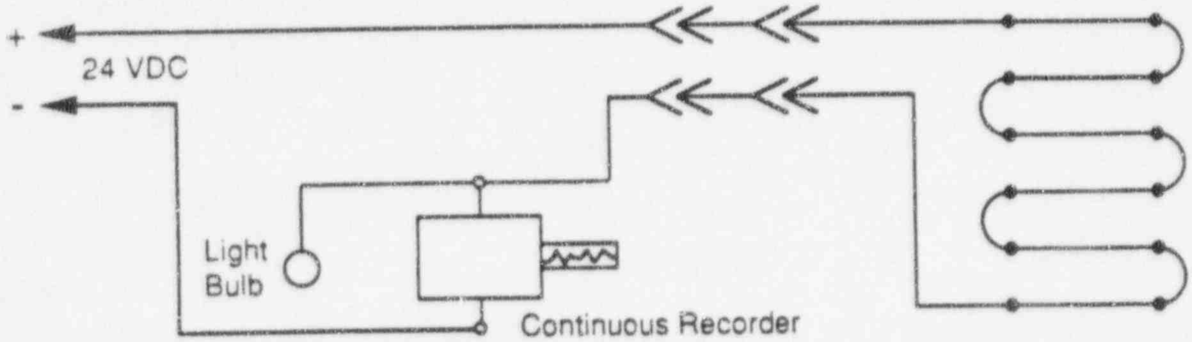
TEST RESULTS

The electrical protective envelope system was subjected to a 3-hr fire exposure on May 5, 1989.

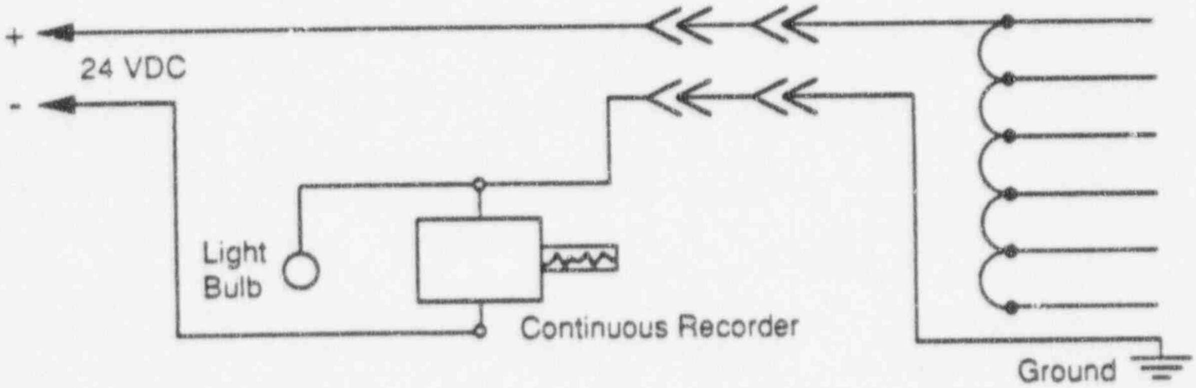
A listing of furnace atmosphere temperatures is given in Appendix C. Variation of measured furnace temperatures from the standard was approximately 0.12% based on comparison of total area under the time/temperature curve. This is within the 5% variation permitted by ASTM Designation: E119. The average furnace draft pressure was -0.03 in. of water.



TYPICAL CIRCUIT TO CIRCUIT MONITORING CHANNEL



TYPICAL CIRCUIT TO SYSTEM MONITORING CHANNEL



TYPICAL CIRCUIT TO GROUND MONITORING CHANNEL

Fig. 10 Schematic Diagram For Cable Integrity Monitoring Circuits

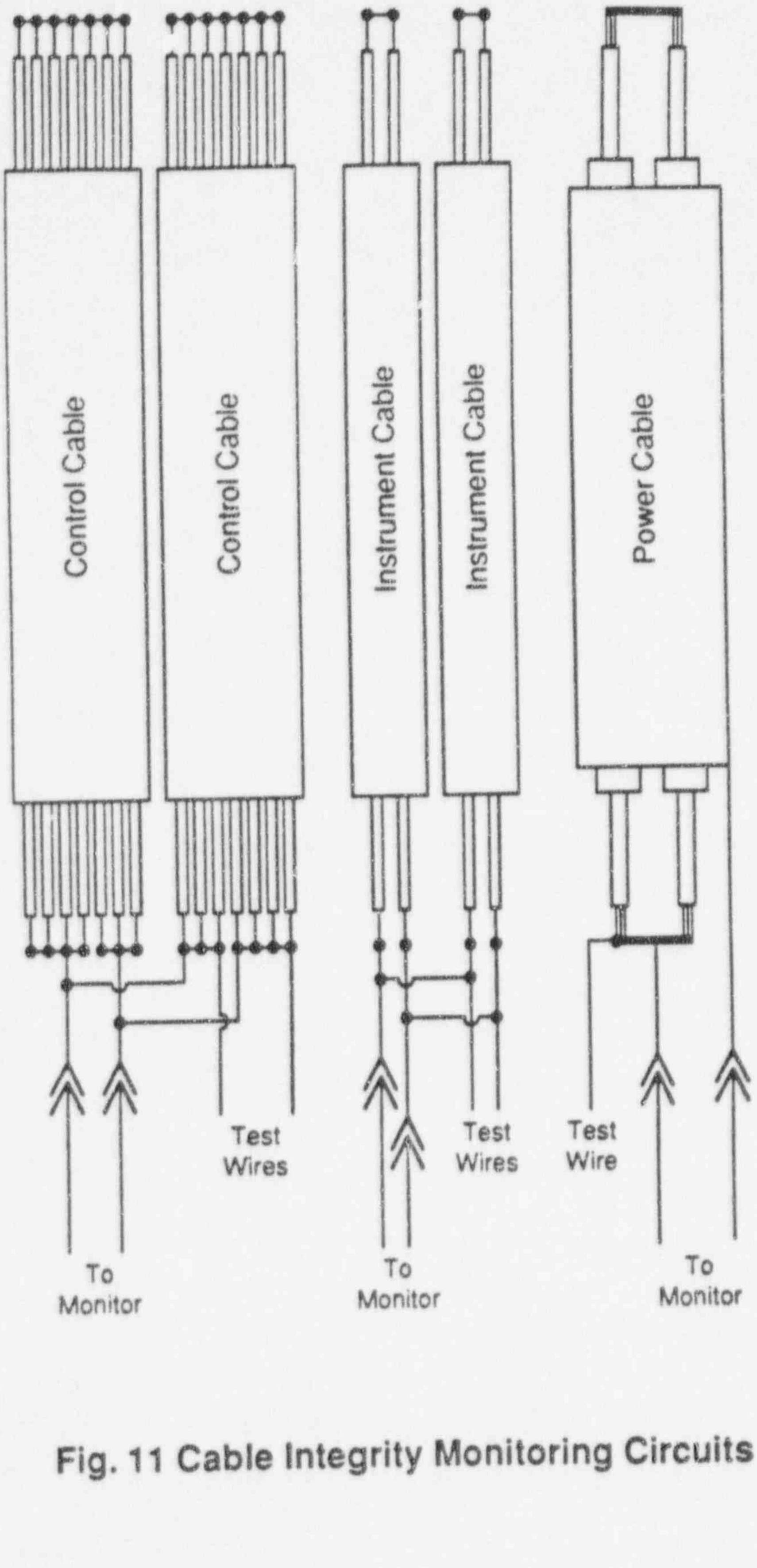


Fig. 11 Cable Integrity Monitoring Circuits

A list of test article thermocouple temperatures recorded during the 3-hr fire test are given in Appendix C.

After the 3-hr fire exposure, the test article was tested for circuit integrity. The test article passed circuit integrity testing.

At the conclusion of the 3-hr fire test, the test assembly was removed from the furnace in preparation for the hose stream test as shown in Figs. 12 through 14. The test assembly was exposed to ASTM Designation: E119 and ANI's hose stream test for a period of 4 minutes and 56 seconds. Following the hose stream test, the test article was again checked for circuit integrity. The test article passed the circuit integrity testing.

LABORATORY RESPONSIBILITY

Construction Technology Laboratories, Inc. was not involved in the fabrication of the cable tray, cable conductors, cable instrumentation, and test article installation. Personnel of CTL make no judgment of the suitability of the materials or systems for particular end-point uses. Acceptance of the test results for guidance in field installation is the prerogative of the authority having jurisdiction.

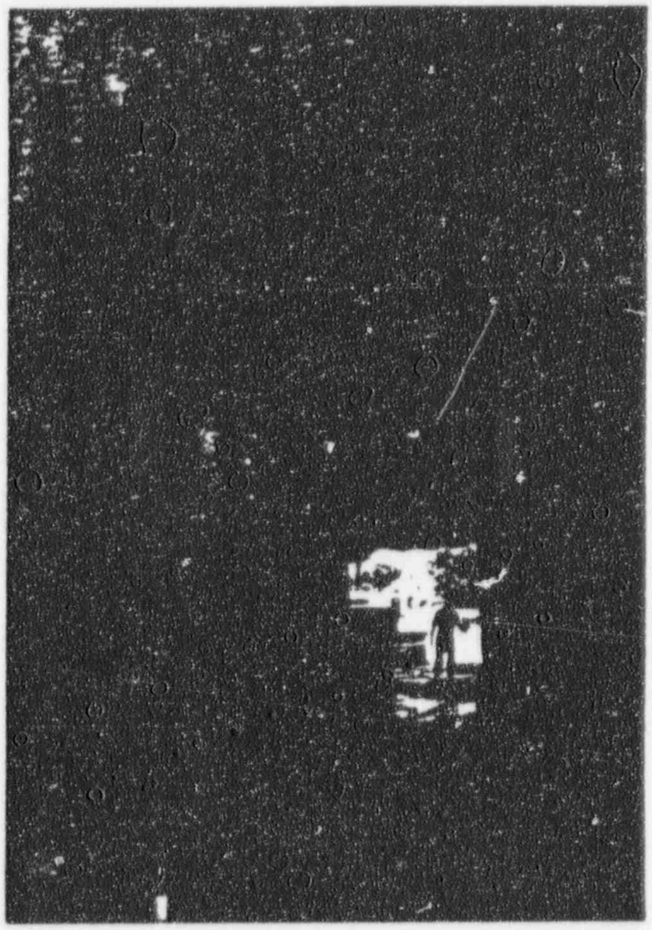


Fig. 12 View of Test Assembly Being Removed from Furnace (Cable Tray on left Hand Side) (240056 - 5/5/89)

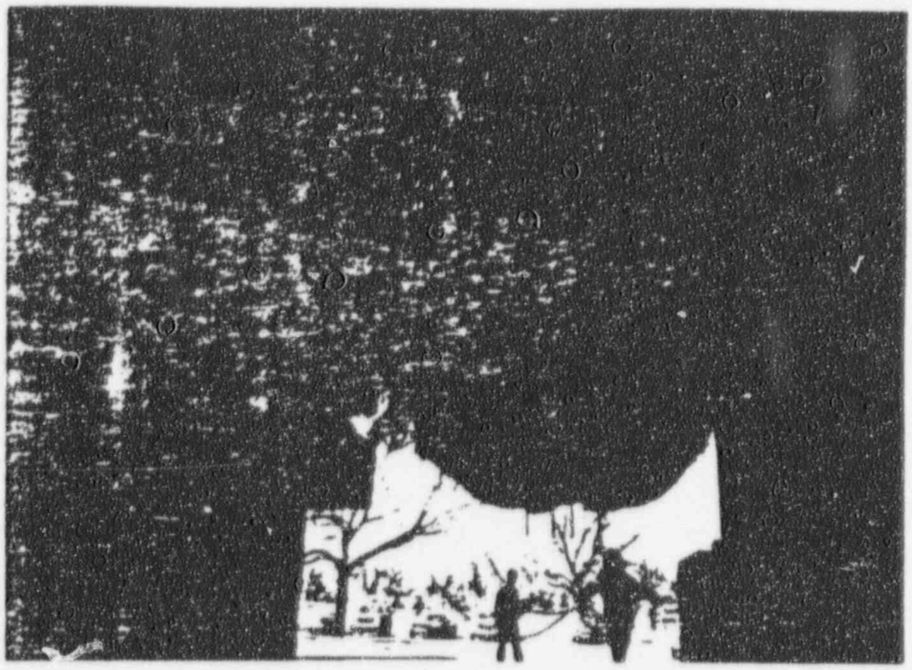


Fig. 13 Test Assembly Completely Removed from Furnace (Cable Tray on Right Hand Side) (240056 - 5/5/89)

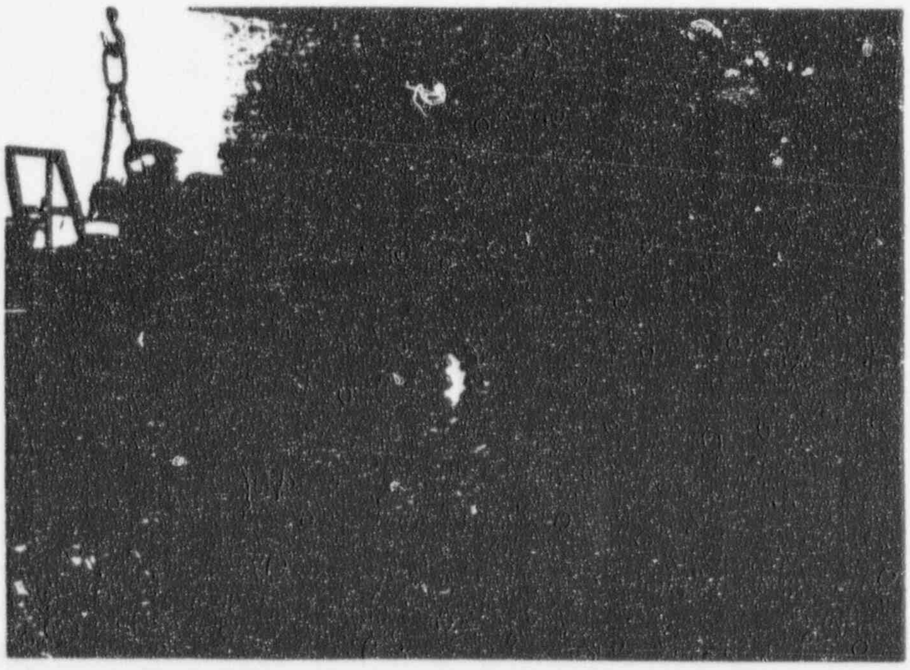


Fig. 14 Test Assembly Placed on Turn-up Pedstals Prior to Hose Stream Test (Cable Tray on Right Hand Side) (240056 - 5/5/89)

REFERENCES

1. ASTM Designation: E119 "Standard Methods of Fire Tests of Building Construction and Materials," American Society of Testing and Materials, Philadelphia, PA 1983.

2. American Nuclear Insurers Bulletin #5(79) "ANI/MAERP Standard Fire Endurance Test Method to Qualify a Protective Envelope for Class IE Electrical Circuits," Farmington, CT1979.

APPENDIX A

ANI/MAERP STANDARD FIRE ENDURANCE TEST METHOD TO QUALIFY
A PROTECTIVE ENVELOPE FOR CLASS 1E ELECTRICAL CIRCUITS

1.0 INTRODUCTION

The ANI/MAERP "Basic Fire Protection Guidelines" (April, 1976) recommend that redundant safety circuits be cut-off from each other by standard fire walls and floors (Item I, E-6). It has been our experience, that in new designs, this feature is "built-in". However, for operating plants, and some plants nearing completion, the provision of standard, rated, fire barriers may not be practical. When this condition exists, the options are to relocate the vital circuit to another fire area, or protect them in place. "Protecting-in-place" is defined as the ability to maintain the circuit's function during a standard exposure fire by use of a Protective Envelope.

In an effort to provide, for insurance purposes only, a reasonable and reliable means of "protecting-in-place" these vital circuits, without limiting our Insureds to conventional methods, and giving them the option of using products/materials not normally seen in this type of application, we have developed this test method. In this manner evaluations of different products/materials can be made, using a standard test approach.

In developing this Standard Test Method, the need to maintain circuit integrity during a standard "temperature-time" fire exposure was the prime consideration. In addition, the ability of the Protective Envelope to contain an internal fire exposure, was also considered important.

It should be emphasized that this Standard Test Method in no way decreases our requirements for fixed automatic fire suppression systems nor will it be considered the equivalent of rated fire barriers, where required. Its intent is to provide a means for "protecting-in-place" redundant cable systems in existing plants, or unusual situations in new designs.

2.1 The purpose of this test is to qualify for insurance purposes a <u>Protective Envelope for Redundant Class 1E Cables in Nuclear Power Plants</u> when located in the same fire area. (A fire area is defined as that portion of a building that is encompassed by rated fire walls, ceilings and floors.) The maintenance of circuit integrity in these Class 1E safety circuits during a postulated fire is of prime importance.

2.2 The intent of this Test Method is to establish a protective envelope that maintains circuit integrity for safety circuits when:

---Redundant safety circuits, located in the same fire area, are exposed to a fire outside of the cable system, or

---Redundant safety circuits, located in the same fire area, are exposed by a fire originating in an adjacent "protected-in-place" cable system, or

---Redundant safety circuits, located in the same fire area, are subjected to mechanical impact damage as simulated by a hose stream, or other impact test.

3.0 ACCEPTANCE CRITERIA

ANI/MAERP Acceptance will be based on the completion and review of <u>all</u> of the following:

3.1 Successful passage of fire tests, as outlined in Section 3.4 of this test method, and submittal of necessary test documentation as prepared by a recognized testing laboratory or consultant.

3.2 A Quality Control/Quality Assurance Program for the system/design should be submitted for review. Complete details covering installation procedures, physical characteristics, identification methods, sample forms for third party sign-off, etc. should be included.

The QC/QA Program is considered an integral part of the acceptance process and variations between the QC/QA Program for the test and the program developed for the actual installation will not be acceptable.

3.3 All materials and components in the completed system, with the exception of the cable, shall be rated as non-combustible i.e., Flame Spread, Fuel Contributed, and Smoke Developed ratings of 25 or less.

Materials or components that are combustible or hazardous during the installation phase, should have a material hazard analysis performed with procedures developed for quantities on hand, storage practices, and precautions to be taken during installation.

3.4 The Cable Protective Envelope shall be exposed to the following fire endurance and hose stream tests. Test configuration and details should be submitted for review and comment prior to test.

3.4.1 Test I - Exposure Fire - The Protective Envelope shall be exposed to the standard temperature-time curve found in ASTM E-119-76 (ANSI A2.1) for a minimum of one hour. Sketch # 1 outlines a suggested test configuration.

3.4.2 Hose Stream Test - Immediately following Test I, accessible surfaces of the Protective Envelope shall be subjected to one of the following hose stream tests. The hose stream shall be applied for a minimum of 2 1/2 minutes, without de-energizing the circuits. PROPER SAFETY PRECAUTIONS SHALL BE EXERCISED. One of the following tests shall be used:

1. The stream shall be delivered through a 2 1/2 inch national standard playpipe equipped with 1 1/8 inch tip, nozzle pressure of 30 psi, located 20 feet from the system.

or

2. The stream shall be delivered through a 1 1/2 inch nozzle set at a discharge angle of 30° with a nozzle pressure of 75 psi and a minimum discharge of 75 gpm with the tip of the nozzle a maximum of 5 ft. from the system.

or

3. The stream shall be delivered through a 1 1/2 inch nozzle set at a discharge angle of 15° with a nozzle pressure of 75 psi and a minimum discharge of 75 gpm with the tip of the nozzle a maximum of 10 ft. from the system.

NOTE: #1 is the preferred test.

3.4.3 Test II - Internal Fire - For systems/designs that require heat to activate the Protective Envelope, the system shall also be subjected to Test II - Internal Fire. Sketch #2 outlines a suggested test configuration.

3.4.4 Cable Construction & Test Details

3.4.4.1 Cables shall be energized for circuit monitoring during Test Method I. For the purpose of this test method, "energized" means sufficient current to monitor failure.

ordance with suggested test layouts.

3.4.4.3 In both test methods, cable tray construction shall be representative of actual site conditions, where applicable.

3.4.4.4 Cable system supports shall be those currently found in nuclear power plants and follow accepted installation procedures. Care should be exercised in using only supports that are necessary for the test. Supports that are used for the Protective Envelope shall be part of the final installed design.

3.4.4.5 Thermocouples shall be located strategically on the surface and at one foot intervals in the cable system and temperatures recorded throughout the test.

3.4.4.6 Fire stops or breaks, if used, shall be acceptable to American Nuclear Insurers. Failure of the fire stop or break shall not necessarily constitute a failure of the the Protective Envelope.

3.5 The tests shall be constituted a failure if any of the following occur:

1. Circuits fail or fault during the fire test as required in Test I or fail during the hose stream test.

2. Cotton waste in Test II ignites during the test period.

3.6 The minimum fire endurance rating acceptable for Test I shall be one hour. If longer ratings are desired, they shall be in one hour increments, such as 2 hr. and 3 hr. ratings.

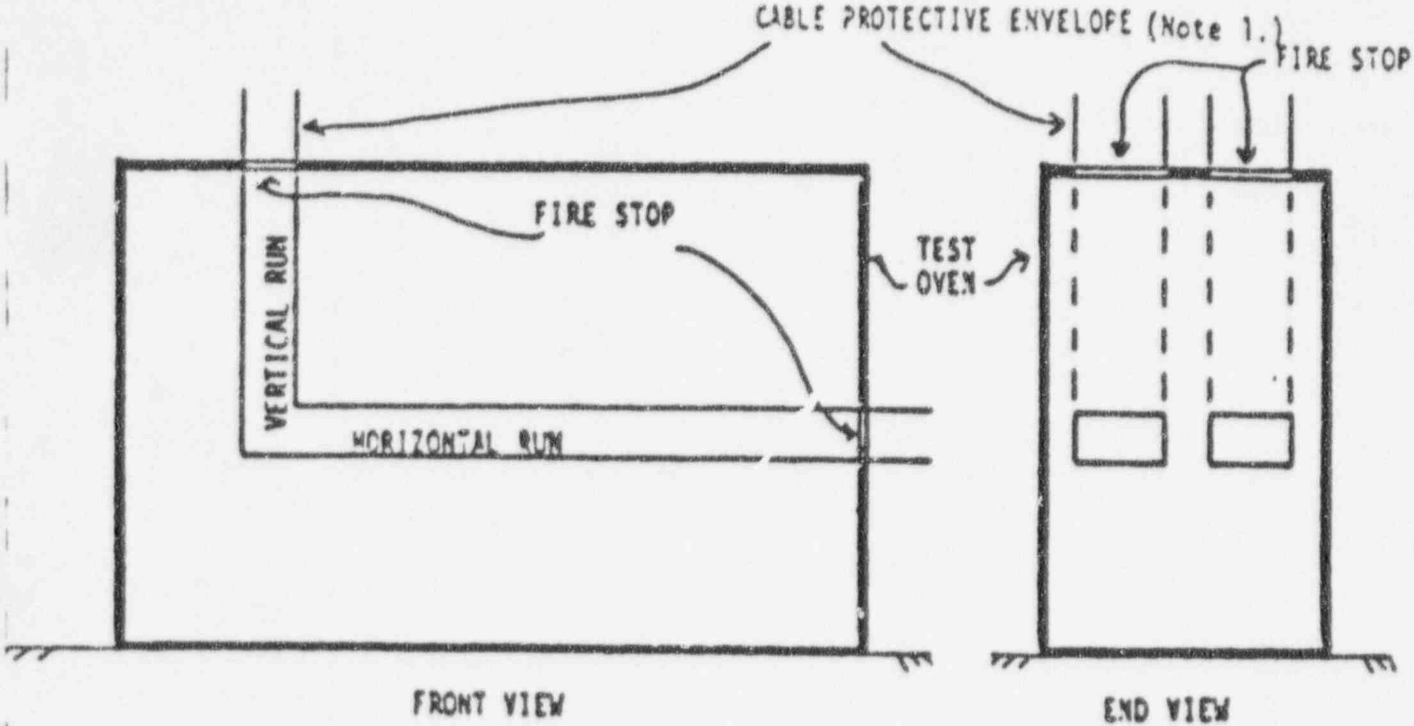
4.0 FINAL ACCEPTANCE

Prior to any installation at plants insured by American Nuclear Insurers, or Mutual Atomic Energy Reinsurance Pool, complete plans outlining system to be installed, location, etc. shall be submitted for review and acceptance.

JULY, 1979

SUGGESTED TEST LAYOUT - TEST METHOD 1

EXPOSURE FIRE TEST



(NO SCALE)

NOTE 1: TWO PROTECTIVE ENVELOPES TO BE TESTED. ONE LOADED TO MAXIMUM (40%) DESIGN AND ONE LIGHTLY LOADED. (ONE LAYER).

SUFFICIENT CIRCUITS TO BE MONITORED TO DETECT FAILURE; CIRCUIT TO CIRCUIT, CIRCUIT TO SYSTEM, OR CIRCUIT TO GROUND.

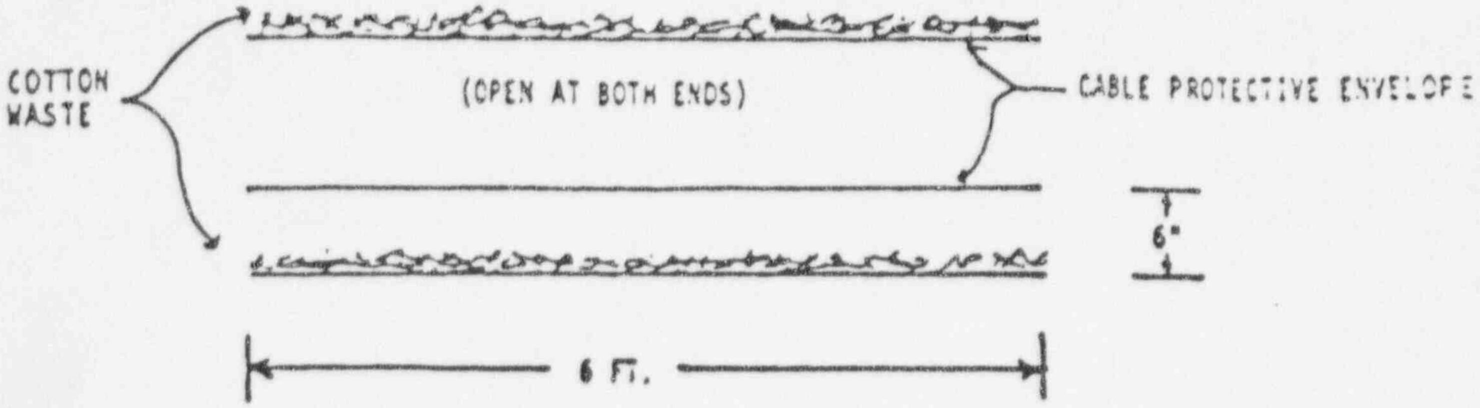
VARIOUS TYPES OF CABLE; SUCH AS POWER, CONTROL AND INSTRUMENTATION.

CABLE SHOULD NOT EXTEND MORE THAN THREE FEET OUTSIDE THE TEST OVEN.

NOTE 2: DUE TO FURNACE DESIGN, IT MAY BE NECESSARY TO ENTER AND EXIT THE FURNACE ON THE TOP OR THE SIDE.

SUGGESTED TEST LAYOUT - TEST METHOD 2

INTERNAL FIRE TEST



NOTE 1: COTTON WASTE SHALL BE PLACED OVER THE ENTIRE TOP SURFACE OF THE TEST SYSTEM AND A SAMPLE SYSTEM 6 INCHES BELOW THE TEST SYSTEM.

NOTE 2: THE CABLES USED IN THE TEST SHALL BE REPRESENTATIVE OF THE CABLE USED AT THE SITE. LOADINGS SHOULD BE 20% FILL WITH RANDOM LAY.

THE CABLES IN THE TRAY SHALL BE IGNITED USING THE "OIL SOAKED BURLAP" METHOD AS OUTLINED IN IEEE/ICC/WG 12-32, DATED 6/27/73, OR OTHER ACCEPTABLE "FLAME SOURCE", DEPENDING ON DESIGN AND OPERATING CONDITIONS OF THE COATING. THE FLAME SOURCE SHALL BE LOCATED AT THE MID-POINT OF THE CABLE SYSTEM. THE INTENT BEING TO PROVIDE AN IGNITION/FLAME SOURCE THAT IS DESIGNED TO LAST APPROXIMATELY 20 MINUTES AND ACTIVATE THE PROTECTIVE ENVELOPE.

OBSERVATIONS AND THERMOCOUPLE READINGS SHALL BE MAINTAINED FOR ONE HOUR FROM THE POINT OF IGNITION OF THE "FLAME SOURCE".

APPENDIX B

TSI

CERTIFICATE OF QUALIFICATION

MANAGER OF QUALITY CONTROL

BEN EVANS

The individual listed above is hereby certified by TSI, Inc., as being qualified to perform the duties of a Level II Quality Control Inspector in the company plant and at the client's jobsite, by virtue of "on the job" training and experience.

This certificate is valid until revoked.

Richard A. Lohman

Richard A. Lohman
Manager of Quality Assurance

Date Signed: 6·30·82

TSI, INC. • 3260 BRANNON AVE. • ST. LOUIS, MO. 63139 • (314) 352-8422 • Telex: 44-2384

THIS WILL CERTIFY THAT

BILL PADDOCK

OF

THERMAL SCIENCE, INC.

HAS SATISFACTORILY COMPLETED THE COURSE OF TRAINING IN THE APPLICATION OF:

THERMO-LAG 330-1 SUBLIMING COATING SYSTEM

AND IS QUALIFIED TO APPLY THE PRODUCTS.

(THIS CERTIFICATION IS VALID UNTIL REVOKED)

R. A. Lohman — JANUARY 8, 1988

RICHARD A. LOHMAN — (DATE)

MANAGER OF QUALITY ASSURANCE

TSI, INC., 2200 CASSENS DRIVE, ST.LOUIS, MO. 63026
(314) 349-1233 TLX NO. 44-2384

THIS WILL CERTIFY THAT

KEVIN CURLE

OF

THERMAL SCIENCE, INC.

HAS SATISFACTORILY COMPLETED THE COURSE OF TRAINING IN THE APPLICATION OF:

THERMO-LAG 330-1 SUBLIMING COATING SYSTEM

AND IS QUALIFIED TO APPLY THE PRODUCTS.

(THIS CERTIFICATION IS VALID UNTIL REVOKED)

R. A. Lohman

RICHARD A. LOHMAN
MANAGER OF QUALITY ASSURANCE

APRIL 5, 1988
(DATE)

TSI, INC., 2200 CASSENS DRIVE, ST.LOUIS, MO. 63026
(314) 349-1233 TLX NO. 44-2384

THIS WILL CERTIFY THAT

TIM HILL

OF

THERMAL SCIENCE, INC.

HAS SATISFACTORILY COMPLETED THE COURSE OF TRAINING IN THE APPLICATION OF:

THERMO-LAG 330-1 SUBLIMING COATING SYSTEM

AND IS QUALIFIED TO APPLY THE PRODUCTS.

(THIS CERTIFICATION IS VALID UNTIL REVOKED)

R A Lohman

RICHARD A. LOHMAN
MANAGER OF QUALITY ASSURANCE

MARCH 3, 1988
(DATE)

TSI, INC., 2200 CASSENS DRIVE, ST.LOUIS, MO. 63026
(314) 349-1233 TLX NO. 44-2384

TSI TECHNICAL NOTE 20684

THERMO-LAG 330 FIRE BARRIER SYSTEM

INSTALLATION PROCEDURES MANUAL

POWER GENERATING PLANT APPLICATIONS

SECTION II

THERMO-LAG 330 FIRE BARRIER SYSTEMS

FOR PROTECTION OF CABLE TRAYS

TSI TECHNICAL NOTE 20684

SECTION II

THERMO-LAG 330 FIRE BARRIER SYSTEMS

FOR PROTECTION OF CABLE TRAYS

The three (3) basic designs of the THERMO-LAG 330 Fire Barrier System, used to provide thermal protection for cable trays installed in power generating plants, are:

.... Prefabricated Panel "Ready Access" Design ......

.... Direct Spray Over Stress Skin Design ......

.... Direct Spray-On Design ......

The material components of the first two (2) designs consist of THERMO-LAG Stress Skin Type 330-69 and THERMO-LAG 330-1 Subliming Material. The only difference between these two (2) designs is that the Prefabricated Panel Ready Access Design is prefabricated at the factory and the Direct Spray Over Stress Skin Design is field sprayed at the jobsite.

The Direct Spray-On Design is comprised of THERMO-LAG 330-1 Subliming Material which is also sprayed at the jobsite and but does not include the THERMO-LAG Stress Skin Type 330-69.

The following paragraphs set forth the sequential steps involved in installing these three (3) designs.

1.1.3 Cut a piece of material large enough to form the top section from a one hour fire rated Prefabricated Panel. The width of the top section shall be equal to the base, plus both flanges of the tray, plus the thickness of each of the two (2) sides of the bottom rectangular section.

1.1.4 Mount the rectangular shaped bottom section on the cable tray using 18 ga. minimum stainless steel tie wires or 0.5" x 0.020" minimum stainless steel banding material as shown in Figures II-1, II-2 and II-3, following this page. The recommended maximum spacing between the tie wires shall not exceed 12 inches.

1.1.5 Attach the flat top section with the stress skin side on the inside to the installed bottom section using 18 ga. minimum stainless steel tie wire or 0.5" x 0.020" minimum banding material at a maximum recommended spacing of 12 inch intervals as shown in Figures II-4 and II-5.

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

OR AS AN OPTION

1.1.7 Cut individual pieces having either butted or miter cut edges large enough to form the bottom, sides and top section from a one hour fire rated Prefabricated Panel.

1.1.8 Mount the bottom, side and top pieces on the cable tray using 18 ga. minimum stainless steel tie wire or 0.5" x 0.020" minimum stainless steel banding material. The recommended maximum spacing between the tie wires shall not exceed twelve (12) inches.

1.1.9 Attach additional top, side and bottom pieces to previously installed pieces by butt joining them together at their ends.

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

1.2 Installation of the Three Hour Ready Access Fire Barrier Design

1.2.1 Using three hour fire rated Prefabricated Panel, form and mount a three hour ready access fire barrier onto cable trays following the procedures previously described in Steps 1.1.1 through 1.1.10.

AS AN OPTION - OR FOR UPGRADING A ONE HOUR TO A THREE HOUR FIRE BARRIER SYSTEM

1.2.2 As an option to Step 1.2.1, or for upgrading a previously installed one hour fire rated system to a three hour fire rated system by the use of one hour fire rated Prefabricated Panels, form and mount the first layer of the fire barrier on the cable tray following the procedures described in Steps 1.1.1 through 1.1.10.

1.2.3 Following the procedures described in Steps 1.1.1 through 1.1.10, mount a second one hour fire rated Fire Barrier layer over the first layer previously installed in Step 1.2.2. This second layer shall be formed and mounted in such a manner that the THERMO-LAG Stress Skin Type 330-69 is on the outside.

TSI TECHNICAL NOTE 20684

THERMO-LAG 330 FIRE BARRIER SYSTEM

INSTALLATION PROCEDURES MANUAL

POWER GENERATING PLANT APPLICATIONS

SECTION VI

THERMO-LAG 330 FIRE BARRIER SYSTEMS FOR INTERFACES

SECTION VI

THERMO-LAG 330 FIRE BARRIER SYSTEMS

FOR INTERFACES

The three (3) basic designs of the THERMO-LAG 330 Fire Barrier System, used to provide thermal protection for cable trays, conduit and instrument tubing interfaces with penetration seals, walls, ceilings and other raceways installed in power generating plants, are:

.... Prefabricated Panel Design ......

.... Direct Trowel-On Design ......

.... 330-660 Flexi-Blanket Thermal Barrier Design ......

The material components of the first design are comprised of THERMO-LAG Stress Skin Type 330-69 and THERMO-LAG 330-1 Subliming Material which are prefabricated into panels at the factory.

The Direct Trowel-On Design is comprised of THERMO-LAG 330-1 Subliming Trowel Grade Material which is troweled on at the jobsite.

The material components of the THERMO-LAG 330-660 Flexi-Blanket Thermal Barrier Design are comprised of a heat blocking thermal catalizer, reinforced on both sides with a low density fiberglass cloth.

The following paragraphs set forth the sequential steps involved in installing these three (3) designs.

1.0 INSTALLATION OF ONE OR THREE HOUR INTERFACES BETWEEN A CABLE TRAY, CONDUIT, INSTRUMENT TUBING, AND A PENETRATION SEAL

DESIGN METHOD 1

1.1 Cut and form a box shaped and flanged section from a one or three hour fire rated Prefabricated Panel as shown in Figures VI-1, VI-2 and VI-3. The minimum height of the flange shall be sufficient to cover the wall opening and accommodate approved fasteners.

1.2 Mount the four (4) sided and flanged section, using approved fasteners, installed at a maximum of 12 inch intervals, and a minimum of two (2) approved fasteners per flange minimum, to fasten the section to the concrete wall, and 18 ga. minimum stainless steel tie wires or 0.5" x 0.020" minimum stainless steel banding material, installed at a maximum of 12 inch intervals, to secure the four (4) sided section to the cable tray, conduit or instrument tube.

1.3 Apply sufficient amounts of the THERMO-LAG 330-1 Subliming Trowel Grade Material to cover the bolt heads and to fill in the ends of the installed interface.

DESIGN METHOD NO. 2

1.4 Cut and form a box shaped and flanged section from a sheet of THERMO-LAG Stress Skin Type 330-69.

1.5 Mount the four (4) sided and flanged section on the entity using 18 ga. minimum stainless steel tie wires or approved fasteners to fasten the assembly together, and approved fasteners to fasten the section to the concrete wall.

1.6 Apply a coating of THERMO-LAG 330-1 Subliming Trowel Grade Material, in a minimum dry film thickness of 0.500 inches for one hour protection and 1.00 inches for three hour protection to the Stress Skin section using a trowel.

RATION: 3 HOUR

CEND: C - CONTROL
I - INSTRUMENTATION
P - POWER
T - Temperature Reference

TE: 4 MAY 1989

ALUMINUM LADDER BACK CABLE TRAY (A6C-30-144)
PROTECTED BY THERMO-LAG 330- PREFABRICATED
3 HOUR DESIGN. 2 ELBOWS (ALC-30V-190-12) .

CHECKED BY: B.E. Evans
B. E. EVANS - QUALITY CONTROL MANAGER

TEST ARTICLE 2

ITEM NO.	TYPE	DESCRIPTION	FUNCTION	AREA IN^2	REMARKS
1	Generic	300 MCM Triangle TWC INCS NA 300 MCM Type THHN or THWN or Gasoline, Oil Resistant 11MTW or AWM 1321 or AWM 14/13 VW/1 600 Volt CS use (UL)	P	9 X 0.519	CABLES PURCHASED FROM: Melville B. Hall, Inc. 3001 Spruce Street St. Louis, MO 63103 TSI P. O. 6654
2	Generic	12/7C Royal Electric SDS/TC SUN/RES, Direct Burial Type TC 12/7C Type THHN CDRS 600 Volt (UL)	C	24 X 0.307	
3	Generic	14/2C Royal Electric SDT/TC SUN/RES, Direct Burial Type TC 14/2C Type THHN or THWN CDRS 600 Volt (UL).	I	195 X .086	
4	Generic	#6 Bare Copper Wire	T	1 X .024	
5		#6/3C XLPE - Insulated	P	4 X .750	CABLES ORGINATING FROM: Bechtel
				31.083 In^2	

DAIL' 'K SHEET

TEST: FIRE TEST ON ALUMINUM LADDER BACK CABLE TRAY (A 30-1440) PROTECTED BY THERMO-LAG PREFABRICATED PANELS. 3 HOUR DESIGN. 2 ELBOWS (ALC-30V-190-12)

JOB NO:

NO. OF WORKMEN IN CREW: 3

DURATION: 3 HOURS

WEATHER: INTERIOR AIR TEMP: N/A

SUBSTRATE TEMPERATURE: N/A

CHECKED BY: B Elvers

DATE: 18 APRIL 1989

LOT NO: THERMO-LAG 330-1 PREFABRICATED PANELS F9-03011

LOT NO: THERMO-LAG 330-1 9-04010

THERMO-LAG 330-69
TYPE STRESS SKIN
LOT F-081188
ON PANELS AND PATCHES

Test article 2

PART NO.	SUBSTRATE		AVERAGE	QTY USED	SIZE	DATE	INIT
Thermo Lag Prefabricated Panels were taken from Thermal Science In						4/18/89	BE
House Inventory and they were cut up into the proper size						↓	↓
pieces to cover the various areas of the test article. Thermal							
Science Quality Control Department took Thickness measure-							
ments on all Panels.							
Right Leg of Cable Tray viewed from marked "Front"							
Pc 1	330-69	outside, bottom from unistrut to top	—	1	72"L X 35 1/2 W		
Pc 2	330-69	Inside Bottom & continuous to top	—	1	72"L X 35 1/2 W		
Left Leg of Cable Tray viewed from marked "Front"						↓	↓
Pc 3	330-69	outside, bottom from unistrut to top.	—	1	72"L X 35 1/4 W	4/18/89	BE

SIGNATURE: B Elvers DATE: 18 april 1989

DAILY WORK SHEET

FIRE TEST ON ALUMINUM LADDER BACK CABLE TRAY PROTECTED BY THERMO-LAG PREFABRICATED PANELS. DESIGN. 2 ELBOWS (ALC-30V-190-12) -30-1440) HOUR

JOB NO: ____________ TEST: ____________

NO. OF WORKMEN IN CREW: 3 DURATION: 3 HOURS

WEATHER: INTERIOR AIR TEMP: N/A SUBSTRATE TEMPERATURE: N/A

CHECKED BY: B Elwar DATE: 18 APRIL 1989

THERMO-LAG 330-1 PREFABRICATED PANELS — LOT NO: F9-03011

THERMO-LAG 330-1 — LOT NO: 9-04010

THERMO-LAG 330-69 TYPE STRESS SKIN LOT F-081188 ON PANELS AND PATCHES

Test article 2

PART NO.	SUBSTRATE		AVERAGE	QTY USED	SIZE	DATE	INIT
Pc 4	330-69	Inside bottom & Continuous to top	—	1	72" X 35¼"	4/18/89	BE
Right Leg –		Vertical Side Pieces				↓	↓
Pc 5	330-69	Front, from unistrut to right + up	—	1	50" X 6½"		
Pc 6	330-69	Rear, from unistrut to right + up	—	1	50" X 6½"		

All edges and seams were caulked using Trowel Grade 330-1 Batch No. 9-04010. The right leg was banded at 12 inch spacing using Stainless Steel Banding ½" X 0.020" Lot No. BLL PX8420-5. The first five (5) bands to right of the unistrut made use of Corner L Angles made of 20 gage galvanized steel. The angle was 2" X 2" X 2". The upper steel banding did not use the corner Angles. Thermo Lag 330-69 Stress Skin (Flat) — 4/18/89 BE

SIGNATURE: B Elwar DATE: 18 april 1989

DAI ORK SHEET

JOB NO:

NO. OF WORKMEN IN CREW: 3

WEATHER: INTERIOR AIR TEMP: N/A

CHECKED BY: B Elvas

LOT NO: THERMO-LAG 330-1 PREFABRICATED PANELS F9-03011

TEST: FIRE TEST ON ALUMINUM LADDER BACK CABLE TRAY (AoC-30-1440) PROTECTED BY THERMO-LAG PREFABRICATED PANELS. 3 HOUR DESIGN. 2 ELBOWS (ALC-30V-190-12)

DURATION: 3 HOURS

SUBSTRATE TEMPERATURE: N/A

DATE: 18 APRIL 1989

THERMO-LAG 330-1 LOT NO: 9-04010

THERMO-LAG 330-69 TYPE STRESS SKIN LOT F-081188 ON PANELS AND PATCHES

Test article 2

PART NO.	SUBSTRATE		AVERAGE	QTY USED	SIZE	DATE	INIT
—		was used over the side seams, both front and rear, where				4/18/89	BE
Pc 5 + 6 butted up against the pieces above.							
Left Leg - Vertical Side Pieces							
Pc 7	330-69	Front from unistrut left + up	—	1	50" X 6½"		
Pc 8	330-69	Rear from unistrut left + up	—	1	50" X 6½"		
All edges and seams were caulked and sealed using trowel grade							
330-1 Batch No. 9-04010. The left leg was banded at 12"							
spacing using Stainless Steel Banding ½" w X 0.020" thick. Lot							
No. BLLPX8420-5							
Test article bottom ℄ piece							
Pc 9	330-69	Bottom, between unistruts	—	1	35¼" X 19¼"	4/18/89	BE

SIGNATURE: B Elvas DATE: 18 April 1989

DAILY 'RK SHEET

TEST: FIRE TEST ON ALUMINUM LADDER BACK CABLE TRAY (.)0-1440) PROTECTED BY THERMO-LAG PREFABRICATED PANELS. 3 HOUR DESIGN. 2 ELBOWS (ALC-30V-190-12)

JOB NO:

NO. OF WORKMEN IN CREW: 3

DURATION: 3 HOURS

WEATHER: INTERIOR AIR TEMP: N/A

SUBSTRATE TEMPERATURE: N/A

CHECKED BY: B Elvers

DATE: 18 APRIL 1989

THERMO-LAG 330-1 PREFABRICATED PANELS — LOT NO: F9-03011

THERMO-LAG 330-1 — LOT NO: 9-04010

THERMO-LAG 330-69 TYPE STRESS SKIN LOT F-081188 ON PANELS AND PATCHES

Test article 2

PART NO.	SUBSTRATE		AVERAGE	QTY USED	SIZE	DATE	INIT
Bottom – Vertical – Side Pieces – Front and Rear				—		4/18/89	BE
Pc 10	330-69	Vertical inserts between unistruts	Front	1	6" X 20½"	↓	↓
Pc 11	330-69	Vertical inserts between unistruts	Rear	1	6" X 20½"	↓	↓
Thermo-Lag 330-69 (Flat) was used across all seams, front and rear,							
both left and right sides. Trowel Grade 330-1 Batch No. 904010							
was used to seal all seam and all voids. Stainless Steel							
Banding was used within two (2) inches of each side of							
the seams. The spacing of the steel banding was 12" max.							
Steel Lot No. BLLPX8420-5 and ½" Wide X 0.020" thick.							
Right Leg – Side Vertical Pcs Front and Rear above Pc 5 + Pc 6.						↓	↓
Pc 12	330-69	Front, above Pc 5 to top	—	1	24" X 6½"	4/18/89	BE

SIGNATURE: B Elvers

DATE: 18 april 1989

DAILY K SHEET

TEST: FIRE TEST ON ALUMINUM LADDER BACK CABLE TRAY (A 0-1440) PROTECTED BY THERMO-LAG PREFABRICATED PANELS. 3 HOUR DESIGN. 2 ELBOWS (ALC-30V-190-12)

JOB NO:

NO. OF WORKMEN IN CREW: 3

WEATHER: INTERIOR AIR TEMP: N/A

CHECKED BY: B Evans

THERMO-LAG 330-1 PREFABRICATED PANELS

LOT NO: F9-03011

DURATION: 3 HOUR

SUBSTRATE TEMPERATURE: N/A

DATE: 18 APRIL 1989

THERMO-LAG 330-1

LOT NO: 9-04010

THERMO-LAG 330-69

TYPE STRESS SKIN

LOT F-081188 ON PANELS AND PATCHES

Test article 2

ART NO.	SUBSTRATE		AVERAGE	QTY USED	SIZE	DATE	INITI
Pc 13	330-69	Rear, above Pc 6 to top	—	1	24" X 6½"	4/18/89	BE
Thermo-Lag 330-69 Stress Skin (Flat) was used across the seams						↓	↓
between Pc 5 + Pc 12 and Pc 6 and Pc 13. Thermo-Lag 330-1, Trowel							
Grade Lot # 9-04010 was used to seal all edges and seams.							
Stainless Steel Banding, ½" X 0.020" Lot BLL PX8420-5 was							
used within two (2) inches on both sides of all seams							
Left Leg - Vertical, Side Pieces, Front and Rear above Pc 7 + Pc 8							
Pc 14	330-69	Rear Vertical above Pc 7 to top	—	1	24" X 6½"		
Pc 15	330-69	Rear Vertical above Pc 8 to top	—	1	24" X 6½"	↓	↓
						4/18/89	BE

SIGNATURE: B Evans DATE: 18 April 1989

DAIL' ᴜK SHEET

FIRE TEST ON ALUMINUM LADDER BACK CABLE TRAY (30-1440) PROTECTED BY THERMO-LAG PREFABRICATED PANELS. 3 HOUR DESIGN. 2 ELBOWS (ALC-30V-190-12)

JOB NO: ______

NO. OF WORKMEN IN CREW: 3

WEATHER: INTERIOR AIR TEMP: N/A

CHECKED BY: B Elwon

THERMO-LAG 330-1 PREFABRICATED PANELS

LOT NO: F9-03011

TEST: ______

DURATION: 3 HOUR

SUBSTRATE TEMPERATURE: N/A

DATE: 18 APRIL 1989

THERMO-LAG 330-1

LOT NO: 9-04010

THERMO-LAG 330-69 TYPE STRESS SKIN LOT F-081188 ON PANELS AND PATCHES

Test article 2

PART NO.	SUBSTRATE		AVERAGE	QTY USED	SIZE	DATE	INITI
As before, Thermo-Lag 330-69 Stress Skin was used across						4/18/89	BE
the seams. Trowel Grade 330-1 was used to seal all edges						↓	↓
and seams and all voids. Stainless Steel Banding was						↓	↓
used within two (2) inches of the seams on both sides of						4/18/89	BE
the seam. Lot NO. BLLPX8420-5.							

SIGNATURE: B Elwon

DATE: 18 april 1989

DAILY WORK SHEET

JOB NO:

NO. OF WORKMEN IN CREW: 3

WEATHER: INTERIOR AIR TEMP: N/A

CHECKED BY: W. PADDOCK

THERMO-LAG 330-1
SUBLIMING COATING
LOT NO: 79-03011

TEST: FIRE TEST ON ALUMINUM LADDER BACK CABLE TRAY (30-144) PROTECTED BY THERMO-LAG PREFABRICATED PANELS. 3 HOUR DESIGN TEST FOR GULF STATES UTILITIES 2 ELBOWS (ALJA-30V-15

DURATION: 3 HOUR

SUBSTRATE TEMPERATURE: N/A

DATE: 4 MAY 1989

THERMO-LAG 330-1
SUBLIMING COATING
LOT NO: 79-04010

THERMO-LAG 330-69
TYPE STRESS SKIN
LOT F-081188
ON PANELS AND PATCHES

Test Article #2

PART NO. / SUBSTRATE / AVERAGE / QTY USED / SIZE	DATE	INITIA
Test Article was attached to bulkhead by using P1000 unistrut which ran under test article, supported with P1000 unistruts that were anchored to concrete bulkhead using 1/2" Thunder Studs which were covered with Thermo-Lag 330.	5/4/89	WP
Unistruts were covered with Thermo-Lag 330 Prefabricated Panel 3 Hour design minimum 1" in thickness.		
During shipping and handling at C.T.L. Test Article Developed minor surface cracks.		
When Test Article was placed in furnace Thermo-Lag 330 was applied to surface of test article .010 to .060 mils thickness to cover surface cracks.	5/4/89	WP

SIGNATURE: [signature] DATE: 5/4/89

DAILY 'K SHEET

FIRE TEST ON ALUMINUM LADDER BACK CABLE TRAY (30-144)
PROTECTED BY THERMO-LAG PREFABRICATED PANELS. 3 HOUR
DESIGN TEST FOR GULF STATES UTILITIES 2 ELBOWS (ALJA-30V-19(

JOB NO: ____________ TEST:

NO. OF WORKMEN IN CREW: 3 DURATION: 3 HOUR

WEATHER: INTERIOR AIR TEMP: N/A SUBSTRATE TEMPERATURE: N/A

CHECKED BY: [signature] DATE: 4 MAY 1989

THERMO-LAG 330-1 SUBLIMING COATING — LOT NO: E9-03011

THERMO-LAG 330-1 SUBLIMING COATING — LOT NO: 9-04010

THERMO-LAG 330-69 TYPE STRESS SKIN — LOT F-081188 ON PANELS AND PATCHES

Test Article #2

PART NO.	SUBSTRATE		AVERAGE	QTY USED	SIZE	DATE	INITIAL
Spacing of banding was at minimum of six (6) inches on center						4/18	[initials]
on elbows. Banding used was Stainless Steel 3/4 x 0 x .020 Stainless Steel							
At all seams the Stainless Steel banding was at a maximum distance							
of two (2") inches from edge of Thermo-Lag 330-1 Panels							
Stainless Steel Edge Guards (L Corner angles 2"x2"x 2"x .032) were							
used at corners between the Stainless Steel banding							
and Thermo-Lag 330-1 panels.							
						4/18	[initials]

SIGNATURE: [signature] DATE: 18 April 1989

F 9-03011	F 9-03011	F 9-03011	F 9-03011
SS# F 081188	SS# F 081188	SS# F 081188	SS# F 081188
EL # 1	PANEL # 2	PANEL # 3	PANEL # 4
SIZE 72"X35½"	SIZE 72"X35¼"	SIZE 72"X35¼"	SIZE 72"X35¼
THICKNESS	THICKNESS	THICKNESS	THICKNESS
1 : 1.27	1 : 1.02	1 : 1.06	1 : 1.25
2 : 1.29	2 : 1.30	2 : 1.22	2 : 1.30
3 : 1.28	3 : 1.29	3 : 1.32	3 : 1.28
4 : 1.27	4 : 1.20	4 : 1.27	4 : 1.27
5 : 1.24	5 : 1.36	5 : 1.34	5 : 1.27
6 : 1.28	6 : 1.18	6 : 1.35	6 : 1.24
7 : 1.22	7 : 1.15	7 : 1.26	7 : 1.24
8 : 1.26	8 : 1.28	8 : 1.21	8 : 1.25
9 : 1.30	9 : 1.28	9 : 1.15	9 : 1.25
10 : 1.28	10 : 1.24	10 : 1.25	10 : 1.26
11 : 1.24	11 : 1.22	11 : 1.26	11 : 1.25
12 : 1.26	12 : 1.26	12 : 1.28	12 : 1.25
13 : 1. —	13 : 1. —	13 : 1. —	13 : 1. —
14 : 1. —	14 : 1. —	14 : 1. —	14 : 1. —
15 : 1. —	15 : 1. —	15 : 1. —	15 : 1. —
16 : 1. —	16 : 1. —	16 : 1. —	16 : 1. —
17 : 1. —	17 : 1. —	17 : 1. —	17 : 1. —
18 : 1. —	18 : 1. —	18 : 1. —	18 : 1. —
19 : 1. —	19 : 1. —	19 : 1. —	19 : 1. —
20 : 1. —	20 : 1. —	20 : 1. —	20 : 1. —
AVERAGE = 1.27	AVERAGE = 1.23	AVERAGE = 1.25	AVERAGE = 1.26

CHECKED BY: B Elvers DATE: 5 april 1989

330-1 PREFABRICTED PANELS FILM COATING THICKNESS

F 9-03011	F 9-03011	F 9-03011	F 9-03011
SS# F 081188	SS# F 081188	SS# F 081188	SS# F 081188
PANEL # 5	PANEL # 6	PANEL # 7	PANEL # 8
SIZE 50" X 6 1/2	SIZE 50" X 6 1/2	SIZE 50" X 6 1/2"	SIZE 50" X 6 1/2
THICKNESS	THICKNESS	THICKNESS	THICKNESS
1 : 1.08	1 : 1.18	1 : 1.20	1 : 1.10
2 : 1.10	2 : 1.20	2 : 1.20	2 : 1.12
3 : 1.10	3 : 1.22	3 : 1.18	3 : 1.20
4 : 1.09	4 : 1.24	4 : 1.22	4 : 1.22
5 : 1.10	5 : 1.24	5 : 1.24	5 : 1.20
6 : 1.12	6 : 1.26	6 : 1.24	6 : 1.24
7 : 1.14	7 : 1.24	7 : 1.25	7 : 1.22
8 : 1.10	8 : 1.26	8 : 1.26	8 : 1.28
9 : 1.10	9 : 1.26	9 : 1.28	9 : 1.22
10 : 1.10	10 : 1.18	10 : 1.24	10 : 1.26
11 : 1.08	11 : 1.20	11 : 1.22	11 : 1.28
12 : 1.12	12 : 1.22	12 : 1.22	12 : 1.24
13 : 1.12	13 : 1.24	13 : 1.24	13 : 1.26
14 : 1.14	14 : 1.24	14 : 1.22	14 : 1.26
15 : 1.10	15 : 1.28	15 : 1.20	15 : 1.28
16 : 1.10	16 : 1.26	16 : 1.24	16 : 1.22
17 : 1.12	17 : 1.20	17 : 1.24	17 : 1.24
18 : 1.10	18 : 1.22	18 : 1.22	18 : 1.20
19 : 1.12	19 : 1.24	19 : 1.24	19 : 1.20
20 : 1.14	20 : 1.22	20 : 1.24	20 : 1.18
AVERAGE= 1.11	AVERAGE= 1.23	AVERAGE= 1.23	AVERAGE= 1.22

CHECKED BY: B. Elvers DATE: 5 April 1989

330-1 PREFABRICTED PANELS FILM COATING THICKNESS

F 9-03011	F 9-03011	F 9-03011	F 9-03011
F 081188	SS# F 081188	SS# F 081188	SS# F 081188
PANEL # 9	PANEL # 10	PANEL # 11	PANEL # 12
SIZE 35¼" X 19¼"	SIZE 6" X 20½"	SIZE 6" X 20½"	SIZE 24" X 6½"
THICKNESS	THICKNESS	THICKNESS	THICKNESS
1 : 1.10	1 : 1.14	1 : 1.24	1 : 1.20
2 : 1.08	2 : 1.16	2 : 1.24	2 : 1.20
3 : 1.06	3 : 1.16	3 : 1.26	3 : 1.20
4 : 1.06	4 : 1.18	4 : 1.28	4 : 1.18
5 : 1.08	5 : 1.20	5 : 1.24	5 : 1.22
6 : 1.10	6 : 1.18	6 : 1.24	6 : 1.18
7 : 1.08	7 : 1.14	7 : 1.22	7 : 1.20
8 : 1.16	8 : 1.12	8 : 1.24	8 : 1.16
9 : 1.10	9 : 1.12	9 : 1.26	9 : 1.20
10 : 1.12	10 : 1.14	10 : 1.28	10 : 1.20
11 : 1.08	11 : 1.14	11 : 1.24	11 : 1.16
12 : 1.10	12 : 1.14	12 : 1.20	12 : 1.20
13 : 1.12	13 : 1.14	13 : 1.22	13 : 1.22
14 : 1.14	14 : 1.18	14 : 1.28	14 : 1.24
15 : 1.16	15 : 1.16	15 : 1.26	15 : 1.24
16 : 1.10	16 : 1.16	16 : 1.24	16 : 1.26
17 : 1.11	17 : 1.12	17 : 1.24	17 : 1.22
18 : 1.12	18 : 1.14	18 : 1.20	18 : 1.28
19 : 1.12	19 : 1.18	19 : 1.22	19 : 1.16
20 : 1.12	20 : 1.16	20 : 1.20	20 : 1.18
ERAGE= 1.11	AVERAGE= 1.15	AVERAGE= 1.24	AVERAGE= 1.21

CHECKED BY: B Elvo DATE: 5 april 1989

330-1 PREFABRICTED PANELS FILM COATING THICKNESS

P 9-03011	P 9-03011	P 9-03011	P
SS# F 081188	SS# F 081188	SS# F 081188	SS# F
PANEL # 13	PANEL # 14	PANEL # 15	PANEL #
SIZE 24' X 6½'	SIZE 24' X 6½"	SIZE 24' X 6½'	SIZE
THICKNESS	THICKNESS	THICKNESS	THICKNESS
1: 1.20	1: 1.28	1: 1.19	1: 1.
2: 1.20	2: 1.28	2: 1.18	2: 1.
3: 1.22	3: 1.26	3: 1.20	3: 1.
4: 1.24	4: 1.26	4: 1.20	4: 1.
5: 1.24	5: 1.24	5: 1.18	5: 1.
6: 1.25	6: 1.22	6: 1.16	6: 1.
7: 1.26	7: 1.22	7: 1.18	7: 1.
8: 1.24	8: 1.22	8: 1.18	8: 1.
9: 1.20	9: 1.24	9: 1.16	9: 1.
10: 1.18	10: 1.22	10: 1.14	10: 1.
11: 1.16	11: 1.24	11: 1.14	11: 1.
12: 1.18	12: 1.20	12: 1.18	12: 1.
13: 1.17	13: 1.22	13: 1.20	13: 1.
14: 1.16	14: 1.22	14: 1.18	14: 1.
15: 1.18	15: 1.24	15: 1.22	15: 1.
16: 1.20	16: 1.26	16: 1.24	16: 1.
17: 1. —	17: 1.22	17: 1.16	17: 1.
18: 1. —	18: 1.22	18: 1.20	18: 1.
19: 1. —	19: 1.20	19: 1.20	19: 1.
20: 1. —	20: 1.22	20: 1.18	20: 1.
AVERAGE = 1.16	AVERAGE = 1.23	AVERAGE = 1.18	AVERAGE = 1.

CHECKED BY: B Evans DATE: 5 April 1989

RECEIVING RECORD

RECEIVED FROM:

COMPANY: National Standard Co

ADDRESS: ______

CITY/STATE: Corbin, Ky. 40701

LOC NUMBER: 2041

DATE: 16 Aug. 1988

P.O. NO: 6159

REC. NO: ______

DESCRIPTION: ✓ RAW MATERIAL ______ RETURNED GOODS

IF RETURNED GOODS:

PROJECT NO: ______ LOCATION: ______

FREIGHT BILL NO: ______ PREPAID ______ COLLECT ______

PRODUCT CODE	NO. OF PACKAGES	NET QUANTITY	LOT NUMBER
330-69-4 (4ft wide)	150 X 100 LF Rolls	60,000 sq ft	081188

TOTAL NO. OF PKGS. 150 Rolls TOTAL NET ~~WT~~. 60,000 sq ft GROSS WT. ______

ANY DAMAGE TO CONTAINERS: __ YES ✓ NO REMARKS: ______

DID CERTIFICATE OF CONFORMANCE ACCOMPANY SHIPMENT: ✓ YES ___ NO

IS BILL OF LADING ATTACHED: ✓ YES ___ NO

IS PACKAGING LIST ATTACHED: ✓ YES ___ NO

RECEIVED BY: B Elvers

(See reverse side for more details)

[illegible]

RAW MATERIAL

QUALITY CONTROL REPORT

DATE: 8-16-88

THERMO-LAG STRESS SKIN

RAW MATERIAL SHEET

CODE NUMBER	LOT NUMBER	DATE RECEIVED	RECEIVING TICKET NO.	QUANTITY
330-69-4	081188	8-16-88	2041	60,000 sq ft

QUALITY CONTROL PROCEDURE	PROCEDURE NUMBER	SPECIFICATION	RESULTS
Strand Diameter	A-22	0.018" Min.	0.01939 8-16-88
W t/Square Yard	A-23	1.74 lbs. Min.	1.91 LBS/yd² 8-16-88
Mesh Size	A-24	60 Min.	64 8-16-88

ACCEPTED: ✓

REJECTED: ____

SIGNATURE: [signature]

DATE: 8-16-88

QUALITY CONTROL STAMP AFFIXED:

DATE: 8-16-88

DISTRIBUTION

ORIGINAL: MASTER FILE

XC: INVENTORY CONTROL SUPERVISOR

MANAGER OF QUALITY CONTROL

NATIONAL-STANDARD COMPANY

WOVEN PRODUCTS PLANT

NS NATIONAL-STANDARD COMPANY

[illegible]
Wire Cloth
CORBIN, KENTUCKY
Telephone Corbin 528-2141
TWX [illegible]

CERTIFIED TEST REPORT

TO: Thermal Science, Inc.
2200 Cassens Drive
St. Louis, MO 63026

Gentlemen:

To the best of our knowledge and belief the following covers the chemical analysis and physical properties of the 15,730 ft.; 190 rolls of 36 & 48 in. x 19,000 ft.; 8 x 8 mesh x 27 Ga. x 27 Ga. Hot Galv. St. Industrial Wire Cloth shipped on P. O. No. 6159 dated 5/19/88 to specification ASTM-A-740

CHEMICAL ANALYSIS:

HEAT NO. (Warp) 64452
(Filler) 3184
LOT NO. (Warp)
(Filler)

	C	Mn	P	S	Si	Cr	Ni	Mo	Cu			
Filler	.07	.34	.008	.020								
Warp												

* Zinc plus wire cloth will weigh min. of 1.75 lbs. per square yard

Warp												
Filler												

PHYSICAL ANALYSIS:

Average U. T. S. (Warp) 110,000 p. s. i.
(Filler) ______ p. s. i.

Average Elong. -10 in. Ga. (Warp) ______ %
(Filler) ______ %

E. M. Lewis (Signed)
(Inspector)

STATE OF KENTUCKY
COUNTY OF KNOX

Subscribed and sworn to this 11 day of Aug. 1988 before the undersigned who does hereby certify that under the laws of the State aforesaid he is duly authorized to administer oaths.

Jamie W. Vermillion (Signed)
Notary Public

My commission expires 12/10/91.

Lot # 081188

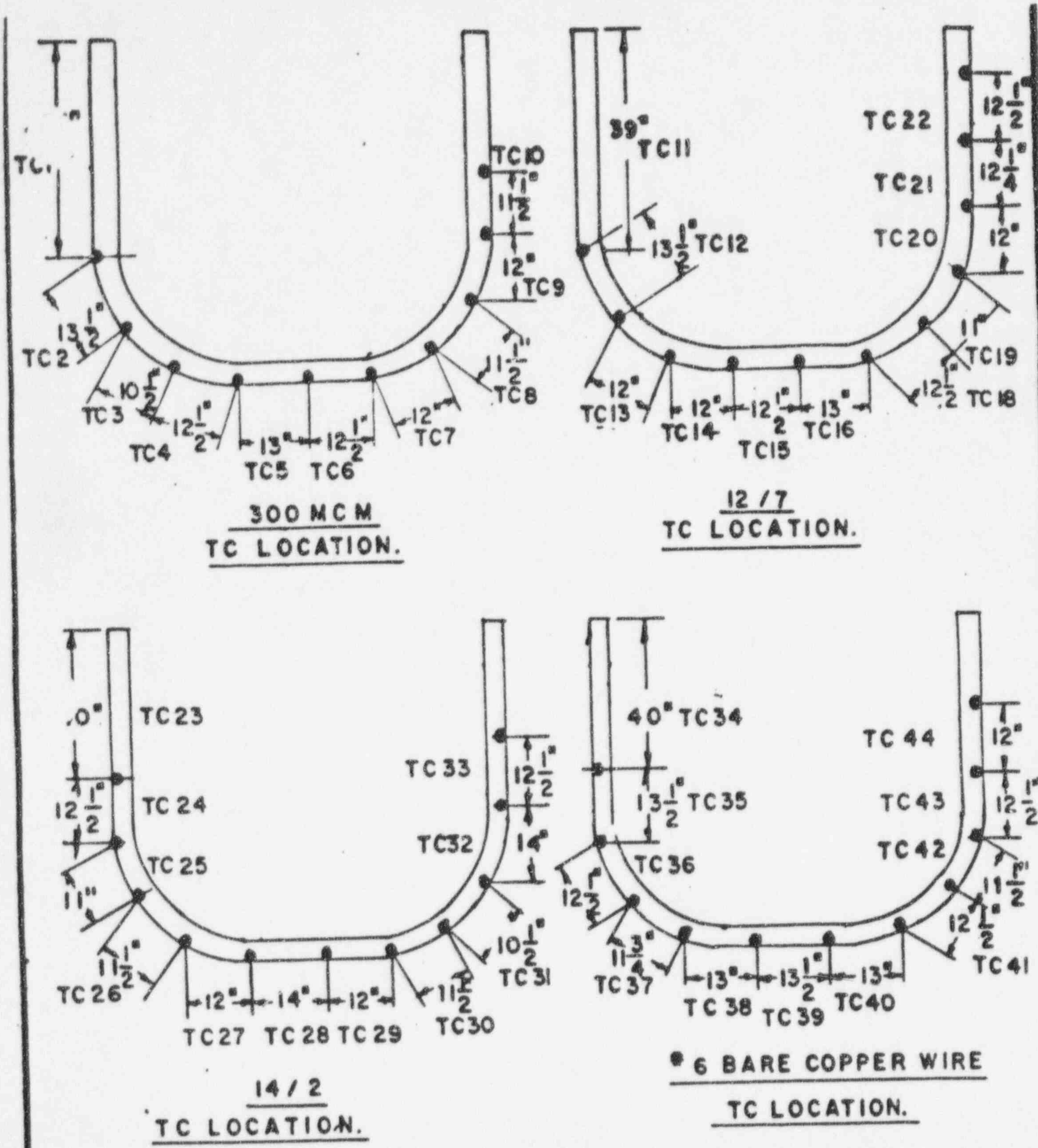
APPENDIX C

240056 - TSI - 05/05/89

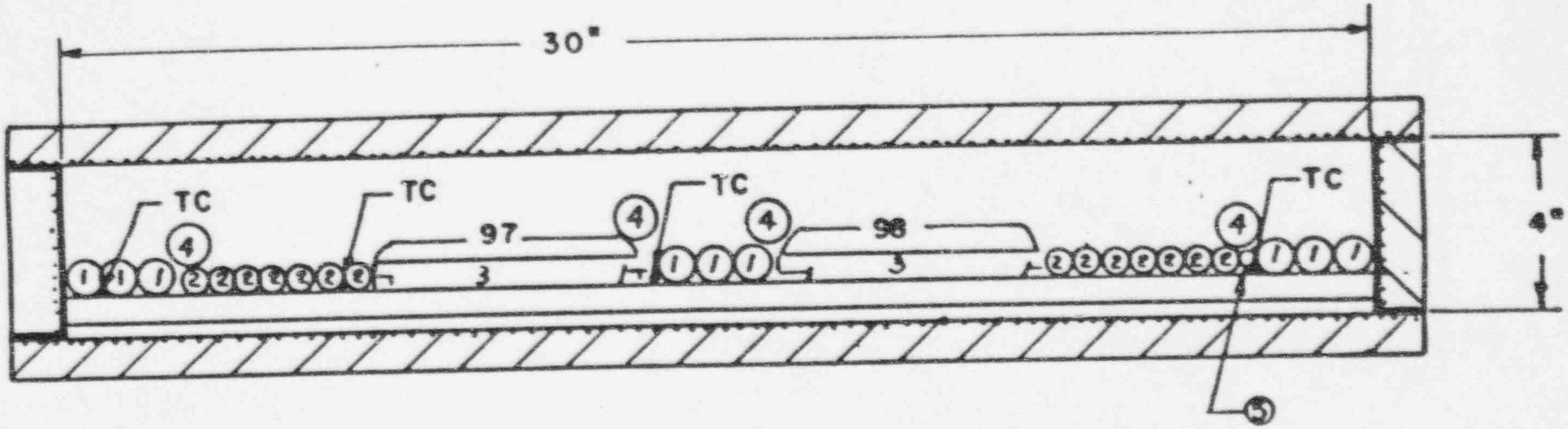
FURNACE ATMOSPHERE TEMPERATURE (DEG. F)

TEST TIME, Hr:Min	FURNACE TEMP. F	ASTM E119 TEMP. F	VARIATION FROM ASTM TEMP. F
0:00	210	68	142
0:05	1110	1000	110
0:10	1360	1300	60
0:15	1392	1399	-7
0:20	1454	1462	-8
0:25	1511	1510	1
0:30	1560	1550	10
0:35	1594	1584	10
0:40	1630	1613	17
0:45	1657	1638	19
0:50	1669	1661	8
0:55	1687	1681	6
1:00	1706	1700	6
1:05	1722	1718	4
1:10	1741	1735	6
1:15	1759	1750	9
1:20	1761	1765	-4
1:25	1761	1779	-18
1:30	1772	1792	-20
1:35	1795	1804	-9
1:40	1802	1815	-13
1:45	1814	1826	-12
1:50	1825	1835	-10
1:55	1834	1843	-9
2:00	1847	1850	-3
2:10	1863	1862	1
2:20	1865	1875	-10
2:30	1869	1888	-19
2:40	1881	1900	-19
2:50	1894	1912	-18
3:00	1905	1925	-20

AREA UNDER CURVE= 294961 DEG. F-MINUTES
AREA UNDER ASTM E119 CURVE= 294600 DEG. F-MINUTES
VARIATION FROM ASTM CURVE= 00.1225 %



TSI TSI, Inc.	2200 CASSENS DRIVE ST LOUIS, MISSOURI 63026.	
SCALE NONE	APPROVED BY [signature]	DRAWN BY J DUMPIS
DATE 9-12-89		REVISED
FIGURE 1: LOCATION OF THERMOCOUPLES WITHIN		
THE TEST ASSEMBLY		DRAWING NUMBER FIGURE 1



① 300 MCM – 9

② 12 / 7C – 24

3 14 / 2 C – 195

④ #6/ 3C XLPE – 4

O #6 BARE COPPER WIRE

TSI

2200 CASSENS DRIVE
ST. LOUIS, MISSOURI

SCALE NONE

DATE 8-25-89

FIGURE 2: CABLE AND THERMOCOUPLE LOCATIONS

FIGURE 2

UNSHIELDED THERMOCOUPLE LOCATION

TEST NO: 2

DESCRIPTION: FIRE TEST ON ALUMINUM LADDER BACK CABLE TRA (A6C-30-144) PROTECTED BY THERMO-LAG PRE-FABRICATED PANELS. 3 HOUR DESIGN

DURATION: 3 HOUR

ORIENTATION: 2 ELBOWS (ALC-30V-190-12)

CONDUCTOR: Chromel/Alumel

TYPE: GG-20-KK

SIZE: #20

STRAND: Solid

DATE: 5 APRIL 1989

CHECKED BY: B. E. Evans
B. E. Evans - Quality Control Manager

TEST ARTICLE 2

THERMOCOUPLE	CTL No.	CABLE	DIRECTION	DISTANCE	COMMENTS
TC 1	(41)	300MCM	Down Left Leg	39½" From Left Cable End	--------------------
TC 2	(42)	300MCM	Down Left Leg	53" From Left Cable End	13½" Below TC 1
TC 3	(43)	300MCM	Down Left Leg	63½" From Left Cable End	10½" Below TC 2
TC 4	(44)	300MCM	Across Flat Area	76" From Left Cable End	12½" Right of TC 3
TC 5	(45)	300MCM	Across Flat Area	88½" From Left Cable End	12½" Right of TC 4
TC 6	(46)	300MCM	Across Flat Area	101½" From Left Cable End	13" Right of TC 5
TC 7	(47)	300MCM	Across Flat Area	114" From Left Cable End	12½" Right of TC 6
TC 8	(48)	300MCM	Across Flat Area	126" From Left Cable End	12" Right of TC 7
TC 9	(73)	300MCM	Up Right Leg	137½" From Left Cable End	11½" Above TC 8
TC 10	(64)	300MCM	Up Right Leg	149½" From Left Cable End	12" Above TC 9
TC 11	(65)	300MCM	Up Right Leg	161" From Left Cable End	11½" Above TC 10

ACTUAL T. C. LOCATION 1-5/8" FROM MARKED FRONT EDGE OF TRAY TOWARD CENTER.

UNSHIELDED THERMOCOUPLE LOCATION

TEST NO: 2

DESCRIPTION: FIRE TEST ON ALUMINUM LADDER BACK CABLE TRAY (A6C-30-144) PROTECTED BY THERMO-LAG PRE-FABRICATED PANELS. 3 HOUR DESIGN

DURATION: 3 HOUR

ORIENTATION: 2 ELBOWS (ALC-30V-190-12)

CONDUCTOR: Chromel/Alumel

TYPE: GG-20-KK

SIZE: #20

STRAND: Solid

DATE: 5 APRIL 1989

CHECKED BY: B. E. Evans - Quality Control Manager

TEST ARTICLE 2

THERMOCOUPLE		CABLE	DIRECTION	DISTANCE	COMMENTS
TC 12	CTL No. (76)	12/7	Down Left Leg	39" From Left Cable End	--------------------
TC 13	(77)	12/7	Down Left Leg	52½" From Left Cable End	13½" Below TC 12
TC 14	(78)	12/7	Down Left Leg	64½" From Left Cable End	12" Below TC 13
TC 15	(79)	12/7	Across Flat Area	76½" From Left Cable End	12" Right of TC 14
TC 16	(80)	12/7	Across Flat Area	89" From Left Cable End	12½" Right of TC 15
TC 17	(81)	12/7	Across Flat Area	102" From Left Cable End	13" Right of TC 16
TC 18	(82)	12/7	Across Flat Area	114½" From Left Cable End	12½" Right of TC 17
TC 19	(83)	12/7	Across Flat Area	125½" From Left Cable End	11" RIght of TC 18
TC 20	(84)	12/7	Up Right Leg	137½" From Left Cable End	12" Above TC 19
TC 21	(85)	12/7	Up Right Leg	143-3/4" From Left Cable End	12¼" Above TC 20
TC 22	(86)	12/7	Up Right Leg	162¼" From Left Cable End	12½" Above TC 21

ACTUAL T. C. LOCATION 6-3/4" FROM MARKED FRONT EDGE OF TRAY TOWARD CENTER.

UNSHIELDED THERMOCOUPLE LOCATION

TEST NO: 2

DESCRIPTION: FIRE TEST ON ALUMINUM LADDER BACK CABLE TRA (A6C-30-144) PROTECTED BY THERMO-LAG PRE-FABRICATED PANELS. 3 HOUR DESIGN

DURATION: 3 HOUR

ORIENTATION: 2 ELBOWS (ALC-30V-190-12)

CONDUCTOR: Chromel/Alumel

TYPE: GC-20-KK

SIZE: #20

STRAND: Solid

DATE: 5 APRIL 1989

CHECKED BY: B. E. Evans - Quality Control Manager

TEST ARTICLE 2

THERMOCOUPLE	CABLE	DIRECTION	DISTANCE	COMMENTS
TC 23 (CTR No. 87)	14/2	Down Left Leg	40" From Left Cable End	--------------------
TC 24 (88)	14/2	Down Left Leg	52½" From Left Cable End	12½" Below TC 23
TC 25 (89)	14/2	Down Left Leg	63½" From Left Cable End	11" Below TC 24
TC 26 (90)	14/2	Across Flat Area	75" Across Flat Area	11½" Right of TC 25
TC 27 (91)	14/2	Across Flat Area	87" Across Flat Area	12" Right of TC 26
TC 28 (92)	14/2	Across Flat Area	101" Across Flat Area	14" RIght of TC 27
TC 29 (93)	14/2	Across Flat Area	113" Across Flat Area	12" Right of TC 28
TC 30 (94)	14/2	Up Right Leg	124½" Across Flat Area	11½" Right of TC 29
TC 31 (95)	14/2	Up Right Leg	135" Up Right Leg	10½" Above TC 30
TC 32 (96)	14/2	Up Right Leg	149" Up Right Leg	14" Above TC 31
TC 33 (97)	14/2		161½" Up Right Leg	12½" Above TC 32

ACTUAL T. C. LOCATION 22-5/8" FROM MARKED FRONT EDGE OF TRAY TOWARD CENTER.

UNSHIELDED THERMOCOUPLE LOCATION

TEST NO: 2

DESCRIPTION: FIRE TEST ON ALUMINUM LADDER BACK CABLE TR (A6C-30-144) PROTECTED BY THERMO-LAC PRE-FABRICATED PANELS. 3 HOUR DESIGN

DURATION: 3 HOUR

ORIENTATION: 2 ELBOWS (ALC-30V-190-12)

CONDUCTOR: Chromel/Alumel

TYPE: GC-20-KK

SIZE: #20

STRAND: Solid

DATE: 5 APRIL 1989

CHECKED BY: B. E. Evans - Quality Control Manager

TEST ARTICLE 2

THERMOCOUPLE	CTL No.	CABLE	DIRECTIC	DISTANCE	COMMENTS
TC 34	(98)	Bare 6 Copper	Down Left Leg	40" From Left Cable End	--------------------
TC 35	(99)	Bare 6 Copper	Down Left Leg	53½" From Left Cable End	13½" Below TC 34
TC 36	(100)	Bare 6 Copper	Down Left Leg	66" From Left Cable End	12½" Below TC 35
TC 37	(101)	Bare 6 Copper	Across Flat Area	77-3/4" From Left Cable End	11-3/4" Right of TC 3
TC 38	(102)	Bare 6 Copper	Across Flat Area	90-3/4" From Left Cable End	13" Right of TC 37
TC 39	(103)	Bare 6 Copper	Across Flat Area	104¼" From Left Cable End	13½" Right of TC 38
TC 40	(104)	Bare 6 Copper	Across Flat Area	117¼" From Left Cable End	13" Right of TC 39
TC 41	(105)	Bare 6 Copper	Across Flat Area	129-3/4" From Left Cable End	12½" Right of TC 40
TC 42	(106)	Bare 6 Copper	Up Right Leg	141¼" From Left Cable End	11½" Above TC 41
TC 43	(107)	Bare 6 Copper	Up Right Leg	153-3/4" From Left Cable End	12½" Above TC 42
TC 44	(108)	Bare 6 Copper	Up Right Leg	165-3/4" From Left Cable End	12" Above TC 43

ACTUAL T. C. LOCATION 27¼" FROM MARKED FRONT EDGE OF TRAY TOWARD CENTER.

UNSHIELDED THERMOCOUPLE LOCATION

TEST NO: 2

DESCRIPTION: FIRE TEST ON ALUMINUM LADDER BACK CABLE TRA (A6C-30-144) PROTECTED BY THERMO-LAC PRE-FABRICATED PANELS. 3 HOUR DESIGN

DURATION: 3 HOUR

ORIENTATION: 2 ELBOWS (ALC-30V-190-12)

CONDUCTOR: Chromel/Alumel

TYPE: GG-20-KK

SIZE: #20

STRAND: Solid

DATE: 5 APRIL 1989

CHECKED BY: B. E. Evans - Quality Control Manager

TEST ARTICLE 2

THERMOCOUPLE		CABLE	DIRECTION	DISTANCE	COMMENTS
TC 1	CTR No. (109)	Rung 7	Down Left Leg	37" From Tray Top	--------------------
TC 3	(111)	Rung 10	Down Left Leg	50" From Tray Top	13" Below TC 1
TC 5	(49)	Rung 12	Down Left Leg	76" From Tray Top	26" Below TC 3
TC 2	(110)	Rung 6	Right Leg Down	31" From Tray Top	--------------------
TC 4	(112)	Rung 9	Right Leg Down	57" From Tray Top	26" Below TC 2
TC 6	(50)	Rung 11	Right Leg Down	73½" From Tray Top	16½" Below TC 4

R. C.s LOCATED AT CENTER OF THE RUNGS.

240056 - TSI - 05/05/89

TEMP. READINGS (DEG. F.)

TEST TIME, Hr:Min	T/C NO.					
	41 (1)	42 (2)	43 (3)	44 (4)	45 (5)	46 (6)
0:00	68	67	68	68	68	68
0:05	68	68	68	68	68	68
0:10	68	68	68	68	68	68
0:15	68	68	68	68	69	68
0:20	69	69	69	69	71	70
0:25	70	71	71	71	73	73
0:30	72	74	74	74	77	77
0:35	76	79	77	77	83	82
0:40	80	85	82	82	89	89
0:45	85	89	87	87	95	95
0:50	90	94	93	93	101	102
0:55	95	105	100	100	107	109
1:00	102	109	107	107	115	116
1:05	109	108	117	116	124	122
1:10	117	125	128	128	133	127
1:15	124	129	137	138	144	132
1:20	129	139	143	145	152	138
1:25	133	147	149	151	160	144
1:30	136	152	153	157	167	150
1:35	139	162	159	162	174	158
1:40	143	158	164	168	180	167
1:45	147	170	171	174	187	176
1:50	154	169	177	182	195	184
1:55	160	182	184	190	203	192
2:00	166	186	191	200	213	201
2:10	177	198	209	220	235	219
2:20	189	211	229	238	253	239
2:30	202	235	249	259	273	260
2:40	222	255	270	276	291	282
2:50	241	277	287	293	309	304
3:00	258	295	305	311	331	327

240056 - TSI - 05/05/89

TEMP. READINGS (DEG. F.)

TEST TIME, Hr:Min	T/C NO.					
	47 (7)	48 (5)	49 5 Tray	50 6 Tray	[illegible]1	[illegible]2
0:00	68	67	68	68	[illegible]7	[illegible]7
0:05	68	68	68	68	[illegible]8	[illegible]8
0:10	68	68	68	68	[illegible]8	[illegible]8
0:15	68	68	71	69	[illegible]9	[illegible]8
0:20	70	69	76	72	[illegible]1	[illegible]0
0:25	72	71	83	77	[illegible]3	[illegible]4
0:30	76	74	89	82	[illegible]6	[illegible]8
0:35	81	79	96	90	[illegible]0	[illegible]3
0:40	87	85	103	98	[illegible]4	[illegible]8
0:45	93	90	110	106	[illegible]7	[illegible]3
0:50	99	96	117	113	[illegible]2	[illegible]8
0:55	105	103	124	120	[illegible]7	1[illegible]5
1:00	112	109	134	127	1[illegible]5	1[illegible]2
1:05	118	114	139	133	1[illegible]6	120
1:10	123	119	145	137	1[illegible]3	127
1:15	128	124	151	143	1[illegible]3	1[illegible]4
1:20	133	129	157	148	1[illegible]1	1[illegible]2
1:25	138	135	163	154	1[illegible]7	1[illegible]0
1:30	143	141	170	159	1[illegible]2	1[illegible]7
1:35	148	147	179	166	1[illegible]5	1[illegible]3
1:40	155	153	188	172	1[illegible]7	1[illegible]9
1:45	164	160	197	179	1[illegible]9	1[illegible]5
1:50	172	167	207	186	1[illegible]3	1[illegible]2
1:55	180	174	217	192	1[illegible]8	1[illegible]0
2:00	188	181	225	199	[illegible]3	1[illegible]8
2:10	206	196	245	214	2[illegible]7	2[illegible]4
2:20	225	213	272	229	2[illegible]2	2[illegible]1
2:30	245	232	294	244	2[illegible]0	2[illegible]9
2:40	264	250	311	260	2[illegible]7	2[illegible]7
2:50	284	269	329	278	2[illegible]8	2[illegible]7
3:00	304	287	346	297	2[illegible]6	3[illegible]7

240856 - TSI - 05/05/89
TEMP. READINGS (DEG. F.)

TEST TIME, Hr:Min	T/C NO.					
	73 (9)	74 (10)	75 (11)	76 (12)	77 (13)	78 (14)
0:00	67	67	67	67	67	67
0:05	67	67	67	67	67	67
0:10	67	67	67	67	67	67
0:15	68	67	67	67	68	67
0:20	69	68	67	68	69	68
0:25	72	71	69	69	71	70
0:30	77	75	73	72	74	73
0:35	81	81	78	75	78	77
0:40	86	86	84	79	81	82
0:45	91	91	89	84	86	87
0:50	96	95	92	88	91	92
0:55	101	100	96	94	97	98
1:00	106	104	100	99	103	104
1:05	110	108	104	105	109	110
1:10	115	112	108	109	114	116
1:15	119	116	112	114	120	122
1:20	124	120	116	118	125	129
1:25	130	125	120	122	130	134
1:30	136	129	123	126	134	140
1:35	143	134	126	130	139	145
1:40	149	138	129	134	144	151
1:45	156	143	132	139	149	157
1:50	162	148	134	144	154	163
1:55	169	154	138	149	160	168
2:00	178	160	142	155	165	177
2:05	186	169	146	159	172	183
2:10	195	177	151	167	183	200
2:15	203	185	158	175	200	211
2:20	213	194	165	183	207	216
2:25	221	203	173	193	213	224
2:30	230	212	180	201	220	230
2:35	239	221	188	209	228	238
2:40	247	230	196	216	235	245
2:45	257	238	204	223	244	253
2:50	265	247	213	228	253	262
2:55	274	256	221	233	261	271
3:00	282	264	229	238	269	279

240056 - TSI - 05/05/89

TEMP. READINGS (DEG. F.)

TEST TIME, Hr:Min	T/C NO.					
	79 (15)	80 (16)	81 (17)	82 (18)	83 (19)	84 (20)
0:00	67	67	67	67	67	67
0:05	67	67	67	67	67	67
0:10	67	67	67	67	67	67
0:15	68	67	68	67	67	68
0:20	70	69	69	68	68	69
0:25	73	71	73	71	70	73
0:30	76	74	78	74	73	77
0:35	80	79	85	79	76	82
0:40	84	84	92	85	81	87
0:45	89	89	99	92	86	92
0:50	95	96	106	97	91	97
0:55	102	102	113	104	97	103
1:00	109	109	119	110	102	108
1:05	116	115	125	116	108	113
1:10	122	121	131	122	113	118
1:15	129	128	138	128	118	124
1:20	136	135	145	135	124	130
1:25	143	143	152	141	131	136
1:30	147	150	159	148	137	142
1:35	154	158	166	154	143	147
1:40	160	167	174	161	150	153
1:45	167	175	182	169	156	159
1:50	175	185	191	176	163	166
1:55	182	194	199	184	169	172
2:00	198	205	208	192	176	179
2:05	206	213	217	200	183	186
2:10	222	229	226	209	191	193
2:15	237	241	236	217	198	200
2:20	243	257	245	226	206	208
2:25	255	262	255	235	214	216
2:30	255	268	265	244	222	224
2:35	260	274	274	253	230	231
2:40	266	281	284	262	238	239
2:45	275	291	294	271	246	246
2:50	282	301	303	279	253	253
2:55	291	310	313	288	261	260
3:00	299	319	323	297	268	267

240856 - TSI - [illegible]5/05/89
TEMP. READINGS (DEG. F.)

TEST TIME, Hr:Min	T/C NO.					
	85 ([illegible])	86 ([illegible])	87 ([illegible])	88 ([illegible])	89 ([illegible])	90 ([illegible])
0:00	67	67	67	67	67	67
0:05	67	67	67	67	67	67
0:10	67	67	67	67	67	67
0:15	67	67	67	68	68	68
0:20	69	68	68	71	69	70
0:25	71	70	70	75	72	72
0:30	74	74	71	78	75	76
0:35	79	78	77	81	79	80
0:40	84	82	83	85	82	85
0:45	89	86	87	90	87	89
0:50	94	89	90	96	92	95
0:55	99	98	96	105	98	101
1:00	105	103	101	113	104	107
1:05	110	106	106	119	110	113
1:10	115	111	111	125	117	119
1:15	120	115	115	131	124	125
1:20	125	119	118	135	129	132
1:25	131	123	122	135	133	137
1:30	136	127	126	136	136	142
1:35	141	132	129	140	140	147
1:40	147	136	133	142	144	153
1:45	152	140	137	145	149	158
1:50	157	145	142	150	154	164
1:55	162	148	148	157	160	171
2:00	167	151	153	162	166	176
2:05	173	155	155	164	173	185
2:10	178	158	158	167	181	194
2:15	184	163	162	172	190	204
2:20	191	168	165	182	198	211
2:25	198	173	171	192	205	218
2:30	205	178	178	201	212	225
2:35	214	184	185	209	220	233
2:40	222	190	191	220	230	242
2:45	231	195	197	230	242	253
2:50	239	202	204	239	253	265
2:55	248	209	211	247	264	275
3:00	255	216	216	255	272	281

240056 - TSI - 05/05/89

TEMP. READINGS (DEG. F.)

TEST TIME, Hr:Min	T/C NO.					
	91 (27)	92 (28)	93 (29)	94 (30)	95 (31)	96 (32)
0:00	67	67	67	67	67	67
0:05	67	67	67	67	67	67
0:10	67	67	67	67	67	67
0:15	69	68	68	69	68	68
0:20	71	71	69	72	71	70
0:25	76	75	73	75	75	73
0:30	81	80	77	80	80	77
0:35	87	86	83	84	84	81
0:40	92	92	89	88	88	85
0:45	99	99	96	93	93	89
0:50	106	105	102	96	97	94
0:55	111	112	109	105	104	99
1:00	117	118	115	110	108	104
1:05	124	124	120	113	112	108
1:10	130	131	125	117	116	113
1:15	137	137	131	120	119	118
1:20	144	143	136	124	124	122
1:25	151	149	142	127	127	126
1:30	157	155	147	131	132	130
1:35	165	161	153	136	136	134
1:40	172	168	158	139	140	138
1:45	180	174	164	144	144	142
1:50	188	181	170	148	148	146
1:55	196	188	175	151	151	150
2:00	206	195	179	154	155	157
2:05	216	202	184	158	161	164
2:10	227	208	188	162	166	171
2:15	239	216	193	166	171	177
2:20	249	223	199	171	177	182
2:25	258	230	204	177	184	187
2:30	268	237	211	183	191	192
2:35	278	245	217	190	198	198
2:40	288	254	224	198	208	204
2:45	300	262	232	205	216	212
2:50	310	271	240	213	225	220
2:55	318	279	247	221	234	228
3:00	323	288	255	228	242	236

240056 - TSI - 05/05/89
TEMP. READINGS (DEG. F.)

TEST TIME, Hr:Min	T/C NO.					
	97 (33)	98 (34)	99 (35)	100 (36)	101 (37)	102 (38)
0:00	67	67	67	67	67	67
0:05	67	67	67	67	67	67
0:10	67	67	67	67	67	67
0:15	67	67	68	68	68	68
0:20	68	68	69	69	69	70
0:25	70	70	72	72	72	73
0:30	73	72	75	75	77	79
0:35	77	79	81	80	84	85
0:40	82	86	87	86	92	91
0:45	87	91	94	92	97	97
0:50	90	95	99	98	101	101
0:55	94	102	107	105	108	108
1:00	100	107	113	112	114	120
1:05	106	112	118	116	118	124
1:10	112	117	123	121	122	127
1:15	116	121	127	125	126	132
1:20	121	125	132	130	129	138
1:25	126	129	135	134	134	143
1:30	129	132	139	137	138	148
1:35	133	136	143	143	143	158
1:40	138	139	147	149	148	165
1:45	142	143	151	154	154	170
1:50	146	148	157	161	161	176
1:55	149	154	164	167	169	186
2:00	150	159	169	174	170	192
2:05	150	162	173	180	172	203
2:10	151	166	178	180	178	214
2:15	153	169	178	187	189	214
2:20	158	174	188	196	203	229
2:25	163	181	198	208	217	234
2:30	168	188	209	215	227	242
2:35	172	194	217	224	237	252
2:40	176	201	226	233	245	262
2:45	181	207	234	242	254	278
2:50	186	214	242	252	266	289
2:55	192	221	251	263	277	296
3:00	197	230	260	273	291	307

240056 - TSI - 05/05/89

TEMP. READINGS (DEG. F.)

TEST TIME,	T/C NO.					
Hr:Min	103 (39)	104 (40)	105 (41)	106 (42)	107 (43)	108 (44)
0:00	67	67	67	67	67	67
0:05	67	67	67	67	67	67
0:10	67	67	67	67	67	67
0:15	68	68	68	68	68	68
0:20	71	69	70	70	70	69
0:25	76	72	74	75	74	74
0:30	81	77	80	81	79	79
0:35	86	84	85	86	84	85
0:40	92	90	89	90	89	89
0:45	98	96	94	94	94	92
0:50	103	101	97	97	96	95
0:55	111	110	106	104	100	101
1:00	117	115	110	109	106	106
1:05	122	118	113	112	110	109
1:10	127	123	118	115	115	114
1:15	132	128	122	120	119	117
1:20	137	133	126	124	123	121
1:25	143	137	131	128	127	124
1:30	149	142	135	131	131	127
1:35	155	147	138	135	135	131
1:40	161	152	143	138	139	135
1:45	168	157	147	142	144	138
1:50	174	162	152	146	149	142
1:55	181	166	157	152	155	146
2:00	188	170	163	159	163	151
2:05	195	175	170	166	173	157
2:10	202	181	176	174	180	161
2:15	210	186	183	181	187	165
2:20	218	193	190	190	195	172
2:25	226	200	198	199	202	181
2:30	235	207	205	207	209	189
2:35	243	214	212	215	217	196
2:40	251	223	220	224	225	204
2:45	261	230	228	232	234	211
2:50	269	233	235	241	242	218
2:55	278	245	244	249	250	226
3:00	290	254	252	258	258	233

240056 - TSI - 05/05/89

TEMP. READINGS (DEG. F.)

TEST TIME, Hr:Min	T/C NO.					
	109 (1)	110 (2)	111 (3)	112 (4)	1[illegible]3	1[illegible]4
0:00	67	67	67	67	[illegible]8	[illegible]8
0:05	67	67	67	67	[illegible]8	[illegible]9
0:10	67	67	67	67	[illegible]0	[illegible]0
0:15	68	68	68	69	[illegible]1	[illegible]2
0:20	71	71	70	72	[illegible]3	[illegible]5
0:25	74	75	74	76	[illegible]6	[illegible]8
0:30	79	79	78	81	[illegible]9	[illegible]2
0:35	85	84	83	87	[illegible]5	[illegible]9
0:40	89	90	88	92	[illegible]4	[illegible]9
0:45	94	96	94	98	1[illegible]4	1[illegible]1
0:50	98	101	99	104	1[illegible]3	1[illegible]0
0:55	105	106	106	111	1[illegible]5	1[illegible]7
1:00	113	111	112	118	1[illegible]8	1[illegible]8
1:05	118	117	118	123	1[illegible]5	1[illegible]8
1:10	123	122	123	127	1[illegible]6	1[illegible]8
1:15	127	127	129	132	1[illegible]0	1[illegible]9
1:20	131	132	134	137	1[illegible]1	1[illegible]7
1:25	135	137	141	141	1[illegible]6	1[illegible]2
1:30	138	141	146	147	1[illegible]9	1[illegible]8
1:35	142	146	153	152	1[illegible]2	1[illegible]5
1:40	146	151	159	157	1[illegible]5	1[illegible]1
1:45	150	156	165	162	1[illegible]7	1[illegible]6
1:50	155	161	172	168	1[illegible]8	1[illegible]2
1:55	160	166	179	173	1[illegible]9	1[illegible]7
2:00	165	171	190	177	1[illegible]1	2[illegible]2
2:05	169	177	198	181	1[illegible]3	2[illegible]7
2:10	177	181	207	186	1[illegible]4	2[illegible]0
2:15	188	185	219	193	1[illegible]7	2[illegible]5
2:20	201	189	234	199	1[illegible]9	2[illegible]0
2:25	213	193	246	206	1[illegible]1	2[illegible]5
2:30	223	199	252	213	1[illegible]3	2[illegible]0
2:35	231	206	261	221	1[illegible]5	2[illegible]4
2:40	242	213	267	229	1[illegible]7	2[illegible]9
2:45	252	221	276	238	1[illegible]8	2[illegible]4
2:50	254	229	285	245	1[illegible]9	2[illegible]9
2:55	258	237	293	257	1[illegible]1	2[illegible]6
3:00	263	244	300	263	1[illegible]4	2[illegible]2

APPENDIX D

TSI SUPPLIED EQUIPMENT

Certificate of Conformance

1. Job No. 65394-SJ Customer Industrial Measurement Co.

P.O. No. 3367-NC Item(s): One (1)

Part No., Code or Description PW0129, G/G-20-KK

Quantity: 1,060 Ft.: 3 Spools

THIS IS TO CERTIFY THAT THE MATERIALS AND/OR PARTS FURNISHED ON THE SUBJECT PURCHASE ORDER COMPLY WITH THE TERMS AND SPECIFICATIONS CONTAINED THEREIN.

BY: Ed Kohler - QC Supervisor
QUALITY CONTROL DEPT.

DATE: 3 / 13 / 89

TE-250-1

THERMO ELECTRIC Saddle Brook, New Jersey 07662

CTL SUPPLIED EQUIPMENT

CSO# 2613-11644 001 *Traceability Number*
ship to:
CONSTRUCTION TECHNOLOGY LABORATORIES

5420 OLD ORCHARD ROAD
SKOKIE IL 60077

customer reference:
E50434QA

product: serial#:
3455A 2 1622A0042

mainframe/system: serial#:

Certificate of Calibration

☐ *This certifies that the above item was calibrated by this facility and completed on the indicated date in accordance with applicable Hewlett-Packard procedures. At the time of calibration the item met its published operating specifications.*

☒ *This certifies that the above item was calibrated in compliance with "Military Standard Calibration Systems Requirements" (MIL-STD-45662) and applicable Hewlett-Packard procedures. At the time of calibration, the item met its published operating specifications.*

Hewlett-Packard calibration measurements are traceable to National Standards, to the extent allowed by the National Bureau of Standards' calibration facilities, or to the calibration facilities of other National Laboratories. When no National or International Standards exist, traceability will be to Hewlett-Packard Corporate Standards.

Temperature: 23.3 °C *Rel. Humidity:* 44 % *Calibration Date:* 01/02/89

Geza Roz
HEWLETT-PACKARD COMPANY

HP 3455A TEST REPORT

RO # : 261311644001
SER # : 1622A00460
DATE : 01 FEB 89

Segment No. 1. Test performed - PASSED !

INITIAL SEGMENT

1. SAFETY CHECK

POWER CORD RESISTANCES

HOT LINE TO CHASSIS

TEST VOLTAGE	EXPECTED (MOHM)	MEASURED (MOHM)
101.3	=> 2.00	96.70

GROUND LINE TO CHASSIS

EXPECTED (OHMS)	MEASURED (OHMS)
=< 1.000	0.010

2. UUT HP-IB ADDRESS CHECK

HP-IB ADDRESS
22

3. SPECIFICATIONS USED

6 month specifications are used in the following test segments.

Segment No. 2. Test performed - PASSED !

HP-IB & DISPLAY CHECKS

1. CHECK USING TEST' FUNCTION

EXPECTED	MEASURED
10	10

2. HP-IB CONTROL CHECK

FUNCTION	OPERATES	LAMP
REMOTE	YES	GOOD
TALK	YES	GOOD
LISTEN	YES	GOOD
SRQ	YES	GOOD
DATA READY (RQS)	YES	GOOD
BINARY PROGRAM	YES	GOOD

3. MAINFRAME CONTROL CHECK

CONTROL	CONTROL OPERATES	PUSHBUTTON LAMP	INDICATOR LAMP
DC VOLTS	YES	GOOD	GOOD
AC VOLTS	YES	GOOD	GOOD
FAST AC VOLTS	YES	GOOD	GOOD
2 WIRE KOHMS	YES	GOOD	GOOD
4 WIRE KOHMS	YES	GOOD	N/A
TEST	YES	GOOD	GOOD
SCALE	YES	GOOD	GOOD
% ERROR	YES	GOOD	N/A
MATH OFF	YES	GOOD	

CONTROL	CONTROL OPERATES	PUSHBUTTON LAMP
.1	YES	GOOD
1	YES	GOOD
10	YES	GOOD
100	YES	GOOD
1k	YES	GOOD
10k	YES	GOOD
AUTO	YES	GOOD
INTERNAL	YES	GOOD
EXTERNAL	YES	GOOD
HOLD/MANUAL	YES	GOOD
AUTO CAL	YES	GOOD
HIGH RESOLN	YES	GOOD
ENTER Y	YES	GOOD
ENTER Z	YES	GOOD

CONTROL	CONTROL OPERATES	INDICATOR LAMP
INPUT SELECT	YES	GOOD

Segment No. 3. Test performed - PASSED !

DCV ACCURACY CHECK

UUT RANGE	HIGH RESOLN	EXPECTED (V DC)	MEASURED (V DC)	DEVIATION (V)	TO
1k V	OFF	500.00	500.00	0.00	
1k V	ON	500.000	499.995	-0.005	
1k V	OFF	100.00	100.00	0.00	
1k V	ON	100.000	99.998	-0.002	
100 V	OFF	100.000	100.000	0.000	

100 V	ON	50.0000	49.9999	-0.0001	0.0053
100 V	OFF	10.000	10.000	0.000	0.002
100 V	ON	10.0000	9.9999	-0.0001	0.0013
10 V	OFF	10.0000	10.0000	0.0000	0.0009
10 V	ON	10.00000	10.00006	0.00006	0.00083
10 V	OFF	5.0000	5.0000	0.0000	0.0005
10 V	ON	5.00000	5.00003	0.00003	0.00043
10 V	OFF	1.0000	0.9999	-0.0001	0.0002
10 V	ON	1.00000	1.00000	0.00000	0.00011
1 V	OFF	1.00000	1.00000	0.00000	0.00010
1 V	ON	1.000000	1.000012	0.000012	0.000095
1 V	OFF	0.50000	0.50000	0.00000	0.00006
1 V	ON	0.500000	0.500004	0.000004	0.000050
1 V	OFF	0.10000	0.10000	0.00000	0.00002
1 V	ON	0.100000	0.099999	-0.000001	0.000014
0.1 V	OFF	0.100000	0.100001	0.000001	0.000051
1k V	OFF	-500.00	-499.99	0.01	0.06
1k V	ON	-500.000	-499.997	0.003	0.053
1k V	OFF	-100.00	-99.99	0.01	0.02
1k V	ON	-100.000	-99.999	0.001	0.013
100 V	OFF	-100.000	-99.999	0.001	0.011
100 V	ON	-100.0000	-99.9997	0.0003	0.0103
100 V	OFF	-50.000	-50.000	0.000	0.006
100 V	ON	-50.0000	-49.9999	0.0001	0.0053
100 V	OFF	-10.000	-9.999	0.001	0.002
100 V	ON	-10.0000	-10.0000	0.0000	0.0013
10 V	OFF	-10.0000	-10.0001	-0.0001	0.0009
10 V	ON	-10.00000	-10.00006	-0.00006	0.00083
10 V	OFF	-5.0000	-5.0000	0.0000	0.0005
10 V	ON	-5.00000	-5.00003	-0.00003	0.00043
10 V	OFF	-1.0000	-1.0000	0.0000	0.0002
10 V	ON	-1.00000	-0.99999	0.00001	0.00011
1 V	OFF	-1.00000	-1.00002	-0.00002	0.00010
1 V	ON	-1.000000	-1.000017	-0.000017	0.000095
1 V	OFF	-0.50000	-0.50001	-0.00001	0.00006
1 V	ON	-0.500000	-0.500010	-0.000010	0.000050
1 V	OFF	-0.10000	-0.10001	-0.00001	0.00002
1 V	ON	-0.100000	-0.100003	-0.000003	0.000014
0.1 V	OFF	-0.100000	-0.100004	-0.000004	0.000051

Segment No. 4. Test performed - PASSED !

ACV ACCURACY CHECK

TRUE RMS AC CONVERTER

1. ACV ACCURACY CHECK

UUT RANGE	INPUT FREQUENCY	EXPECTED (V AC)	MEASURED (V AC)	DEVIATION (V)	TOLERANCE (+/- V)
		ACV Function			
1 V	30 Hz	1.00000	1.00013	0.00013	0.00120
1 V	300 Hz	1.00000	1.00004	0.00004	0.00120
1 V	10 kHz	1.00000	1.00012	0.00012	0.00120
1 V	20 kHz	1.00000	1.00025	0.00025	0.00120

1 V	110 kHz	1.00000	1.00206	0.00206	0.02400
1 V	250 kHz	1.00000	0.99974	-0.00026	0.02400
1 V	500 kHz	1.00000	0.99819	-0.00181	0.05700
1 V	1 MHz	1.00000	1.02400	0.02400	0.09000
10 V	30 Hz	5.0000	5.0021	0.0021	0.0090
10 V	300 Hz	5.0000	5.0013	0.0013	0.0090
10 V	20 kHz	5.0000	5.0020	0.0020	0.0090
10 V	100 kHz	5.0000	5.0000	0.0000	0.0430
10 V	30 Hz	10.0000	10.0023	0.0023	0.0120
10 V	50 Hz	10.0000	10.0008	0.0008	0.0120
10 V	100 Hz	10.0000	10.0011	0.0011	0.0120
10 V	500 Hz	10.0000	10.0013	0.0013	0.0120
10 V	1 kHz	10.0000	10.0013	0.0013	0.0120
10 V	5 kHz	10.0000	10.0024	0.0024	0.0120
10 V	10 kHz	10.0000	10.0033	0.0033	0.0120
10 V	20 kHz	10.0000	10.0034	0.0034	0.0120
10 V	50 kHz	10.0000	10.0015	0.0015	0.0730
10 V	100 kHz	10.0000	9.9952	-0.0048	0.0730
10 V	110 kHz	9.0000	9.0224	0.0224	0.2190
10 V	250 kHz	9.0000	9.0300	0.0300	0.2190
10 V	500 kHz	9.0000	9.0774	0.0774	0.5190
10 V	1 MHz	9.0000	9.3726	0.3726	0.9170
100 V	30 Hz	100.000	100.026	0.026	0.120
100 V	300 Hz	100.000	100.021	0.021	0.120
100 V	10 kHz	100.000	100.027	0.027	0.120
100 V	20 kHz	100.000	100.038	0.038	0.120
100 V	100 kHz	100.000	100.023	0.023	0.730
1k V	30 Hz	1000.00	1000.25	0.25	3.00
1k V	300 Hz	1000.00	1000.31	0.31	3.00
1k V	10 kHz	1000.00	1000.60	0.60	3.00

FAST ACV Function

1 V	300 Hz	1.00000	1.00000	0.00000	0.00120
1 V	10 kHz	1.00000	1.00009	0.00009	0.00120
1 V	20 kHz	1.00000	1.00022	0.00022	0.00120
1 V	50 kHz	1.00000	1.00015	0.00015	0.00730
1 V	100 kHz	1.00000	0.99951	-0.00049	0.00730
1 V	110 kHz	1.00000	1.00203	0.00203	0.02400
1 V	250 kHz	1.00000	0.99971	-0.00029	0.02400
1 V	500 kHz	1.00000	0.99817	-0.00183	0.05700
1 V	1 MHz	1.00000	1.02400	0.02400	0.09800
10 V	500 Hz	10.0000	10.0006	0.0006	0.0120
10 V	1 kHz	10.0000	10.0009	0.0009	0.0120
10 V	5 kHz	10.0000	10.0019	0.0019	0.0120
10 V	10 kHz	10.0000	10.0033	0.0033	0.0120
10 V	20 kHz	10.0000	10.0030	0.0030	0.0120
10 V	50 kHz	10.0000	10.0012	0.0012	0.0730
10 V	100 kHz	10.0000	9.9951	-0.0049	0.0730
10 V	110 kHz	9.0000	9.0222	0.0222	0.2190
10 V	250 kHz	9.0000	9.0297	0.0297	0.2190
10 V	500 kHz	9.0000	9.0774	0.0774	0.5190
10 V	1 MHz	9.0000	9.3724	0.3724	0.9170
100 V	300 Hz	100.000	100.021	0.021	0.120
100 V	10 kHz	100.000	100.026	0.026	0.120
100 V	20 kHz	100.000	100.037	0.037	0.120
100 V	100 kHz	100.000	100.022	0.022	0.730
1k V	300 Hz	1000.00	1000.20	0.20	3.00
1k V	10 kHz	1000.00	1000.50	0.50	3.00

2. ZERO OFFSET CHECK

UUT RANGE	EXPECTED (V AC)	MEASURED (V AC)

[illegible]	=<	0.0120	0.0013
100 V	=<	0.120	0.014
1k V	=<	1.20	0.12

Segment No. 5. Test performed - PASSED !

OHMMETER ACCURACY CHECK

2/4 WIRE kOHM	HIGH RESOLN	EXPECTED (kOHM)	MEASURED (kOHM)	DEVIATION (kOHM)	TOLERANCE (+/-kOHM)
		0.1 kOHM Range			
2	OFF	0.100003	0.100004	0.000001	0.000411
4	OFF	0.100003	0.100002	-0.000001	0.000011
		1 kOHM Range			
2	OFF	1.00007	1.00010	0.00003	0.00046
2	ON	1.000073	1.000075	0.000002	0.000446
4	OFF	1.00007	1.00008	0.00001	0.00006
4	ON	1.000073	1.000076	0.000003	0.000046
		10 kOHM Range			
2	OFF	10.0008	10.0003	-0.0005	0.0013
2	ON	10.00077	10.00020	-0.00057	0.00111
4	OFF	10.0008	10.0003	-0.0005	0.0009
4	ON	10.00077	10.00026	-0.00051	0.00071
		100 kOHM Range			
2	OFF	100.001	100.001	0.000	0.007
2	ON	100.0008	100.0015	0.0007	0.0051
4	OFF	100.001	100.006	0.005	0.007
4	ON	100.0008	100.0002	-0.0006	0.0047
		1000 kOHM Range			
2	OFF	999.97	999.95	-0.02	0.19
2	ON	999.970	999.977	0.007	0.146
4	OFF	999.97	1000.01	0.04	0.19
4	ON	999.970	999.976	0.006	0.146
		10 MOHM Range			
2	OFF	10017.3	10015.8	-1.5	10.5
2	ON	10017.30	10016.46	-0.84	10.06
4	OFF	10017.3	10016.8	-0.5	10.5
4	ON	10017.30	10015.59	-1.71	10.06

STANDARDS USED:

Gordon Company
5710 Kenosha St. Box 500
Richmond Illinois 60071

CERTIFICATE OF CALIBRATION April 22, 1987

For: Construction Technology P.O.: E500310A

Gordon Order #: C483090 Cat. #: 1409-54
Items Calibrated: T/Cs ANSI Type: K

NBS Cert. T/C: KP 2356638, KN 2306218 Lot #: 6528P/9068P
Standards Inst: Fluke 8840A DMM Insp By: arh

Item no.	Nominal Cal. Temp.	Actual Cal. Temp.	Std mVolt Reading	Item mVolt Reading	Fahrenheit Departure
1	800	803.61	17.635	17.614	0.25
	1200	1202.51	27.084	27.122	3.73
	1500	1506.17	34.090	34.101	2.10
	1700	1701.45	38.437	38.500	3.70
	1900	1900.89	42.744	42.778	1.27

K. L. Krumpen
Quality Technician

Calibrated in accordance with ASTM E-220, E-230, and IPTS 68.

construction technology laboratories, inc.

5420 Old Orchard Road Skokie Illinois 60077-1030 • Phone 312/965-7500
Telex 9102401569 CTL SKO • Easylink 62200170 • Facsimile 312/965-6541

Issue Date: 8/1/88

THIS IS TO CERTIFY THAT

__Gene R. Hall__

HAS BEEN EVALUATED AND IS CONSIDERED QUALIFIED TO

PERFORM THE SPECIFIED ASSIGNED TASKS OF

Level II Instrumentation Specialist
DAS Operation
Thermocouple Installation

Level II Fire Test Specialist
Furnace Operation
ASTM E119 ASTM E 814
I EEE 634 U1 1479
ANI Fire Test Method
Coast Guard Department of Transportation
Sub Part 92.07
Structural Fire Protection

Level I Construction Technician
Concrete Placing
Steel Placing
Nondestructive Field Testing (Pachometer)

IN COMPLIANCE WITH

CTL Quality Assurance Procedure 2a

and ANSI N45.2.6

CERTIFICATION FROM ____8/1/88________ TO _____8/1/90_______________

CTL LEVEL III ____[signature]____________________________

QA COORDINATOR ____W. Dyedzic____ 8/3/88 ________________

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

DEC - 1 1989

In Reply Refer To:
Dockets: 50-445/89-71
50-446/89-71

Mr. W. J. Cahill, Jr.
Executive Vice President
TU Electric
400 North Olive Street, Lock Box 81
Dallas, Texas 75201

Dear Mr. Cahill:

This refers to the inspection conducted by Mr. R. M. Latta and NRC consultants during the period October 4 through November 7, 1989, of activities authorized by NRC Construction Permits CPPR-126 and CPPR-127 for the Comanche Peak Steam Electric Station, Units 1 and 2, and to the discussion of our findings with you and members of your staff at the conclusion of the inspection.

The enclosed copy of our inspection report identifies areas examined during the inspection. Within these areas, the inspection consisted of selective examination of procedures and representative records, interviews with personnel, and observations by the inspectors.

During this inspection, it was found that certain of your activities were in violation of NRC requirements, as specified in the enclosed Notice of Violation. A written response to these violations is required.

In accordance with 10 CFR 2.790 of the Commission's regulations, a copy of this letter, the enclosures, and your response to this letter will be placed in the NRC Public Document Room.

The responses directed by this letter and the accompanying Notice are not subject to the clearance procedures of the Office of Management and Budget as required by the Paperwork Reduction Act of 1980, PL 96-511.

8912080030

2/87

Should you have any questions concerning this inspection, we will be pleased to discuss them with you.

Sincerely,

RFWarnick

R. F. Warnick, Assistant Director
for Inspection Programs
Comanche Peak Project Division
Office of Nuclear Reactor Regulation

Enclosures:
Appendix A - Notice of Violation
Appendix B - Inspection Report 50-445/89-71; 50-446/89-71

cc w/enclosures:
See next page

cc w/enclosure:
Roger D. Walker
Manager, Nuclear Licensing
TU Electric
Skyway Tower
400 North Olive Street, L.B. 81
Dallas, TX 75201

Juanita Ellis
President - CASE
1426 South Polk Street
Dallas, TX 75224

Texas Radiation Control
Program Director
Texas Department of Health
1100 West 49th Street
Austin, Texas 78756

GDS Associates, Inc.
1850 Parkway Place, Suite 720
Marietta, GA 30067-8237

Honorable George Crump
County Judge
Glen Rose, Texas 76043

Ms. Billie Pirner Garde, Esq.
Robinson, Robinson, et al.
103 East College Avenue
Appleton, WI 54911

Regional Administrator, Region IV
U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 1000
Arlington, Texas 76011

William A. Burchette, Esq.
Counsel for Tex-La Electric
Cooperative of Texas
Heron, Burchette, Ruckert & Rothwell
1025 Thomas Jefferson St., NW
Washington, DC 20007

TU Electric
c/o Bethesda Licensing
3 Metro Center, Suite 610
Bethesda, Maryland 20814

E. F. Ottney
P. O. Box 1777
Glen Rose, Texas 76043

Jack R. Newman
Newman & Holtzinger
1615 L Street, NW
Suite 1000
Washington, DC 20036

George R. Bynog
Program Mgr./Chief Inspector
Texas Dept. of Labor & Standards
Boiler Division
P.O. Box 12157, Capitol Station
Austin, Texas 78711

APPENDIX A

NOTICE OF VIOLATION

TU Electric | Docket: 50-445/89-71

Comanche Peak Steam Electric Station | Permit: CPPR-126
Unit 1, Glen Rose, Texas

During an NRC inspection conducted on October 4 through November 7, 1989, violations of NRC requirements were identified. In accordance with the "General Statement of Policy and Procedure for NRC Enforcement Actions," 10 CFR Part 2, Appendix C (1989), the violations are listed below:

A. Criterion V of Appendix B to 10 CFR Part 50 as implemented by Section 5.0 of the TU Electric Quality Assurance Manual requires that activities affecting quality shall be prescribed by and accomplished in accordance with documented instructions, procedures, or drawings.

Paragraph 9.3.1 of TU Electric's Specification 2323-MS-38H, Revision 2, requires that "Thermo-lag 330-1 (site prefabricated sections) dry film thickness shall be 1/2 inch to 3/4 inch."

Contrary to the above, the required dimensional inspections to insure a minimum dry film thickness of 1/2-inch minimum to 3/4-inch maximum were inadequately performed in that deficient site-fabricated thermolag was inspected, accepted, and issued to construction by the applicant's Quality Control (QC) organization.

This is a Severity Level IV violation (Supplement II) (445/8971-V-01).

B. Criterion XVI of Appendix B to 10 CFR Part 50 as implemented by Section 16 of the TU Electric Quality Assurance Manual requires that in the case of significant conditions adverse to quality, the identification and corrective measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition.

Contrary to the above, the applicant's response to the reportable deficiency documented as SDAR CP-89-025, involving defective site-fabricated thermolag, was determined to be inadequate. Specifically, the generic implications associated with a QC program which failed to detect a significant deficiency were not adequately addressed and the response did not provide adequate assurance that the cause of this condition was properly determined and corrected. The response did not address the broadness issue: in what other areas or disciplines had QC issued potential defective material?

This is a Severity Level IV violation (Supplement II) (445/8971-V-02).

Pursuant to the provisions of 10 CFR 2.201, TU Electric is hereby required to submit a written statement or explanation to the U. S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC, 20555, with a copy to the Assistant Director for Inspection Programs, Comanche Peak Project Division, Office of Nuclear Reactor Regulation, within 30 days of the date of the letter transmitting this Notice. This reply should be clearly marked as a "Reply to a Notice of Violation" and should include for each violation: (1) the reason for the violation, if admitted, (2) the corrective steps that have been taken and the results achieved, (3) the corrective steps that will be taken to avoid further violations, and (4) the date when full compliance will be achieved. If an adequate reply is not received within the time specified in this Notice, an order may be issued to show cause why the license should not be modified, suspended, or revoked or why such other action as may be proper should not be taken. Where good cause is shown, consideration will be given to extending the response time.

FOR THE NUCLEAR REGULATORY COMMISSION

RFWarnick

Dated at Comanche Peak Site
this 1st day of December 1989

DEC - 1 1989

In Reply Refer To:
Dockets: 50-445/89-71
50-446/89-71

Mr. W. J. Cahill, Jr.
Executive Vice President
TU Electric
400 North Olive Street, Lock Box 81
Dallas, Texas 75201

Dear Mr. Cahill:

This refers to the inspection conducted by Mr. R. M. Latta and NRC consultants during the period October 4 through November 7, 1989, of activities authorized by NRC Construction Permits CPPR-126 and CPPR-127 for the Comanche Peak Steam Electric Station, Units 1 and 2, and to the discussion of our findings with you and members of your staff at the conclusion of the inspection.

The enclosed copy of our inspection report identifies areas examined during the inspection. Within these areas, the inspection consisted of selective examination of procedures and representative records, interviews with personnel, and observations by the inspectors.

During this inspection, it was found that certain of your activities were in violation of NRC requirements, as specified in the enclosed Notice of Violation. A written response to these violations is required.

In accordance with 10 CFR 2.790 of the Commission's regulations, a copy of this letter, the enclosures, and your response to this letter will be placed in the NRC Public Document Room.

The responses directed by this letter and the accompanying Notice are not subject to the clearance procedures of the Office of Management and Budget as required by the Paperwork Reduction Act of 1980, PL 96-511.

CPPD:NRR	CPPD:NRR	RFW AD:CPPD:NRR
RLatta:ww	HLivermore	RWarnick
12/ 1 /89	12/ 1 /89	12/ 1 /89

8912050030

IE01
1/1

Should you have any questions concerning this inspection, we will be pleased to discuss them with you.

Sincerely,

ORIGINAL SIGNED BY R. F. WARNICK

R. F. Warnick, Assistant Director
for Inspection Programs
Comanche Peak Project Division
Office of Nuclear Reactor Regulation

Enclosures:
Appendix A - Notice of Violation
Appendix B - Inspection Report 50-445/89-71; 50-446/89-71

cc w/enclosures:
See next page

APPENDIX B

U. S. NUCLEAR REGULATORY COMMISSION

OFFICE OF NUCLEAR REACTOR REGULATION

NRC Inspection Report: 50-445/89-71 50-446/89-71

Permits: CPPR-126 CPPR-127

Dockets: 50-445 50-446

Construction Permit Expiration Dates:
Unit 1: August 1, 1991
Unit 2: August 1, 1992

Applicant: TU Electric
Skyway Tower
400 North Olive Street
Lock Box 81
Dallas, Texas 75201

Facility Name: Comanche Peak Steam Electric Station (CPSES), Units 1 & 2

Inspection At: Comanche Peak Site, Glen Rose, Texas

Inspection Conducted: October 4 through November 7, 1989

Inspector: R. M. Latta — 1 Dec 89
R. M. Latta, Resident Inspector (Electrical) (paragraphs 2, 3, 4, 5, 6, 7 and 8) — Date

Consultants: W. D. Richins, Parameter (paragraph 6)
J. L. Taylor, Parameter (paragraphs 2, 3, 4, 5, and 7)

Reviewed by: H. H. Livermore — 12-1-9
H. H. Livermore, Lead Senior Inspector — Date

489

Inspection Summary:

Inspection Conducted: October 4 through November 7 1989 (Report 50-445/89-71; 50-446/89-71)

Areas Inspected: Unannounced, resident safety inspection of the applicant's actions on follow-up to violations/deviations, 10 CFR 50.55(e) deficiencies identified by the applicant, allegation follow up, electrical components and systems, safety-related mechanical components, and general plant area tours.

Results: Within the areas inspected, a weakness was identified in the applicant's procurement program in that it failed to provide adequate receipt inspection criteria for vendor procured thermolag material (paragraph 3.i). Additionally, during this inspection period, two violations were identified which involved the applicant's response to SDAR CP-89-25, "Site Fabricated Thermo-lag Material." The first violation concerned the applicant's failure to follow procedures during the dry film thickness measurements of site fabricated thermolag in that defective material was inspected and accepted by the applicant's QC organization (paragraph 3.i). The second violation involved the applicant's failure to properly identify the required corrective measures associated with defective site fabricated thermolag in that the identification of the cause of the condition adverse to quality, the generic implications, and the establishment of measures to preclude repetition were not adequately addressed in the response provided in TU Electric's letter TXX-89737 (paragraph 3.i).

DETAILS

1. Persons Contacted

*M. Axelrad, Newman and Holtzinger
*J. L. Barker, Manager, ISEG, TU Electric
*D. P. Barry, Senior, Manager, Engineering, Stone and Webster Engineering Corporation (SWEC)
*J. W. Beck, Vice President, Nuclear Engineering, TU Electric
*J. E. Bentham, President, The Bentham Group, Inc.
*O. Bhatty, Issue Interface Coordinator, TU Electric
*M. R. Blevins, Manager of Nuclear Operations Support, TU Electric
*H. D. Bruner, Senior Vice President, TU Electric
*A. R. Buhl, IAG
*W. J. Cahill, Executive Vice President, Nuclear, TU Electric
*H. M. Carmichael, Senior Quality Assurance (QA(Program Manager, CECO
*W. G. Counsil, Vice Chairman, Nuclear, TU Electric
*C. G. Creamer, Manager, Unit 1 Completions Engineering, TU Electric
*B. S. Dacko, Licensing Engineer, TU Electric
*R. J. Daly, Manager, Startup, TU Electric
*G. G. Davis, Nuclear Operations Inspection Report Item Coordinator, TU Electric
*D. E. Deviney, Deputy Director, QA, TU Electric
*N. M. Eifert, Chief Engineer EA, SWEC
*J. C. Finneran, Jr., Manager, Civil Engineering, TU Electric
*C. A. Fonseca, Deputy Director, CECO
*S. P. Frantz, Newman and Holtzinger
*J. L. French, Independent Advisory Group
*B. P. Garde, Attorney, CASE
*J. Greene, Site Licensing, TU Electric
*W. G. Guldemond, Manager of Site Licensing, TU Electric
*T. L. Heatherly, Licensing Compliance Engineer, TU Electric
*J. C. Hicks, Licensing Compliance Manager, TU Electric
*C. B. Hogg, Chief Manager, TU Electric
*R. T. Jenkins, Manager, Unit 1 Operations Support Engineering, TU Electric
*J. J. Kelley, Plant Manager, TU Electric
*O. W. Lowe, Director of Engineering, TU Electric
*F. W. Madden, Mechanical Engineering Manager, TU Electric
*S. G. McBee, NRC Interface, TU Electric
*J. W. Muffett, Manager of Project Engineering, TU Electric
*S. S. Palmer, Project Manager, TU Electric
*W. O. Porter, Operations Support Engineering, TU Electric
*P. Raysircar, Deputy Director/Senior Engineer Manager, CECO
*A. B. Scott, Vice President, Nuclear Operations, TU Electric
*J. C. Smith, Plant Operations Staff, TU Electric
*R. L. Spence, TU/QA Senior Advisor, TU Electric

*J. F. Streeter, Director, QA, TU Electric
*C. L. Terry, Manager of Projects, TU Electric
*R. D. Walker, Manager of Nuclear Licensing, TU Electric
*J. E. Woods, Assistant Project Engineer, SWEC/CECO

The NRC inspectors also interviewed other applicant employees during this inspection period.

*Denotes personnel present at the November 7, 1989, exit meeting.

2. Follow-up on Violations/Deviations (92702)

a. (Closed) Violation (EA86-09, Appendix A.I.B.1): Failure to satisfy the minimum separation requirements of IEEE Standards. This violation involved the applicant's failure to properly translate IEEE standard requirements to instructions and drawings, as well as several examples of electrical separation deficiencies which were not in accordance with the controlling drawings.

The applicant performed Issue-Specific Action Plan (ISAP) I.b.1, among others, to address this issue. Subsequent NRC staff evaluations of the ISAPs were reported as satisfactory in SSER 20, Appendix A. Additionally, as reported in previous NRC Inspection Reports, the Post-Construction Hardware Validation Program (PCHVP) which included Field Verification Method (FVM)-088 was reviewed and determined to be acceptable. The NRC inspectors also followed the implementation aspects of the separation portion of FVM-088 as previously documented in NRC Inspection Reports 50-445/89-15, 50-446/89-15; 50-445/89-22, 50-446/89-22; and 50-445/89-49, 50-446/89-49 and determined that it was acceptable.

The NRC inspector subsequently examined a sample of 4 out of approximately 70 equipment panels and determined that: proper inspections had been performed; nonconformance reports (NCRs) had been initiated where required; and that these NCRs had been properly closed. The panels selected for review were CP1-EPSWEA-02-02, CP1-ECDPPC-03, CP1-ECPRCB-06, and CP1-ECPRLV-17. Based on the above reviews and inspection activities, the NRC inspector concluded that the applicant had taken adequate corrective action to prevent reoccurrence. Therefore, this violation is closed.

b. (Closed) Violation (445/8964-V-01): Bypassing hold point. This violation occurred when a Quality Control (QC) hold point was bypassed and a section of electrical cable tray was welded prior to a QC inspection of the lifted cables.

In response to this violation, the applicant issued NCR 89-9245, Revision 0, to document the missed hold point and to verify that no cable damage resulted from the welding. Also, the personnel involved were counseled, a memorandum to all craft personnel was issued by the electrical craft manager, and additional craft training was conducted. Based on the above actions, this violation is closed.

c. (Closed) Deviation (445/8964-D-02): Missed commitment date for Class 1E meter replacement. This deviation occurred when the Class 1E Unit 1 diesel generator watt meters were replaced subsequent to Hot Functional Testing (HFT) rather than prior to HFT as committed to in TU Electric's letter TXX-88294 dated March 25, 1988.

The applicant's response to this deviation stated that this occurrence was the result of an error in the manual transcription of data to a new commitment tracking system (CTS) database. The applicant's corrective actions included enhancing the procedures regarding the use of the CTS and review of the CTS database.

Based on the above corrective actions delineated in TU Electric's letter TXX-89743 dated October 26, 1989, the NRC inspector determined that adequate measures had been implemented to correct the process which allowed this deviation. Therefore, this item is closed.

3. Action on 10 CFR Part 50.55(e) Deficiencies Identified by the Applicant (92700)

a. (Closed - Unit 1 only) Construction Deficiency (SDAR CP-86-03): "Sealing of Class 1E Devices." This deficiency initially addressed an apparent failure to install Class 1E limit switches in accordance with the manufacturer's requirements concerning both the application of qualified conduit thread sealant and the torquing of conduit threads. Subsequently, the scope of this construction deficiency was expanded to include a potential design deficiency involving the failure to include the required electrical conduit seal assemblies (ECSAs) in the applicable Specification 2323-ES-100. ECSAs are necessary to preserve the environmental qualification of the equipment when located in a harsh environment.

In response to this issue, the applicant reviewed Installation Procedure EEI-21 as well as 20 construction travellers and concluded that the initial aspect of the deficiency was not substantiated in that both the thread sealant and the torque requirements were addressed during the installation of limit switches. Corrective Action Request (CAR)-048 was initiated to address the second aspect of this deficiency and it included the following corrective actions: clarification between the specific project engineering requirements and the generically applied manufacturer's instructions, revision of Specification 2323-ES-28 to include all 1E devices requiring qualification, and the revision of Electrical Specification 2323-ES-100 to identify devices by type when ECSAs are required and to list their inspection requirements. Additionally, the NRC inspector determined that certain aspects of this deficiency were addressed by the Corrective Action Program (CAP).

Based on a review of the actions implemented by CAR-048, the revision of Electrical Specification 2323-ES-100 and the evaluation of the associated design change authorizations (DCAs) and NCRs, the NRC inspector determined that the applicant's actions regarding Unit 1 activities were acceptable. Therefore, this SDAR is closed.

b. (Closed - Unit 1 only) Construction Deficiency (SDAR CP-86-40): "Application of Non-Qualified Agastat Relays." The applicant verbally reported this deficiency on May 20, 1986. It involved the procurement and use of nonqualified Agastat relays in Class 1E applications.

The reportability analysis and the associated corrective actions were reported by TU Electric letter TXX-6017 dated October 10, 1986. As stated in this correspondence, the corrective actions included: revising the vendor designed equipment drawings to require the use of prequalified components, the revision of the applicable procurement procedures, the updating of the nuclear operations defective items list (NODIL), and the replacement of the nonqualified relays.

The NRC inspector reviewed the NODIL, Revision 7; Procurement Procedure WHS-002, Revision 11, as well as various DCAs which replaced the existing relays with "E" prefix types; and NCR PE-87-606, Revision 0, which implemented the subject DCAs. The NRC inspector also randomly inspected 4 out of approximately 14 affected cabinets and determined that the relays involved were the correct "E" prefix types.

Based on the above reviews and inspections, the NRC inspector determined that the applicant's actions for Unit 1 were acceptable; however, pending the implementation of corrective actions for Unit 2, this SDAR is closed for Unit 1 only.

c. (Closed, Unit 1 only) Construction Deficiency (SDAR CP-86-68): "Weather Protection for Class 1E Components:" Specifically, this deficiency involved rust and water observed inside the exposed Class 1E terminal boxes.

The applicant's corrective actions as delineated in TU Electric's letter TXX-88607 dated August 11, 1988, included the clarification of Electrical Specification 2323-ES-100 pertaining to outdoor conduits/junction boxes sealing requirements, the performance of walkdowns in accordance with FVM-089, and the issuance of 6 NCRs. The implementation aspects of FVM-089 have been previously inspected and accepted as documented in NRC Inspection Reports 50-445/88-38, 50-446/88-32; 50-445/88-53, 50-446/88-49; 50-445/89-36, 50-446/89-36; 50-445/89-15, 50-446/89-15, and 50-445/89-28, 50-446/89-28. The NRC inspector also reviewed the pertinent changes to Specification 2323-ES-100 and the 6 NCRs associated with this issue.

Based on the above documentation reviews and inspections of selected Class 1E terminal boxes, the NRC inspector determined that the applicant's corrective actions appeared to have been adequately implemented for Unit 1. However, in that no work has been performed on Unit 2, this SDAR is closed for Unit 1 only.

d. (Closed - Unit 1 only) Construction Deficiency (SDAR CP-88-09): "Electrical Penetration Overload Protection." As reported by the applicant, this significant deficiency involved the potential overloading and lack of backup protection devices for electrical penetrations. This deficiency involved the following three subjects: backup protection incomplete or nonexistent, protection devices uncoordinated with penetration conductor ratings, and momentary short-circuit currents of module conductors exceeding the penetration ratings.

The NRC inspector determined that the applicant's corrective action included the incorporation of the penetration protection design criteria in the Design Basis Document (DBD)-EE-062. Additionally, compliance with the applicable design criteria has been addressed by the implementation of hardware changes involving the rerouting of cables, the paralleling of penetration conductors, the resetting of protective relays, and the replacement or addition of relays. The NRC inspector reviewed DBD-EE-062 and the portions of calculation 16345-EE(B)-048 which were related to this issue. The NRC inspector also reviewed a sample of the approximately 32 DCA packages including DCAs 71741, 75070, 78248, and 85145 which implemented corrective actions. No discrepancies were identified during this review process.

The NRC inspector also conducted inspections of the work associated with DCAs 71741 and 85145 and determined that the specified hardware changes appeared complete.

Based on the above reviews and inspection activities, the NRC inspector determined that the programs and procedures in effect appear to adequately control the corrective actions pertaining to the identified penetration overload protection issues for Unit 1. This SDAR is considered closed for Unit 1 only.

e. (Closed) Construction Deficiency (SDAR CP-88-35): "M&TE Program." Specifically, this SDAR involved deficiencies in the applicant's calibration procedures and inadequate/inaccurate calibration standards which could have rendered the accuracy of measuring and test equipment (M&TE) indeterminate.

In response to these issues, CAR 88-029 and several NCRs were initiated to address the deficiencies which originated in the Brown & Root (B&R) calibration facility on site. Among other actions, the CAR discontinued B&R calibration facility activities, checked/recalibrated standards and transferred them to the applicant's calibration facility, and evaluated the effects of calibration standard inaccuracies on plant hardware acceptance tests.

In order to evaluate the applicant's actions regarding this issue, the NRC inspector reviewed the results of CAR 88-29 and Procedure STA-608, "Control of M&TE," as well as several specific M&TE calibration procedures and the completed dispositions of 4 out of approximately 50 NCRs. Additionally, the NRC inspector interviewed selected facility personnel and observed various activities at the current calibration facility, including the conduct of specific M&TE calibrations.

As a result of the above reviews and inspection related activities, the NRC inspector concluded that the applicant's determination of nonreportability was acceptable in that no hardware changes or invalidated tests resulted from the completed NCRs. The NRC inspector determined that, although some minor issues involving nonproceduralized administrative handling of M&TE records existed, they did not adversely impact the results of the M&TE calibration program.

Based on the above reviews and inspection efforts, the NRC inspector determined that the applicant's actions in response to this deficiency were adequate. Therefore, this SDAR is closed.

f. (Closed - Unit 1 only) Construction Deficiency (SDAR CP-88-41): "W-2 Type Cell Switches." Subsequent to the issuance of NRC Information Notice 87-61 and its associated supplement dated May 3, 1988, the applicant notified the NRC of a deficiency involving Westinghouse circuit breaker W-2 type cell switches on December 2, 1988.

The applicant's response to this reportable deficiency included the replacement of four deficient switches which were found during the performance of inspections directed by NCR 88-15325, the initiation of DCA 85927 to replace W-2 switches, and implementation of Maintenance Procedure MSE-PO-6002 which directed the inspection of cell switches at half the Westinghouse recommended interval.

Based on review of the above documentation and programmatic evaluations, the NRC inspector determined that the applicant's actions in response to this issue were acceptable. Therefore, this SDAR is closed.

g. (Closed) Construction Deficiency (SDAR CP-89-03): "Gamma-Metrics Neutron Flux Monitoring." This reportable deficiency involved Gamma-Metrics supplied cable assemblies which are used for post-accident neutron flux monitoring. In particular, Gamma-Metrics issued a 10 CFR Part 21 notification that identified potential leaks at the threads/solder connections of the neutron flux monitor cable assemblies. As stated in TU Electric's final response to this issue contained in their letter TXX-89643 dated September 1, 1989, the applicant had received four of the subject cable assemblies from Gamma-Matrices.

The NRC inspector reviewed the documentation associated with this deficiency including the identifying correspondence from Gamma-Metrics to TU Electric dated February 22 and May 10, 1988, and to the Office of Inspection and Enforcement dated February 19, 1988. The NRC inspector also reviewed NCR 88-19400, Revision 0, which documented the potential deficiency involving the soldered joints on the neutron flux monitors and which directed the return of these devices to the vendor for repair in accordance with CPSES purchase order 665-70037. The subject cable assemblies were subsequently returned to the site and were installed by the vendor for Unit 1. The Unit 2 cable assemblies were similarly repaired and placed in storage in the applicant's warehouse. Concurrently, five of the detector assemblies (one spare) were returned to Gamma-Metrics for inspection, testing, and rework. The corrective actions associated with the Unit 1 assemblies have been implemented as committed to by TU Electric in their response to this issue, and the Unit 2 detector assemblies will be corrected prior to Unit 2 fuel load.

Based on the above documentation reviews, the NRC inspector determined that the applicant's corrective actions regarding this reportable occurrence were acceptable. This SDAR is closed for Units 1 and 2.

h. (Closed - Unit 1 only) Construction Deficiency (SDAR CP-89-21): "Limitorque MOV Spring Packs." The applicant reported a deficiency involving configuration of limitorque actuator spring packs which was subsequently determined to be reportable. In particular, the model No. 60-600-0022-1 spring packs which were being replaced had only 11 of the 12 Belleville washers required for proper operating characteristics and the replacement model No. 0301-113 spring packs had apparently been supplied with improper Belleville washer configurations and missing locknut setscrews. Based on communications with Limitorque, the applicant was able to obtain sufficient information to correctly configure the new spring packs. Further investigation by the NRC inspector revealed that the applicant had questioned Limitorque regarding the possible Part 21 action regarding the misconfigured spring packs originally provided. Limitorque informed the applicant that the "-0022" spring packs had been changed to model "-0044," and that there was no safety significance associated with this modification in that the torque characteristic of the "-0044" pack was essentially the same as the "-0022" pack consequently, no Part 21 action was contemplated.

As specified in the applicant's closeout documentation, the corrective actions included the inspection of all safety-related MOVs utilizing the "-0022" pack, the inspection of at least one of each type of spring pack in all other safety-related MOVs, and the incorporation of baseline spring pack configuration data verified by Limitorque, into the appropriate maintenance procedures. In addition, torque switch setting and operational testing of safety-related MOVs are continuing in response to NRC IE Bulletin 85-03.

The NRC inspector reviewed NCRs 89-7483, 6320, 6321, and 2361 involving MOV spring packs. Additionally, the NRC inspector witnessed the complete configuration testing of the spring pack for 1HV-4286 on work order C89-12527.

This testing included parts measurement, configuration documentation, and load profiling. During this process, it was observed that QC was present for the required portions of the test and no discrepancies were identified.

Based on these reviews and inspection activities, the NRC inspector determined that the applicant's response to the deficiency was adequate. In addition, the NRC inspector will continue to follow-up MOV testing and the results of these activities will be documented in a future NRC inspection report as part of NRC IE Bulletin 85-03 closure. Therefore, this SDAR is closed for Unit 1 only.

i. (Open) Construction Deficiency (SDAR CP-89-25): "Site Fabricated Thermo-Lag Panels." This issue concerned site-fabricated thermolag panels which were inspected and accepted by the applicant's QC organization. The panels were inspected for a 1/2-inch minimum dry film thickness (DFT) and were subsequently determined to be less than the specified dimension. As stated in the applicant's response to this reportable condition in TU Electric's letter TXX-89737 dated October 12, 1989, this material deficiency impacted approximately 2,000 square feet of thermolag that was installed on cable trays and conduits in Unit 1 and approximately 11,000 square feet of material that was in the applicant's warehouse. Also, during the removal of site-fabricated panels from Unit 1, it was determined that some installed configurations were in disagreement with the Installation Specification 2323-MS-38H, Revision 2, "Cable Raceway Fire Barrier Materials." Specifically, certain thermolag panels were identified as having less than the required 1/2-inch thickness in the areas of seams, joints, edges, and bolted joints. Additionally, some of the removed panels had been modified to accommodate extended configuration geometries without proper compensation for the reduced material thickness. This issue affected an additional estimated 12,000 square feet of installed thermolag. As stated in the applicant's final response to this deficiency, had this condition remained uncorrected, the potential existed that a fire could have breached the barrier and adversely affected the ability to safely shut down the plant.

In order to evaluate this issue, the NRC inspector reviewed the associated documentation including NCRs 89-8519, 89-9313, and 89-09314; Construction Hold Notice Form 572; Procedure ECC 10.07, "Application of Fire Protection Materials"; Procedure NQA 3.09-1.07, "Inspection of Fire Protection Cable Raceway and Structural Steel"; CAR 89-009; Specification 2323-MS-38H, "Cable Raceway Fire Barrier Materials"; and the subject material.

These reviews indicated that the applicant's initial corrective actions as prescribed by the above mentioned NCRs included the scrapping of the defective (site-fabricated thermolag) panels in the warehouse. Also, the questionable configurations installed on cable trays and conduits in the plant were removed and were replaced with thermolag purchased from an approved vendor (Thermal Science, Inc.). Additionally, the NRC inspector conducted evaluations of work in progress in both the Safeguards and the Auxiliary buildings during the removal of defective thermolag and the subsequent replacement process where vendor supplied material was utilized. These efforts were generally conducted in accordance with the installation specification with the exception of the deficient conditions documented on NCR 89-11142, Revision 1. This NCR identified discrepancies associated with the vendor supplied (prefabricated sheets) of thermolag which were determined to have variations in thickness ranging from 3/8 inch to 1 1/4 inch.

The NRC inspector reviewed the applicant's technical disposition of NCR 89-11142, Revision 1, and determined that although the basis for accepting the reported condition appeared adequate in that this condition was determined by the supplier to not be detrimental to the fire resistant response of the panel, this anomaly could have been avoided had the applicant not deleted its site QC inspection requirements for the thickness attribute from Verification Plan 89-2092. Based on discussions with members of the applicant's QA and QC staff, it was determined that these inspection criteria were deleted from the receipt inspection verification plans by Procurement Engineering (Change Order 6C33604). This action was reportedly the result of the supplier's status (with no restrictions) on TU Electric's approved vendor list.

This decision by the applicant's Procurement Engineering organization was apparently made in the absence of historical information relative to thermolag discrepancies. The applicant's failure to provide adequate receipt inspection criteria for the vendor procured thermolag material, which could have detected this deficient condition and averted the potential for significant rework, is identified as a weakness within the procurement program.

The NRC inspector also examined the process whereby site-fabricated thermolag which did not comply with the required dry film thickness (DFT) had been inspected and accepted by the applicant's QC staff. This examination revealed that the material in question had been inspected under the auspices of Procedure QI-QP-11.20-1 which was in effect from October 1982 through December 1986. Although this procedure underwent several revisions during this time frame, the requirement to verify a DFT of 1/2-inch minimum was continuously mandated during the preapplication inspection process. Additionally, the controlling Specification 2323-MS-38H, Revision 2, "Cable Raceway Fire Barrier Materials," stated, in part, that Thermolag 330-1 (site prefabricated sections) shall have a dry film thickness of 1/2 inch to 3/4 inch.

As delineated in NCR 89-8519, the deficiency in the DFT involving the site-fabricated thermolag was identified on July 28, 1989. This NCR indicated that several panels were examined by engineering personnel and all boards selected were determined to exhibit a DFT measurement of less than the required 1/2-inch minimum. As described by representatives of the applicant's QC organization during a meeting with members of the NRC Resident Inspector's staff on October 26, 1989, the reported condition was potentially attributable to fabrication techniques utilized by the applicant during the manufacturing of thermolag panels on site which did not provide for a proper cure time prior to DFT measurements. Thus, subsequent to DFT measurements, the site-fabricated panels "settled" producing the nonconforming condition. As described by the applicant during the referenced meeting, the recommended cure time for these panels was approximately 20 days; however, this consideration was not factored into the inspection verification plan and no mechanism existed to detect this defect following the fabrication DFT inspections.

Based on the NRC inspector's review of the associated documentation, system inspections, and the results of several meetings with representatives of the applicant's QA/QC and licensing organizations, it was determined that the dimensional inspections required by the applicant's Materials Specification 2323-MS-38H, Revision 2, and by Inspection Procedure QI-QP-11.20-1 to insure a minimum DFT of 1/2-inch minimum to 3/4-inch maximum were inadequate and were not properly performed to insure that the specified inspection criteria were maintained.

This example of failure to follow procedures during QC inspections performed on deficient site-fabricated thermolag material is identified as a violation (445/8971-V-01).

Additionally, during the assessment of SDAR CP-89-25, the NRC inspector identified several questionable issues concerning the applicant's response to this event. In particular, the documented actions relative to this reportable deficiency contained, in part, in CAR 89-09, neglected to address the inadequate inspection techniques/criteria which allowed the deficient site-fabricated thermolag material to be inspected and accepted for installation without detection. As stated in this CAR, the actions to preclude recurrence simply concluded that site-fabricated thermolag panels would not be used for future applications. Furthermore, the generic implications stated in the CAR were inadequately addressed in that the conclusion indicated that there were no generic implications. This conclusion ignored the ramifications implicit in a QC program which failed to detect a significant deficiency.

The applicant's final response to the issue, contained in TU Electric's letter TXX-89737, failed to adequately identify the cause of this significant condition adverse to quality in that the conditions which allowed the deficient site-fabricated material to be inspected, accepted by QC, and subsequently installed were not adequately addressed. No specificity was provided in this response to provide assurance that the cause of the condition had been properly determined or that the corrective actions to prevent reoccurrence were adequate.

Collectively these deficiencies in the applicant's response to this event which represented a significant condition adverse to quality are identified as a violation (445/8971-V-02): failure to assure that the cause of the condition is determined and corrective action is taken to preclude repetition.

4. <u>Allegation Follow-up (99014)</u>

a. (Closed) Allegation (OSP-89-A-86): This allegation involved the termination of a worker subsequent to the incorrect cutting of safety-related wires associated with the heating, ventilation, and air-conditioning (HVAC) system. The alleger stated his concerns to members of the NRC Resident Inspector's office at Comanche Peak on September 14, 1989.

The alleger stated that he had been formerly employed as a journeyman electrician by an onsite contractor, but that he had been terminated on or about August 15, 1989. The alleger went on to state that immediately preceding his termination he had been performing safety-related work (Train A) on the 852 foot level in the Safeguards building, room 150, when he was directed by his foreman to cut specific wires in a pull box. The alleger also stated that the work was being performed in accordance with a DCA (unspecified) which was associated with the repair of an electrical seal that was out of service in the room. The alleger stated that an electrical QC inspector was present below the work area, and that after confirming with his foreman which wires were to be cut, he completed the action by severing the conductors. Subsequent to this activity, the alleger was advised by the QC inspector that he had cut the wrong conductors and that an NCR was being written.

The alleger stated that he had been specifically directed by his foreman to accomplish this activity and that the punitive action taken against him was unfair. The alleger also stated that he had provided his concerns to SAFETEAM. The NRC inspector asked the alleger if there were any other witnesses to this event or if the QC inspector could corroborate his statements regarding the verbal directions provided to the alleger by his foreman. The alleger stated that there were no other witnesses and that the QC inspector could not substantiate his statements. Subsequent to the alleger's identification of this issue, the NRC inspector conducted a field walkdown of the associated equipment including junction box JB11A11330 and conduit C14021429. These components were the subject of NCR 89-8417, Revision 3, which stated, in part, that due to a craft error, cable E0146318 had been cut in JB1A11330 rather than at the condulet as required in Revision 2 of this NCR.

The NRC inspector also examined the SAFETEAM files concerning this issue including Corporate Security's investigation which appeared to have been thorough in that all persons involved including the alleger, his foreman, the general foreman, the QC inspector involved in identifying and reporting this condition, and a fellow worker who was assigned to this work activity were interviewed. As stated in this report, the alleger's assertion that he had been unfairly terminated for violating procedures in that he was following his foreman's instructions was not supported by the investigation. Corporate Security's investigation concluded that this individual was dismissed for negligence.

Although the termination of this individual appears unnecessarily harsh, given that the technical disposition of NCR 89-8417, Revision 3, concluded that the cutting of cable E0146318 at JB1A11330 had no impact on the disposition of the subject NCR, the statements from the individuals interviewed indicated that the alleger was instructed to cut the cable inside the condulet, and then pull them from the junction box. The NRC inspector also examined the findings of the Termination Review Committee which reviewed this case and affirmed the recommendation for termination on August 15, 1989.

Based on the above reviews, discussions with the applicant's SAFETEAM and Corporate Security personnel; and related inspection activities, the NRC inspector determined that the alleger had incorrectly cut safety-related wires associated with the HVAC system at junction box JB11A11330 and that his assertion that he was only following the instructions of his foreman could not be substantiated. However, given the minimal effect of this apparent miscommunication between an electrical foreman and an electrician on the system work being performed, the termination action appears to be extreme.

b. (Closed) Allegation (OSP-89-A-69): Directed procedure violations and SAFETEAM conflict of interest. This allegation involved the circumventing of M&TE procedures at the direction of a group leader and the associated inability to communicate these concerns to SAFETEAM in that the group leader's spouse was employed at SAFETEAM. The NRC inspector reviewed the M&TE facility, the governing procedures, and in-process calibrations as part of the closure process for SDAR CP-88-35 (see paragraph 3.e of this report). As noted in the closure of this item, minor weaknesses were noted in the M&TE program but no additional allegations or evidence of deliberate procedure violations were identified by the NRC inspector. A review of SAFETEAM records revealed no additional concern specifically regarding the subject group leader; however, a previous concern, No. 11630, did involve the apparent conflict of interest resulting from the SAFETEAM member/M&TE group leader relationship. The NRC inspector determined that the applicant had addressed this potential conflict by implementation of policy constraints which specified that the subject SAFETEAM member involved would remove themselves from any concern related to the group leader or CPSES operations in general. However, the NRC inspector's investigation indicates that the current allegation supports the perception by plant personnel that there is a conflict which could impede the free flow of information to SAFETEAM. In that the NRC inspector was unable to substantiate the procedural violation aspects of this allegation, this item is considered closed.

No violations or deviations were identified.

5. <u>Electrical Components and Systems (51053, 51063, 52053)</u>

During this reporting period, the NRC inspectors performed direct inspections of work performance to determine if the technical requirements contained in the applicant's Final

Safety Analysis Report (FSAR) for safety-related electrical systems and components had been adequately translated into applicable drawings, procedures, and instructions. Additionally, the NRC inspectors evaluated the applicant's work control program to determine if the specified documents and procedures were of sufficient detail to provide adequate work performance and control.

As part of the inspection requirements for IE Bulletin 85-03, the NRC inspector observed dynamic motor operated valve testing (MOVAT) of 1HV-2493A, auxiliary feedwater isolation valve. The valve performed properly on closing and opening against an operating differential pressure of approximately 1515 psig. Review of the valve signature data revealed no discrepancies of torques, motor current, etc.

The NRC inspector also observed work in progress for package ECE-89-01073, "Tag Maintained Space Cables During Train A Outage 89-091." The NRC inspector determined that this work was being performed in accordance with DCA 77139 and work order C89-0013439 at the 480v motor control center MCC XEB1-2. The NRC inspector observed that the labels identifying "maintained space" cables were being properly affixed where cables were not already identified. The NRC inspector's review of the package and work process did not reveal any discrepancies and it was observed that a QC representative was present at the job site for the performance of specified witness points.

Within the instrumentation area, the NRC inspector observed the installation of 1PT-3616 in accordance with work package SWP-Z-5714. This work also involved the implementation of DCAs 89836 and 84502 and work packages 1LT-3615 A and B in response to NRC Generic Letter 88-17 regarding reactor coolant level monitoring during mid-loop operations. Additionally, the NRC inspector observed installation of conduit supports involving conduit C14036219. During the conduct of these activities, no discrepancies were identified by the NRC inspector.

No violations or deviations were identified.

6. Safety-Related Components, Mechanical (50071, 50073)

Reverse Flow Testing of Borg-Warner Check Valves

As a follow-up to the events which identified multiple failures of Borg-Warner check valves in the auxiliary feedwater system, previously documented in NRC Inspection Reports 50-445/89-30, 50-446/89-30; and 50-445/89-64, 50-445/89-64, the NRC inspector witnessed the reverse flow leak testing of the following Borg-Warner check valves:

1AF-057	3" pressure seal	Procedure EGT-328A
1AF-083	4" pressure seal	Procedure EGT-328A
1AF-093	4" pressure seal	Procedure EGT-328A
1AF-167	8" bolted bonnet	Procedure EGT-165

The NRC inspector determined that the test personnel involved appeared knowledgeable and that they efficiently performed the required evaluations. All reverse flow tests witnessed had satisfactory results and no discrepancies were identified during either the performance or the documentation phase of this program.

The reverse flow testing of the 80 Unit 1 Borg-Warner check valves is approximately 65% complete. The NRC inspector previously reviewed the applicant's program and procedures for testing the operability of Borg-Warner check valves and witnessed two additional tests as documented in NRC Inspection Report 50-445/89-73; 50-446/89-73. Due to differences in system configuration, the availability of drain and test valves, etc., diverse methods are employed to test the subject valves. These methods include the following configuration options:

Test Method	No. of System Valves
Demin Water Pressure Test	37
System pressure	9
Radiograph Test	26
10 CFR 50, Appendix J, Local Leak Rate Test	6
Air Pressure Test	2
Total	80

The NRC inspector has reviewed the film records from several radiograph tests and determined that they were of good quality and provided a definitive test methodology.

To date, four valves have required rework following their initial failure to pass the reverse flow leak test. The root cause and corrective action for these valves is summarized below:

Valve 1AF-0083 (valve body/bonnet) was rotatively misaligned and the disc-stud was bent. A new disc-stud assembly was installed, the valve internals were reinstalled, and the reverse flow leak testing was satisfactory.

Valve 1CA-0016 exhibited excessive seat leakage. The swing arm and bushing were replaced and the valve was blue checked. The valve internals were reinstalled and the subsequent reverse flow leak testing was satisfactory.

Valve 1AF-0057 exhibited unacceptable valve body/bonnet rotational misalignment and incorrect bonnet elevation. The valve was disassembled and supplemental measurements were taken, the valve internals were reinstalled using the new height specification, and the valve was successfully tested in the reverse flow direction.

Valve 1SW-0048 was determined to have an excessively long swing arm bushing. The bushing length was reduced by 0.08" and replaced in the disk-stud assembly. The valve internals were reinstalled and the valve was successfully tested in the reverse flow direction.

In conjunction with the above documented activities, the applicant has revised the Borg-Warner check valve reassembly procedure and designed a specialized set of tools to allow for the establishment of more precise rotational alignment of the bonnet to the valve body. The NRC inspector witnessed a demonstration of the new tools and technique in the mechanical maintenance shop and the reassembly of valve 1AF-045 in the plant. The NRC inspector concluded that the new procedure will enhance the rotational alignment between the valve bonnet and body.

During the latter portion of this reporting period, approximately 13 Borg-Warner check valves in the auxiliary feedwater and feedwater systems were identified by the applicant as having excessive body to bonnet external leakage. These valves are presently being disassembled, honed to remove scratches in the valve body throat and provide better sealing surfaces, reassembled, and leak tested. NRC inspection of these activities will be continued.

No violations or deviations were identified.

7. Plant Tours (51063)

The NRC inspectors conducted routine plant tours during this inspection period which included evaluation of work in progress as well as completed work to determine if activities involving safety-related electrical systems and components including electrical cable were being controlled and accomplished in accordance with regulatory requirements, industry standards, and the applicant's procedures.

No violations or deviations were identified.

8. Exit Meeting (30703)

An exit meeting was conducted November 7, 1989, with the applicant's representatives identified in paragraph 1 of this report. No written material was provided to the applicant by the inspectors during this reporting period. The applicant did not identify as proprietary any of the materials provided to or reviewed by the inspectors during this inspection. During this meeting, the NRC inspectors summarized the scope and findings of the inspection.

GULF STATES UTILITIES COMPANY

January 9, 1990
RBG- 32073
File Nos. G9.5, G9.25.1.4

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Gentlemen:

River Bend Station - Unit 1
Docket No. 50-458

Please find enclosed a revision to the Informational Report regarding a recent test of Thermo-Lag fire barrier material which is used at River Bend Station. The initial report was originally transmitted on December 20, 1989. This report is being submitted to provide information regarding our ongoing investigation of this matter and interim actions taken.

Sincerely,

for J. E. Booker
Manager-River Bend Oversight
River Bend Nuclear Group

JEB/TFP/RGW/CMC/pg

cc: U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 1000
Arlington, TX 76011

NRC Resident Inspector
P.O. Box 1051
St. Francisville, LA 70775

Mr. Walt Paulson
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

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90-081

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GULF STATES UTILITIES COMPANY

January 9 . 1990
RBG- 32073
File Nos. G9.5, 89.25.1.4

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90-081

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GULF STATES UTILITIES COMPANY

January 9, 1990
RBG- 32073
File Nos. G9.5, 89.25.1.4

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90-081

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REPORTED CONDITION

At approximately 1100 hours on 10/28/89, with the unit in Operational Condition 1, a problem was reported in a test of plant-specific Appendix R fire barriers as described herein. Since the results of this test placed into question the qualification of Thermo-Lag fire barrier material, Condition Report (CR) 89-1144 was initiated which detailed the areas in the plant protected by these fire barriers. All of these areas, with the exception of the piping tunnels and the upper elevations of the reactor building, were being covered by preexisting firewatch patrols. As a conservative precaution, the other areas were added to the firewatch routes satisfying the action statement of section 3/4.7.7 of the plant Technical Specifications.

This condition is currently determined not to be reportable pursuant to 10CFR50.73 because the test results are indeterminate and thus the impact on installed River Bend Station (RBS) equipment is unknown. If the evaluation determines that RBS equipment has been inoperable due to inadequate fire barriers appropriate reporting requirements will be evaluated and satisfied.

INVESTIGATION

The fire barrier test was conducted to verify barrier performance and to compare the three hour rated fire barrier products of two competing manufacturers. One material used in the test, Thermo-Lag, produced by Thermal Science, Inc. is the material typically used at River Bend Station for one and three hour Appendix R fire barriers. The other material was undergoing initial qualification testing and is not currently in use at RBS. Standard site installation procedures were used to install the Thermo-Lag material on the test apparatus. Both materials were applied and inspected by Gulf States Utilities (GSU) personnel on identical 30 inch wide aluminum cable trays. Both barrier materials were also used to protect the tube steel support underneath the trays, coming into contact near the midpoint of the support. Testing was performed in accordance with the American Nuclear Insurers test standard, including monitoring of circuit integrity.

During the performance of the test, it was noticed that thermocouples inside the Thermo-Lag tray enclosure were experiencing abnormally high temperatures in one area. At approximately 41 minutes into the test, the Thermo-Lag covering the bottom of the support fell off, exposing the steel support. As the test continued, temperatures inside the cable tray enclosure continued to increase, with a loss of circuit integrity at 47 minutes.

As a result of GSU's ongoing investigation some generic issues have been revealed during a recent conference with the vendor, Thermal Science, Inc. as follows:

1. Use of Aluminum Conduit - No testing has been performed to evaluate the effect of aluminum conduit penetrating the protective envelope. The typical "18 inch rule" where Thermo-Lag covering limits heat transfer due to penetrants may or may not be sufficient.

??

2. Joints in Protective Envelopes - Two methods for sealing joints are shown in the TSI installation manual. One method involves coating board butt edges prior to installation, called "prebuttering". The second method allows all board material to be dry fitted and the joints covered with trowel grade material once in the final position, called "skin coating". This second method, although sanctioned in the TSI manual, has not been tested.

3. Size of Tested Configurations - Until the most recent test series conducted with GSU, the maximum size of barrier tested is apparently a 12 inch wide cable tray. However, enclosures of much larger sizes are typically used at River Bend Station, based on extrapolation of data from tests on 12 inch wide trays. The effect on barrier performance due to this larger size in unknown.

The results of the testing performed on the Thermo-Lag barrier continue to be studied by GSU and the vendor, Thermal Science, Inc. The influence of the dissimilar material joint on the overall results of the fire test is in question. This application is not typical at River Bend Station. Evaluation of the test will continue until the results are attributed to either test article construction or test performance. At that time, the applicability of the results to the barriers installed at RBS will be determined.

alumin conduit!

Information Notice

CORRECTIVE ACTION

In addition to conservatively satisfying the firewatches specified by the action statement of Technical Specification 3/4.7.7, GSU Engineering has specified when stationary or 30 minute roving firewatches will be posted for inoperative fire suppression systems or fire detection zones in safety related areas of the plant which utilize Thermo-Lag fire barriers. Use of either a stationary or 30 minute roving firewatch is justified as the inspection frequency exceeds the worst case barrier rating. This action conservatively exceeds the current Technical Specification requirements for fire suppression and detection systems. The procedure governing control of transient combustibles has been revised to require that all combustible liquids brought into the power block remain in the possession of the worker until they are removed from the building. As an alternative to removal from the building, small amounts of liquids may be stored in the flammable storage lockers in the plant.

GSU will continue to evaluate the test results and will provide an updated report by March 31, 1990.

? updated report

SAFETY ASSESSMENT

Fire safety was and is an integral part of the design of RBS. This process begins in the selection of the cable used, which is IEEE rated and fire resistive. (Electrical cable insulation forms the majority of the fixed fire load in the plant). Fire detection systems cover the entire power block, giving early warning of fires. Fire suppression systems are provided in areas such as cable chases and diesel rooms with large concentrations of combustibles. The various buildings are subdivided into discrete fire areas, usually by concrete walls and floors. This 'defense in depth' philosophy is crafted to detect fires in the early stages, contain fires in one area and provide control and extinguishment.

Thermo-Lag barriers form a small fraction of the total number of fire barriers.

Based on the interim actions implemented, the fire protection design features at RBS and the generally low combustible loadings in the fire areas, GSU concludes that continued operation is justified.

GULF STATES UTILITIES COMPANY

RIVER BEND STATION POST OFFICE BOX 220 ST. FRANCISVILLE, LOUISIANA 70775
AREA CODE 504 635-6094 346-8651

March 8 , 1990
RBG- 32467
File Nos. G9.5, G9.25.1.3

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, D. C. 20555

Gentlemen:

River Bend Station - Unit 1
Docket No. 50-458

Please find enclosed Licensee Event Report No. 90-003 for River Bend Station - Unit 1. This report is being submitted pursuant to 10CFR50.73.

Sincerely,

W. H. Odell
Manager-River Bend Oversight
River Bend Nuclear Group

WHO/TFP/PDG/RGW/JHM/MAS:jg

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St. Francisville, LA 70775

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Atlanta, GA 30339-3064

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NRC Form 366 (9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES 8/31/88

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
RIVER BEND STATION	0 5 0 0 0 4 5 8	1 OF 0 4

TITLE (4): Inadequate Thermolag Fire Barrier Envelopes Surrounding Safe Shutdown Circuits per TS 3/4.7.7

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
										0 5 0 0 0
0 2	0 6	9 0	9 0	0 0 3	0 0	0 3	0 8	9 0		0 5 0 0 0

OPERATING MODE (9): 1

POWER LEVEL (10): 1 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)

	20.402(b)		20.405(c)		50.73(a)(2)(iv)		73.71(b)
	20.405(a)(1)(i)		50.36(c)(1)		50.73(a)(2)(v)		73.71(c)
	20.405(a)(1)(ii)		50.36(c)(2)		50.73(a)(2)(vii)		OTHER (Specify in Abstract below and in Text, NRC Form 366A)
	20.405(a)(1)(iii)	X	50.73(a)(2)(i)		50.73(a)(2)(viii)(A)		
	20.405(a)(1)(iv)		50.73(a)(2)(ii)		50.73(a)(2)(viii)(B)		
	20.405(a)(1)(v)		50.73(a)(2)(iii)		50.73(a)(2)(x)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
L. A. England, Director-Nuclear Licensing	AREA CODE 5 0 4 381-4145

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)

		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
X YES (If yes, complete EXPECTED SUBMISSION DATE)	NO		0 7	1 5	9 0

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

During the performance of Surveillance Test Procedure STP-000-3602 on 02/06/90 through 02/08/90 with the unit in Operational Condition 1 (full power), it was found that several minor deficiencies existed in the Thermo-Lag fire barrier envelopes redundant safe shutdown circuits. These deficiencies consisted of small holes, cracks and unfilled seams in the Thermo-Lag material. A fire watch had already been established in areas utilizing Thermo-Lag as a fire barrier.

GSU is currently working with the vendor to resolve the identified discrepancies which occurred during construction and the deficient Thermo-Lag barriers.

A supplemental response to this LER and the information report dated 01/09/90 will be submitted to the NRC by 07/15/90.

The combination of the cable jacket properties, the control of transient combustibles, the use of suppression systems in the plant, and the minor nature of the defects in the barriers provides assurance that plant safety and the health and safety of the public has not been jeopardized.

REPORTED CONDITION

During the performance of Surveillance Test Procedure STP-000-3602 on 02/06/90 through 02/08/90 with the unit in Operational Condition 1 (full power), it was found that several minor deficiencies existed in the Thermo-Lag fire barrier envelopes redundant safe shutdown circuits. These deficiencies consisted of small holes, cracks and unfilled seams in the Thermo-Lag material. Condition reports (CR) 90-0094, 90-0095, 90-0101, and 90-0106 were initiated to evaluate the conditions according to 10CFR50, Appendix R, fire barrier requirements. Since these deficiencies rendered the fire barrier inoperable and the unfilled seams existed since construction, this event is reportable pursuant to 10CFR50.73(a)(2)(i)(B) as a condition prohibited by Technical Specifications. A fire watch had already been established in areas utilizing Thermo-Lag as a fire barrier, thus Technical Specification Section 3/4.7.7 action statement requirements had already been fulfilled.

INVESTIGATION

Thermo-Lag fire barriers have been under review at River Bend Station since late 1989. Potential discrepancies between the installation manual of Thermal Science Incorporated (TSI) (a GSU subcontractor during construction) and the actual site installation practices, and discrepancies between TSI installation manual and the qualification fire test results were discovered at that time. Due to these issues, the fire barriers were indeterminate for operability and firewatches were established for all areas utilizing Thermo-Lag as a fire barrier. An information report was submitted to the NRC 01/09/90 concerning this subject.

The performance of STP-000-3602 was intended to identify conditions in fire barriers where normal wear and tear had caused damage to the barriers. The small holes and miscellaneous cracks that were identified during the performance of the STP fall into this category. Normally a fire watch would be established and the holes and cracks would be repaired. However, the unfilled seams in the Thermo-Lag installations that were identified during the performance of the STP are a condition that must have existed from the time of initial construction and are not in accordance with either the vendors installation manual or normal site practices. In accordance with the vendor manual, the seams between boards of a Thermo-Lag were to be prebuttered with a trowel grade material and then joined; or alternatively dry fitted together with trowel grade material then applied to the joint. In either case, the seams were to have been grouted with the trowel grade material and they were not. The preexisting firewatches satisfy the action statement of section 3/4.7.7 of the Technical Specifications. Eight fire areas were identified by the condition reports as having Thermo-Lag barriers exhibiting the unfilled seams. A brief description of each area follows.

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6) YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	PAGE (3)
RIVER BEND STATION	0 5 0 0 0 4 5 8	9 0	— 0 0 3	— 0 0	0 3 OF 0 4

TEXT (If more space is required, use additional NRC Form 366A's) (17)

Fire area C2A is the southeast cable chase at elevation 70 feet of the control building (*NA*). Fire area C2C is in the same cable chase but located at elevation 115 feet. These areas have safety related cabling feeding through up to the termination cabinets in the main control room. The areas have sprinkler suppression systems (*KP*) on the cable trays, which comprise the exposed fixed combustible in the areas. Area C6 is adjacent to area C2A on the west side. The area contains safety related air accumulators as well as safety related cabling. The exposed cables in cable trays comprising the exposed fixed combustible in the area, are protected by a sprinkler suppression system.

Fire area AB2/Z2 is located in the auxiliary building (*NF*) at elevation 95 feet in the southeast corner of the building. The area contains safety related instruments, piping and safety related cables. The cabling, which makes up the fixed combustible in the area, represents a fire loading of 1.0 hour. Fire area AB7 is the "D" tunnel located at elevation 70 feet on the south end of the auxiliary building. Safety related piping and motor operated valves (MOV) (*FCV*) are located in the area in addition to the safety related cabling. The cable trays and the MOVs are protected by a water deluge sprinkler system (*KP*).

Fire FB1/Z1 is located at elevation 70 feet of the fuel building (*ND*). The area contains fuel pool cooling piping (*DA*) and equipment, reactor plant component cooling water piping (*CC*) and MOVs as well as safety related cabling. The crescent area, near the reactor building shield wall (*NH*), contains the major portion of the cable trays in the area. The cable trays represent a fire loading of 21 minutes and are the fixed combustible in the area. Fire areas FB3 and FB4 are the charcoal filter rooms located at elevation 148 feet of the fuel building. The ventilation system charcoal filters and fans are contained in the area. All cabling is routed in conduit in these areas. The charcoal filters are the fixed combustible for this area. They are protected by manually actuated water spray systems. The charcoal in each area is a fire loading of 45 and 46 minutes respectively for areas FB3 and FB4.

Fire area PT1 is the pipe tunnel at elevation 70 feet which extends from the standby cooling tower (*CTW*) to the fuel building. The area contains piping, MOVs and instrumentation in addition to the safety related cabling. The cable trays are the only fixed combustible in the area and are protected by a sprinkler suppression system. The cable trays represent a fire loading of 29 minutes.

In addition to the informational report submitted on 01/09/90, LERs 87-005 and 89-009 were reviewed for similarity. This is the first time unfilled seams have been identified.

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6) YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	PAGE (3)
RIVER BEND STATION	0 5 0 0 0 4 5 8	9 0	— 0 0 3	— 0 0	0 4 OF 0 4

TEXT (If more space is required, use additional NRC Form 366A's) (17)

CORRECTIVE ACTION

GSU is currently working with the vendor to resolve the identified discrepancies which occurred during construction and the deficient Thermo-Lag barriers.

The corrective action to be taken to repair deficiencies identified by the STP in the Thermo-Lag barriers will be dependent on the extent of the overall Thermo-Lag problems identified (and yet to be identified) at River Bend and the resolution of those problems. A supplemental response to this LER and the information report dated 01/09/90 will be submitted to the NRC by 07/15/90.

SAFETY ASSESSMENT

The primary fixed combustible at River Bend in the safety related areas is cable jacketing on the electrical cables. The type of cable used at River Bend has been shown through testing to resist ignition and when the ignition/heat source is removed, the cable self extinguishes. Transient combustibles are controlled through administrative means to limit the amounts brought into any given area of the plant. The charcoal filter rooms of the fuel building are the only areas that require any appreciable amount of combustibles to be brought into the area. This happens infrequently during changing of the charcoal in the filters.

The combination of the cable jacket properties, the control of transient combustibles, the use of suppression systems in the plant, and the minor nature of the defects in the barriers provides assurance that plant safety and the health and safety of the public has not been jeopardized.

NOTE: Energy Industry Identification System Codes are identified in the text as (*XX*).

GULF STATES UTILITIES COMPANY
RIVER BEND STATION POST OFFICE BOX 220 ST. FRANCISVILLE, LOUISIANA 70775
AREA CODE 504 635-6094 346-8651

July 12 , 1990
RBG- 33190
File Nos. G9.5, G9.25.1.3

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, D. C. 20555

Gentlemen:

River Bend Station - Unit 1
Docket No. 50-458

Please find enclosed Revision 1 to Licensee Event Report No. 90-003 for River Bend Station - Unit 1. This revision is submitted to provide the current status of issues concerning Thermo-Lag fire barriers at River Bend Station.

Sincerely,

W. H. Odell
Manager-Oversight
River Bend Nuclear Group

TFP/LAE/PDG/RGW/DCH/MAS/pg

cc: U. S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 1000
Arlington, TX 76011

NRC Resident Inspector
Post Office Box 1051
St. Francisville, LA 70775

INPO Records Center
1100 Circle 75 Parkway
Atlanta, GA 30339-3064

IE22

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES 8/31/88

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
RIVER BEND STATION	0 5 0 0 0 4 5 8	1 OF 0 4

TITLE (4) Inadequate Thermo-Lag Fire Barrier Envelopes Surrounding Safe Shutdown Circuits per TS 3/4.7.7

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
0 2	0 6	9 0	9 0	0 0 3	0 1	0 7	1 2	9 0		0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9): 1

POWER LEVEL (10): 1 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR § (Check one or more of the following) (11)

20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)
20.405(a)(1)(iii)	X 50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
L. A. England, Director-Nuclear Licensing	AREA CODE 5 0 4 3 8 1 - 4 1 4 5

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)

X YES (If yes, complete EXPECTED SUBMISSION DATE)   NO

EXPECTED SUBMISSION DATE (15): MONTH 0 1 DAY 3 1 YEAR 9 1

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

During the performance of Surveillance Test Procedure STP-000-3602 on 02/06/90 through 02/08/90 with the unit in Operational Condition 1 (full power), it was found that several minor deficiencies existed in the Thermo-Lag fire barrier envelopes redundant safe shutdown circuits. These deficiencies consisted of small holes, cracks and unfilled seams in the Thermo-Lag material. A fire watch had already been established in areas utilizing Thermo-Lag as a fire barrier.

GSU is currently working with the vendor to resolve the identified discrepancies which occurred during construction and the deficient Thermo-Lag barriers. Fire tests are planned to confirm acceptability of as installed barriers in the plant and develop repair methods where necessary.

A supplemental response to this LER and the information report dated 01/09/90 will be submitted to the NRC by 01/31/91.

The combination of the cable jacket properties, the control of transient combustibles, the use of suppression systems in the plant, and the minor nature of the defects in the barriers provides assurance that plant safety and the health and safety of the public has not been jeopardized.

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INVESTIGATION

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Fire area C2A is the southeast cable chase at elevation 70 feet of the control building (*NA*). Fire area C2C is in the same cable chase but located at elevation 115 feet. These areas have safety related cabling feeding through up to the termination cabinets in the main control room. The areas have sprinkler suppression systems (*KP*) on the cable trays, which comprise the exposed fixed combustible in the areas. Area C6 is adjacent to area C2A on the west side. The area contains safety related air accumulators as well as safety related cabling. The exposed cables in cable trays comprising the exposed fixed combustible in the area, are protected by a sprinkler suppression system.

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In addition to the informational report submitted on 01/09/90, LERs 87-005 and 89-009 were reviewed for similarity. This is the first time unfilled seams have been identified.

CORRECTIVE ACTION

GSU is currently working with the vendor to resolve the identified discrepancies which occurred during construction and the deficient Thermo-Lag barriers. It has been determined that fire tests will be required to fully qualify the Thermo-Lag as it is installed in the plant. A two stage testing procedure is planned. The first stage will consist of duplicating the installation process that was used in the plant for barriers on conduit, cable tray, supports, and enclosures. Each item will be tested in both a one hour barrier configuration and a three hour barrier configuration. The second stage will consist of additional testing to determine acceptable repair methods for those items that do not meet the requirements of the first stage tests.

The corrective action to be taken to repair deficiencies identified by the STP in the Thermo-Lag barriers will be dependent on the results of the testing that is to be performed. A supplemental response to this LER and the information report dated 01/09/90 will be submitted to the NRC by 01/31/91.

SAFETY ASSESSMENT

The primary fixed combustible at River Bend in the safety related areas is cable jacketing on the electrical cables. The type of cable used at River Bend has been shown through testing to resist ignition and when the ignition/heat source is removed, the cable self extinguishes. Transient combustibles are controlled through administrative means to limit the amounts brought into any given area of the plant. The charcoal filter rooms of the fuel building are the only areas that require any appreciable amount of combustibles to be brought into the area. This happens infrequently during changing of the charcoal in the filters.

The combination of the cable jacket properties, the control of transient combustibles, the use of suppression systems in the plant, and the minor nature of the defects in the barriers provides assurance that plant safety and the health and safety of the public has not been jeopardized.

NOTE: Energy Industry Identification System Codes are identified in the text as (*XX*).

TU ELECTRIC

Log # TXX-90255
File # 909.5
Ref. # 10CFR50.48

July 13, 1990

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION (CPSES)
DOCKET NO. 50-445
THERMO-LAG PREFABRICATED PANELS

Gentlemen:

On Thursday, July 5, 1990, in a teleconference with NRC Region IV personnel and the Site Resident Inspector, TU Electric committed to provide the basis for implementation of THERMO-LAG fire barrier material acceptance criteria as revised in October of 1989. The criteria were revised and implemented after minor deviations from our original material acceptance criteria were identified. The following information regarding the revised acceptance criteria is submitted.

To understand the relative sensitivity of THERMO-LAG to configuration variations, a review of the behavior of THERMO-LAG under fire conditions is useful. THERMO-LAG is a passive barrier system until it is exposed to the heat flux of a fire. On exposure to the heat flux at the surface of the barrier, the following mechanisms are activated:

- An inorganic salt is contained within an organic binder that contains glass fiber reinforcement. This salt undergoes sublimation, which occurs at a constant temperature, absorbing heat and leaving behind a char layer through which sublimed gases must transpire.
- The sublimed gases encounter a sufficient residence time in the char layer to undergo endothermic decomposition and disassociation before injection into the surface boundary layer.
- The mass transfer of the sublimed gases carries heat to the surface boundary layer.
- The charred surface re-radiates heat energy away from the system.

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THERMO-LAG does not work solely as an insulating material where thickness governs material effectiveness. THERMO-LAG behavior under fire conditions is dependent on the mass (density) of the THERMO-LAG and minor configuration (thickness) differences in the THERMO-LAG are not significant. Material that is compressed from normal fabrication thicknesses retains the mass of sublimation salts equivalent to normal fabricated THERMO-LAG.

Thermal Science, Inc.'s (TSI) Quality Assurance/Quality Control program requires that each THERMO-LAG prefabricated panel be subjected to detailed QC thickness measurements to verify minimum 1/2 inch material thickness prior to acceptance. TSI's QC procedures require that the entire surface be visually scanned and a minimum of 18 preselected locations on each panel be measured to verify required panel thickness. Measurements are made with devices which are tested to verify their accuracy. These tests are performed at a prescribed frequency. Only panels which meet the criteria of the TSI QC procedure are shipped. This panel fabrication and inspection methodology has remained essentially unchanged since TSI began production of prefabricated panels in the early 1980s.

TSI randomly selected THERMO-LAG prefabricated panels for use in fire tests conducted to qualify the product (including fabrication and inspection processes) from panels accepted by QC in accordance with TSI's QA program. Fire tests involving 200 or more randomly selected panels manufactured and inspected under identical requirements have resulted in no failures of the THERMO-LAG Fire Barrier System.

The fabrication and inspection methodologies employed by TSI assure a qualified product; however, minor variations in panel thickness not associated with the specific preselected inspection points may occur. Such minor variations would have occurred in any of the panels subjected to the fire testing performed by TSI. Thus, the fire testing demonstrates that the panels are qualified even with minor variations in the panel thickness.

Subsequent to TU Electric's initial supplier qualification audit of TSI's QA Program in 1981, a number of additional audits and surveillances have been conducted to verify TSI's continued compliance with procurement documents. During late 1989, TU Electric maintained source (shop) inspection at TSI's facilities over extended periods to monitor the performance of TSI's QC inspection efforts and performed independent inspections of completed panels. These audits and surveillances have established that TSI has satisfactorily implemented the approved QA program requirements.

The QC inspections by TSI provide the basis for determining that THERMO-LAG shipped to CPSES complies with the TSI and TU Electric acceptance criteria, including acceptance criteria on thickness. In addition to the QC inspections performed by TSI, CPSES performs receipt inspections.

Minor deviations from TU Electric's QC receipt inspection criteria contained in Specification 2323-MS-38H, Appendix A, regarding minimum thickness of THERMO-LAG prefabricated panels were identified during receipt of material at CPSES in October 1989. These deviations were evaluated by TU Electric and TSI. In many instances of localized thickness reductions, areas of the panels were apparently compressed during handling and or shipment of the material. In other instances localized thickness reductions apparently resulted from the fabrication process.

To address localized areas of thickness reduction of panels supplied to TU Electric in October 1989, a tolerance for the 1/2 inch minimum panel thickness was developed. TSI provided a quantified tolerance that allowed deviations up to minus 1/8 inch from the 1/2 inch minimum for no more than 2% of the entire surface area of the panel. This tolerance is similar to Underwriters' Laboratories tolerance for sprayed-on fire barriers. The basis for reduced panel thickness tolerance included :

1) Localized areas of compressed THERMO-LAG material did not represent an actual reduction in the amount of subliming material available for fire response; therefore, initial fire test results were not compromised.

2) Minor localized areas of reduced panel thickness resulting from the fabrication process were not unanticipated. The random selection of THERMO-LAG panels for fire testing and acceptable fire test results have established that minor thickness variations of this nature do not have an adverse effect on the THERMO-LAG Fire Barrier System and do not compromise initial fire test results.

Based on the above and TSI's responsibility for certification of the product as a one hour fire barrier, the tolerance as defined by TSI was included in TU Electric's receipt inspection criteria. However, in attempting to implement this criteria it was determined that the area measurement (e.g., 2% of surface area) was not practical at receipt inspection. Therefore, TU Electric receipt inspection criteria based on panel weight were developed in conjunction with TSI's recommendation. In addition, TU Electric still requires inspection for damage due to shipping and handling. This does not change the performance criteria required of TSI to provide a one hour fire rated material to TU Electric, nor does it affect TSI's responsibility to inspect and accept THERMO-LAG for the requisite thickness prior to shipment to CPSES.

TU Electric's weight measurement in conjunction with the controls and manufacturer's inspections implemented by TSI and the visual receipt inspections to identify any shipping damage performed at receipt of material provide assurance that the THERMO-LAG prefabricated panels meet applicable fire test qualification requirements.

Sincerely,

William J. Cahill, Jr.

JDS/DEN/daj

c - Mr. R. D. Martin, Region IV
Resident Inspectors, CPSES (3)
Mr. J. H. Wilson, NRR

JUL 20 1990

In Reply Refer To:
Dockets: 50-445
50-446

TU Electric
ATTN: W. J. Cahill, Jr., Executive
Vice President, Nuclear
Skyway Tower
400 North Olive, L.B. 81
Dallas, Texas 75201

Gentlemen:

Thank you for your letter of July 13, 1990, in response to our July 5, 1990, telephone request regarding the acceptability of THERMO-LAG fire barrier material, which is installed at Comanche Peak Steam Electric Station (CPSES), Unit 1.

In your letter you concluded that current receipt inspection acceptance criteria, although modified from the original acceptance criteria, continues to ensure that THERMO-LAG is acceptable as installed. Your conclusion is based, in part, on letters from the vendor, Thermal Science, Inc. (TSI), to TU Electric, dated November 21 and 22, 1989, which certify that THERMO-LAG, as installed, is an adequate one hour fire barrier at CPSES Unit 1. We have reviewed the referenced correspondence and have no further questions at this time.

Sincerely,
Original Signed By:
Samuel J. Collins

Samuel J. Collins, Director
Division of Reactor Projects

cc:
TU Electric
ATTN: Roger D. Walker, Manager,
Nuclear Licensing
Skyway Tower
400 North Olive Street, L.B. 81
Dallas, Texas 75201

Juanita Ellis
President - CASE
1426 South Polk Street
Dallas, Texas 75224

RIV:RI:TPS	C:TPS	D:DRS	D:DRP
ASingh:jg	WSeidle	LJCallan	SJCollins
7/18/90	7/18/90	7/18/90	/90

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Billie Pirner Garde, Esq.
Robinson, Robinson, et. al.
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Appleton, Wisconsin 54911

TU Electric
Bethesda Licensing
3 Metro Center, Suite 610
Bethesda, Maryland 20814

Heron, Burchette, Ruckert, & Rothwell
ATTN: William A. Burchette, Esq.
Counsel for Tex-La Electric
Cooperative of Texas
1025 Thomas Jefferson St., N.W.
Washington, D.C. 20007

E. F. Ottney
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Glen Rose, Texas 76043

Newman & Holtzinger, P.C.
ATTN: Jack R. Newman, Esq.
1615 L. Street, N.W.
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Washington, D.C. 20036

Texas Department of Labor & Standards
ATTN: G. R. Bynog, Program Manager/
Chief Inspector
Boiler Division
P.O. Box 12157, Capitol Station
Austin, Texas 78711

Honorable George Crump
County Judge
Glen Rose, Texas 76043

Texas Radiation Control Program Director
1100 West 49th Street
Austin, Texas 78756

bcc to DMB (IE01)

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Lisa Shea, RM/ALF
RSTS Operator

Ralph

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

August 6, 1991

NRC INFORMATION NOTICE NO. 91-47: FAILURE OF THERMO-LAG FIRE BARRIER MATERIAL TO PASS FIRE ENDURANCE TEST

Addressees:

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose:

This information notice is intended to alert addressees to problems that could result from the use of or improper installation of THERMO-LAG material to satisfy the electrical raceway fire protection requirements for safe shutdown components specified in Section III.G.2 of Appendix R to Part 50 of Title 10 of the Code of Federal Regulations (10 CFR Part 50). It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice do not constitute any new Nuclear Regulatory Commission (NRC) requirements; therefore, no specific action or written response is required.

Description of Circumstances:

The Gulf States Utilities Company, the licensee for the River Bend Station (RBS), submitted Licensee Event Reports (LERs) 87-005, 89-009, 90-003, and an Informational Report to the NRC concerning deficiencies identified in fire barriers. The NRC staff reviewed test report information and associated documents regarding the RBS electrical raceway fire barriers to determine if the problems identified in the LERs and Informational Report could affect other NRC licensees. The electrical raceway fire barrier material used at RBS is THERMO-LAG, a product manufactured and supplied by Thermal Science, Incorporated, (TSI), of St. Louis, Missouri. TSI provides THERMO-LAG for 1-hour and 3-hour rated fire barriers.

A 3-hour fire endurance test of a 30-inch aluminum electrical cable tray was performed in October 1989 at the Southwest Research Institute (SwRI) for Gulf States Utilities Company. In this test, a THERMO-LAG envelope system failed resulting in high temperatures inside the cable tray envelope and loss of circuit integrity within approximately 60 minutes. Catastrophic failure and collapse of the tray occurred within 1 1/2 hours. The failure of this test raised concerns regarding the adequacy of THERMO-LAG cable tray enclosures protecting 30-inch wide cable trays.

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Discussion:

NRC requirements and guidelines for fire barriers are contained in various documents, including Appendix R to 10 CFR 50, Generic Letter 86-10, "Implementation of Fire Protection Requirements", and NUREG-0800, "Standard Review Plan." The extent to which these requirements or guidelines are applicable to a specific plant depends on plant age, commitments established by the licensee in developing the fire protection plan, the staff safety evaluation reports (SERs) and supplements, and the license conditions pertaining to fire protection. Fire barrier wrap material is designed to provide reasonable assurance that the effects of a fire are limited to one division of a safe shutdown related system while another division will remain free of fire damage.

The Gulf States Utilities Company uses THERMO-LAG to protect raceways and components throughout RBS that are related to safe shutdown. In addition, at least 40 NRC licensed facilities use THERMO-LAG to construct fire barrier assemblies with 3-hour and 1-hour ratings to enclose electrical raceway and other safe shutdown components.

During routine walkdown inspections in early 1987, RBS fire protection personnel identified degradation of the THERMO-LAG 1-hour and 3-hour rated barriers. During repairs to correct the deficiencies discovered during the walkdowns, the licensee found that the fire barriers had not been installed in accordance with the manufacturer's specifications. The large number of observed deficiencies prompted the licensee to expand these walkdown inspections to include all THERMO-LAG fire barriers. Hourly fire watches were posted in all affected safety-related areas pending completion of all inspections and correction of any deficiencies found. The licensee attributed the deficiencies to failure of the subcontractor installation and quality control inspection program.

During maintenance activities in early 1989, the licensee found additional deficiencies indicating an apparent deficiency in the installation and quality control inspection program. The subcontractor who installed the THERMO-LAG fire barriers at RBS was approved by TSI as a qualified installer. However, during the installation at RBS, the subcontractor removed the factory-installed components of the THERMO-LAG called "stress skin" and structural ribbing. The stress skin component, a wire mesh, is critical to the structural integrity of the fire product during fire exposure. The RBS fire protection personnel considered that all barriers were degraded because of the many sections of the inside layer of the stress skin that had been removed during initial installation at RBS.

The discrepancies identified between the manufacturer's installation manual, actual site installation manual and qualification fire tests resulted in the licensee conducting additional fire endurance testing. In October 1989, SwRI tested a U-shaped 30-inch wide aluminum ladder back cable tray enclosed in a 3-hour fire-rated barrier constructed of THERMO-LAG material. RBS personnel constructed the cable tray protective envelope in accordance with the manufacturer's published installation instructions.

During the 3-hour fire endurance test, all thermocouples inside the THERMO-LAG protected tray reached failure temperatures (>325°F) in times ranging from approximately 45 minutes to 80 minutes. Conductor-to-ground failure occurred in the power cable at 60 minutes. The THERMO-LAG enclosure disintegrated at 77 minutes, and the cable tray collapsed at 82 minutes. The SwRI test results on the as-designed THERMO-LAG configuration prompted RBS to institute a fire watch patrol in all areas that depend on THERMO-LAG barriers for protection of safe shutdown capability.

Additional deficiencies, such as small holes, cracks and unfilled seams, were found in the THERMO-LAG material during walkdowns conducted in early 1990. The licensee conducted additional testing of as-installed barriers in November and December 1990. Certain 1-hour and 3-hour cable tray and conduit envelope tests failed. The envelopes were upgraded and tests of the upgraded barriers passed with the exception of the 3-hour cable tray envelope. Final resolution of the 3-hour envelope may include replacing existing fire wrap materials with fully qualified fire wrap, repairing and then qualifying in-plant fire wrap assemblies by supplemental fire tests, or rerouting the cables into acceptable enclosures.

Additionally, other fire barrier wrap design and installation concerns have been reported by RBS that indicate the possibility that NRC requirements for fire protection were not being met in all aspects. The type of concerns identified to date include the following:

1. Lack of documentation of qualification tests which demonstrate that aluminum conduits penetrating the THERMO-LAG protective envelope have been tested.

2. Lack of documentation of qualification tests for different joint installations that demonstrate that varying fitup methods (i.e., dry fitting) are qualified.

3. Lack of documentation of qualification tests of THERMO-LAG installations applicable to large cable trays. The licensee questioned the validity of extrapolating results from small cable tray tests to its 30-inch wide trays.

The NRC is particularly interested in obtaining information on fire barriers that have been found with deficiencies similar to those described in this notice. Documentation, in as much detail as practicable, of any such deficiencies discovered, especially in cases where a fire barrier may have been improperly installed or tested is important. Licensees may communicate the availability of information of this type by telephone to the NRC technical contact listed below. Information Notice No. 88-04, "Inadequate Qualification and Documentation of Fire Barrier Penetration Seals," provides additional discussion and considerations regarding qualification of installed fire barriers.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contact: Ralph Architzel, NRR
301-492-0804

Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
89-56, Supp. 2	Questionable Certification of Material Supplied to the Defense Department by Nuclear Suppliers	07/19/91	All holders of OLs or CPs for nuclear power reactors.
91-46	Degradation of Emergency Diesel Generator Fuel Oil Delivery Systems	07/18/91	All holders of OLs or CPs for nuclear power reactors.
91-45	Possible Malfunction of Westinghouse ARD, BFD, and NBFD Relays, and A200 DC and DPC 250 Magnetic Contactors	07/05/91	All holders of OLs or CPs for nuclear power reactors.
91-44	Improper Control of Chemicals in Nuclear Fuel Fabrication	07/08/91	All nuclear fuel facilities.
91-43	Recent Incidents Involving Rapid Increases in Primary-to-Secondary Leak Rate	07/05/91	All holders of OLs or CPs for pressurized-water reactors (PWRs).
91-42	Plant Outage Events Involving Poor Coordination Between Operations and Maintenance Personnel During Valve Testing and Manipulations	06/27/91	All holders of OLs or CPs for nuclear power reactors.
91-41	Potential Problems with The Use of Freeze Seals	06/27/91	All holders of OLs or CPs for nuclear power reactors.
88-63, Supp. 2	High Radiation Hazards from Irradiated Incore Detectors and Cables	06/25/91	All holders of OLs or CPs for nuclear power reactors, research reactors, and test reactors.

OL = Operating License
CP = Construction Permit

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PLANT SYSTEMS BRANCH
W/F 8-D-1
WASHINGTON DC 20555

September 10, 1991

Mr. Rubin Feldman
Thermal Science, Inc.
2200 Cassens Drive
St. Louis, MO 63026

Dear Mr. Feldman:

The NRC recently became aware of the failure of a Thermo-Lag protective envelope during a three hour fire endurance test performed in October 1989 at the Southwest Research Institute (SWRI) for River Bend Station. Due to the large number of plants which use Thermo-Lag to meet our regulations found in 10 CFR 50 Appendix R, we are concerned with the potential implications of this test data. We have conducted an initial review of activities at River Bend Station and have concerns regarding the ability of Thermo-Lag to perform as a fire rated barrier.

Following our review of the documents provided by River Bend Station, and other available information concerning Thermo-Lag, we have developed a number of technical questions concerning the Thermo-Lag material and installation and test procedures. In order to resolve our concerns regarding the adequacy of the Thermo-Lag fire barriers, we request that you provide responses to the attached questions. Your prompt response would be appreciated.

If you require further clarification of the attached questions, please call me at 301-492-1272.

Sincerely,

Original signed by
Frank J. Miraglia

Frank J. Miraglia, Deputy Director
Office of Nuclear Reactor Regulation

Enclosure:
As stated

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Per S. West

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Add: S. West
L. Plisco
P. Madden
R. Architzel

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I. FIRE BARRIER SYSTEM MATERIALS AND DESIGN

A. 1-Hour Fire Rated Barriers

1. List all components required to construct a Thermo-Lag fire barrier system with a 1-hour fire resistance rating? Identify and discuss any deviations from the specified components, e.g., the installation of additional components or the deletion of components, allowed by TSI installation procedures. Are there any optional components?

2. What are the minimum wet and dry film thicknesses of Thermo-Lag required to achieve the 1-hour fire resistance rating?

3. What are the Thermo-Lag thickness tolerances allowed (minimum and maximum) by TSI procedures to obtain the 1-hour fire resistance rating?

4. With respect to support systems for 1-hour fire rated Thermo-Lag barriers, e.g., cable tray supports, what specific support protection is required by TSI to ensure the 1-hour fire rating of the system?

5. What are ampacity deratings for 1-hour fire rated Thermo-Lag fire barrier systems?

B. 3-Hour Fire Rated Barriers

1. List all components required to construct a Thermo-Lag fire barrier system with a 3-hour fire resistance rating? Identify and discuss any deviations from the specified components, e.g., the installation of additional components or the deletion of components, allowed by TSI installation procedures. Are there any optional components?

2. What are the minimum wet and dry film thicknesses of Thermo-Lag required to achieve the 3-hour fire resistance rating?

3. What are the Thermo-Lag thickness tolerances allowed (minimum and maximum) by TSI procedures to obtain the 3-hour fire resistance rating?

4. With respect to support systems for 3-hour fire rated Thermo-Lag barriers, e.g., cable tray supports, what specific support protection is required by TSI to ensure the 3-hour fire rating of the system?

5. What are ampacity deratings for 3-hour fire rated Thermo-Lag fire barrier systems?

C. General

1. How do Thermo-Lag fire barrier systems achieve fire performance and endurance properties. Discuss all applicable mechanisms, e.g., chemical, physical, and mechanical.

2. Discuss whether or not the selection of fire barrier components is dependent on the system to be protected or any other factor. For example, does cable tray size, material of construction, or cable loading influence the choice of components?

3. Have changes been made to Thermo-Lag fire barrier materials, including changes in the formulation of Thermo-Lag, since the original development of the system?

4. Are there any differences in the formulations of the different Thermo-Lag coatings, i.e., factory manufactured prefabricated panels and preshaped items, spray, brush, roll, trowel, and caulking materials.

5. Describe how the prefabricated panels and preformed shapes are manufactured. What are the differences between the materials used for the prefabricated products and the spray-on application materials?

6. What cure time is needed for the prefabricated panels and preformed shapes to be considered a rated fire barrier?

7. What cure time is needed for the field applied Thermo-Lag subliming coatings (spray, brush, roll, trowel, and caulking materials) to be considered a rated fire barrier?

8. A review of fire endurance test reports held by River Bend Station, ITL Reports 82-11-80 and 82-11-81, indicate that Thermo-Lag 330-1 cure accelerator mixture was applied to the test articles. Discuss the properties and uses of the cure accelerator mixture. Discuss how this material affects cure time and identify whether or not this material has been purchased by any licensee of a domestic nuclear power reactors for use in a fire rated barrier.

9. Provide the specifications for Stress Skin Type 330-69 and any other stress skins used to construct Thermo-Lag fire barrier systems. Identify any changes to these specifications since the development of the Thermo-Lag fire barrier system.

II. FIRE BARRIER SYSTEM INSTALLATION AND INSPECTION

A. List and provide copies of all TSI installation and quality control procedures for the use of Thermo-Lag fire barrier systems by the commercial nuclear power reactor industry, including related documents such as Technical Notes, issued by TSI since the development of the Thermo-Lag fire barrier system. Include procedures that address protection of support systems, e.g., cable tray supports.

B. Of the procedures listed above, identify those that are currently in effect and discuss any changes from the original procedures and the current procedures.

C. Identify the training and experience requirements for the installation of Thermo-Lag fire barrier systems. Discuss TSI's role in training and certifying installers. Provide the training syllabus used in training Thermo-Lag installers.

D. Identify the training and experience requirements for quality control inspection of Thermo-Lag fire barrier systems. Discuss TSI's role in training and certifying quality control inspectors. Provide the training syllabus followed in training Thermo-Lag inspectors.

E. Describe how material thickness is verified during field application of subliming coating by direct spray, brushing, rolling, troweling, and caulking.

III. FIRE BARRIER QUALIFICATION

A. Fire Endurance Tests

1. With respect to fire resistance ratings, what standards and test methods has TSI used to qualify Thermo-Lag fire barrier systems for use in nuclear power reactors to meet NRC requirements and guidelines? What specific acceptance criteria have been applied?

2. Identify all reports (testing laboratory, test report number, date of test, title of test, summary of test results) that document fire endurance test results that are or have been used by TSI to substantiate the fire endurance and ampacity derating performance of Thermo-Lag fire barrier systems provided for use in nuclear power reactors to meet NRC requirements and guidance. Include test reports that substantiate protection requirements for support systems, e.g., cable tray supports.

3. What are the flame spread, fuel contributed, and smoke developed ratings for Thermo-Lag fire barrier systems. Provide test results that substantiate the ratings.

B. Ampacity Derating Tests

1. With respect to ampacity derating, what standards and test methods has TSI used to qualify Thermo-Lag fire barrier systems for use in nuclear power reactors to meet NRC requirements and guidelines? What specific acceptance criteria have been applied?

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IV. PLANT SPECIFIC APPLICATIONS

A. What domestic nuclear power plants use Thermo-Lag fire barrier systems?

B. The NRC first approved the Thermo-Lag fire barrier system in 1981 for use at Comanche Peak as a 1-hour fire rated barrier. The approved configuration included fiberglass armoring. When was this component deleted from the fire barrier design? Why is this component no longer used?

C. Our understanding of the corrective action to be taken at River Bend Station is to upgrade the existing Thermo-Lag fire barrier systems by the addition of a 1/4-inch layer of Thermo-Lag and stress skin. What is the impact of this upgrade on ampacity derating?

V. AUGUST 23, 1991 LETTER FROM TSI TO LICENSEES

A. The following statements are made in the subject letter: "The Thermo-Lag Stress Skin Type 330-69 was therefore cut, providing a gap in substantial excess of 1/4 inch, probably more than 1 inch. That void was filled with the Thermo-Lag 330-1 Subliming Trowel Grade Material. The Stress Skin, at this separation, was not replaced. The above method of installation is not acceptable." Explain why this installation method is not acceptable. Provide references to TSI procedures that address allowable gap sizes, replacement of stress skin at the gaps, and subliming coating thickness requirements at joints and gaps.

B. TSI installation procedures appear to allow fitting of prefabricated panel sections followed by application of trowel grade material to openings at joints. It is our understanding that butt and miter joints are tight fitting, which prevents the trowel grade material from penetrating the joints during its application. Some licensees, therefore, refer to this installation method as "dry fitting." However, the subject letter states that dry fitting is not allowed under TSI procedure. Explain why TSI does not consider the above installation method to be dry fitting.

September 10, 1991

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Office of Nuclear Reactor Regulation

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September 18, 1991

Mr. Rubin Feldman
Thermal Science, Inc.
2200 Cassens Drive
St. Louis, MO 63026

Dear Mr. Feldman:

As we discussed on September 17, 1991, your written response to my September 10, 1991 letter is expected to be provided to me by Federal Express October 7, 1991. In addition, we scheduled a meeting at NRC Headquarters for Thursday, October 17, 1991 at 10:00 a.m. to discuss your response and related technical issues.

If you require additional information, please call me at 301-492-1272.

Sincerely,

Original signed by
Frank J. Miraglia

Frank J. Miraglia, Deputy Director
Office of Nuclear Reactor Regulation

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