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AUTH.NAME AUTHOR AFFILIATION
ALEXICH,M.P. Indiana & Michigan Electric Co.
RECIP.NAME RECIPIENT AFFILIATION
DENTON,H.R. Office of Nuclear Reactor Regulation, Director

SUBJECT: Responds to 840404 request for addl info re request for exemption from 10CFR50,App R requirements re fire hatches. Drawings,sketches & description of addl insulation encl. Results of calculations & addl info will be sent by 840627.

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INDIANA & MICHIGAN ELECTRIC COMPANY

P.O. BOX 16631
COLUMBUS, OHIO 43216

June 15, 1984
AEP:NRC:06920

Donald C. Cook Nuclear Plant Unit Nos. 1 and 2
Docket Nos. 50-315 and 50-316
License Nos. DPR-58 and DPR-74
INFORMATION CONCERNING REQUEST FOR TECHNICAL
EXEMPTIONS FROM REQUIREMENTS OF APPENDIX R TO 10 CFR 50
FIRE HATCHES

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Denton:

This letter responds in part to your request of April 4, 1984 for additional information on our request for exemption from the requirements of Appendix R to 10 CFR Part 50 with regard to fire hatches.

We are providing as attachments to this letter the relevant physical information with regard to the hatches which you requested. Attachment 1 contains drawings and sketches. Attachment 2 provides a description of the additional insulation including how it is currently being applied. Attachment 3 includes sketches which identify the movable parts and unprotected areas of the hatches.

Since the hatches do not have a specific fire rating, we performed our own engineering evaluation and associated heat transfer calculations. The results of these calculations and information regarding alternatives (Item 4 of Mr. Steven A. Varga's letter, dated April 4, 1984) are currently under management review and will be transmitted to you by June 27, 1984.

This letter has been prepared following Corporate procedures which incorporate a reasonable set of controls to insure its accuracy and completeness prior to signature by the undersigned.

Very truly yours,

M. P. Alexich 6/15/84
Vice President

MPA/cm

cc: John E. Dolan
W. G. Smith, Jr. - Bridgman
R. C. Callen
G. Charnoff - w/attachment
E. R. Swanson, NRC Resident Inspector - Bridgman - w/attachment

A006
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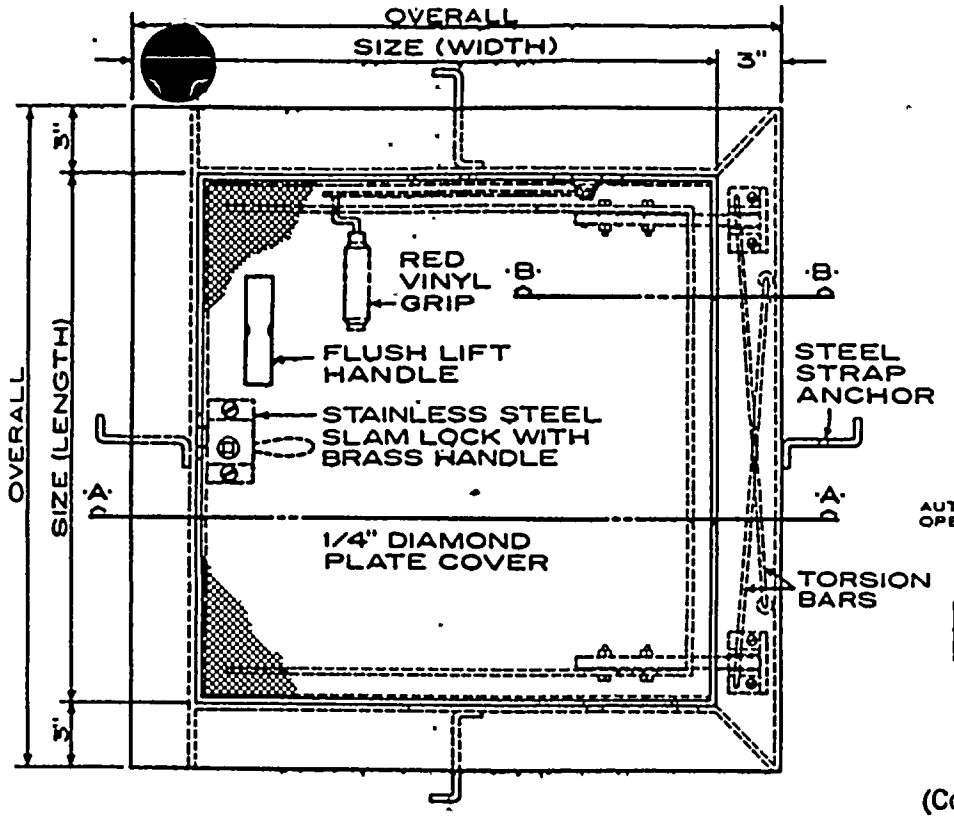
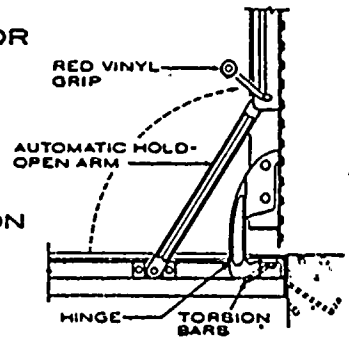
ATTACHMENT 1

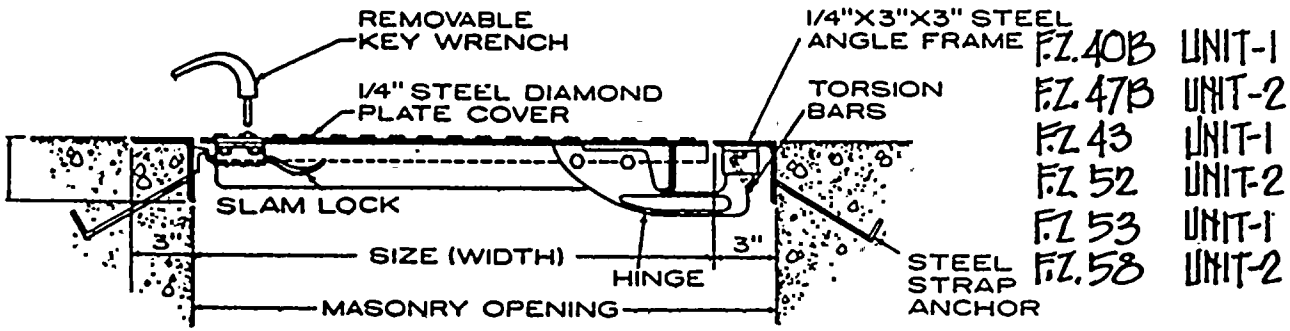
ITEM 1 - SKETCHES OF UNPROTECTED HATCHES.



PLAN VIEW



SECTION B-B
(Cover in Open Position)



SECTION A-A

F.Z.40B	UNIT-1	
F.Z.47B	UNIT-2	
F.Z.43	UNIT-1	
F.Z.52	UNIT-2	
F.Z.53	UNIT-1	
F.Z.58	UNIT-2	

Type Q FLOOR DOOR

SINGLE LEAF STEEL DIAMOND PATTERN PLATE

Reinforced for 150 lbs. per square foot live load.

General Contractor, Please Note:

Be careful not to rack or twist frame when setting unit. Block up and shim the frame if necessary to be sure door rests evenly on frame all around.

Factory Finish: Steel — red oxide primer

Hardware — cadmium plated steel

Manufacturers of Doors for Special Services
THE BILCO COMPANY
New Haven, Connecticut 06505

QUANTITY	TYPE	SIZE WIDTH LENGTH
	Q-1	2'-0" x 2'-0"
	Q-2	2'-6" x 2'-6"
6	Q-3	2'-6" x 3'-0"
	Q-4	3'-0" x 3'-0"

ARCH'T. OR ENG'R. _____

PURCHASE ORDER _____ DATE _____

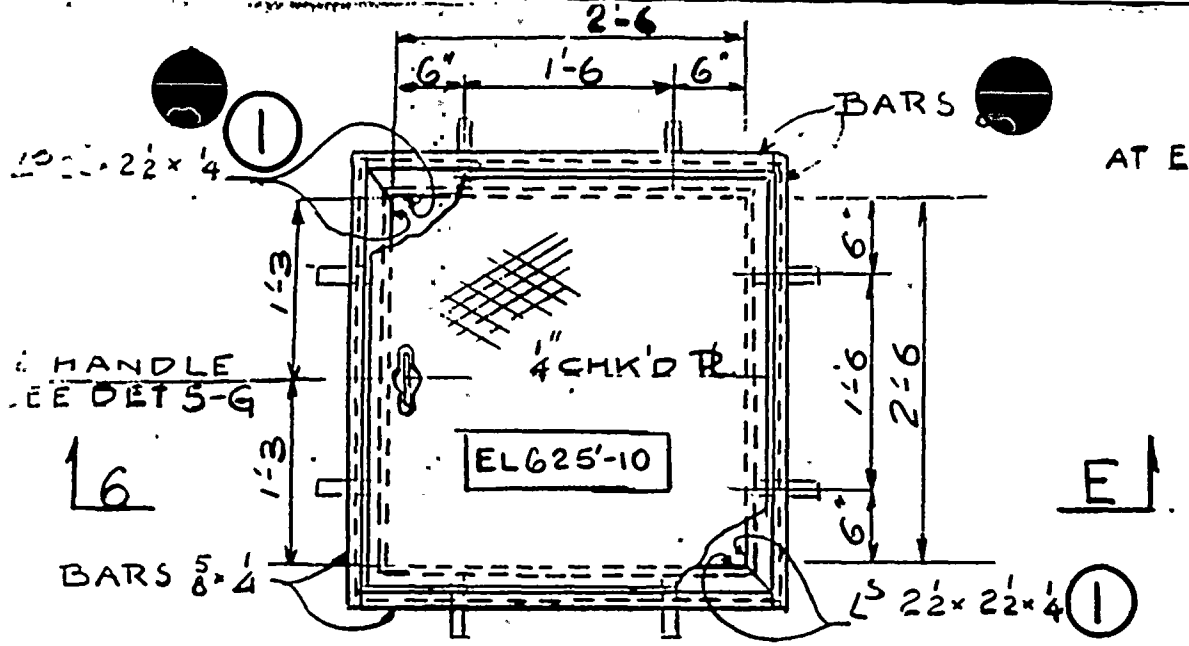
PROJECT _____

GEN'L. CONTRACTOR _____

PURCHASER _____

BILCO REPRESENTATIVE _____

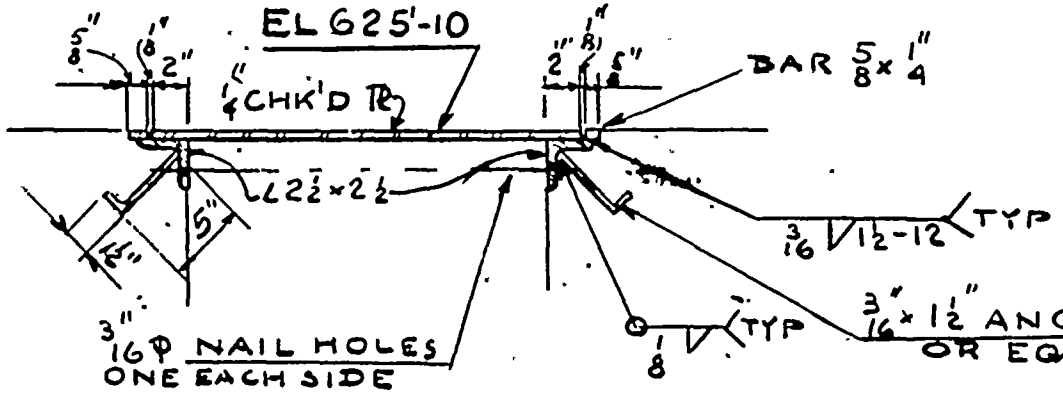
DWG. NO. _____ DATE _____



FRAME MK F10 - TWO REQ'D

REF. DWG 12-3434 ; 12-3436

¾" = 1'-0"



SECTION 6-E

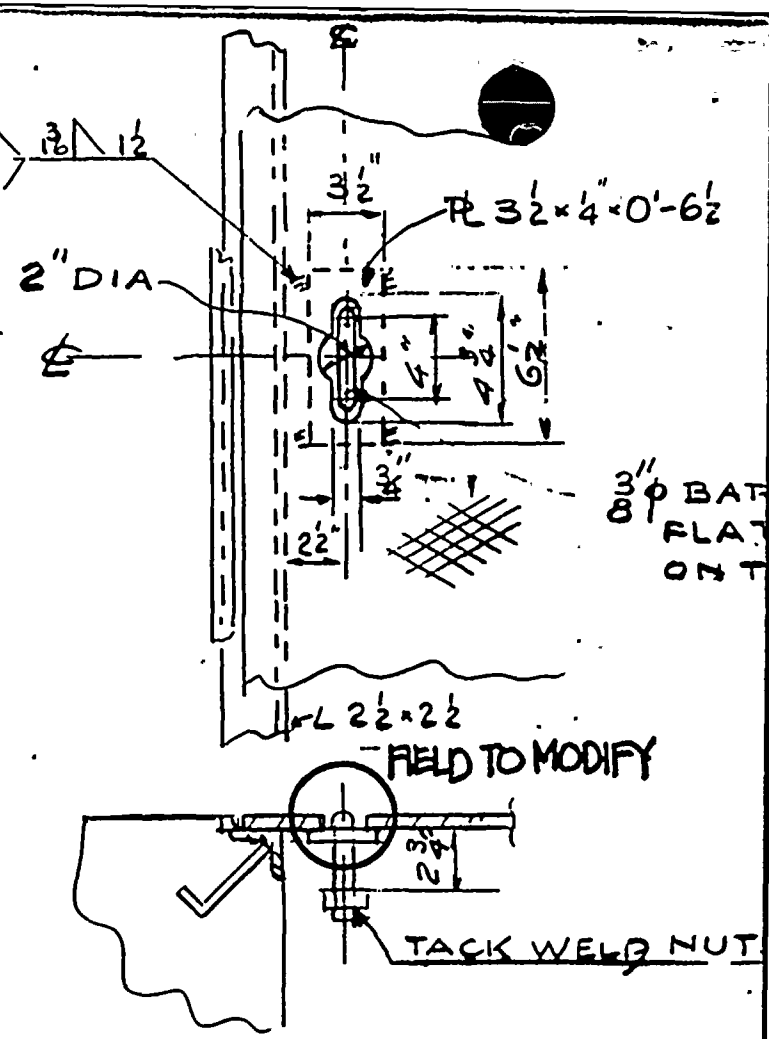
UNPROTECTED FLOOR HATCH AREA

1. FRAME

FLOOR HATCH

FIRE ZONE 41 - UNIT 1

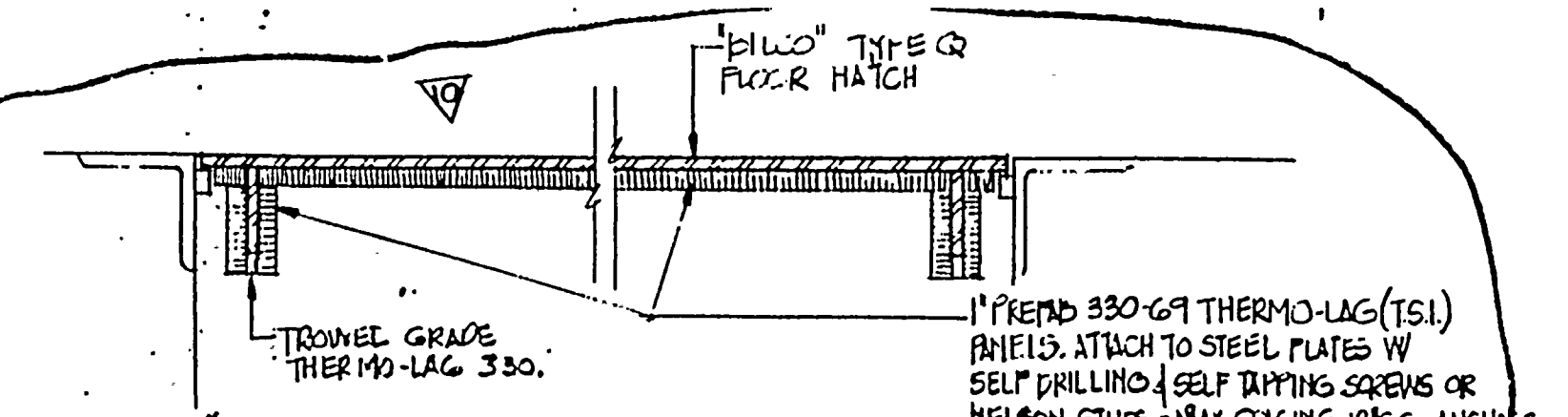
FIRE ZONE 45 - UNIT 2



DETAIL 5-G

ATTACHMENT 2

ITEM 2 - DESCRIPTION OF ADDITIONAL INSULATION INCLUDING HOW IT IS APPLIED AND PROTECTED.



DETAIL 12 (NO SCALE)

SECTION THRU FLOOR HATCH
(UP TO THREE HOURS FIRE PROTECTION)
SEE DWG 12-4021 FOR WEATHERSTRIPPING

TSI INC.

APPROVED FIRE BARRIERS FOR THE NUCLEAR INDUSTRY

thermo-lag® 330-1 FIRE BARRIER

APPLICATIONS IN THE NUCLEAR INDUSTRY

USES

Where fire hazards analysis indicates equipment necessary for safe-shutdown must be protected from design basis fire.

The following are examples of nuclear power plant equipment which can be adequately protected by THERMO-LAG:

- Cable Trays
- Conduit
- Junction Boxes
- Condulets
- Electrical Devices and Equipment
- Instrumentation Tubing
- Instrumentation Devices
- Instrumentation Racks
- Motor Operated and Solenoid Valves
- Fire Stop
- Fire Barrier Non-Load Bearing Wall

ADVANTAGES

- Low weight (minimum impact on existing hangers)
- Minimum ampacity derating
- Fully qualified and approved for nuclear use
- Quick delivery and rapid installation time
- Economical (three-hour THERMO-LAG barrier is less costly than sprinklers plus one-hour barriers)
- Easy to backfit to operating plants

ONE-HOUR RATED THERMO-LAG BARRIER APPLICATION

The one-hour THERMO-LAG fire barriers are used for 10CFR50, Appendix R compliance retro-fit in operating plants, and plants nearing operation (NTOL plants) ***where sprinklers are already installed*** or are planned to be installed in the fire area.

Appendix R, Paragraph G.2.C. permits "Enclosure of cable and equipment and associated non-safety circuits of one redundant train ***in a fire barrier having a one-hour rating.*** In addition, fire detectors and an automatic fire suppression system shall be installed in the fire area."

One-hour fire barriers are also recommended for use in plants still in the design phase, where sprinklers are planned to be used in a given fire area.

THREE-HOUR RATED THERMO-LAG BARRIER APPLICATION

The three-hour THERMO-LAG fire barriers are used to comply with the requirements of 10CFR50, Appendix R. The barriers are recommended for use in retro-fit of operating plants, NTOL plants, and plants in the design phase ***where sprinklers will not be installed in the fire area.*** Some buildings in the nuclear plant complex are not compatible with sprinklers such as the Reactor Building and electrical equipment areas. The three-hour THERMO-LAG barriers can be installed in these areas.

Economic trade-off studies indicate that even where sprinklers can be installed, it is cheaper to use a three-hour THERMO-LAG barrier and no sprinklers versus using the one-hour THERMO-LAG barrier plus sprinklers, due to the high cost of sprinklers.

The three-hour THERMO-LAG barrier satisfies the requirements of Appendix R, Paragraph G.2.A, "Separation of cables and equipment and associated non-safety circuits of redundant trains ***by a fire barrier having a three-hour rating".***

QUALIFICATIONS

Both the one-hour THERMO-LAG fire barrier, and the three-hour THERMO-LAG fire barrier have been approved by the American Nuclear Insurers (ANI) and the Nuclear Regulatory Commission (NRC) for use in nuclear plants.

series of ASTM E119 fire tests were run for various configurations of ladder-type trays, solid-bottom trays, and conduits for 40 percent cable fill and single layer cable fill. At the conclusion of each fire test, the test specimens were subjected to, and passed, the mandatory hose stream test. In addition to conducting the fire tests in accordance with ASTM E119, the test procedures specified in the ANI/MAERP, "Basic Fire Protection Guidelines" were strictly adhered to.

Both the one-hour and three-hour barriers have had ampacity derating tests in accordance with IPCEA-NEMA standards.

THERMO-LAG LEADING PARTICULARS

Item	One-Hour Barrier	Three-Hour Barrier
Thickness of barrier	1/2 inch	1 inch
Weight of barrier	3.5 lbs./ft^2	7 lbs./ft.^{2}
Radiation Resistance	2 x 10^8 rads	2 x 10^8 rads
Ampacity Derating	7-12 percent	17 percent

INSTALLATION

THERMO-LAG is quickly installed by unskilled craftsmen who can be trained by TSI. The material can be installed by means of preformed panels (1/2 inch thick) which are scored and contoured to fit most equipment. It can also be applied by air spray methods, or hand trowel. The product sets up semi-hard in a few days, and is fully cured, ready for use in 28 days. Prefabricated panels installation format, is quicker, cleaner, and barrier thickness quality control is factory controlled. However, in-place spray installation is also acceptable, and will generally be required for irregular objects and difficult to work places. Prefabricated panels may be fabricated at the job site by the installer, or be factory supplied from TSI. The use of prefabricated panels avoids masking/covering non-sprayed areas, and also eliminates over-spray.

SEISMIC QUALIFICATION

THERMO-LAG has been analyzed to Seismic I requirements, and found to be adequate. However, there are no NRC requirements for the fire barriers to be Seismic I, since the accident scenerio does not require a nuclear plant to be designed for a seismic event and a fire concurrently.

If a particular nuclear plant requires the fire barriers to be Seismic I, the product can meet that criteria.

QA/QC

THERMO-LAG can be supplied and installed to any required quality classification, e.g., Quality I (safety related), Quality II (balance of plant), or Quality III (or general) (remainder not included in Quality I or II). Most users have specified Quality Class II, since the Nuclear Insurers required quality control on the barrier material, installation, and inspection.

TSI has approved quality assurance/quality control manuals suitable for the required quality classification.

DELIVERY

THERMO-LAG is supplied in 55 gallon drums and initial shipment can be made in 6 weeks ARO. Prefabricated panels can be supplied in sizes to suit the user (4 ft. x 6½ ft. is the usual size), and usually shipped 6 weeks ARO.

In special cases, where plants have an unusually critical need, TSI has made special arrangements to accommodate even shorter delivery cycles.

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St. Louis, Mo. 63139
• (314) 352-8422
• Telex: 44-2364
• TWX: 20-0901

TSI 10 92 (400)

TSI INC.

APPROVED FIRE BARRIERS FOR THE NUCLEAR INDUSTRY

thermo-lag® 330-1 FIRE BARRIER

ADVANTAGES OF thermo-lag® FIRE BARRIERS

— THERMO-LAG one-hour and three-hour rated fire barriers are fully qualified by the American Nuclear Insurers (ANI), and the Nuclear Regulatory Commission. Both one-hour and three-hour barriers have been tested to ASTM E119 fire endurance requirements, and ANI qualification criteria. The barriers are fully approved for use in Nuclear Plants.

— THERMO-LAG one-hour and three-hour rated fire barriers have been tested for ampacity derating, when applied to electrical cable trays and conduit. The derating values of 10 percent (one-hour barrier) and 17 percent (three-hour barrier) are extremely low values, and provide the ability to retro-fit THERMO-LAG to power cable raceways.

— THERMO-LAG'S low weight has minimum effect on hangers and raceway systems. This feature makes THERMO-LAG particularly suited to retro-fit applications in operating, or near operational nuclear plants.

— THERMO-LAG is readily installed by various methods such as spray, trowel, or roller. It can also be installed as prefabricated panels. The versatility of installing THERMO-LAG by different methods provides construction management with options, which can be best suited to the plant needs.

— THERMO-LAG is essentially chemically inert. It has negligible chloride content, and will not affect stainless steel.

— THERMO-LAG is water based, and contains no asbestoes fibers. It will not pose any environmental problems to personnel or equipment. It will not introduce potential maintenance problems for motors or HVAC systems due to airborne fiber release.

— THERMO-LAG is not affected by water, therefore, pipe leaks, clean-up operations, or inadvertent fire suppression system sprinkler actuation will not require any repair or replacement of the THERMO-LAG fire barriers.

— THERMO-LAG is only one inch thick for the three-hour rated barrier, and one-half inch thick for the one-hour rated barrier. It does not require large spatial volumes around the protected equipment. This is particularly beneficial to raceway systems such as trays, since THERMO-LAG barriers will not reduce aisle space or the space between trays.

— THERMO-LAG is easily removed from protected equipment for access or to pull additional cables. Removable access panels can be provided or the THERMO-LAG barriers can be cut and repaired by a tested/approved procedure.

— THERMO-LAG can be provided to any required seismic criteria. It has been seismically qualified to SSE accelerations up to 7.5g.

— THERMO-LAG has a minimum effect on previously seismically qualified equipment, since it does not appreciably change the natural frequency of raceway systems due to its low weight.

— THERMO-LAG can be provided to any required Quality Assurance level, i.e., up to Quality Class I. TSI has a complete QA program for nuclear work, meeting all the requirements of ANSI 45.2.

— Several nuclear power plants are using THERMO-LAG fire barriers for new and retro-fit applications.

— THERMO-LAG can be used to protect raceway supports, as required by 10CFR50, Appendix R.

— THERMO-LAG three-hour rated fire barriers negate the need for sprinklers, at a considerable cost saving. This is extremely useful in nuclear plants, since sprinklers are not desirable in some areas, such as electrical equipment rooms, portions of the Reactor Building, and Radwaste areas.

— THERMO-LAG can be supplied with short lead time, in both pre-fabricated panels and 55 gallon drums for spray or trowel applications.

— TSI can provide field service engineers to assist construction management during the installation phase.

— TSI qualifies THERMO-LAG applicators at the TSI facility, and provides certification as THERMO-LAG applicators. This insures quality installation of THERMO-LAG, and that the expected fire performance will be met.

— THERMO-LAG is low cost, for both the material and installation.

— THERMO-LAG is extremely versatile, and may be used for many fire barrier protective purposes, in addition to raceway protection such as protection of diesel oil day tanks, non-load bearing partitions, protection of instruments, and valves

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• Telex: 20-9901

TSI INC.

APPROVED FIRE BARRIERS FOR THE NUCLEAR INDUSTRY

thermo-lag® 330-1 FIRE BARRIER

ONE-HOUR FIRE BARRIER TEST

PURPOSE OF TESTS

The purpose of the tests was to qualify, and gain ANI approval for THERMO-LAG, for use as a one-hour rated fire barrier in nuclear power generating plants.

Specifically, the tests were designed to prove the adequacy of THERMO-LAG material for Appendix R compliance applications, since Appendix R, Paragraph G.2.C., permits the use of an approved one-hour rated fire barrier, plus sprinklers and detectors to protect equipment needed for safe shutdown.

The one-hour fire rated THERMO-LAG barriers are used to protect cable trays, conduits, instrument tubing, and equipment.

TEST LOCATION

All tests were conducted at TSI, Incorporated, St. Louis, Missouri, by Industrial Test Laboratories (independent third party), St. Louis, Missouri.

TEST CRITERIA

All the requirements of the American Nuclear Insurer's publication, "ANI/MAERP STANDARD FIRE ENDURANCE TEST METHOD TO QUALIFY A PROTECTIVE ENVELOPE FOR CLASS 1E ELECTRICAL CIRCUITS", were implemented in the fire test procedures. In addition, the fire test procedure was reviewed and approved by ANI prior to testing.

The THERMO-LAG one-hour fire barrier was subjected to the standard temperature — time curve found in ASTM E-119-76 (ANSI A2.1) for a minimum of one hour. Immediately following the E-119 fire endurance test, the test specimen was subjected to a 2-1/2 minute hose stream test, delivered through a 2-1/2 inch national standard playpipe, equipped with a 1-1/8 inch tip, nozzle pressure of 30 psi, located 20 feet from the test article.

The main criteria was that the cable circuit integrity be maintained throughout the fire endurance and hose stream test. Secondary considerations were to keep the temperature of the cable jackets well below the auto-ignition temperature of the cable.

DESCRIPTION OF TEST ARTICLES

The cables used for the fire tests were representative of "GENERIC" and the IEEE-383 cables installed in nuclear generating plants, for use in power, control and instrumentation circuits. Cables made by the major suppliers of IEEE-383 cable, such as Rockbestos, Raychem, Okonite, and BIW were tested.

Tests were conducted on the following configurations:

1. Solid bottom 6 inch by 6 inch tray, 40 percent filled.
2. Solid bottom 6 inch by 6 inch tray, one layer of cables.
3. Ladder bottom tray 12 inch by 4 inch, 40 percent filled with one air drop cable.
4. Ladder bottom tray 12 inch by 4 inch, one layer of cables.
5. 2-1/2 inch and 4 inch conduits, 40 percent filled, including condulet and pull box.

The tray, conduits, and equipment used are the same as installed in a typical nuclear generating plant. The test specimens utilized "U" shaped, horizontally mounted tray sections in order to comply with the ANI requirment to have one horizontal and one vertical section in the furnace.

Each test article was covered with a nominal one-half inch thickness of THERMO-LAG in strict accordance with TSI QC procedures. The various methods of installing THERMO-LAG were tested, in order to qualify each method. Pre-fabricated panels, air spray and hand trowel installation was used. A repair patch was also tested to qualify repair procedures. The THERMO-LAG barrier was then cured for up to 28 days prior to testing.

TSI INC

See Figure 1 for a photograph of a typical specimen before testing.

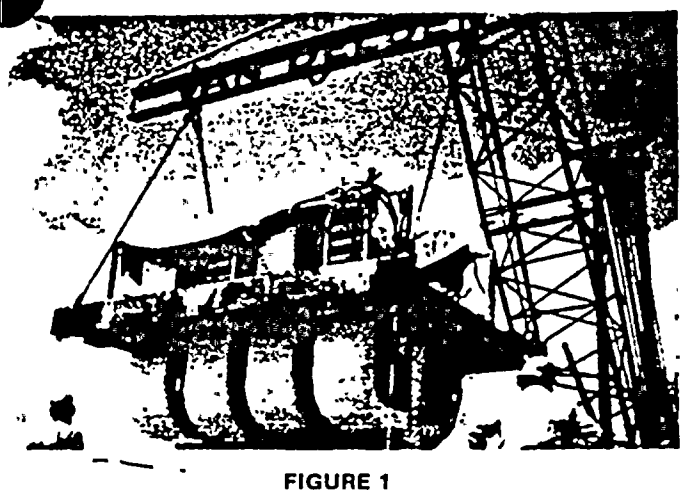

FIGURE 1
Typical Specimen Before Testing

TEST EQUIPMENT

The equipment used for the test was calibrated just prior to the test, and consists of the following:

ASTM-E-119 FIRE SIMULATION TEST FURNACE — The furnace was steel plated and insulated, and its inside dimensions measured 36 inches x 71 inches by 50-1/2 inches. It included 11 gas burners (with individual adjustable valves), mounted four on each of two sides, and three on the rear wall. Ten chromel/alumel thermocouples are provided to monitor furnace temperature. The front face of the furnace was used to mount the test specimen. Adequate exhaust, and control of gas supply was provided.

Thermocouples on Cables — Ten number 24 gauge chromel/alumel thermocouples were mounted to the cable jackets at selected points in trays/conduits to monitor cable jacket temperatures. The locations were selected in both the upper, lower, and center of the "U" section to provide representative data, from all locations on the test specimen. .

Multi-Light Display — A multi-light display panel and strip chart recorder was used to monitor cable circuit integrity for circuit to circuit, circuit to system, and circuit to ground cases. Nine cables were monitored in each test, from various locations in the tray.

Thermocouple Recorders Two thermocouple point chart type recorders were utilized to monitor and record furnace, and cable temperatures.

Fire Pumper Truck — A 1250 gpm Class "A" Pumper truck capable of 90 psi discharge pressure was used for the hose stream test

TEST PROCEDURE

The procedure used for each test was as follows:

1. Before the test, ANI for some tests, Architect Engineer for some tests, Owner for some tests, and Industrial Test Laboratory for all tests reviewed the test article to verify THERMO-LAG application thickness and cure time. The test instrumentation was checked for calibration and operability.
2. Light furnace and place test article inside; seal furnace and start clock.
3. Stabilize furnace temperature, and follow ASTM E-119 time/temperature curve; record temperature/time values.
4. Monitor cable thermocouples and circuit continuity light panel.
5. Regulate gas supply to achieve temperature control.
6. After one hour remove test article, keeping circuit integrity lights hooked up.
7. Within as short a time as possible (approximately 2 minutes) initiate hose stream test, rotating and pitching test article assembly to play hose stream on all surfaces of the object. Terminate hose stream test in 2-1/2 minutes.
8. Visually inspect specimen, verify test data and sign data sheet.

TEST RESULTS

The test results have been approved by ANI, and THERMO-LAG certified for use in nuclear generating plants based on the following:

- All cable circuits retained electrical continuity throughout fire endurance and hose stream tests.

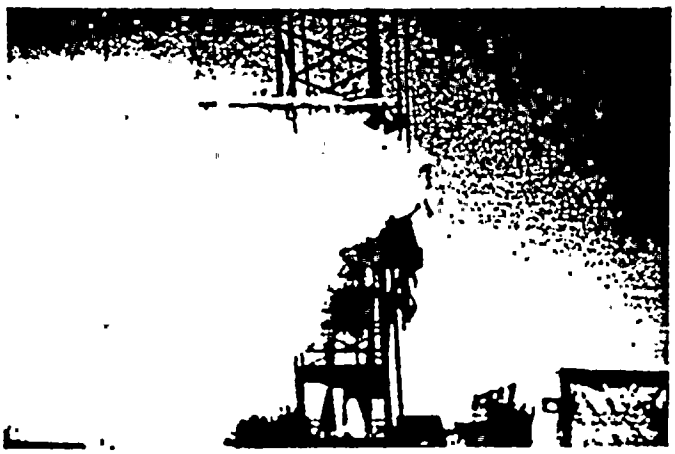

FIGURE 2
Typical Specimen After Testing

- The THERMO-LAG fire barriers were structurally intact and charred, but did not have any burn through holes, and the test specimen had no damage from the hose stream tests. (See Figure 2 for photograph of a typical specimen after testing).

- The THERMO-LAG fire barrier was cut open, and the cables examined. The cables showed no visible sign of fire damage. (See Figure 3 for photograph of the cables within a typical specimen after exposure to the One-Hour Fire Endurance and Water Hose Stream Tests.

In addition to ANI approval, the Nuclear Regulatory Commission (NRC) has approved THERMO-LAG one-hour rated fire barriers for installation in some nuclear generating plants.

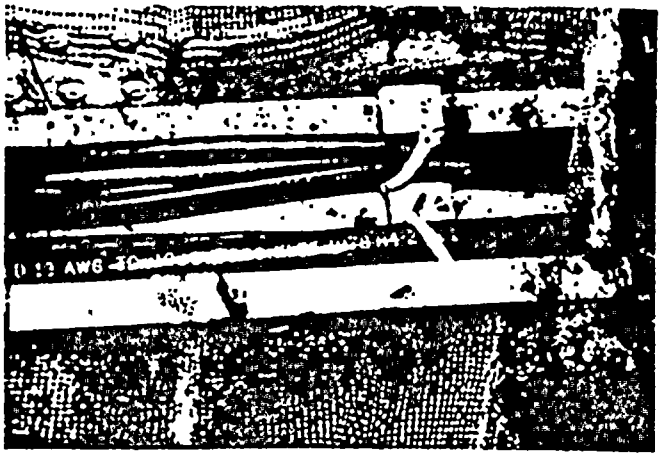

FIGURE 3
Cables Within A Typical Specimen After Testing

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thermo-lag® 330-1 FIRE BARRIER

THREE-HOUR FIRE BARRIER TESTS

PURPOSE OF TESTS

The purpose of the tests was to qualify, and gain ANI approval for THERMO-LAG, for use as a three-hour rated fire barrier in nuclear power generating plants.

Specifically, the tests were designed to prove the adequacy of THERMO-LAG material for Appendix R compliance applications, since Appendix R, Paragraph G.2.a, permits the use of an approved three-hour rated fire barrier to protect equipment needed for safe shutdown.

The three-hour fire rated THERMO-LAG barriers are used to protect cable trays, conduits, instrument tubing, and equipment.

TEST LOCATION

All tests were conducted at TSI, Incorporated, St. Louis, Missouri, by Industrial Test Laboratories (independent third party), St. Louis, Missouri.

TEST CRITERIA

All the requirements of the American Nuclear Insurer's publication, "ANI/MAERP STANDARD FIRE ENDURANCE TEST METHOD TO QUALIFY A PROTECTIVE ENVELOPE FOR CLASS 1E ELECTRICAL CIRCUITS", were implemented in the fire test procedure. In addition, the fire test procedure was reviewed and approved by ANI prior to testing.

The THERMO-LAG three-hour fire barrier was subjected to the standard temperature — time curve found in ASTM E-119-76 (ANSI A2.1), for a minimum of three hours. Immediately following the E-119 fire endurance test, the test specimen was subjected to a 2-1/2 minute hose stream test, delivered through a 2-1/2 inch national standard playpipe, equipped with a 1-1/8 inch tip, nozzle pressure of 30 psi, located 20 feet from the test article.

The main criteria was that the cable circuit integrity be maintained throughout the fire endurance and hose stream test. Secondary considerations were to keep the temperature of the cable jackets well below the auto-ignition temperature of the cable.

DESCRIPTION OF TEST ARTICLES

The cables used for the fire tests were representative of "GENERIC" and the IEEE-383 cables installed in nuclear generating plants, for use in power control and instrumentation circuits. Cables made by the major suppliers of IEEE-383 cable, such as Rockbestos, Raychem, Okonite, and BIW were tested.

Tests were conducted on the following configurations:

1. Solid bottom 6 inch by 6 inch tray, 40 percent filled.
2. Solid bottom 6 inch by 6 inch tray, one layer of cables.
3. Ladder bottom tray 12 inch by 4 inch, 40 percent filled with one air drop cable.
4. Ladder bottom tray 12 inch by 4 inch, one layer of cables.
5. 2-1/2 inch and 4 inch conduits, 40 percent filled, including condulet and pull box.

The tray, conduits, and equipment used are the same as installed in a typical nuclear generating plant. The test specimens utilized "U" shaped, horizontally mounted tray sections in order to comply with the ANI requirement to have one horizontal and one vertical section in the furnace.

Each test article was covered with an inner layer of stress skin screen, followed by a nominal one-inch thickness of THERMO-LAG, and then an outer wrap of stress skin screen. The installation was made in accordance with TSI QC procedures. The various methods of installing THERMO-LAG were tested, in order to qualify each method. Pre-fabricated panels, air spray and hand trowel installation was used. A repair patch was also tested to qualify repair procedures. The THERMO-LAG barrier was then cured for up to 28 days prior to testing.

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See Figure 1 for a photograph of a typical specimen before testing.

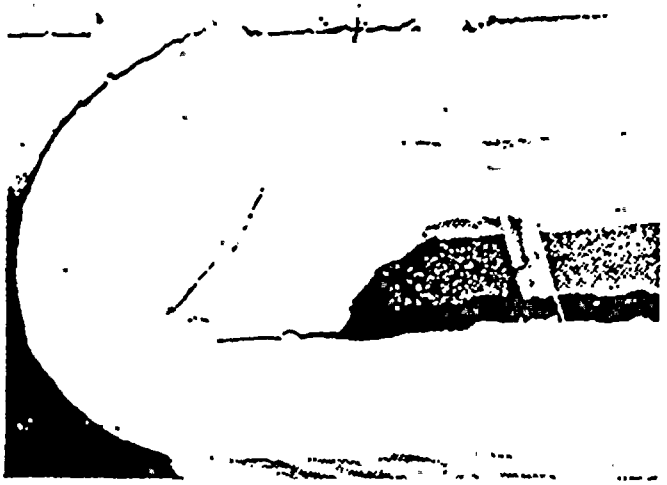

FIGURE 1
Typical Specimen Before Testing

TEST EQUIPMENT

The equipment used for the test was calibrated prior to the tests, and consists of the following:

ASTM-E-119 FIRE SIMULATION TEST FURNACE — The furnace was steel plated and insulated, and its inside dimensions measured 36 inches x 71 inches by 50-1/2 inches. It included 11 gas burners (with individual adjustable valves), mounted four on each of two sides, and three on the rear wall. Then chromel/alumel thermocouples are provided to monitor furnace temperature. The front face of the furnace was used to mount the test specimen. Adequate exhaust, and control of gas supply was provided.

Thermocouples on Cables — Ten Number 24 gauge chromel/alumel thermocouples were mounted to the cable jackets at selected points in trays/conduits to monitor cable jacket temperatures. The locations were selected in both the upper, lower, and center of the "U" section to provide representative data, from all locations on the test specimen.

Multi-Light Display — A multi-light display panel and strip chart recorder was used to monitor cable circuit integrity for circuit to circuit, circuit to system, and circuit to ground cases. Nine cables were monitored in each test, from various locations in the tray.

Thermocouple Recorders — Two thermocouple point chart type recorders were utilized to monitor and record furnace, and cable temperatures.

Fire Pumper Truck — A 1250 gpm Class "A" Pumper truck capable of 90 psi discharge pressure was used for the hose stream test.

TEST PROCEDURE

The procedure used for each test was as follows:

1. Before the test, ANI, Architect Engineer, Owner and Industrial Test Laboratory reviewed the test article to verify THERMO-LAG application thickness and cure time. The test instrumentation was checked for calibration and operability.
2. Light furnace and place test article inside; seal furnace and start clock.
3. Stabilize furnace temperature, and follow ASTM E-119 time/temperature curve; record temperature/time values.
4. Monitor cable thermocouples and circuit continuity light panel.
5. Regulate gas supply to achieve temperature control.
6. After three hours, remove test article, keeping circuit integrity lights hooked up.
7. Within as short a time as possible (approximately 2 minutes) initiate hose stream test, rotating and pitching test article assembly to play hose stream on all surfaces of the object. Terminate hose stream test in 2-1/2 minutes.
8. Visually inspect specimen, verify test data and sign data sheets.

TEST RESULTS

The test results have been submitted to ANI, and THERMO-LAG is pending certification for use in nuclear generating plants. The following are the major test results:

— All cable circuits retained electrical continuity throughout fire endurance and hose stream tests.

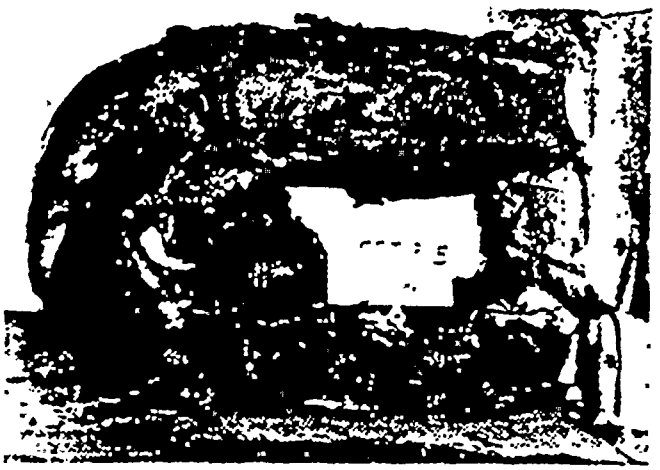

FIGURE 2
Typical Specimen After Testing

— The THERMO-LAG fire barriers were structurally intact and charred, but did not have any burn through holes, and the test specimen had no damage from the hose stream tests. (See Figure 2 for photograph of a typical specimen after testing).

— The THERMO-LAG fire barrier was cut open, and the cables examined. The cables showed no visible sign of fire damage. (See Figure 3 for photograph of the cable within a typical specimen after exposure to the Three-Hour Fire Endurance and Water Hose Stream Tests.

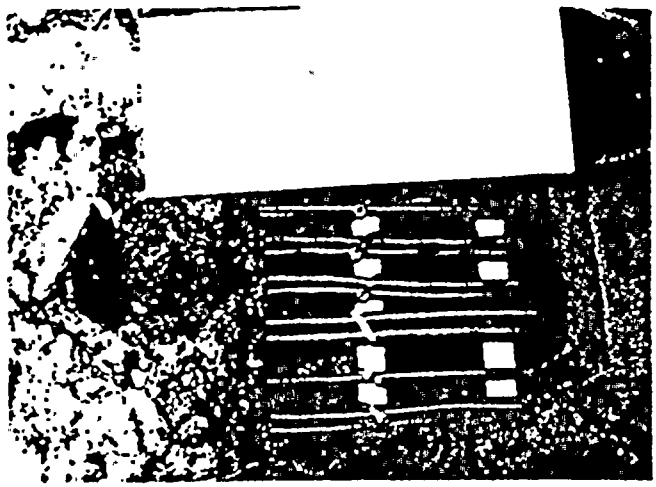

FIGURE 3
Cables Within A Typical Specimen After Testing

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APPROVED FIRE BARRIERS FOR THE NUCLEAR INDUSTRY

thermo-lag® 330-1 FIRE BARRIER

MATERIAL PROPERTIES

This brochure presents the major properties of THERMO-LAG in interest for nuclear generating plant application. For additional data not presented, consult TSI.

RADIATION RESISTANCE

— 2.12 x 10^8 rads total 40 year integrated dose

— After irradiation no degradation in fire resistive properties

FIRE PROTECTIVE FEATURES

— ASTM E-84 Testing for THERMO-LAG 330-1

— Flame Spread Rating	—	5
— Fuel Contributed Rating	—	0
- Smoke Developed Rating	—	15

— ASTM E-84 Testing for THERMO-LAG Primer

— Flame Spread Rating	—	0
— Fuel Contributed Rating	—	0
— Smoke Developed Rating	—	5

— ASTM E-84 Testing for THERMO-LAG 350-2P Topcoat

— Flame Spread Rating	—	5
— Fuel Contributed Rating	—	0
— Smoke Developed Rating	—	0

— One-hour and three-hour fire endurance test, in accordance with ASTM E-119, and ANI/MAERP test "ANI/MAERP Standard Fire Endurance Test Method to Qualify a Protective Envelope for Class 1E Electrical Circuits".

— 1/2 inch THERMO-LAG rated one hour
— 1 inch THERMO-LAG rated three hours

— ASTM E-119 hose stream test on electrical trays and conduit for one and three hour rated THERMO-LAG (2-1/2 minute hose stream application)

— ASTM E-119 fire tests for structural steel, hangers to determine required THERMO-LAG thickness for one and three hour rating

AMPACITY DERATING

Ampacity derating tests performed in accordance with IPCEA Publication Number P-54-440 (Second Edition) (to determine cable base ampacity) and NEMA Publication No. WC51-1975. The following results were obtained (for 40 percent loading):

One-Hour THERMO-LAG Barriers

— Tray	—	12.5 percent derating
— Conduit	—	6.8 percent derating

Three-Hour THERMO-LAG Barriers

— Tray	—	17 percent derating
— Conduit	—	10.9 percent derating

MECHANICAL (PHYSICAL) PROPORTIES

— Density wet — 10.5 lbs/gallon
— Density dry — 75±3 lbs/ft^3
— Dry Weight 1/2 inch thickness (one-hour rated) = 3.25 lb/ft^2
— Dry Weight 1 inch thickness (three-hour rated) = 6.5 lb/ft^2
— Water based

— Tensile strength	— (75°F)	—	800 PSI
— Shear strength	— (75°F)	—	1100 PSI
— Flexural stiffness	— (75°F)	—	85 KSI
— Flexural strength	— (75°F)	—	2200 PSI
— Bond strength	— (75°F)	—	575 PSI
— Initial Modulus	— (75°F)	—	70 KSI

— Thermal Conductivity (Unfired, full cured) 0.1 Btu/hr ft.²°F/ft

SEISMIC PROPORTY

THERMO-LAG has been qualified by static analysis for a very conservative loading. A value of 7.5g horizontal, and 6.0g vertical acceleration, combined biaxially was used for the analysis. These values bound most nuclear generating plant seismic criteria.

MISCELLANEOUS DATA

- Shelf Life (Bulk) 6 months
- Storage Conditions above 32°F and below 100°F
- Asbestoes free
- Non-toxic

CHEMICAL RESISTANCE OF THERMO-LAG 330-1

- Water
- Sulfuric acid — 10 percent solution
- Hydrochloric acid — 10 percent solution
- Sodium hydroxide — 10 percent solution
- Sodium chloride — 5 percent solution
- Acetic acid
- Kerosene
- Anhydrous Ammonia
- LNG
- LPG
- Methanol

CHEMICAL RESISTANCE OF THERMO-LAG 350-2P TOPCOAT

- Frequent Contact
  - Alkali solutions
  - Salt solutions
  - Alcohols
  - Aliphatic hydrocarbons
  - Aromatic hydrocarbons
- Occasional Contact
  - Fresh water
  - Waste water
  - Mineral oils
  - Vegetable oils
  - Organic acids
  - Mineral acids
  - Oxidizing agents
  - Ketones

ACCELERATED AGING AND WEATHERING

- Exterior Environmental Conditions
  - High humidity
  - Industrial atmosphere (CO_2 — SO_2 mix)
  - Salt spray
- Interior Environmental Conditions
  - High humidity
  - CO_2 — SO_2 atmosphere mix
  - Chlorine

Results: Service life of at least 40 years

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TSI QA/AC NUCLEAR PROGRAM HIGHLIGHTS

INTRODUCTION

THERMO-LAG one-hour, and three-hour fire barriers can be supplied to any required QA level (i.e. QA-I, QA-II, or G), since TSI has an approved QA/QC manual which meets all the applicable requirements of 10CFR50, Appendix B, as defined by ANSI 45.2 for nuclear generating plant applications.

QUALITY ASSURANCE REQUIREMENTS FOR NUCLEAR GENERATING PLANTS

The general requirements for quality assurance in nuclear generating plants is provided by 10CFR50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants". The detail requirements are specified by ANSI/ASME N45.2-1977 "Quality Assurance Program Requirements for Nuclear Facilities". In addition, Branch Technical Position 9.5.1 provides specific Quality Assurance requirements for fire protection systems in nuclear facilities. It requires "The Quality Assurance (QA) programs of applicants and contractors should ensure that the guidelines for design, procurement, installation and testing, and the administrative controls for the fire protection systems for safety-related areas are satisfied". Branch Technical Position 9.5-1 includes the same requirements as ANSI/ASME N45.2-1977 and 10CFR50, Appendix B.

The 18 general requirements of 10CFR50, Appendix B are as follows:

- Organization
- Quality Assurance Program
- Design Control
- Procurement Document Control
- Instructions, Procedures, and Drawings
- Document Control
- Control of Purchased Material, Equipment, and Services
- Identification and Control of Materials, Parts, and Components
- Control of Special Processes
- Inspection
- Test Control
- Control of Measuring and Test Equipment
- Handling, Storage, and Shipping
- Inspection, Test, and Operating Status
- Non-conforming Materials, Parts, or Components
- Corrective Action
- Quality Assurance Records
- Audits

Each of the above requirements is an integral part of TSI's Quality Assurance Plan. The TSI Quality Assurance Manager reports through an independent chain of authority directly to the President, and has complete autonomy from Engineering and Manufacturing.

All phases of the manufacturer of THERMO-LAG fire barriers, from purchase of raw materials, through product manufacturer, inspection, tests, storage, and shipping are carefully governed by QA procedures.

TSI QA/QC MANUAL PRINCIPLE FEATURES

TSI has, and is presently doing Quality Class I, and Quality Class II work at nuclear generating stations. The basic TSI Quality Assurance Program, including QA manual has been reviewed and approved by Architect Engineers, and the American Nuclear Insurers for use on nuclear power plants.

The main points covered by the TSI Quality Assurance Program are as follows:

TSI INC

— **Organization**

TSI has a documented organizational structure, with clearly defined lines of authority. The responsibility and job duties are also specified. A Quality Assurance manager, directs all quality related activities, reporting directly to the President. The QA manager is completely independent from the manufacturing and engineering departments.

— **Quality Assurance Program**

TSI has a corporate QA program which complies with all the applicable requirements of ANSI/ASME N45.2-1977. The TSI QA program covers all the quality related activities of THERMO-LAG fire barriers such as: raw material purchase, manufacturing of THERMO-LAG, inspection, tests, storage, shipping, indoctrination and training, calibration of equipment, records and includes provision for periodic management review of the QA program.

In special cases the corporate QA program is revised to include specific customer QA requirements. These project-specific requirements are clearly identified.

— **Design Control**

TSI is essentially a manufacturer of a standard product — THERMO-LAG fire barriers, and as such does not perform design work, since the product chemistry is well established. However, all codes, government regulations and OSHA requirements have been factored into the THERMO-LAG material.

— **Procurement Document Control**

In order to provide quality control and traceability, raw materials are strictly controlled by means of review of supplier Quality Assurance, Source Inspection, Audits, Inspection, and by Documentation Requirements. All procurement documentation for quality-related items is maintained and readily retrievable.

— **Instructions, Procedures and Drawings**

TSI has documented procedures, appropriate for the type of activity for all quality related work.

— **Document Control**

TSI has a system for control of issuance of documents, including revisions for all activities affecting quality. A review and sign-off is required for both initial issue and revisions. Revisions are numbered, and clearly identified on documents.

— Control of Purchased Material, Equipment, and Services

TSI maintains documented records for all raw materials used for quality affecting items. TSI has procedures to assure that purchased raw materials conform to the procurement documents. Source surveillance, inspections, and testing are utilized to insure raw material quality. In addition, documentation records are maintained to provide traceability.

— **Identification and Control of Materials, Parts, and Components**

TSI has procedures to completely identify THERMO-LAG, which is related to the manufacturing batch number. TSI also utilizes the physical separation method, when supplying pre-fabricated THERMO-LAG one-hour and three-hour rated panels. All quality rated items are manufactured in a separate area, and stored in segregated areas prior to shipment. The materials used in the pre-fabricated panels are traceable to the manufacturing batch. Panels can be marked, if required to suit customer requirements.

— **Control of Special Processes**

Special processes used for TSI for testing of raw materials, cleaning, and nondestructive testing of THERMO-LAG are documented and accomplished in accordance with applicable codes, standards, and specifications using qualified personnel.

— **Inspection**

All THERMO-LAG manufactured by TSI is inspected to assure that the product conforms to the etablished standard. The inspection process utilizes quality control personnel, different from the people who manufactured the THERMO-LAG.

— **Test Control**

TSI has a test program which incorporates the test procedures, including acceptance limits for the manufacture of THERMO-LAG. The purpose of the test program is to assure that the THERMO-LAG fire barriers will perform satisfactorily in service.

In addition, TSI will provide product certification to the customer assuring that the product supplied is identical to the product qualified during the approved fire tests. This link is a mandatory requirement of the American Nuclear Insurers.

— **Control of Measuring and Test Equipment**

TSI has a program for the calibration of all equipment used to manufacture THERMO-LAG. Each item is calibrated at specified intervals, depending on the nature of the equipment. Records are maintained which provide the calibration history of the equipment. TSI calibrates each item to within the specified limits established by the equipment manufacturer.

— **Handling, Storage, and Shipping**

TSI has procedures to control handling, storge, and shipping including packaging and preservation, to assure the product is received at the job site in usable condition. Particular care is exercised to insure that THERMO-LAG is not subjected to sustained freezing temperatures, or excessively hot temperatures during shipment. Temperature recorders, providing a visual trace of the temperature versus time are utilized for all 55 gallon drum shipments of THERMO-LAG.

— **Inspection, Test, and Operating Status**

TSI provides each customer with a simple acceptance test procedure, which is utilized to assure that the THERMO-LAG received has not been harmed during shipment. A small sample is taken from a statistical number of drums and checked to insure product acceptability. The results of the acceptance testing are documented, and the records preserved.

Each THERMO-LAG 55-gallon drum is also clearly marked with the date of manufacture, temperature storge limits, and TSI internal numbering methods which provide traceability to the batch number.

— **Nonconforming Materials, Parts, or Components**

TSI employs documented measures to control nonconforming items. In general, items which cannot be reworked or repaired are scrapped. Items which can be repaired, or brought up to acceptable limits are corrected. The control of non-conforming items is by both tagging and segregation.

— **Corrective Action**

TSI management periodically reviews non-conformances to find means to preclude repetition. All quality affecting nonconforming items are reviewed by the Quality Assurance manager to determine the cause and look for trends.

— **Quality Assurance Records**

TSI prepares, maintains, and records Quality Assurance records for all quality-affecting work. The records include inspection, test, and material analysis for all equipment items which are quality related. The records are indexed and filed in suitable facilities to prevent their loss, and are strictly controlled by the TSI Quality Assurance manager.

— **Audits**

TSI utilizes a planned, documented system of audits to verify all quality affecting operations. The audits are directed by the Quality Assurance Manager, and cover all aspects of the work. The purpose of the audits is to insure procedural compliance, verify adequancy of the Quality Assurance Program, and measure progress.

The above listed highlights of TSI's Quality Assurance program, are utilized for all Quality Class I work. Although not required for Quality Class II (BOP) work, many of the same product control measures are used to assure that THERMO-LAG is manufactured within tolerance limits, such that the fire resistant proporties are retained.

In summary, TSI has a fully developed Quality Assurance program, which is implemented to the degree specified, or as required to insure product performance, and product similiarity to that tested.

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TSI INC.

APPROVED FIRE BARRIERS FOR THE NUCLEAR INDUSTRY

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TYPICAL APPLICATION AND GENERAL INSTALLATION DETAILS

INTRODUCTION

The purpose of this brochure is to provide nuclear power plant general applications for THERMO-LAG. and typical details for the installation of THERMO-LAG one-hour, and three-hour rated fire barriers.

Specific installation details are available in TSI's typical installation specification (not part of this brochure).

SCHEDULE CONSIDERATIONS

THERMO-LAG fire barriers require approximately six to nine months to install in the typical nuclear power plant, which is in full compliance with 10CFR50, Appendix R. The exact installation period depends on the extent of THERMO-LAG coverage, and productivity factors for a given geographical location.

THERMO-LAG installation should be scheduled to begin at least one year prior to fuel load for plants in the construction phase. For operational plants, or plants very close to startup, THERMO-LAG is easily retro-fitted.

GENERAL INFORMATION

THERMO-LAG approved one-hour, and three-hour fire barriers can be used for many applications in nuclear plants. Some typical uses are as follows:

— Electrical Trays.
— Electrical Conduits, Junction Boxes, Condulets
— Electrical Cable Air Drops
— Instrumentation Tubing
— Instruments
— Instrument Racks
— Fire Walls/Partitions — Non Load Bearing
— Fire Wall Seals
— Support Hangers – Tray, Conduit Tubing
— Fireproofing of Structural Members
— Fireproofing of Oil, or Flamable Material Tanks and Piping
— Regulatory Guide 1.75 Fire Barriers
— Motor Operated Valves.

APPLICATION METHODS

THERMO-LAG can be applied to cable trays before they are one hundred percent pulled with cables, by providing access holes for pulling of cables to be added after installation of THERMO-LAG. THERMO-LAG is easily cut, and repaired by a tested/approved repair procedure. This feature of THERMO-LAG allows last minute cable pulling, due to revisions in trays covered with THERMO-LAG. However, it is preferable to begin THERMO-LAG installation when the trays are completely pulled with cables.

TSI provides a factory training program, including certification for THERMO-LAG applicators. In additon, TSI provides field engineers to give technical direction to the installation contractor. The TSI field service engineers are normally Owner's representatives, to provide the necessary objectivity in dealing with construction support to the installing contractor.

THERMO-LAG can be applied by any of the following methods:

— Pre-fabricated Panels
— Air Spray
— Hand Trowel
— Brush
— Roller

Pre-fabricated panels are the recommended installation technique for most applications, since quality control on thickness is assured, and installation time is minimized. Pre-fabricated panels also delete the need for covering adjacent areas during spraying, and no THERMO-LAG is lost due to over spray. The panels can be pre-fabricated at the Site by the installation contractor, or be factory supplied by TSI

There are locations near walls, or in congested areas where spray or hand trowel are the only available method, due to space limitations. Hangers and structural members can be sprayed or fitted with pre-fabricated panels. Generally, the structural members are sprayed, since the required thickness of THERMO-LAG is less, and stress skin is not required.

THERMO-LAG can be installed by spray to a tolerance of one-eighth of an inch, when applying a half-inch of THERMO-LAG. Since THERMO-LAG shrinks on setting (full cure time is 28 days), and allowance is made for shrinkage when applying THERMO-LAG. The allowance is one-eighth of an inch for a half-inch finished thickness of THERMO-LAG, i.e., install five-eighths of an inch of THERMO-LAG to obtain one-half inch dry.

GENERAL INSTALLATION DETAILS

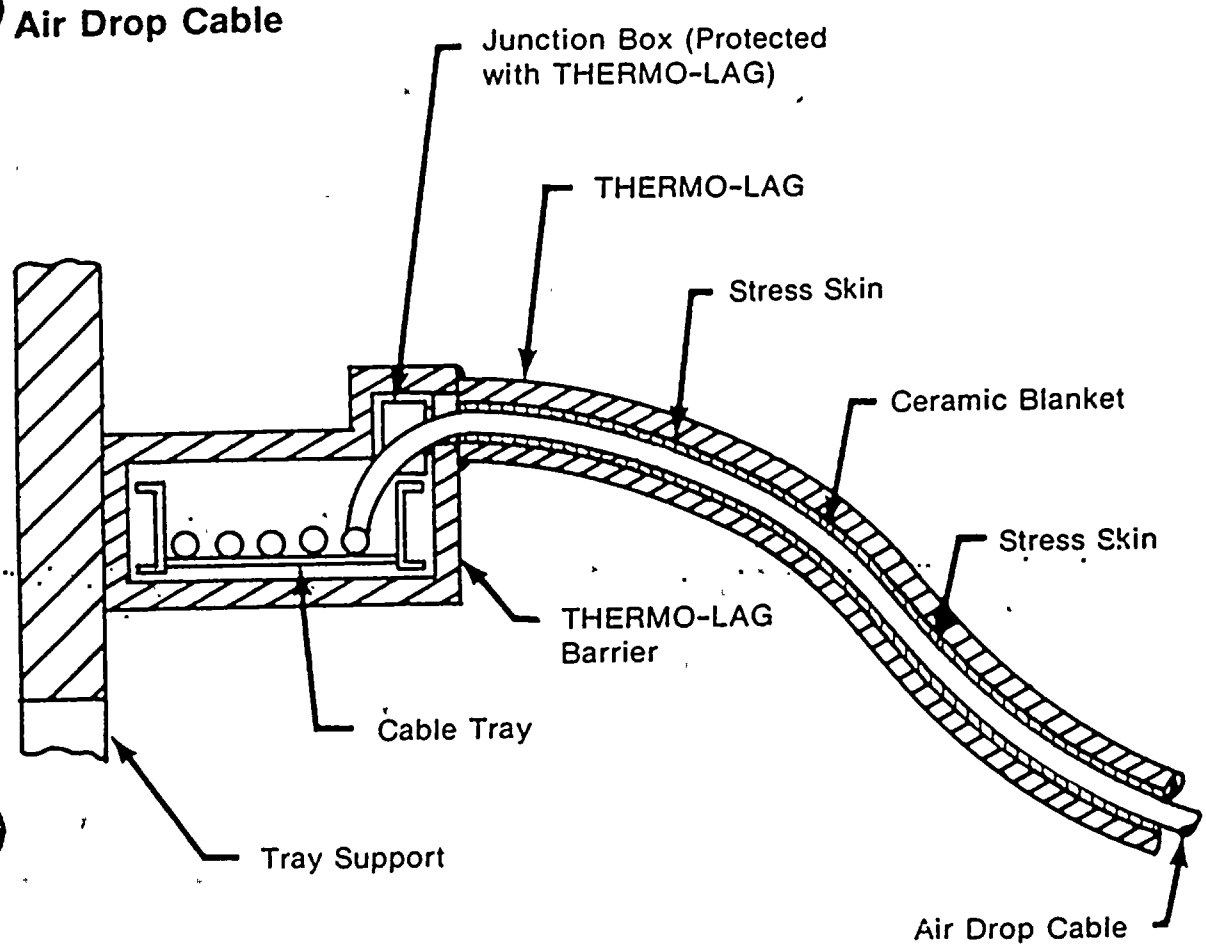
This brochure only provides general installation details. For specific construction details see TSI's typical installation specification for THERMO-LAG.

Other applications and installations not illustrated are possible, the methods shown are only to illustrate the wide versatility of THERMO-LAG for nuclear applications, and is not intended to be all inclusive.

STRUCTURAL STEEL MEMBERS/HANGERS

Structural steel members, particularly galvanized members (zinc bearing) require a primer undercoat, prior to applying THERMO-LAG. The required thickness of THERMO-LAG is about 1/4" for one-hour fire rating, and 1/2 to 3/4 inch for three-hour rating. The required thickness of THERMO-LAG is a function of the mass of the steel member to be sprayed. Tabular data for various shapes and sizes of structural members, including unistruts is provided in TSI's typical installation specification for THERMO-LAG.

Air Drop Cable



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SEISMIC DATA

NUCLEAR GENERATING PLANT SEISMIC CRITERIA

Safety-related equipment needed for safe shutdown of the reactor, and related systems is required to be qualified to Seismic I criteria. The classification of equipment and qualification criteria is covered by various Regulatory Guides such as 1.122 and 1.100, as well as IEEE 323-1974, and IEEE 344-1975.

For each plant site, maximum credible earthquake data is used to prepare ground level acceleration (g) versus frequency curves, which form the basis of the seismic criteria (Safe Shutdown Earthquake) for each plant. Regulatory Guide 1.122 provides the basis for response spectra development, and was used to analyze THERMO-LAG for seismic loads.

GENERAL CONSIDERATIONS

Appendix A to Branch Technical Position APCSB 9.5-1, states that for operating plants "postulated fires or fire protection system failures need not be considered concurrent with other plant accidents or the most severe natural phenonema". Therefore, a seismic event need not be considered concurrent with a fire, and THERMO-LAG fire barriers are not required to be qualified to Seismic I criteria. However, there are other considerations which dictate the seismic category of equipment, such as location of non-safety related equipment in Seismic I buildings. Equipment of this nature is usually supported to Seismic I loads to insure it will not become a missile during a seismic event and damage safety-related equipment.

THERMO-LAG one-hour, and three-hour fire barriers can meet the severest seismic criteria, and have been analytically qualified.

Nuclear generating plants generally have the following types of seismic criteria: none, UBC (Uniform Building Code), Seismic II, Seismic I. The regulatory guides provide criteria which requires safe-shutdown equipment to be rated Seismic I The Balance of Plant equipment related to power generation is usually specified to Seismic II for availability (economic) reasons

The remainder of the plant can be specified to UBC criteria. THERMO-LAG fire barriers are usually specified to Seismic II criteria for economic reasons, but have been provided for Seismic I applications in special cases. The reason for specifying Seismic II criteria for THERMO-LAG fire barriers is for insuring purposes. The American Nuclear Insurers have required fire seals to be rated Seismic II for quality control reasons, and have requested THERMO-LAG be similarly rated.

SPECIFIC CONSIDERATIONS

There are two very important considerations in the use of THERMO-LAG fire barriers on cable trays, conduits, instrumentation tubes, and equipment:

1. For operating plants, or plants almost completed, a major concern is what effect will THERMO-LAG have on seismically qualified equipment, notably cable trays and their supports.
2. Will THERMO-LAG specified to Seismic II criteria break loose, and if so could the THERMO-LAG missile damage safety-related equipment.

THERMO-LAG due to its low weight (3.5 lbs per square foot for one-hour barriers, and 7 lbs per square foot for three-hour barriers) generally will not affect previously qualified tray systems, including hangers, thus making THERMO-LAG barriers ideal for retro-fit in existing plants. The reason for THERMO-LAG not affecting previously design trays/hangers can be shown by considering a typical 18 inch wide by 6 inch high tray section. The area of THERMO-LAG per foot of tray is 4 square feet, thus adding 14 lbs per foot for one-hour THERMO-LAG barriers, and 28 lbs per foot for the three-hour barriers. Trays of this size are usually supported on 6 to 8 foot intervals, thereby adding a dead load of about 225 lbs per section. The added stress in typical tray sections (6, 12, 18, and 24) have been analyzed dynamically, for the heavier three-hour barriers, and the results shown in all cases sufficient margin to accommodate the

THERMO-LAG barriers. The effect of THERMO-LAG on hangers is a function of the hanger design utilized by the Electrical Contractor, and the number of trays supported which are to be protected with THERMO-LAG. One nuclear generating plant which utilized heavy square tubular sections for hangers, has been able to re-qualify almost all the existing hangers for the added THERMO-LAG barriers.

Typical cable tray systems, including cables and supports have natural frequencies on the order of 10 to 20 Hz. Addition of mass in the form of THERMO-LAG fire barriers would decrease the natural frequency by the square root of the ratio of the new total mass to the old mass. For example, consider the typical 18 inch by 6 inch tray section. The weight of a 40 percent filled tray, including the weight of both cables and tray is on the order of 50 lbs per foot. THERMO-LAG three-hour fire barriers weigh 28 lb/ft. for this tray size. Therefore, the decrease in natural frequency would be 10 to 20 Hz divided by the square root of 84, divided by 50, or the new tray plus THERMO-LAG natural frequency would be in the range of 7.7 to 15.4 Hz, which is not a significant change. The change in natural frequency will be even less for larger trays.

In regard to THERMO-LAG breaking off during seismic events, a dynamic analysis has been performed which indicated that THERMO-LAG will not break loose. The dynamic analysis used very conservative criteria (7.5g horizontal, 5.0g vertical, combined biaxially).

THERMO-LAG SEISMIC QUALIFICATION

THERMO-LAG fire barriers have been qualified by static analysis for a very conservative seismic loading. A value of 7.5g horizontal, and 6.0g vertical acceleration, combined biaxially was used for the analysis. These values bound all nuclear generating plant seismic criteria. The analysis was performed for various size trays, and was based on 9 foot tray spans.

In addition, a dynamic (vibration) analysis was performed, considering two cases: the first case assumed the THERMO-LAG barriers and the cable trays were a composite section (i.e. shared static characteristics); the second case assumed the total load was carried by the trays. These two cases must bound the actual case. The analysis concluded that the THERMO-LAG barriers are more resistant to an SSE than the cable trays (40 percent fill).

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