

# 3M Fire Protection Products

March 17, 1994

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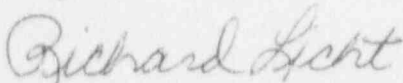
Gentlemen:

Enclosed are two fire test reports on upgrading the TSI material for 3-hour conduit systems using 3M's Interam™ E-50 Series Mats.

The standard 3M system for 3-hour protection requires five layers of Interam™ E-54A Mat. The results of this test would suggest that the upgrade of the TSI "system" would require three layers of Interam™ E-54A Mat, which would add 1.2 inches in thickness to the TSI product.

If you require additional information on this or other fire tests by 3M, please contact me on 612-733-7079.

Regards,



Richard R. Licht  
Technical Manager  
Ceramic Materials Dept.  
3M Center, 207-1S-02  
St. Paul, MN 55144

Reviewed by: RJI A1404

RRL/ks  
Enclosures

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## 3M Fire Test #94-27

### Combined TSI/3M E54A Fire Protection on 2" Steel Conduit

#### Objective:

The objective of this fire test was to determine the fire protection effectiveness of a combined TSI subliming preform/3M Interam™ E54A mat system on a 2" schedule 40 steel conduit. The test was conducted to meet the requirements of the ASTM E-119 Fire Test Standard, excluding the water hose stream requirement. The test criterion is defined as the time in which the average of temperatures on the conduit surface reaches 250° F + ambient and/or 325° F + ambient on any individual thermocouple.

#### Test Information:

Originator - Richard Licht 3M Fire Protection Products Department Manager  
3M Fire Test #94-27  
14 Feb. 1994  
Bldg. #63  
3M Cottage Grove  
Minnesota, USA

#### Furnace Details and Temperature Measurement:

Large Scale Furnace - The inside dimensions of the brick and ceramic fiber insulated furnace are approximately 52 inches wide x 67 inches high x 78 inches long (1,3 m x 1,7 m x 2.0 m). The test sample was mounted horizontally through one "window" lengthwise on each side of the furnace. The window was then filled with insulating bricks and ceramic blanket to seal the furnace from the outside. The furnace was heated with propane gas supplied to two North American Burners located on the sides of the furnace near the bottom.

Furnace Control - The propane input to the burners was adjusted automatically by control valves to match the time-temperature profile listed in ASTM E-119 Fire Test Standard. The control valves were operated through a control loop with a Micricon Controller in conjunction with four thermocouples mounted inside the furnace.

Thermocouples - Four Type "K" thermocouples with 5/8 inch (16-mm) dia. inconel sheaths were used for controlling the furnace temperature. Nine similar thermocouples in sheaths were used for recording the furnace temperature. Eleven additional Type "K" thermocouples were used to record temperatures at various locations on the conduit during the test.

Data Acquisition Equipment - Two systems were used to record and display time and temperatures each minute during the fire test. The first was a Monitor Labs Inc. Model #9302 Datalogger and the second was a Hewlett Packard 200 Model 9816 personal computer connected in parallel to the Datalogger. The temperature measurements and location descriptions were printed on paper and also stored on a computer diskette.

#### Test Materials

TSI Preformed conduit sections Lot # F9117005/F9107060 - Designed for 2 inch conduit - half sections.  
3M Interam™ E54A Mat Lot # 7362513006/0017030101 - 3 layers were installed over the TSI preform.

### Test Assembly:

Prior to applying the preformed TSI subliming preform or 3M Interam™ E54A mat, two sets of thermocouples were placed on the outer surface of the 2" schedule 40 steel conduit in four locations, three of which would correspond to the center of the TSI preform surface and one of which would be placed at the butt joint of two subliming preforms.

Three sections of TSI subliming preform were applied tightly around the conduit and taped into place. Each section is made up of two cylindrical halves. There was a half inch (12,7mm) gap parallel to the conduit on each side of the assembly, between the upper and lower half of the TSI preform sections. Three additional thermocouples were affixed to the outside center of each of the three TSI preform sections. No banding or caulk was used to secure the subliming preform.

Next, three layers of Interam™ E54A Mat were applied around the TSI preform in three 24.5 inch (622 mm) wide pieces and taped into place with 3M T-49 Aluminum Foil Tape, as specified for a 3M Interam™ one hour standard wrap fire protective system. The Interam™ E54A mat was applied without any overlaps. The joints between mat pieces were butted to assure full contact between the mat pieces. Each butt seam was further protected with an additional layer of Interam™ E54A mat approximately four inches (102mm) wide and secured with two 1/2 inch (12 mm) wide stainless steel bands. In between the butt seams the system was secured with additional 1/2 inch (12 mm) wide stainless steel bands placed approximately 12 inches (305 mm) apart. The following chart outlines the total weight of the assembly at various points in the installation of the fire protective envelope.

<u>Assembly Status</u>	<u>Weight (lbs.)</u>	<u>Item</u>	<u>Net Weight (lbs.)</u>
Bare conduit	36	conduit	36
Conduit with TSI preform	95.5	TSI	59.5
Conduit w/ TSI & 3M Interam E54A mat	197.2	Interam™	101.7

The ends of the conduit were stuffed at least 4 inches (102 mm) deep with ceramic fiber insulation to prevent heat escape out the conduit ends during the fire tests. The attached sketches show assembly details and thermocouple locations.

### Test results:

Ambient at the start of the fire tests were 58° F. (14° C.) for 3M Test #94-27.

### Conduit Surface Temperatures

<u>Time</u> (Minutes)	<u>TSI ( Surface )</u>		
	<u>Average TC</u> (°F)	<u>Highest TC</u> (°F)	<u>Average TC</u> (°F)
15	57	58	63
30	59	61	97
45	70	74	188
90	220	242	273
105	223	236	331
120	230	237	382
135	249	273	445
150	280	323	527
165	302	333	596
169	308	335	613
180	323	344	654

Observations:

Key area of failure would be the open seams of the TSI perform sections. No caulk or trowel grade material was used to seal any seams in this fire test. This was due to the requirement that all these types of materials would require extended times to cure or dry and weeks would be required before this test could be conducted. A 1 1/2 inch conduit was chosen in this fire test as the TSI perform does not fit tight on a 2 inch conduit. The use of a 1 1/2 inch conduit allowed the TSI perform to be fit tight together as possible.

Furnace Correlation:

The 3M furnaces are correlated to the UL furnaces by fire testing identical items and systems at each facility and in each furnace. The correlation for the Bldg. 63 furnace is 53 mins. in the 3M furnace and is considered equal to 60 mins. in the UL furnace. 3 Hour correlation was not conducted but on a mathematical basis the correlation would be 159 mins. in the 3M furnace which would equate to 180 mins. in the UL furnace.

Data:

Additional test information can be obtained from the 3M Ceramic Materials Dept. in St. Paul , Minnesota, USA in fire test file number #94-27

CLC

# CHEMOLITE PROPANE TEST FURNACE

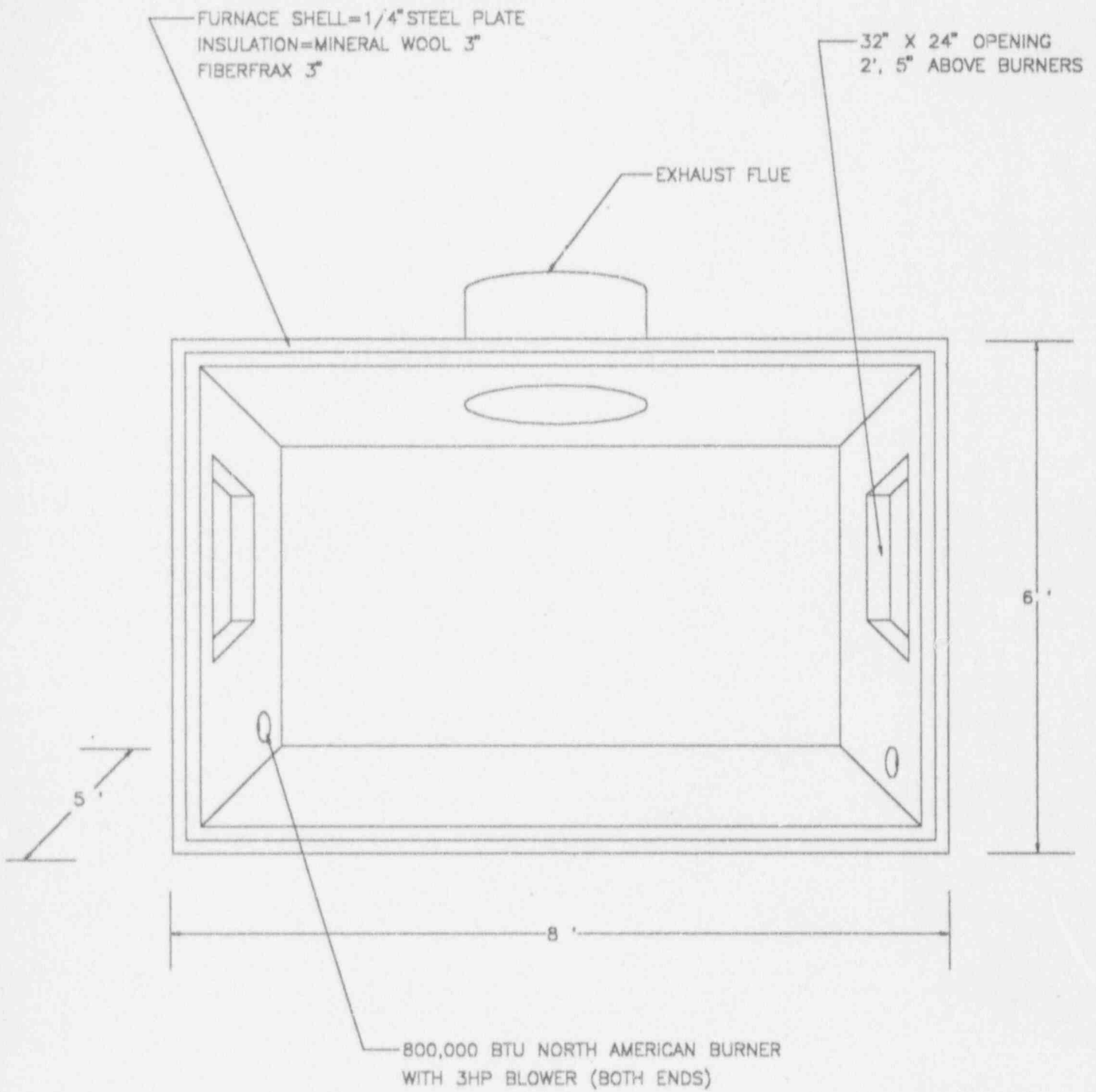
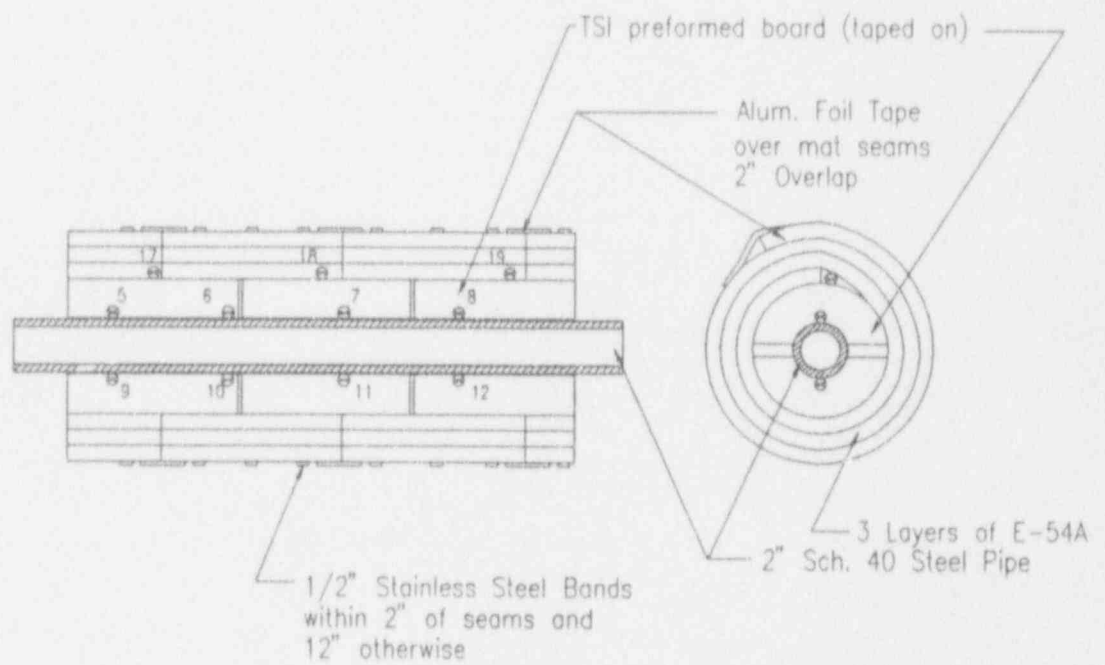


FIGURE 1

Assembly Sketch  
FT 94-27

Length = 10 feet

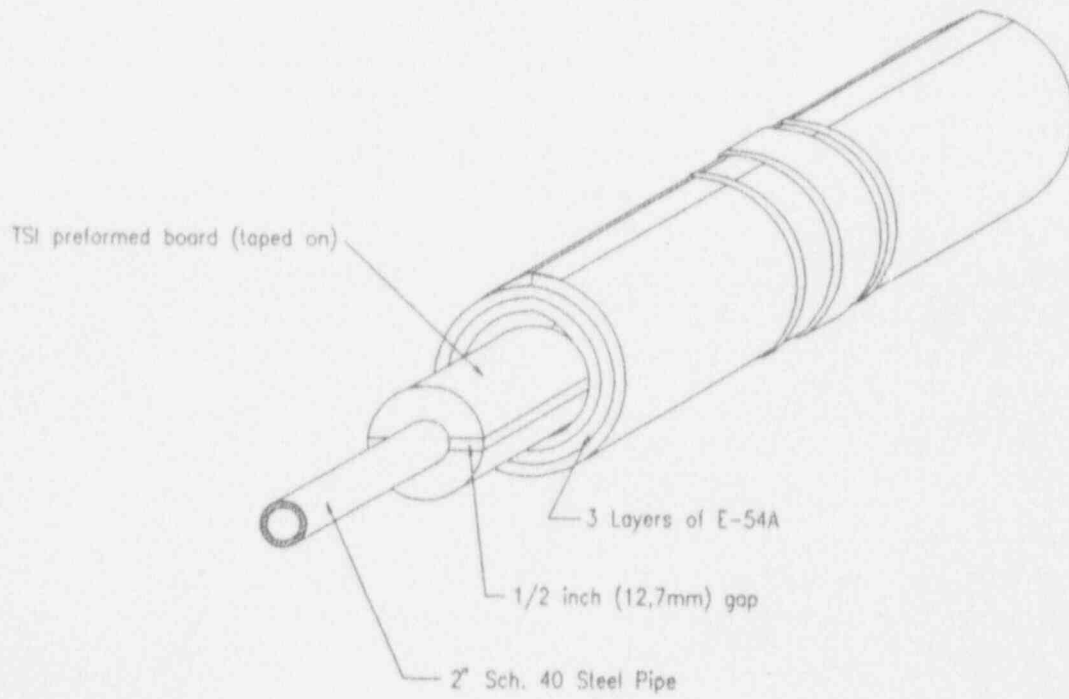


• Thermocouples

- 1-4 Furnace
- 5-12 Outside surface of conduit
- 13-15 Outside center of each TSI section

Drawing Number 94-27a	App'd B.
Drawn By Craig Corney	

FT 94-27



Length = 10 feet

Drawing Number 94-27b	App'd By
Drawn By: Craig Corney	

## 3M Fire Test #94-42

### Combined TSI/3M E54A Fire Protection on 1 1/2" Steel Conduit

#### Objective:

The objective of this fire test was to determine the fire protection effectiveness of a combined TSI subliming preform/3M Interam™ E54A mat system on a 1 1/2" schedule 40 steel conduit. The test was conducted to meet the requirements of the ASTM E-119 Fire Test Standard, excluding the water hose stream requirement. The test criterion is defined as the time in which the average of temperatures on the conduit surface reaches 250° F + ambient and/or 325° F + ambient on any individual thermocouple.

#### Test Information:

Originator - Richard Licht 3M Fire Protection Products Department Manager  
3M Fire Test #94-42  
25 Feb. 1994  
Bldg. #63  
3M Cottage Grove  
Minnesota, USA

#### Furnace Details and Temperature Measurement:

Large Scale Furnace - The inside dimensions of the brick and ceramic fiber insulated furnace are approximately 52 inches wide x 67 inches high x 78 inches long (1,3 m x 1,7 m x 2,0 m). The test sample was mounted horizontally through one "window" lengthwise on each side of the furnace. The window was then filled with insulating bricks and ceramic blanket to seal the furnace from the outside. The furnace was heated with propane gas supplied to two North American Burners located on the sides of the furnace near the bottom.

Furnace Control - The propane input to the burners was adjusted automatically by control valves to match the reference temperature profile listed in ASTM E-119 Fire Test Standard. The control valves were operated through a control loop with a Micricon Controller in conjunction with four thermocouples mounted inside the furnace.

Thermocouples - Four Type "K" thermocouples with 5/8 inch (16-mm) dia. inconel sheaths were used for controlling the furnace temperature. Nine similar thermocouples in sheaths were used for recording the furnace temperature. Eleven additional Type "K" thermocouples were used to record temperatures at various locations on the conduit during the test.

Data Acquisition Equipment - Two systems were used to record and display time and temperatures each minute during the fire test. The first was a Monitor Labs Inc. Model #9302 Datalogger and the second was a Hewlett Packard 200 Model 9816 personal computer connected in parallel to the Datalogger. The temperature measurements and location descriptions were printed on paper and also stored on a computer diskette.

#### Test Materials

TSI Preformed conduit sections Lot # F9117005/F9107060 - Designed for 2 inch conduit - half sections.  
3M Interam™ E54A Mat Lot # 7362513006/0017030101 - 3 layers were installed over the TSI preform.



### Test Assembly:

Prior to applying the preformed TSI subliming preform or 3M Interam™ E54A mat, two sets of thermocouples were placed on the outer surface of the 1 1/2" schedule 40 steel conduit in four locations, three of which would correspond to the center of the TSI preform surface and one of which would be placed at the butt joint of two subliming preforms.

Three sections of TSI subliming preform were applied tightly around the conduit and taped into place. Each section is made up of two cylindrical halves. Three additional thermocouples were affixed to the outside center of each of the three TSI preform sections. No banding or caulk was used to secure the subliming preform.

Next, three layers of Interam™ E54A Mat were applied around the TSI preform in three 24.5 inch (622 mm) wide pieces and taped into place with 3M T-49 Aluminum Foil Tape, as specified for a 3M Interam™ one hour standard wrap fire protective system. The Interam™ E54A mat was applied without any overlaps. The joints between mat pieces were butted to assure full contact between the mat pieces. Each butt seam was further protected with an additional layer of Interam™ E54A mat approximately four inches (102mm) wide and secured with two 1/2 inch (12 mm) wide stainless steel bands. In between the butt seams the system was secured with additional 1/2 inch (12 mm) wide stainless steel bands placed approximately 12 inches (305 mm) apart. The following chart outlines the total weight of the assembly at various points in the installation of the fire protective envelope.

<u>Assembly Status</u>	<u>Weight (lbs.)</u>	<u>Item</u>	<u>Net Weight (lbs.)</u>
Bare conduit	25.4	conduit	25.4
Conduit with TSI preform	82.2	TSI	56.8
Conduit w/ TSI & 3M Interam E54A mat	182.9	Interam™	100.7

The ends of the conduit were stuffed at least 4 inches (102 mm) deep with ceramic fiber insulation to prevent heat escape out the conduit ends during the fire tests. The attached sketches show assembly details and thermocouple locations.

### Test results:

Ambient at the start of the fire tests were 54° F. for 3M Test #94-42.

### Conduit Surface Temperatures

### TSI ( Surface )

<u>Time</u> (Minutes)	<u>Average TC</u> (°F)	<u>Highest TC</u> (°F)	<u>Average TC</u> (°F)
15	54	54	56
30	54	55	90
45	69	192	188
90	114	218	222
105	175	237	225
120	209	277	381
135	209	294	422
150	222	335	476
159	290	366	515
167	304	340	549
180	322	387	610

Observations:

Key area of failure would be the open seams of the TSI preform sections. No caulk or trowel grade material was used to seal any seams in this fire test. This was due to the requirement that all these types of materials would require extended times to cure or dry and weeks would be required before this test could be conducted. A 1 1/2 inch conduit was chosen in this fire test as the TSI preform does not fit tight on a 2 inch conduit. The use of a 1 1/2 inch conduit allowed the TSI preform to be fit tight together as possible.

Furnace Correlation:

The 3M furnaces are correlated to the UL furnaces by fire testing identical items and systems at each facility and in each furnace. The correlation for the Bldg. 63 furnace is 53 mins. in the 3M furnace and is considered equal to 60 mins. in the UL furnace. 3 Hour correlation was not conducted but on a mathematical basis the correlation would be 159 mins. in the 3M furnace and would equate to 180 mins. in the UL furnace.

Data:

Additional test information can be obtained from the 3M Ceramic Materials Dept. in St. Paul , Minnesota. USA in fire test file number #94-42

CLC

# CHEMOLITE PROPANE TEST FURNACE

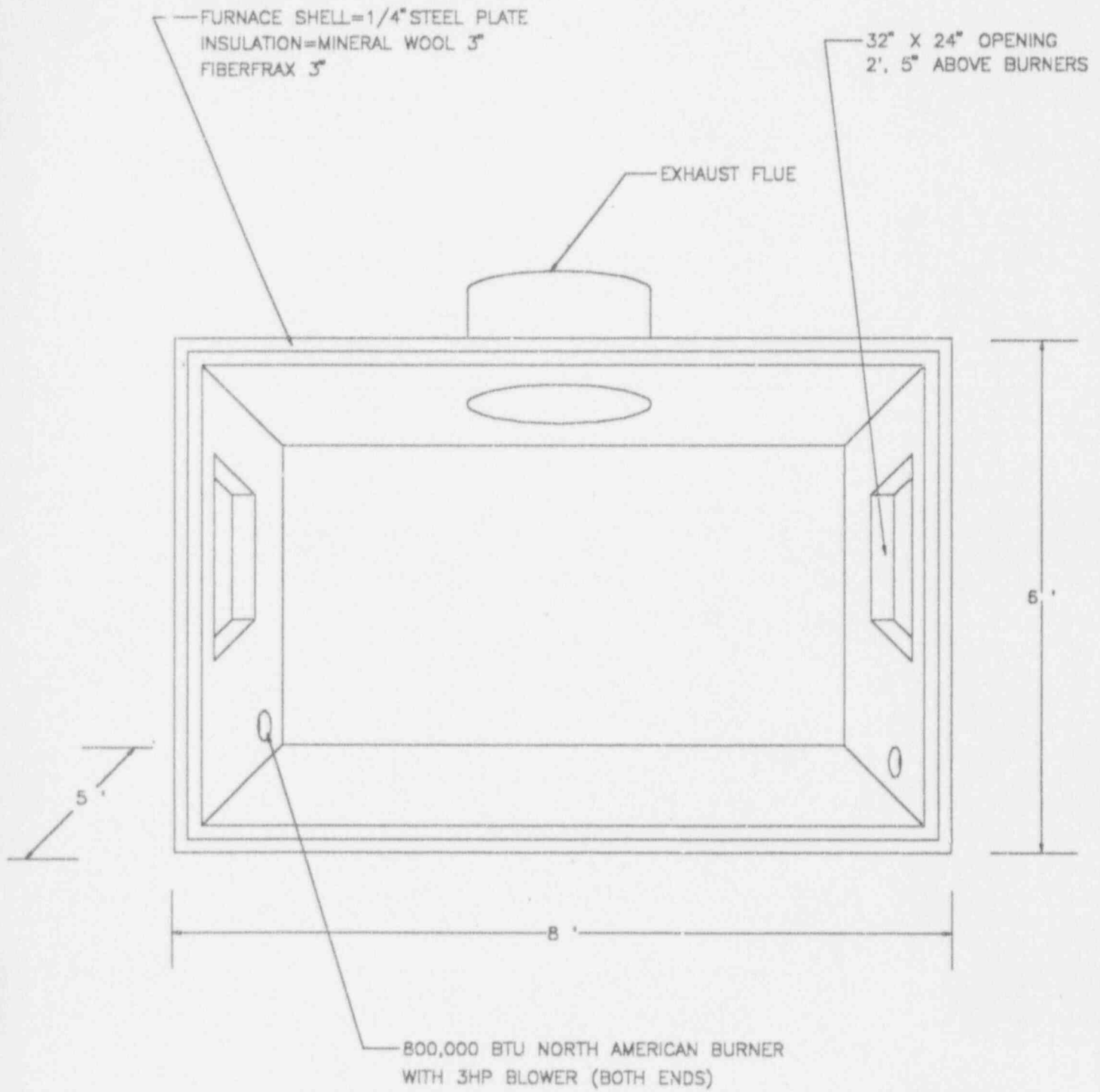
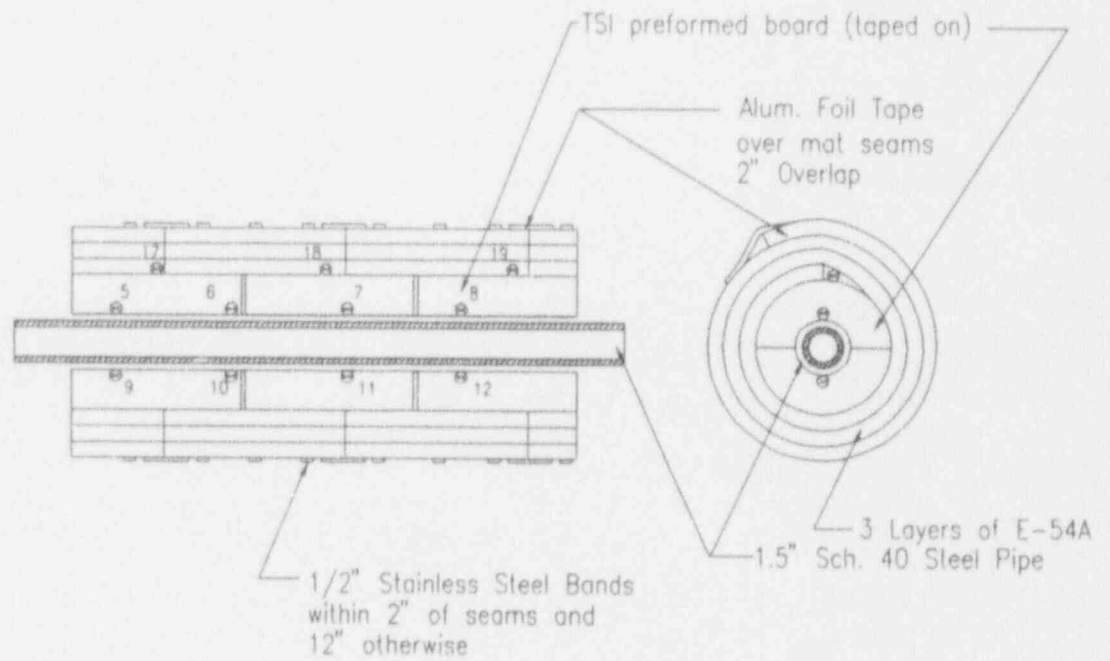


FIGURE 1

Assembly Sketch  
FT 94-42

Length = 10 feet

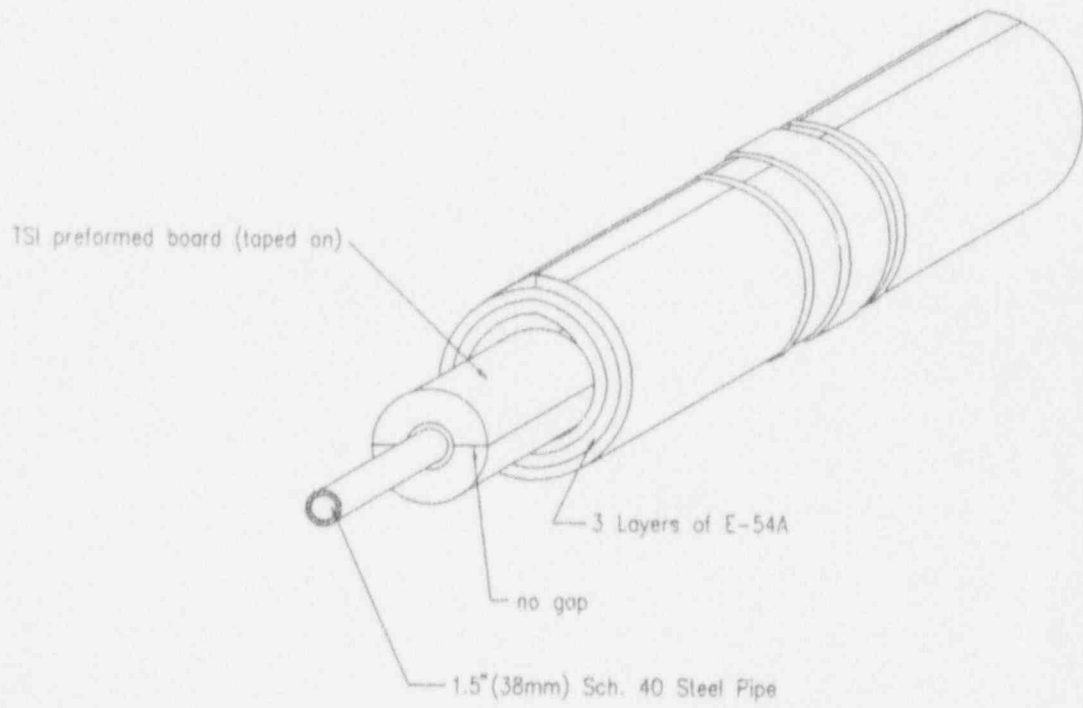


• Thermocouples

- 1-4 Furnace
- 5-12 Outside surface of conduit
- 13-15 Outside center of each TSI section

Drawing Number 94-42a	App'd By
Drawn By: Craig Correy	

FT 94-42



Length = 10 feet

Drawing Number	App'd By
94-42b	
Drawn By	Craig Carney