

Appendix F UL 1709 – RAPID RISE FIRE TESTS OF PROTECTION MATERIALS FOR STRUCTURAL STEEL

TEST REPORT

Intertek

REPORT NUMBER: 3159033
ORIGINAL ISSUE DATE: August 28, 2008
REVISED DATE: N/A

EVALUATION CENTER
16015 Shady Falls Road
Elmendorf, TX 78112
(voice) 210-635-8100
(fax) 210-635-8101
www.intertek-etlsemko.com

RENDERED TO
Aspen Aerogels, Inc.
30 Forbes Road
Building B
NORTHBOROUGH MA 01532

PRODUCT EVALUATED: Pyrogel® XTF Insulation Material
EVALUATION PROPERTY: Safety Fire Resistance

Report of Testing Pyrogel® XTF Insulation Material for compliance with the applicable requirements of the following criteria: UL 1709-05 Standard for Safety Rapid Rise Fire Tests of Protection Materials for Structural Steel

This report is for the exclusive use of Intertek's Client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this report. Only the Client is authorized to copy or distribute this report and then only in its entirety. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek. The observations and test results in this report are relevant only to the sample tested. This report by itself does not imply that the material, product, or service is or has ever been under an Intertek certification program.

Appendix F UL 1709 – RAPID RISE FIRE TESTS OF PROTECTION MATERIALS FOR STRUCTURAL STEEL

Aspen Aerogels, Inc.
 Project No. 3159033

28 August, 2008
 Page 2 of 95

1 Table of Contents

ITEM	PAGE
1 Table of Contents	2
2 Introduction	3
3 Test Samples	3
4 Testing and Evaluation Methods	4
5 Testing and Evaluation Results	5
6 Conclusions	9
Appendices	
Appendix A: Assembly Drawings	11
Appendix D: Temperature Data	15
Appendix E: Photographs	69
Revision Summary / Last Page of Report	95



Appendix F UL 1709 – RAPID RISE FIRE TESTS OF PROTECTION MATERIALS FOR STRUCTURAL STEEL

Aspen Aerogels, Inc.
Project No. 3159033

28 August, 2008
Page 3 of 95

2 Introduction

Intertek Testing Services NA (Intertek) has conducted testing for Aspen Aerogels, Inc. on Pyrogel® XTF Insulation Material, to evaluate its fire resistance. Testing was conducted in accordance with UL 1709-05 Standard for Safety Rapid Rise Fire Tests of Protection Materials for Structural Steel. This evaluation took place on August 21, 2008.

3 Test Samples

3.1. SAMPLE SELECTION

Samples of Pyrogel® XTF were submitted to Intertek directly from the client. Samples were not independently selected for testing. Samples were received at the Evaluation Center on August 18, 2008

3.2. SAMPLE AND ASSEMBLY DESCRIPTION

Intertek technicians installed 14 thermocouples onto the web on each of six W10 X 49 standard columns, 8' long. The thermocouples were installed across 4 zones: A-A, 5; B-B, 3; C-C, 3; and D-D, 3 (see Appendix A).

Representatives from Aspen Aerogels, Inc. installed the Pyrogel® XTF insulation onto the columns. Each of the column web cavities were filled with 19 -21 strips of Pyrogel® XTF (8.9" X 98" X nominal 6mm) to provide a nominal 120mm of insulation on each side of the web. The strips were held in place with 2-3 bands of 0.047" O.D. stainless steel wire (see Appendix C).

Courses (sections) of the Pyrogel® XTF insulation, either 32" or 48" wide and of varying lengths, were wrapped around the web-filled columns in layers (2, 5, 8, 8, 12, 14) alternating the 32" and 48" width insulation to stagger circumferential seams without telescoping. For the thicker, multi-layered columns (P5 – 14) some courses were "double length" and wrapped around twice – 2 layers per course. Some of the columns started with the 32" width and some with the 48" (see configuration table, next page). Each course of insulation overlapped itself by nominally 5", but butted up to the course above and/or below it on the column. If the first course consisted of 32" insulation, the second course was 48" insulation and *visa versa*, staggering the butt joints of the layer beneath it. A 48" course of insulation was the preferred outermost layer on a column to reduce the number of circumferential seams closest to the heat of the furnace. Each course was held in place with 2-3 bands of 0.047" O.D. stainless steel wire, then secured with ½" 0.02 stainless steel bands with ½" stainless steel wing seals, applied 12" o.c. but no closer than 2" from the edge of a seam, tightened with a pistol-grip banding tool (see Appendix A).

The installation process started with the application of a thin film of spray adhesive (3M Hi-Strength 90 Spray Adhesive or Foster Fos-Stik Clear Adhesive Spray 85-45) in a 3 - 4" strip down the leading edge of the section of insulation and the corresponding area of the web-fill strip where the installation would begin. The first course was always installed at the bottom of the column. The leading edge was attached to the edge of the web-fill layers (NOT on the

Intertek

Appendix F UL 1709 – RAPID RISE FIRE TESTS OF PROTECTION MATERIALS FOR STRUCTURAL STEEL

Aspen Aerogels, Inc.
Project No. 3159033

28 August, 2008
Page 4 of 95

metal beam) and wrapped counterclockwise, overlapping itself to a point half way across the web where it started (approx 5") and was held in place with 0.047" O.D wire. Another course was applied above that one, and one above that (if using 32" widths), butting the seams, completing the first course on the column.

The second course was installed in the same fashion as the first but used the alternate width of insulation to overlap the circumferential seams of the previous layer, and was started at the edge of the web-fill on the opposite side of the column (staggering longitudinal seams). Additional courses followed the same process, alternating the width of insulation used as well as the side of the beam as its starting point. The stainless steel bands were applied after each 2 layers (not courses) of wrapping.

The 96" tall columns were covered with 3 strips of 36" wide, 0.02 stainless steel cladding, each strip overlapping itself 3" and overlapping the one below it by 6". The cladding was installed with a slip-joint when overlapping an adjacent piece and each section was secured with ½" 0.02 stainless steel bands and wing seals, installed 12" o.c. Finally, #42 blind rivets with 2 #8 flat stainless steel washers were installed 6" o.c. down the longitudinal seam and in 4 equidistant places around the overlapping circumferential seams (see Appendix A).

4 Testing and Evaluation Methods

The completed column assemblies were placed in the Laboratory's full scale horizontal furnace in two rows of 3 each. The test was initiated at 10:55 a.m. on Thursday, August 21, 2008. Representatives from Aspen Aerogels, Inc. were in attendance. The ambient temperature and humidity at the time were 84°F and 76%RH. The outputs of all test specimens and furnace probes were monitored by a 300 channel Yokogawa, Inc., Model Darwin Data Acquisition Unit. The computer was programmed in LabVIEW to send the commands to the data acquisition systems to sample the data input lines and to convert the raw data into a usable format (i.e., degrees Fahrenheit) for display on screen and storage as an ASCII tab-delimited text file. The data was saved at 60-second intervals. Following the test, the files were imported into MS Excel for tabular and graphical display. The maximum allowed temperature for any one thermocouple on a column was 1200°F and for the TC Average within a section was 1000 °F.

4.1. TEST STANDARD

Testing was conducted in accordance with UL 1709-05 Standard for Safety Rapid Rise Fire Tests of Protection Materials for Structural Steel.



Appendix F UL 1709 – RAPID RISE FIRE TESTS OF PROTECTION MATERIALS FOR STRUCTURAL STEEL

Aspen Aerogels, Inc.
Project No. 3159033

28 August, 2008
Page 5 of 95

5 Testing and Evaluation Results

5.1. RESULTS AND OBSERVATIONS

The test was initiated at 10:55 A.M. on August 21, 2008 and ran for 240 minutes. The observations made during the test are listed below:

Time (min:sec)	Observation
0:00	Test initiated
10:00	Smoke from the furnace, around the lid
21:00	Flame from around the samples
72:54	TC #11 from P2 exceeds max allowed temp
152:00	TC #11 from P5 exceeds max allowed temp
205:00	TC #9 from P8A exceeds max allowed temp
209:00	TC #3 from P8B exceeds max allowed temp
241:00	Test terminated

The test results for each column are presented below.

Column P2 (12mm):

Though the first thermocouple to exceed the 1200°F maximum occurred during the 72nd minute of the test (TC #11) the maximum allowable TC average (1000°F) was exceeded at the 68-minute mark.

In accordance with the UL 1709 test standard, a calculation for any correction to the indicated fire resistance period was done. The correction factor was then mathematically added to the indicated fire resistance period, yielding the fire resistance period achieved by this specimen:

ITEM	DESCRIPTION	TEST VALUE
C	correction factor	-0.53 minutes -32 seconds
I	indicated fire-resistance period	68 minutes
A	area under the curve of indicated average furnace temperature for the first three fourths of the indicated period	89134 (°F·min)
As	area under the standard furnace curve for the same part of the indicated period	90188 (°F·min)
	FIRE RESISTANCE PERIOD ACHIEVED BY THIS SPECIMEN ==>	67 minutes



Appendix F UL 1709 – RAPID RISE FIRE TESTS OF PROTECTION MATERIALS FOR STRUCTURAL STEEL

Aspen Aerogels, Inc.
 Project No. 3159033

28 August, 2008
 Page 6 of 95

Note: The standard specifies that the fire resistance be determined to the nearest integral minute. Consequently, if the correction factor is less than 30 seconds, and the test specimen met the criteria for the full indicated fire resistance period, no correction is deemed necessary.

Column P5 (30mm):

Though the first thermocouple to exceed the 1200°F maximum occurred during the 152nd minute of the test (TC #11), the maximum allowable TC average (1000°F) was exceeded at the 131-minute mark.

In accordance with the UL 1709 test standard, a calculation for any correction to the indicated fire resistance period was done. The correction factor was then mathematically added to the indicated fire resistance period, yielding the fire resistance period achieved by this specimen:

ITEM	DESCRIPTION	TEST VALUE
C	correction factor	-0.47 minutes -28 seconds
I	indicated fire-resistance period	131 minutes
A	area under the curve of indicated average furnace temperature for the first three fourths of the indicated period	176129 (°F•min)
As	area under the standard furnace curve for the same part of the indicated period	177091 (°F•min)
	FIRE RESISTANCE PERIOD ACHIEVED BY THIS SPECIMEN ==>	131 minutes

Note: The standard specifies that the fire resistance be determined to the nearest integral minute. Consequently, if the correction factor is less than 30 seconds, and the test specimen met the criteria for the full indicated fire resistance period, no correction is deemed necessary.

Column P8A (48mm):

Though the first thermocouple to exceed the 1200°F maximum occurred during the 205th minute of the test (TC #9) the maximum allowable TC average (1000°F) was exceeded at the 184-minute mark.

In accordance with the UL 1709 test standard, a calculation for any correction to the indicated fire resistance period was done. The correction factor was then mathematically added to the indicated fire resistance period, yielding the fire resistance period achieved by this specimen:



Appendix F UL 1709 – RAPID RISE FIRE TESTS OF PROTECTION MATERIALS FOR STRUCTURAL STEEL

Aspen Aerogels, Inc.
Project No. 3159033

28 August, 2008
Page 7 of 95

ITEM	DESCRIPTION	TEST VALUE
C	correction factor	-0.37 minutes -22 seconds
I	indicated fire-resistance period	184 minutes
A	area under the curve of indicated average furnace temperature for the first three fourths of the indicated period	250286 (°F•min)
As	area under the standard furnace curve for the same part of the indicated period	251051 (°F•min)
	FIRE RESISTANCE PERIOD ACHIEVED BY THIS SPECIMEN ==>	184 minutes

Note: The standard specifies that the fire resistance be determined to the nearest integral minute. Consequently, if the correction factor is less than 30 seconds, and the test specimen met the criteria for the full indicated fire resistance period, no correction is deemed necessary.

Column P8B (48mm):

Though the first thermocouple to exceed the 1200°F maximum occurred during the 209th minute of the test (TC #3) the maximum allowable TC average (1000°F) was exceeded at the 175-minute mark.

In accordance with the UL 1709 test standard, a calculation for any correction to the indicated fire resistance period was done. The correction factor was then mathematically added to the indicated fire resistance period, yielding the fire resistance period achieved by this specimen:

ITEM	DESCRIPTION	TEST VALUE
C	correction factor	-0.40 minutes -24 seconds
I	indicated fire-resistance period	175 minutes
A	area under the curve of indicated average furnace temperature for the first three fourths of the indicated period	237294 (°F•min)
As	area under the standard furnace curve for the same part of the indicated period	238108 (°F•min)
	FIRE RESISTANCE PERIOD ACHIEVED BY THIS SPECIMEN ==>	175 minutes

Note: The standard specifies that the fire resistance be determined to the nearest integral



Appendix F UL 1709 – RAPID RISE FIRE TESTS OF PROTECTION MATERIALS FOR STRUCTURAL STEEL

Aspen Aerogels, Inc.
 Project No. 3159033

28 August, 2008
 Page 8 of 95

minute. Consequently, if the correction factor is less than 30 seconds, and the test specimen met the criteria for the full indicated fire resistance period, no correction is deemed necessary.

Column P11 (66mm):

Neither the individual nor the average thermocouple maximums were exceeded during the 240-minute test.

In accordance with the UL 1709 test standard, a calculation for any correction to the indicated fire resistance period was done. The correction factor was then mathematically added to the indicated fire resistance period, yielding the fire resistance period achieved by this specimen:

ITEM	DESCRIPTION	TEST VALUE
C	correction factor	-0.37 minutes -22 seconds
I	indicated fire-resistance period	240 minutes
A	area under the curve of indicated average furnace temperature for the first three fourths of the indicated period	327951 (°F•min)
As	area under the standard furnace curve for the same part of the indicated period	328709 (°F•min)
	FIRE RESISTANCE PERIOD ACHIEVED BY THIS SPECIMEN ==>	240 minutes

Note: The standard specifies that the fire resistance be determined to the nearest integral minute. Consequently, if the correction factor is less than 30 seconds, and the test specimen met the criteria for the full indicated fire resistance period, no correction is deemed necessary.

Column P14 (84mm):

Neither the individual nor the average thermocouple maximums were exceeded during the 240-minute test.

In accordance with the UL 1709 test standard, a calculation for any correction to the indicated fire resistance period was done. The correction factor was then mathematically added to the indicated fire resistance period, yielding the fire resistance period achieved by this specimen:

ITEM	DESCRIPTION	TEST VALUE
C	correction factor	-0.37 minutes -22 seconds
I	indicated fire-resistance period	240 minutes
A	area under the curve of indicated average	



Appendix F UL 1709 – RAPID RISE FIRE TESTS OF PROTECTION MATERIALS FOR STRUCTURAL STEEL

Aspen Aerogels, Inc.
Project No. 3159033

28 August, 2008
Page 9 of 95

	furnace temperature for the first three fourths of the indicated period	327951 (°F•min)
As	area under the standard furnace curve for the same part of the indicated period	328709 (°F•min)
	FIRE RESISTANCE PERIOD ACHIEVED BY THIS SPECIMEN ==>	240 minutes

Note: The standard specifies that the fire resistance be determined to the nearest integral minute. Consequently, if the correction factor is less than 30 seconds, and the test specimen met the criteria for the full indicated fire resistance period, no correction is deemed necessary.

Summary of fire resistance achieved by each column:

P2 (12mm).....67 minutes
 P5 (30mm)131 minutes
 P8A (48mm)184 minutes
 P8B (48mm)175 minutes
 P11 (66mm)240 minutes
 P14 (84mm)240 minutes

6 Conclusion

Intertek Testing Services NA (Intertek) conducted testing for Aspen Aerogels, Inc., on Pyrogel® XTF Insulation Material, to evaluate its fire resistance. Testing was conducted in accordance with UL 1709-05 Standard for Safety Rapid Rise Fire Tests of Protection Materials for Structural Steel. The P2 (12mm) column received a fire resistance rating of 67 minutes, the P5 (30mm) column received a fire resistance rating of 131 minutes, the P8A (48mm) column received a fire resistance rating of 184 minutes, the P8B (48mm) column received a fire resistance rating of 175 minutes, the P11 (66mm) column received a fire resistance rating of 240 minutes, and the P14 (84mm) column received a fire resistance rating of 240 minutes. This evaluation was completed on August 21, 2008.

The conclusions of this test report may not be used as part of the requirements for Intertek product certification. Authority to Mark must be issued for a product to become certified.



Appendix F UL 1709 – RAPID RISE FIRE TESTS OF PROTECTION MATERIALS FOR STRUCTURAL STEEL

Aspen Aerogels, Inc.
Project No. 3159033

28 August, 2008
Page 10 of 95

INTERTEK TESTING SERVICES NA

Reported by:



Michael A Brown
Technical Writer

Reviewed by:



Mike Dey
Project Manager, Fire Resistance

Intertek