ARA Design Group

203-7270 Woodbine Ave.
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Tel 905 962 8115
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January 22, 2024

Mitrex
41 Racine Rd
Etobicoke, ON M9W 2Z4

Subject: Spaceloft aerogel Insulation
Ontario Building Code requirement assessment

ARA Design Group Inc. was retained by Mitrex to assess the compliance of *Spaceloft aerogel* insulation with the Ontario Building Code requirements.

This is confirm that *Spaceloft aerogel* insulation meets the requirements of the Ontario Building code CAN/ULC-S702-09 as listed below. This product has R-value of 9.6 per inch (Conductivity of 15 mW/mK). Flame and smoke development numbers for *spaceloft* is zero. Data sheet, MSDS sheet, and three third party testing reports are presented in Appendices 1 to 3, respectively.

Material requirements

The evaluation holder must demonstrate that the product meets the following requirements:

Requirements in Accordance with CAN/ULC-S702-09)	
Property	**Requirement**
Length	–1%, +3% for Batts and rolls
	–3 mm, +10 mm for boards and sheets
Width	–0%, +3% for Batts and rolls
	±3 mm for boards
Thickness	Mean thickness ≥ the design thickness and none of the individual specimen thicknesses < 90% of the design thickness
	–1 mm, +3 mm for boards
Thermal Resistance	Mean thermal resistance ≥ the design thermal resistance (as stated on the product)
Thermal Resistivity	≥ 18.5 (m·K)/W

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Requirements in Accordance with CAN/ULC-S702-09 (Cont.)	
Property	**Requirement**
Surface Burning Characteristics	For Type 1 products not intended for exterior of basement walls: flame-spread classification must not exceed 25; smoke-developed classification must not exceed 50.
Smolder Resistance	Applicable only to Type 1 products, not intended for exterior of basement walls. Mean mass loss ≤ 2% and each specimen ≤ 3%. Smolder *zone must not reach specimen periphery.*
Compressive Resistance of Draining Insulation	Not applicable to Batts or rolls
	Applicable to draining insulation only. Compressive resistance for a 38 mm or thicker draining insulation must be at least 7 kPa at 10% deformation and for thinner than 38 mm it must be at least 10 kPa at 25% deformation.
Water Vapor Permeance	Batts and rolls: not applicable for Type 1 products
	Boards: applicable to adhered membrane/insulation or to non-adhered membranes
Corrosiveness	Applicable to Type 1 Batts and rolls
	Boards: corrosion ≤ control
Fungi resistance	Applicable to Type 1 Batts and rolls
	Boards: growth ≤ comparative item

This review has been carried out in general conformance with the Professional Engineers Ontario Guideline and as required by the Ontario Building Code.

If you have any questions, please do not hesitate to contact us.

Sincerely

Alireza(Ali) Afshin, M.A.Sc., P.Eng.
ARA Design Group

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APPENDIX 1

DATA SHEET

Spaceloft®

EUROPEAN DATA SHEET

aspen aerogels®

Spaceloft®

FLEXIBLE HIGH PERFORMANCE INSULATION FOR BUILDING ENVELOPES & EQUIPMENT

Spaceloft is a flexible, nanoporous aerogel blanket insulation designed to meet the demanding energy conservation requirements of residential and commercial building applications.

Spaceloft's unique properties—extremely low thermal conductivity, superior flexibility, hydrophobicity, and ease of use—make it essential for those seeking the ultimate in thermal protection.

Using patented technology, Spaceloft insulation combines a silica aerogel with reinforcing fibre to deliver industry-leading thermal performance in an easy-to-handle and environmentally friendly product. Spaceloft products are proven, effective insulators, a range of primary new build and retrofit applications including;

- Internal Wall
- External Wall
- Floor
- Terrace
- Balcony
- Roof
- Thermal Bridging
- Services
- Equipment

Advantages

Superior Thermal Performance
Up to five times better thermal performance than competing insulation products, ideal for low energy, passive or zero-energy buildings.

Reduced Thickness and Profile
Equal thermal resistance at a fraction of the thickness, releases space for building occupiers and increases investment returns for owners / investors.

Less Time and Labor to Install
Easily cut and conformed to complex shapes, tight curvatures, and spaces with restricted access. Spaceloft can be prefabricated to reduce installation times, less disruption for occupants.

Physically Robust
Soft and flexible but with excellent springback. Spaceloft can tolerate typical site mechanical abuse without compromising thermal performance.

Shipping and Warehousing Savings
Reduced material volume, high packing density, and low scrap rates can reduce logistics costs by a factor of five or more compared to rigid, preformed insulations.

Hydrophobic Yet Breathable - Hygrothermal Risk Assessments
Spaceloft® repels liquid water but allows vapour to pass through, ideal for heritage application or where a breathable design is desired. Spaceloft's hygrothermal characteristics are available for simulation software such as WUFI®.

Environmentally Friendly
Landfill disposable with no respirable fibre content.

Characteristics

Spaceloft® can be cut using conventional cutting tools including scissors, tin snips, and razor knives. It is recommended gloves, safety glasses, and dust mask be worn when handling material. Additional processing guidelines can be found in the Spaceloft Applications Guide. Refer to the Article Information Sheet (AIS) for additional health and safety information.

Product Properties and Sustainability

Thicknesses[1]	5 mm 10 mm
Width[1]	1.475 m
Thermal Conductivity[2]	15.0 mW/m-K
Colour	Grey
Euro Fire Performance	C,s1,d0
Water Vapour Transmission	μ ≈ 5
Hydrophobic	Yes
Environmental Characteristics	Refer to Environmental Product Declaration
CE Marked	Yes

[1] Nominal Values
[2] Thermal conductivity measurements taken at a compressive load of 2 psi

CE

aspen aerogels®

Aspen Aerogels, Inc.
30 Forbes Road, Building B
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USA

Phone: 508.691.1111
Fax: 508.691.1200
E-Mail: info@aerogel.com
Web: www.aerogel.com

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APPENDIX 2

MSDS SHEET

SAFETY DATA SHEET

1. IDENTIFICATION

Product identifier: Spaceloft®
Synonyms: Spaceloft® Gray silica aerogel material

Manufacturer: Name: Aspen Aerogels, Inc.
Address: 30 Forbes Road Bld. B
Northborough, MA 01532

Telephone number: **(508) 691-1111**
Email: EHS@aerogel.com

Emergency phone number: 800-535-5053 US (INFOTRAC)
352-323-3500 INTERNATIONAL

Recommended use: High performance insulation material
Restrictions on use: None.

Date of Preparation: June 11, 2015

2. HAZARD(S) IDENTIFICATION

Classification:

Physical	Health
Not Hazardous	Not Hazardous

Label Elements

Not hazardous in accordance with the GHS and OSHA Hazcom 2012.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical name	CAS No.	Percent
Synthetic Amorphous Silica	7631-86-9	40-50%
Methylsilylated Silica	68909-20-6	10-20%
Polyethylene Terephthalate (PET or polyester)	25038-59-9	10-20%
Fibrous Glass (textile grade)	Not Applicable	10-20%
Magnesium Oxide	1309-48-4	0-5%
Synthetic Graphite	7782-42-5	0-5%

The exact percentage (concentration) of composition has been withheld as a trade secret.

4. FIRST-AID MEASURES

Inhalation: If dust is inhaled, remove to fresh air. Drink water to clear throat, and blow nose. If irritation occurs or symptoms develop, seek medical attention.

Skin contact: Wash skin with soap and water. If irritation develops, seek medical attention, launder clothing before reuse.

Eye contact: Do not rub eyes. Dust particles may cause abrasive injury. Immediately flush eyes with water while lifting the upper and lower lids. Seek medical attention if irritation persists**.**

Ingestion: No first aid is generally required. No adverse effects are expected from incidental ingestion.

Most important symptoms/effects, acute and delayed: Dust may cause eye irritation. Silica aerogels are hydrophobic (repel water) and may cause temporary drying and irritation of the skin, eyes, and mucous membranes. Inhalation of dust from handling may cause temporary upper respiratory tract irritation. Handling may cause dryness and irritation of the skin.

Indication of immediate medical attention and special treatment, if necessary: Immediate medical attention is generally not required.

5. FIRE-FIGHTING MEASURES

Extinguishing media: Use any media that is suitable for the surrounding fire.

Specific hazards arising from the substance or mixture: Product is a super-insulator. Rolls of material will retain heat within internal layers that may be a source of ignition after the fire is extinguished. Keep hot material away from combustible materials and cool hot insulation with water.

Special protective equipment and precautions for fire-fighters: Normal firefighting procedures should be followed to avoid inhalation of smoke and gases produced by a fire.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment, and emergency procedures: Wear appropriate protective clothing and equipment as described in Section 8. Avoid generating airborne dust during cleanup. Ensure adequate ventilation.

Environmental Precautions: Material is not water soluble. Report spills as required under federal, state and local regulations.

Methods and materials for containment and cleaning up: Collect using methods that avoid the generation of dust (pick up or vacuum dust) and place in appropriate container for disposal.

7. HANDLING AND STORAGE

Precautions for safe handling: Aerogel blankets may generate dust when handled. Workplace exposures to all dusts should be controlled with standard industrial hygiene practices. Local exhaust should be the primary dust control method. Dust generated when handling this product should be cleaned up promptly. Dry vacuuming is the preferred method for cleaning up dust. Because aerogel dust is hydrophobic, water is not an effective dust control agent. Unpack material in the work area. This will help to minimize the area where dust exposure may occur. Trimmed material should be promptly packed in disposal bags. Trims and offcuts may be reused in secondary applications, otherwise scrap material should be packed for disposal. Avoid dust contact with eyes, skin and clothing and avoid breathing dust. Wash hands with soap and water after handling.

Conditions for safe storage, including any incompatibilities: Keep tightly closed in the packaging until ready for use. Store in a dry location.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure guidelines:

Synthetic Amorphous Silica	6 mg/m3 TWA OSHA PEL*
Methylsilylated Silica (as particulates not otherwise classified)	5 mg/m3 (respirable), 15 mg/m3 (total dust) TWA OSHA PEL
Polyethylene Terephthalate (PET or polyester) (as particulates not otherwise classified)	5 mg/m3 (respirable), 15 mg/m3 (total dust) TWA OSHA PEL
Fibrous Glass (textile grade)	5 mg/m3 (respirable), 15 mg/m3 (total dust) TWA OSHA PEL 5 mg/m3 (inhalable) / 1 fiber/cc TWA ACGIH TLV
Magnesium Oxide	15 mg/m3 (total dust) TWA OSHA PEL 10 mg/m3 (inhalable) TWA ACGIH TLV
Synthetic Graphite	5 mg/m3 (respirable), 15 mg/m3 (total dust) TWA OSHA PEL 2 mg/m3 (respirable) TWA ACGIH TLV

*Equivalent to 20 mppcf; 54 FR 2701

Appropriate engineering controls: Use with adequate local exhaust ventilation to minimize exposures. Provide local exhaust ventilation where product is processed in a manner that generates dust.

Individual protection measures:
Respiratory protection: If exposures exceed the occupational exposure limits or if inhalation of dust results in experiencing irritation, an appropriate certified particulate respirator is recommended. Selection of respiratory protection depends on the contaminant type, form and concentration. Select and use in accordance with OSHA 1910.134 and good Industrial Hygiene practice, e.g. a NIOSH approved P100 or N100 particulate filtering facepiece respirator

Skin protection: Impervious gloves recommended for handling product. Long-sleeved and long-legged work clothing are also advised.

Eye protection: Safety glasses with side shields or dust goggles recommended.

Other: None known.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance (physical state, color, etc.): White or gray fabric blanket. Gray material contains an opacifier. White material does not.
Odor: Slight ammonia.

Odor threshold: 0.6-53 ppm (ammonia)	**pH:** Not applicable
Melting point/freezing point: Not determined	**Boiling Point:** Not applicable
Flash point: Not applicable	**Evaporation rate:** Not applicable
Flammability (solid, gas): Not flammable	**VOC:** Not applicable
Flammable limits: LEL: Not applicable	**UEL:** Not applicable
Vapor pressure: Not applicable	**Vapor density:** Not applicable
Relative density: Not determined	**Solubility(ies):** Insoluble in water
Partition coefficient: n-octanol/water: Not available	**Auto-ignition temperature:** Not applicable
Decomposition temperature: Not determined	**Viscosity:** Not applicable

10. STABILITY AND REACTIVITY

Reactivity: Not reactive under normal conditions of use.
Chemical stability: Stable.
Possibility of hazardous reactions: None known.
Conditions to avoid: Avoid prolonged exposure above the recommended use temperature.
Incompatible materials: None known.
Hazardous decomposition products: Under recommended usage conditions, hazardous decomposition products are not expected.

11. TOXICOLOGICAL INFORMATION

Acute effects of exposure:
Inhalation: Inhalation of dust may cause temporary irritation of the mucous membranes and upper respiratory tract.
Ingestion: No adverse effects expected, however, do not ingest.
Skin contact: Handling may cause dryness and temporary irritation of the skin.
Eye contact: Contact may cause irritation with redness and tearing. Dust may cause abrasive injury.
Chronic Effects: None known.
Sensitization: Components are not known to be sensitizers.
Germ Cell Mutagenicity: None of the components have been shown to cause germ cell mutagenicity.
Reproductive Toxicity: Components are not reproductive toxins.
Carcinogenicity: None of the components are listed as carcinogens or suspected carcinogens by IARC, NTP, ACGIH or OSHA. The International Agency for Research on Cancer (IARC) considers synthetic amorphous silica and continuous filament fiber glass to be not classifiable as to carcinogenicity to humans (Group 3).

Acute Toxicity Values: Components are not acutely toxic.

12. ECOLOGICAL INFORMATION

Ecotoxicity values: No data is available
Persistence and degradability: No data is available
Bioaccumulative potential: No data is available
Mobility in soil: No data is available.
Other adverse effects: None known.

13. DISPOSAL CONSIDERATIONS

Dispose in an approved landfill in accordance with federal, state / provincial, and local regulation. Cover promptly to avoid dust generation. This product is not regulated as a hazardous waste under US RCRA regulations.

14. TRANSPORT INFORMATION

	UN Number	Proper shipping name	Hazard Class	Packing Group	Environmental Hazard
DOT		Not Regulated			
TDG		Not Regulated			
IMDG		Not Regulated			
IATA		Not Regulated			

Transport in bulk (according to Annex II of MARPOL 73/78 and the IBC Code): Not applicable – product is transported only in packaged form.

Special precautions: None known.

15. REGULATORY INFORMATION

Safety, health, and environmental regulations specific for the product in question.

CERCLA: This product is not subject to CERCLA release reporting. Many states have more stringent release reporting requirements. Report spills as required under federal, state and local regulations.

SARA Hazard Category (311/312): Not Hazardous

EPA SARA 313: This product contains the following chemicals regulated under SARA Title III, section 313:
None

EPA TSCA Inventory: This product is a manufactured article and not subject to TSCA pre-manufacturing notification requirements**.**

CANADIAN REGULATIONS: All chemical substances in this product are included on or exempted from the Canadian Domestic Substance List (DSL).

16. OTHER INFORMATION

NFPA Rating: Health = 1 Flammability = 0 Instability = 0
HMIS Rating: Health = 1 Flammability = 0 Physical Hazard = 0

SDS Revision History: Update to OSHA Hazcom 2012/GHS Format – changes to all sections.
Date of preparation: June 11, 2015
Date of last revision: February 9, 2011

DISCLAIMER: The information herein is presented in good faith and believed to be accurate as of the effective data given. However, no warranty, expressed or implied, is given. It is the user's responsibility to ensure that its activities comply with Federal, State or Provincial, and local laws.

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APPENDIX 3

THIRD PARTY TESTING REPORTS

TEST REPORT

REPORT NUMBER: 102637146SAT-001A
ORIGINAL ISSUE DATE: July 11, 2016
REVISED DATE:

EVALUATION CENTER
Intertek Testing Services NA Inc.
16015 Shady Falls Road
Elmendorf, TX 78112

RENDERED TO

Aspen Aerogels Inc.
30 Forbes Road
Northborough, MA 01532

Report of Testing "F100371E Blkt 11100" for compliance with the applicable requirements of the following criteria: ASTM E84-15b TEST FOR SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS (UL 723, UBC 8-1, NFPA 255)

ABSTRACT

Specimen I. D.	"F100371E Blkt 11100"
Test Standard:	ASTM E84-15b TEST FOR SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS (UL 723, UBC 8-1, NFPA 255)
Test Date:	July 5, 2016
Client:	Aspen Aerogels Inc.
Test Results:	

FLAME SPREAD INDEX	**0**
SMOKE DEVELOPED INDEX	**0**

Joseph Martinez
Technician III

Reviewed and approved:

Servando Romo
Project Engineer

I. INTRODUCTION

This report describes the results of the ASTM E84-15b TEST FOR SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS a method for determining the comparative surface burning behavior of building materials. This test is applicable to exposed surfaces, such as ceilings or walls, provided that the material or assembly of materials, by its own structural quality or the manner in which it is tested and intended for use, is capable of supporting itself in position or being supported during the test period.

The purpose of the method is to determine the relative burning behavior of the material by observing the flame spread along the specimen. Flame spread and smoke density developed are reported, however, there is not necessarily a relationship between these two measurements.

"The use of supporting materials on the underside of the test specimen may lower the flame spread index from that which might be obtained if the specimen could be tested without such support... This method may not be appropriate for obtaining comparative surface burning behavior of some cellular plastic materials... Testing of materials that melt, drip, or delaminate to such a degree that the continuity of the flame front is destroyed, results in low flame spread indices that do not relate directly to indices obtained by testing materials that remain in place."

This test method is also published under the following designations:

NFPA 255
UL 723
UBC 8-1

This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.

II. PURPOSE

The ASTM E84 (25 foot tunnel) test method is intended to compare the surface flame spread and smoke developed measurements to those obtained from tests of mineral fiber cement board and select grade red oak flooring. The test specimen surface (18 inches wide and 24 feet long) is exposed to a flaming fire exposure during the 10 minute test duration, while flame spread over its surface and density of the resulting smoke are measured and recorded. Test results are presented as the computed comparisons to the standard calibration materials.

The furnace is considered under calibration when a 10 minute test of red oak decking will pass flame out the end of the tunnel in five minutes, 30 seconds, plus or minus 15 seconds. The fiber cement board which complies with Annex A3 of the ASTM E 84 standard forms the zero point for both flame spread and smoke developed indexes, while the red oak flooring smoke developed index is set as 100.

III. TEST PROCEDURE

The tests were conducted in accordance with the procedures outlined in the ASTM E84. The specimens are placed directly on the tunnel ledges. As required by the standard, one or more layers of 0.25 inch thick reinforced concrete board are placed on top of the test sample between the sample and the tunnel lid. After the test, the samples are removed from the tunnel, examined and disposed of.

IV. REVISION SUMMARY

DATE	SUMMARY
July 11, 2016	Original

V. DESCRIPTION OF TEST SPECIMENS

Date Received:	6/28/2016
Date placed in the conditioning room:	6/28/2016
Conditioning (73°F & 50% R.H.):	7 days
Specimen Width (in):	24
Specimen Length (ft):	24
Specimen Thickness (in):	0.3
Total Specimen Weight (lbs):	16

Specimen Description:
The specimen was described by the client as “Spaceloft Gray aerogel insulation blanket”.

The 24 ft. long test specimen consisted of one 24 ft. long aerogel insulation blanket.

The product was received by our personnel in good condition and given an identification number of SAT1606281652-001.

Mounting Method:
The specimen was supported by rods. The specimen was the same on both sides.

VI. TEST RESULTS & OBSERVATIONS

The test results, computed on the basis of observed flame front advance and electronic smoke density measurements are presented in the following table.

Test Specimen	Flame Spread Index	Smoke Developed Index
"F100371E Blkt 11100"	0	0

The data sheets are included in Appendix A. These sheets are actual print-outs of the computerized data system which monitors the tunnel furnace, and contain all calibration and specimen data needed to calculate the test results.

VII. OBSERVATIONS

During the test, the specimen was observed to behave in the following manner.

Time (min:sec)	Observations
0:00	The test burners were turned on.
0:04	Transient ignition was observed.
10:00	The test burners were shut off.

After the test, the specimen was observed to be damaged as follows:

Distance (FEET)	Damage Descriptions
0 – 5	The specimen was observed to be heavily discolored.
5 – 24	The specimen was observed to be lightly discolored.

APPENDIX A
ASTM E84
DATA SHEETS

TEST RESULTS

FLAMESPREAD INDEX: 0

SMOKE DEVELOPED INDEX: 0

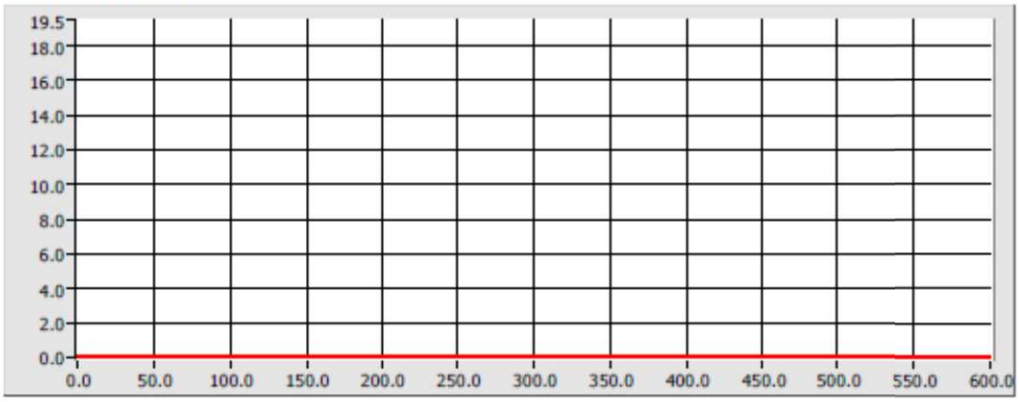
SPECIMEN DATA . . .

Time to Ignition (sec):	0
Time to Max FS (sec):	0
Maximum FS (feet):	0.0
Time to 980 F (sec):	Never Reached
Time to End of Tunnel (sec):	Never Reached
Max Temperature (F):	646
Time to Max Temperature (sec):	521
Total Fuel Burned (cubic feet):	48.13
FS*Time Area (ft*min):	0.3
Smoke Area (%A*min):	0.1
Unrounded FSI:	0.1

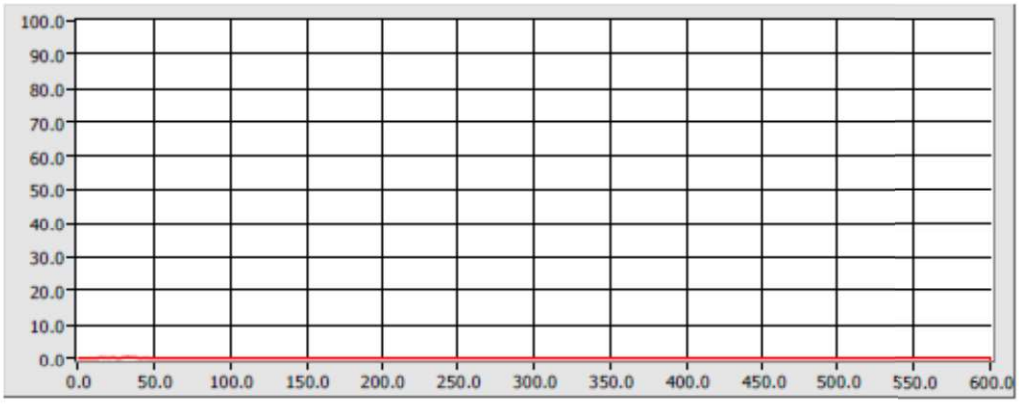
CALIBRATION DATA . . .

Time to Ignition of Last Red Oak (Sec):	43.0
Red Oak Smoke Area (%A*min):	63.8

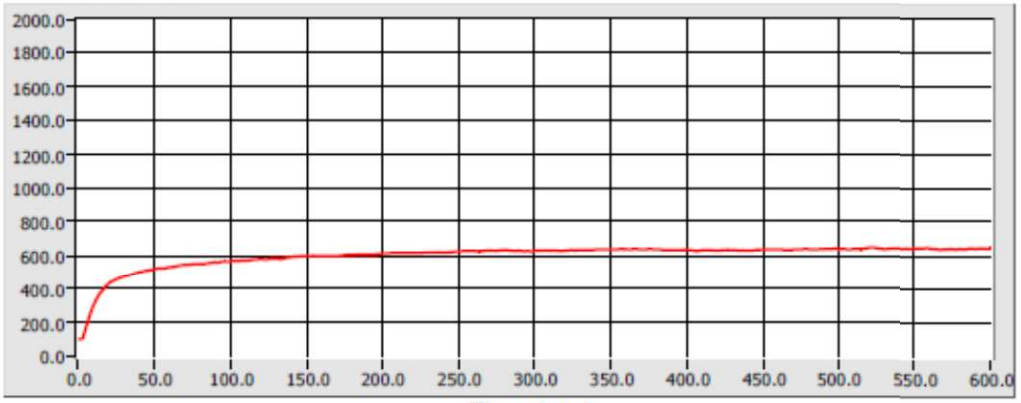
FLAME SPREAD (ft)



Smoke (%A)



Temperature (℉)



Time (sec)

600

intertek
Total Quality. Assured.

ASPEN AEROGELS INC.
TEST REPORT

SCOPE OF WORK
REPORT OF TESTING ES100270 ENG118 SPACELOFT INSULATION FOR COMPLIANCE WITH THE APPLICABLE REQUIREMENTS OF THE FOLLOWING CRITERIA: CAN/ULC S102-18, STANDARD METHOD OF TEST FOR SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS AND ASSEMBLIES.

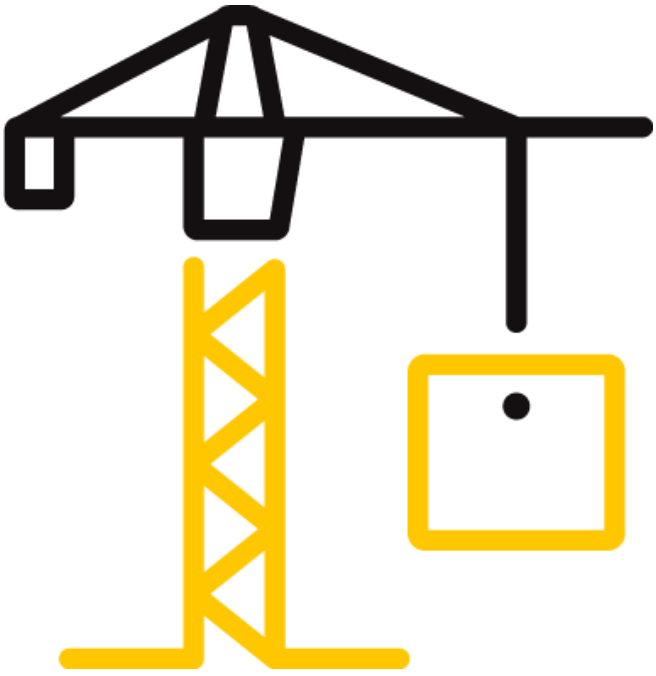
REPORT NUMBER
104912888COQ-001 R0

TEST DATE(S)
12/21/21 - 12/21/21

REVISION DATE
12/21/21

PAGES
16

DOCUMENT CONTROL NUMBER
GFT-OP-10c (09/29/20)



1500 Brigantine Drive
Coquitlam, BC V3K 7C1

Telephone: 604-520-3321
www.intertek.com/building

TEST REPORT FOR ASPEN AEROGELS INC.
Report No.: 104912888COQ-001 R0
Date: 12/21/21

REPORT ISSUED TO
ASPEN AEROGELS INC.
30 FORBES ROAD
NORTHBOROUGH, MA 01532 USA

SECTION 1
SCOPE

Intertek Building & Construction (B&C) was contracted by Aspen Aerogels Inc. 30 Forbes Road Northborough, MA 01532 USA to perform testing in accordance with CAN/ULC S102-18, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies., on their ES100270 ENG118 AFTF Spaceloft Insulation. Results obtained are tested values and were secured by using the designated test method(s). Testing was conducted at Intertek Testing Services NA Ltd. (Intertek) test facility in Coquitlam, BC Canada.

Unless differently required, Intertek reports apply the "Simple Acceptance" rule also called “Shared Risk approach,” of ILAC-G8:09/2019, Guidelines on Decision Rules and Statements of Conformity.

Intertek B&C will service this report for the entire test record retention period. The test record retention period ends four years after the test date. Test records, such as detailed drawings, datasheets, representative samples of test specimens (where required by Certification or Accreditation bodies), or other pertinent project documentation, will be retained for the entire test record retention period.

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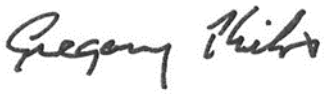
SECTION 2
SUMMARY OF TEST RESULTS

The samples ES100270 ENG118 AFTF Spaceloft Insulation submitted by Aspen Aerogels Inc. were tested in accordance with CAN/ULC S102-18, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

The product test results are presented in Section 10 of this report.

COMPLETED BY:	Sean Fewer	**REVIEWED BY:**	Greg Philp
TITLE:	Technician B&C	**TITLE:**	Reviewer- B&C
SIGNATURE:		**SIGNATURE:**	
DATE:	12/21/21	**DATE:**	12/21/21

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Telephone: 604-520-3321
www.intertek.com/building

TEST REPORT FOR ASPEN AEROGELS INC.
Report No.: 104912888COQ-001 R0
Date: 12/21/21

SECTION 3
TEST METHOD(S)

The specimens were evaluated in accordance with the following:

CAN/ULC S102-18, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

SECTION 4
MATERIAL SOURCE/INSTALLATION

Samples were submitted to Intertek directly from the client and were not independently selected for testing and Intertek accepts no responsibility for any inaccuracies provided.

SECTION 5
EQUIPMENT

ASSET #	DESCRIPTION	MODEL	CAL DUE DATE
WH2189	Photocell	Huygen 856	11/05/22
WH 2190	Smoke Opacity Meter	Huygen	11/05/22
WH 2494	Data Logger	Phidgets DAQ 2020	11/05/22
	FS Tunnel (S102)	N/A	02/17/22

SECTION 6
LIST OF OFFICIAL OBSERVERS

NAME	COMPANY
Sean Fewer	Intertek B&C

1500 Brigantine Drive
Coquitlam, BC V3K 7C1

Telephone: 604-520-3321
www.intertek.com/building

SECTION 7
TEST CALCULATIONS

The results of the tests are expressed by indexes, which compare the characteristics of the sample under tests relative to that of select grade red oak flooring and inorganic-cement board.

(A) Flame Spread Rating:

This index relates to the rate of progression of a flame along a sample in the 7620 mm tunnel. A natural gas flame is applied to the front of the sample at the start of the test and drawn along the sample by a draft kept constant for the duration of the test. An observer notes the progression of the flame front relative to time.

The test apparatus is calibrated such that the flame front for red oak flooring passes out the end of the tunnel in five minutes, thirty seconds (plus or minus 15 seconds).

(B) Smoke Developed:

A photocell is used to measure the amount of light, which is obscured by the smoke passing down the tunnel duct. When the smoke from a burning sample obscures the light beam, the output from the photocell decreases. This decrease with time is recorded and compared to the results obtained for red oak, which is defined to be 100.

SECTION 8
TEST SPECIMEN DESCRIPTION

Upon receipt of the samples at the Intertek Coquitlam laboratory they were placed in a conditioning room where they remained in an atmosphere of 23 $\pm$ 3°C (73.4 $\pm$ 5°F) and 50 $\pm$ 5% relative humidity.

The sample material consisted of 10 mm thick 610 mm wide by 7315 mm long and was identified as “ES100270 ENG118 AFTF Spaceloft Insulation” and was gray in color.

For each trial run, 610 mm wide by 7315 mm of sample material was placed on the upper ledge of the flame spread tunnel to form the required 7315 mm. sample length. The sample material was supported by 6 mm steel rods spaced every 610 mm. A layer of 6 mm. reinforced cement board was placed over top of the samples, the tunnel lid was lowered into place, and the samples were then tested in accordance with CAN/ULC S102-18.

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TEST REPORT FOR ASPEN AEROGELS INC.
Report No.: 104912888COQ-001 R0
Date: 12/21/21

SECTION 9
TEST RESULTS

(A) Flame Spread

The resultant flame spread ratings are as follows:
(Rating rounded to nearest 5)

ES100270 ENG118 AFTF Spaceloft Insulation	Flame Spread	Flame Spread Rating
Run 1	0	0
Run 2	0	
Run 3	0	

(B) Smoke Developed

The areas beneath the smoke developed curve and the related classifications are as follows:
(Classification rounded to nearest 5)

I ES100270 ENG118 AFTF Spaceloft Insulation	Smoke Developed	Smoked Developed Classification
Run 1	14	15
Run 2	27	
Run 3	4	

(C) Observations

During the test runs, there was no visible surface ignition. This was the case for all three test runs.

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SECTION 10
CONCLUSION

The samples of ES100270 ENG118 AFTF Spaceloft Insulation submitted by Aspen Aerogels Inc. exhibited the following flame spread characteristics when tested in accordance with CAN/ULC S102-18, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

A series of three test runs of material was conducted to conform to the requirements of the National Building Code of Canada.

Sample Material	Flame Spread Rating	Smoke Developed Classification
ES100270 ENG118 AFTF Spaceloft Insulation	0	15

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.

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TEST DATA (6 PAGES)

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TEST REPORT FOR ASPEN AEROGELS INC.
Report No.: 104912888COQ-001 R0
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CAN/ULC S102-18 DATA SHEETS
Run 1

Standard: ULC S102

Lab ID: Intertek Coquitlam Fire Laboratory
Client: Aspen Aerogels
Date: 21 Dec 2021
Project Number: 104912888
Test Number: 1
Operator: Sean Fewer

Specimen ID and Description:

AFTF Spaceloft Insulation

TEST RESULTS

FLAMESPREAD INDEX: 0.000
SMOKE DEVELOPED INDEX: 14.000

SPECIMEN DATA

Time to Ignition (sec): 0.000
Time to Max Flame Spread (min): 0.000
Maximum Flame Spread (mm): 0.000
Time to 527 C / 980 F (sec): 0.000
Max Temperature (deg F or C as per test standard): 286.950
Time to Max Temperature (sec): 587.785
Total Fuel Burned (cubic feet): 49.254

Flame Spread*Time Area (M*min): 0.000
Smoke Area (%A*min): 22.206
Unrounded FSI: 0.000
Unrounded SDI: 14.288

CALIBRATION DATA

Time to Ignition of Last Red Oak (sec): 47

Calibrated Smoke Area (%A*min): 155.423

15 point Heptane average for E84-19b
5 point Red Oak average for S102

Tested by: SF Reviewed by: gp

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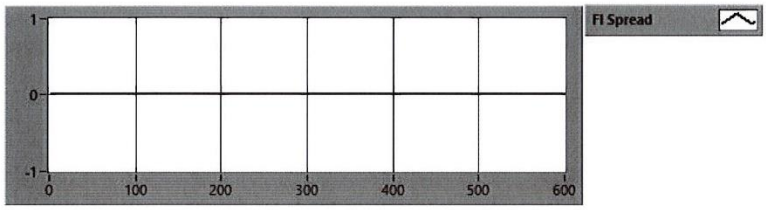
TEST REPORT FOR ASPEN AEROGELS INC.
Report No.: 104912888COQ-001 R0
Date: 12/21/21

CAN/ULC S102-18 DATA SHEETS
Run 1

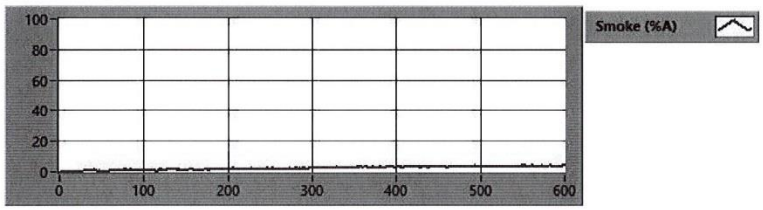
Client: Aspen Aerogels | Project Number: 104912888

Test Number: 1 | Test Standard: ULC S102

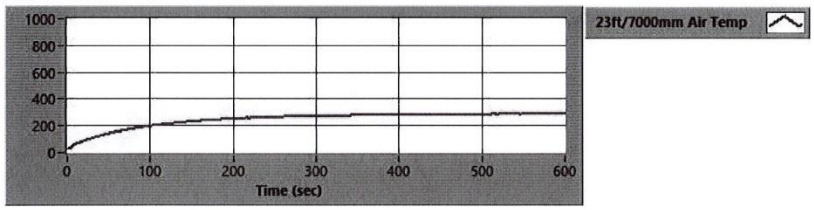
FLAME SPREAD



SMOKE (%A)



TEMPERATURE



Tested by: SF Reviewed by: [signature]

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TEST REPORT FOR ASPEN AEROGELS INC.
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Date: 12/21/21

CAN/ULC S102-18 DATA SHEETS
Run 2

Standard: ULC S102

Lab ID: Intertek Coquitlam Fire Laboratory
Client: Aspen Aerogels
Date: 21 Dec 2021
Project Number: 104912888
Test Number: 2
Operator: Sean Fewer

Specimen ID and Description:

AFTF Spaceloft Insulation

TEST RESULTS

FLAMESPREAD INDEX: 0.000
SMOKE DEVELOPED INDEX: 27.000

SPECIMEN DATA

Time to Ignition (sec): 0.000
Time to Max Flame Spread (min): 0.000
Maximum Flame Spread (mm): 0.000
Time to 527 C / 980 F (sec): 0.000
Max Temperature (deg F or C as per test standard): 289.340
Time to Max Temperature (sec): 598.929
Total Fuel Burned (cubic feet): 49.241

Flame Spread*Time Area (M*min): 0.000
Smoke Area (%A*min): 42.550
Unrounded FSI: 0.000
Unrounded SDI: 27.377

CALIBRATION DATA

Time to Ignition of Last Red Oak (sec): 47

Calibrated Smoke Area (%A*min): 155.423

15 point Heptane average for E84-19b
5 point Red Oak average for S102

Tested by: SF

Reviewed by: gp

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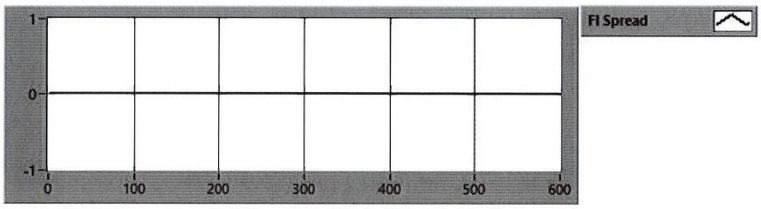
TEST REPORT FOR ASPEN AEROGELS INC.
Report No.: 104912888COQ-001 R0
Date: 12/21/21

CAN/ULC S102-18 DATA SHEETS
Run 2

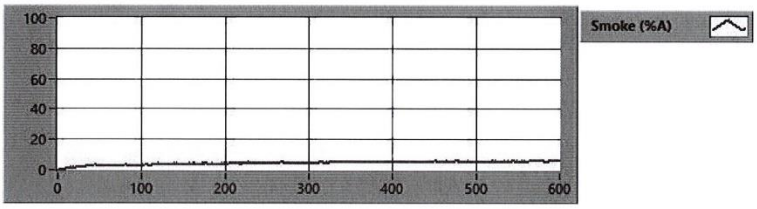
Client: Aspen Aerogels | Project Number: 104912888

Test Number: 2 | Test Standard: ULC S102

FLAME SPREAD



SMOKE (%A)



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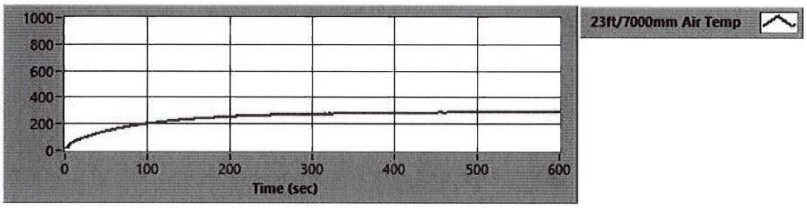

Tested by: SF Reviewed by: [signature]

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TEST REPORT FOR ASPEN AEROGELS INC.
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CAN/ULC S102-18 DATA SHEETS
Run 3

Standard: ULC S102

Lab ID: Intertek Coquitlam Fire Laboratory
Client: Aspen Aerogels
Date: 21 Dec 2021
Project Number: 104912888
Test Number: 3
Operator: Sean Fewer

Specimen ID and Description:

AFTF Spaceloft Insulation

TEST RESULTS

FLAMESPREAD INDEX: 0.000
SMOKE DEVELOPED INDEX: 4.000

SPECIMEN DATA

Time to Ignition (sec): 0.000
Time to Max Flame Spread (min): 0.000
Maximum Flame Spread (mm): 0.000
Time to 527 C / 980 F (sec): 0.000
Max Temperature (deg F or C as per test standard): 292.870
Time to Max Temperature (sec): 593.496
Total Fuel Burned (cubic feet): 49.367

Flame Spread*Time Area (M*min): 0.000
Smoke Area (%A*min): 5.682
Unrounded FSI: 0.000
Unrounded SDI: 47

CALIBRATION DATA

Time to Ignition of Last Red Oak (sec): 9.975

Calibrated Smoke Area (%A*min): 155.423

15 point Heptane average for E84-19b
5 point Red Oak average for S102

Tested by: SF

Reviewed by:

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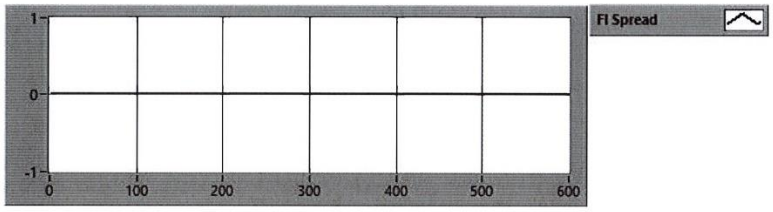
Report No.: 104912888COQ-001 R0
Date: 12/21/21

CAN/ULC S102-18 DATA SHEETS
Run 3

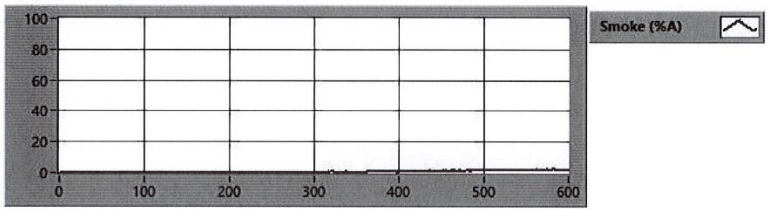
Client: Aspen Aerogels | Project Number: 104912888

Test Number: 3 | Test Standard: ULC S102

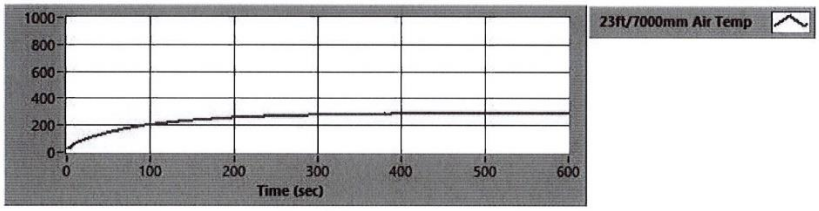
FLAME SPREAD



SMOKE (%A)



TEMPERATURE



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TEST REPORT FOR ASPEN AEROGELS INC.
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SECTION 12
PHOTOGRAPHS

Photo No. 1
Pre-Test

Photo No. 2
Post-Test

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SECTION 13
REVISION LOG

REVISION #	DATE	PAGES	REVISION
0	12/21/21	N/A	Original Report Issue

NETZSCH

Applications Laboratory
Thermophysical Properties Section

Apparent Thermal Conductivity and Thermal Resistance of Aerogel Insulation

Report Number 621005640

Prepared for:

Aspen Aerogels Inc.
30 Forbes Rd.
Northborough, MA 01532

Work Performed Under Purchase Order Number 345141

Submitted By: _____

Nate Marin
Applications Lab Technician
August 18th, 2021

ISO/IEC 17025:2017 Accredited
PJLA accreditation# 74626
Testing Laboratory

NETZSCH Instruments North America, LLC, 129 Middlesex Turnpike, Burlington, MA 01803
Phone 781-272-5353, e-mail: NIB_Laboratory@netzsch.com

Report on the Apparent Thermal Conductivity and Thermal Resistance of Aerogel Insulation

The Thermophysical Property Section of the NETZSCH Instruments Applications Laboratory, Burlington, MA, received five aerogel insulation samples from Aspen Aerogels for apparent thermal conductivity and thermal resistance measurements at a nominal mean temperature of 10°C by the heat flow meter method.

The samples, identified as given in Table 1, were received on 7/26/21 as blankets approximately 305 mm by 305 mm square by 10 mm thick. The samples were tested as received.

The specimens were positioned horizontally with heat flow down during the tests. The thermal transmission results are given in Tables 2 and 3 after a description of equipment and procedure. The results reported apply only to the specimens that were tested.

Thermal Conductivity

Thermal conductivity is the material property that determines the amount of heat that will flow through an object when a temperature difference exists across the object. Thermal conductivity is a steady state property; it can only be directly measured under conditions in which the temperature distribution is not changing and all heat flows are steady. The fundamental equation that governs steady-state heat flow in a slab geometry is:

$$Q = \frac{\lambda \times \Delta T \times A}{\Delta x} \qquad (1)$$

where

Q	=	the rate of heat flow through the slab (W or Btu/hr)
λ	=	the thermal conductivity of the slab material (W/m-K or Btu-in/hr-ft^2-°F)
ΔT	=	the temperature difference across the slab (°C or °F)
Δx	=	the thickness (m or in)
A	=	the cross sectional area (m^2 or ft^2)

Materials that have low values of thermal conductivity allow only a small amount of heat flow and are called thermal insulators. Materials with large values of thermal conductivity allow more heat to flow across the slab with the same temperature difference. Thermal conductivity is a material property and does not depend upon the geometry of the sample. In general, thermal conductivity is a function of the mean sample temperature. The

material comprising the slab is often a mixture of materials. It could be a layered composite or a material containing gas cells in which heat can be transferred by convection and radiation as well as by conduction through the solid. In these cases the parameter, λ, defined in Equation (1) is an "effective" or "apparent" thermal conductivity for the heterogeneous material.

Experimental Procedure for Testing by ASTM C518-17

Testing was performed according to the procedure given in ASTM C518-17, *Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter* utilizing a Netzsch HFM 446/M Lambda model heat flow meter instrument (see Figure 1). The specimen was installed horizontally between 305mm (12 inch) square aluminum surface plates treated to have a total hemispherical emittance of 0.86 at 24ºC (75ºF). The surface plates were smoothly finished to conform to a true plane within 0.25 percent. Above the upper (hot) and below the lower (cold) surface plates, thermoelectric heating/cooling modules, heat sinks and insulation were installed. The two heat sink assemblies were connected to a fluid system controlled at constant temperature and temperature control of the surface plates was accomplished by controlling the power supplied to the thermoelectric modules. The surface plate temperatures were monitored by thermocouples mounted in the surface plates.

Between the test specimen and each surface plate, a heat flux transducer was installed. The instrument heat flux transducers utilized have sensing areas 102 mm (4 inches) square located in the center of the 305 mm (12 inch) square overall area.

Temperature measurements were performed by utilizing Type-K Chromel/Alumel thermocouples calibrated to the special limits of error specified in ASTM E230, *Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples*. All thermocouple sensors were fabricated with # 30 AWG wire. Single temperature sensors were used for measuring the hot and cold surface plate temperatures in the center of the sensing area of the instrument heat flux transducer. All temperature sensors were individually connected to a Lawson Labs Data Acquisition Unit having a resolution of $\pm$ 1 microvolt.

The top surface plate assembly could be adjusted to accommodate surface plate separations from 0 to 100 mm (0 to 4 inches). The opening between the surface plates was measured by using a linear motion potentiometer. The periphery of the test stack was lined with 100 mm (4 inches) of an extruded polystyrene foam insulation having a thermal resistance of about 1.8 m^2-K/W (10 hr-ft^2-°F/Btu) at 24°C (75°F).

In operation, the plate separation was adjusted to accommodate the test thickness of the specimen being evaluated. Typically, the thickness of the specimen was measured prior to its insertion into the instrument and the plates were closed such that the thickness readout corresponded to the average thickness of the specimen. The temperatures of the

top and bottom surface plates were adjusted such that the mean temperature and temperature difference test requirements were satisfied. If no temperature difference requirements are given, 20°C (36°F) is typically used.

At equilibrium, established after ensuring that during two regular sets of fifteen – one minute readings the test specimen apparent thermal conductivity changed less than 0.1 percent and not monotonically, the temperatures of both hot and cold faces were evaluated from the sensors embedded in the plates, and the heat flux through the specimen was derived from the heat flux transducer output.

The apparent thermal conductivity was calculated from

$$\lambda = \frac{(S_I) \times (HFTOP)_I \times \Delta X}{\Delta T}$$

and the thermal resistance was calculated from

$$R = \frac{\Delta X}{\lambda}$$

where λ = apparent thermal conductivity

S_I = instrument heat flux transducer sensitivity ((W/m^2)/µV or (Btu/hr-ft^2)/µV)

$HFTOP_I$ = instrument heat flux transducer output (µV)

Δx = test specimen thickness

ΔT = temperature difference across test specimen

R = thermal resistance (m^2-K/W or hr-°F-ft^2/Btu)

The instrumentation was calibrated using the National Institute of Standards and Technology Standard Reference Material 1450d. The calibration specimen is a high-density fibrous glass material, 25.4 mm (1.00 inch) thick, with a thermal resistance of approximately 4.4 hr-ft^2-°F/Btu. The valid temperature range for this calibration standard is 280K to 340K. The instrumentation calibration was verified within 24 hours before or after the test.

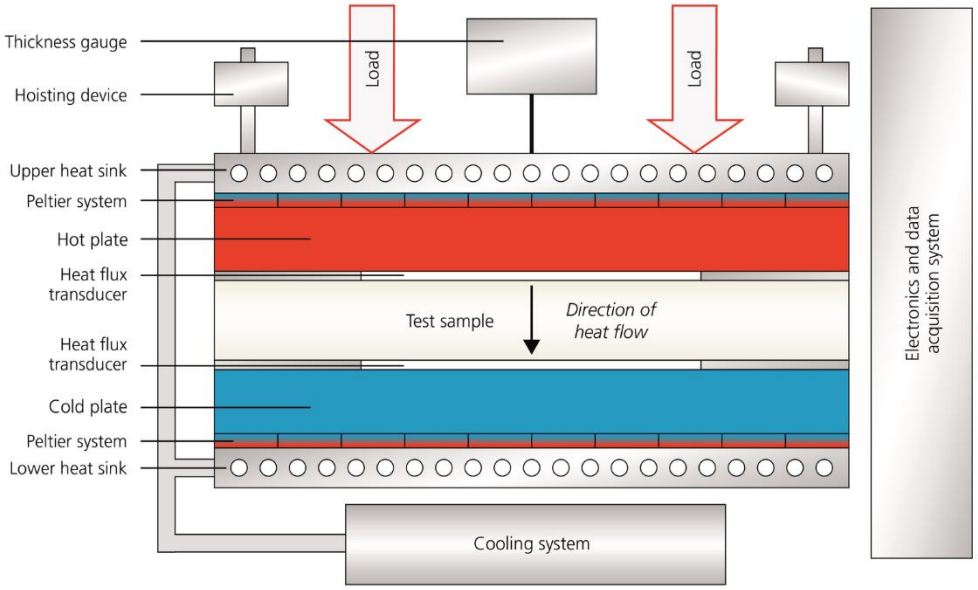

Figure 1. Schematic diagram of heat flow meter instrument

Test Information

Table 1
ASTM C518 Test Information

Sample	As-Received Thickness mm	As-Received Thickness in	Setpoint Temperature °C	Setpoint Temperature °F	Test Start Date mm/dd/yy	Test End Date mm/dd/yy	Test Duration hh:mm:ss
ENG111 ; ES100270 Spaceloft Grey	9.84	0.388	10	50	08/10/21	08/10/21	02:04:06
ENG112 ; ES100270 Spaceloft Grey	10.2	0.403	10	50	08/10/21	08/10/21	02:05:26
ENG114 ; ES100270 Spaceloft Grey	10.0	0.392	10	50	08/12/21	08/12/21	02:05:31
ENG115 ; ES100270 Spaceloft Grey	10.4	0.409	10	50	08/13/21	08/13/21	02:28:01
ENG116 ; ES100270 Spaceloft Grey	10.0	0.393	10	50	08/13/21	08/13/21	02:04:24

Test Results

Table 2
Abridged ASTM C518 Thermal Transmission Results -- SI Units

Sample	Test Thickness Δx @ RT mm	Test Density ρ @ RT kg/m^3	Mean Temperature T_{mean} (°C)	Apparent Thermal Conductivity λ (W/m·K)	Measurment Uncertainty u %	Thermal Resistance R (m^2·K/W)	Measurment Uncertainty u %
ENG111 ; ES100270 Spaceloft Grey	9.23	166	10	0.0147	2.4	0.628	0.99
ENG112 ; ES100270 Spaceloft Grey	9.49	167	10	0.0150	2.3	0.632	0.99
ENG114 ; ES100270 Spaceloft Grey	9.22	168	10	0.0149	2.4	0.617	0.99
ENG115 ; ES100270 Spaceloft Grey	9.61	165	10	0.0148	2.3	0.650	0.99
ENG116 ; ES100270 Spaceloft Grey	9.14	159	10	0.0143	2.4	0.639	0.99

NETZSCH

Table 3
Abridged ASTM C518 Thermal Transmission Results -- English Units

Sample	Test Thickness Δx @ RT in	Test Density ρ @ RT lbs/ft³	Mean Temperature T_{mean} (°F)	Apparent Thermal Conductivity λ (Btu·in/hr·°F·ft²)	Measurment Uncertainty u %	Thermal Resistance R (hr·°F·ft²/Btu)	Measurment Uncertainty u %
ENG111 ; ES100270 Spaceloft Grey	0.363	10.4	50	0.102	2.4	3.57	0.99
ENG112 ; ES100270 Spaceloft Grey	0.374	10.4	50	0.104	2.3	3.59	0.99
ENG114 ; ES100270 Spaceloft Grey	0.363	10.5	50	0.104	2.4	3.50	0.99
ENG115 ; ES100270 Spaceloft Grey	0.378	10.3	50	0.102	2.3	3.69	0.99
ENG116 ; ES100270 Spaceloft Grey	0.360	9.93	50	0.0992	2.4	3.63	0.99

Notes

A mechanical load of 2 psi was applied to the sample during testing. Negligible mass loss/gain was observed post-testing.

The relative standard uncertainties are calculated based on GUM (guide to the expression of uncertainty in measurement, ISO/IEC Guide, 98-3: 2008).

Uncertainties:

$$(U\_TC)^2 = (\delta\lambda/\lambda)^2 = (\delta N/N)^2 + (\delta E/E)^2_S + (\delta E/E)^2_C + (\delta L/L)^2_S + (\delta L/L)^2_C + (\delta\Delta T/\Delta T)^2_S + (\delta\Delta T/\Delta T)^2_C$$

$$(U\_TR)^2 = (\delta R/R)^2 = (\delta N/N)^2 + (\delta E/E)^2_S + (\delta E/E)^2_C + (\delta L/L)^2_C + (\delta\Delta T/\Delta T)^2_S + (\delta\Delta T/\Delta T)^2_C$$

$\delta\lambda/\lambda$	relative standard uncertainty of the thermal conductivity
$\delta R/R$	relative standard uncertainty of the thermal resistance
$\delta N/N$	estimated relative uncertainty of the calibration factor
$\delta E/E$	estimated relative uncertainty of the heat flux meter
$\delta L/L$	estimated relative uncertainty of the thickness transducer
$\delta\Delta T/\Delta T$	estimated relative uncertainty of the temperature difference across the specimen
S	sample measurement
C	calibration measurement

Revision History

Revision	Date	Description

Reviewed By: Guiquan Pan

George Pan
Applications Scientist
August 18, 2021

Accreditation #74626