

NFPA 2112-2023 Edition

Standard on Flame-Resistant Clothing for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire

TIA Log No.: 1858

Reference: 3.3.41.1(new), 3.3.41.2(new), 6.3, 7.1.2.5, 7.1.3, and 7.1.4

Comment Closing Date: October 17, 2025

Submitter: John Morton-Aslanis, NC State University, Rep. Task Group on TIA

www.nfpa.org/2112

1. *Add new paragraphs 3.3.41.1 and 3.3.41.2 to read as follows:*

3.3.4.1 Venting Material. A fabric material used in a flame-resistant garment to aid in the transfer of air through the garment for the primary purpose of increasing the wearer's comfort.

3.3.41.1 Covered Venting Material. Venting material that is covered completely by a material meeting all fabric requirements of this standard.

3.3.41.2 Uncovered Venting Material. Venting material that is not covered completely by a material meeting all fabric requirements of this standard.

2. *Revise section 6.3 to read as follows:*

6.3 Venting Material.

~~**6.3.1** Venting materials used on flame-resistant garments shall be covered by fabric meeting the requirements of this standard.~~

~~**6.3.1.1** Where used on flame-resistant garments and not covered by fabric, venting materials shall not exceed 465 cm² (72 in.²) over the entire flame-resistant garment.~~

6.3.1 Uncovered venting material shall meet all fabric requirements of this standard.

6.3.2 Covered venting material shall meet the venting material requirements of this standard.

3. *Revise paragraphs 7.1.2.5, 7.1.3, and 7.1.4 to read as follows:*

~~**7.1.2.5** Venting Covered venting material utilized in the construction of the garment shall be tested for flame resistance as specified in Section 8.3, have an after flame of not more than 2 seconds, and not melt and drip.~~

7.1.3 Fabric utilized in the construction of flame-resistant garments, excluding manufacturers' labels, linings, interlinings, covered venting materials, and cold weather insulation materials, shall be individually tested for thermal shrinkage resistance as specified in Section 8.4, and shall not shrink more than 10 percent in any direction.

7.1.4 Fabric, linings, cold weather insulation materials, other textile materials, covered venting materials, reinforcements, and reflective striping, other than those items described in 7.1.4.2 and 7.1.4.3, used in the construction of flame-resistant garments shall be individually tested for heat resistance in their original form as specified in Section 8.4 and shall not melt and drip, separate, or ignite.

Substantiation: Background: Uncovered vents are areas of the garment where the primary fabric has been replaced with a "venting material" which has a much lower thermal performance threshold than standard body fabric. Venting materials are tested only for limited flame and heat resistance; they are not tested for heat transfer performance (HTP), char length, or % predicted body burn. Materials passing this abbreviated testing protocol are likely not as protective as standard body fabric which could leave a wearer less protected in areas where uncovered vents exist. Previous editions of the standard did not define venting materials and therefore the certification organizations had to make the determination of whether or not they were allowed to be used at all, and if they were, how much was allowed and did they need to be covered by compliant outer shell. As a result, during development of the 2023 edition of NFPA 2112, Public Input 7 was submitted by UL LLC in order to initiate the discussion with the technical committee

on this topic. First Revision 45 was created using the language that was submitted under PI 7. No further action was taken on this section at the second draft stage. In the meantime, TIA 23-1 (Log No. 1627) was issued which revised the testing requirements for venting materials. The substantiation of that TIA, in part, stated that “the purpose of venting material is not structural integrity or thermal protection, plus it will have little if any direct exposure to the flash fire event, as it is required to be covered.” This supports the fact that committee members did not understand the impact of 6.3.1.1 and understood vents to be covered. After further review of the language in 6.3.1 and 6.3.1.1, concerns from manufacturers, users and testing labs were raised and TIA 1732 was generated and submitted by Amanda Newsom of UL LLC to eliminate the allowance for uncovered venting materials due to the lack of thermal insulation that these types of materials will allow. The basis for this discussion was generated from limitations of the test program and test methods required for venting materials. TIA 1732 reached 100% consensus among the technical committee and was forwarded to the standards council for consideration. During the August 2023 Standards Council meeting, when considering Appeal Decision #23-6, the council decided to overturn the results of the TIA and directed NFPA staff to form a balanced Task Group that included the appellant to review the changes proposed by TIA No. 1732 and report back to the council at the April 2024 meeting. At the balanced Task Group meetings, there was discussion from all members about the reasons for the TIA and a consensus was reached to generate another TIA to put forward to the committee, public, and Standards Council.

The basis for this TIA is as follows: Venting materials are currently allowed to be used as a body fabric (as uncovered vents) in a limited size, but do not have the same performance requirements. The heat transfer performance test (HTP) (reference section 7.1.1) had not been performed on these materials and there was no way for the committee to evaluate if they would meet this minimum requirement. There is a concern that there is a lack of insulation performance when venting materials are used as a body fabric. As a result, the Heat Transfer Performance Test (HTP) was performed by an independent testing laboratory so that any future decisions can be made based on data. HTP Testing was conducted on four distinct materials with a total of 7 different venting configurations that met the current venting material requirements in NFPA 2112-2023 listed below.

- Flame resistance (Sec 8.3), afterflame of not more than 2 seconds, and not melt and drip
- Thermal degradation (Sec 8.4), shall not melt and drip, separate, or ignite as currently specified in NFPA 2112

A body fabric is required to have a heat transfer performance (HTP) “spaced” rating of not less than 25 J/cm² (6.0 cal/cm²) and a “contact” rating of not less than 12.6 J/cm² (3.0 cal/cm²). None of the 7 venting configurations passed the fabric HTP performance requirement as called out in reference section 7.1.1. See attached results. This testing has demonstrated that the thermal insulation properties of venting materials do not offer the same level of protection as the body fabric, which could leave the wearer susceptible to burn injuries in those areas where uncovered venting is used. Therefore, this TIA is being submitted to remove the allowance of even a small amount of venting material to be used as the garment body fabric.

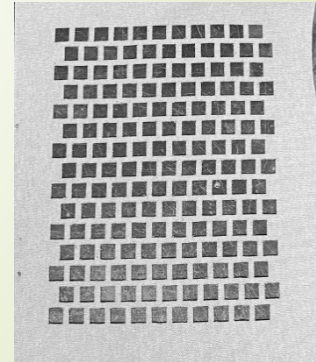
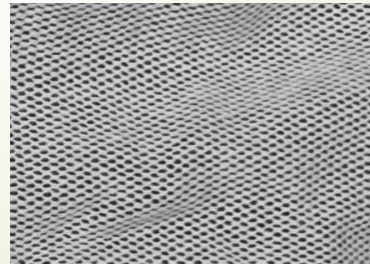
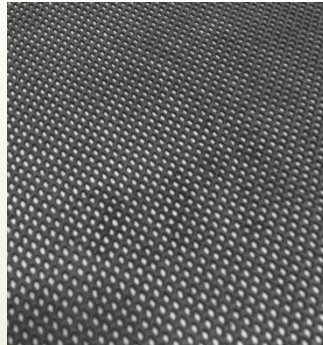
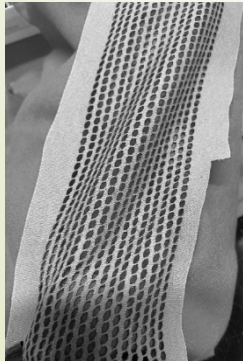
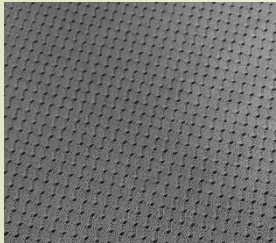
Emergency Nature: The NFPA Standard contains an error or an omission that was overlooked during the regular revision process.

The standard currently allows up to 72 sq.in. of uncovered vents on a garment. These uncovered fabric panels can be made of less protective flame-resistant fabric which is not required to be tested in a simulated flash fire exposure on an instrumented thermal manikin or for insulative capabilities. End users select NFPA 2112 compliant garments for protection against flash fire, and in their current design, could leave wearers vulnerable to increased burn injury where uncovered vents exist.

Anyone may submit a comment by the closing date indicated above. Please identify the TIA number, state whether you SUPPORT or OPPOSE the TIA along with your comment, and forward to the Secretary, Standards Council. [SUBMIT A COMMENT](#)

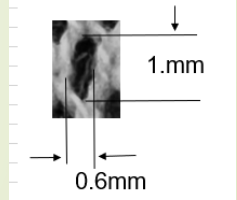
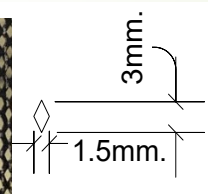
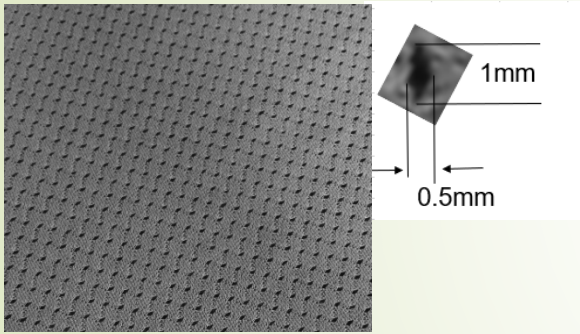
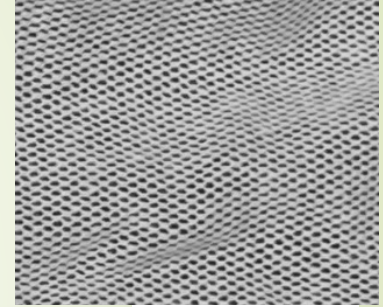
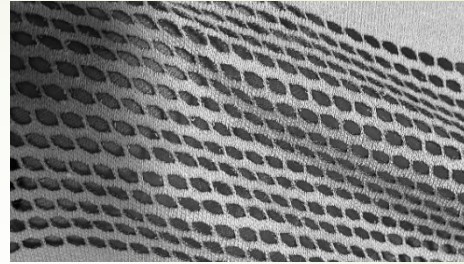
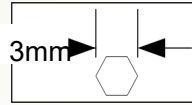
Venting Material Bench Level Testing

1. Four fabrics, 8 configurations-(details on next slide)
2. Samples were tested for flame resistance (Sec 8.3) and thermal degradation (Sec 8.4) as currently specified in NFPA 2112
3. Samples were tested for heat transfer performance (HTP, Sec 8.2) to see if they passed the spaced and contact requirements in NFPA 2112 as they are currently allowed to be exposed directly to flame



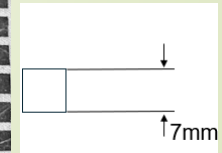
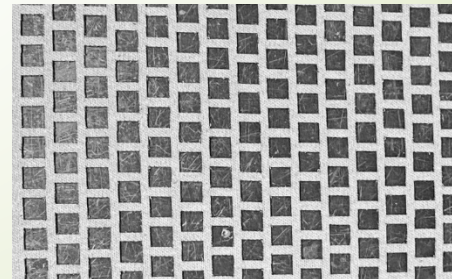
Venting Material Bench Level Testing

- 4 Commercially available FR materials
- 5 Vent hole sizes



NFPA 2112 Venting Material Requirements

- **Flame resistance and thermal degradation**



Venting Material Bench Level Test Results

Sample ID	Thermal Degradation	Flame Resistance	HTP
Fabric A-Diamond	PASS	PASS	FAIL
Fabric A-Polygon	PASS	PASS	FAIL
Fabric A-Square	PASS	PASS	FAIL
Fabric B Diamond	PASS	PASS	FAIL
Fabric B-Polygon	PASS	PASS	FAIL
Fabric B-Square	PASS	FAIL	FAIL
Fabric D	PASS	PASS	FAIL
Fabric E	PASS*	PASS*	FAIL

* Fabric "E": Only 1 rep completed for thermal degradation and flame resistance, insufficient matl. for multiple samples

Product Description:	Fabric A - Diamond Pattern					
Modifications:	None					
NFPA 2112-2023 Section 7.1.2.5						
Testing for flame resistance as specified in Section 8.3						
ASTM D6413/D6413M, Standard Test Method for Flame Resistance of Textiles (Vertical Test), 2015						
Flame Test Preconditioning:	None					
Flame Test Conditioning:	None					
Specimen	1	2	3	4	5	Average
Afterflame Time (sec)	0.18	0.00	0.19	0.00	0.19	0.1
Melting?	No	No	No	No	No	No
Dripping?	No	No	No	No	No	No
Melting and Dripping?	No	No	No	No	No	No
Test Date:	3/28/2024					

Product Description:	Fabric A - Polygon Pattern					
Modifications:	None					
NFPA 2112-2023 Section 7.1.2.5						
Testing for flame resistance as specified in Section 8.3						
ASTM D6413/D6413M, Standard Test Method for Flame Resistance of Textiles (Vertical Test), 2015						
Flame Test Preconditioning:	None					
Flame Test Conditioning:	None					
Specimen	1	2	3	4	5	Average
Afterflame Time (sec)	0.22	0.24	0.18	0.20	0.00	0.2
Melting?	No	No	No	No	No	No
Dripping?	No	No	No	No	No	No
Melting and Dripping?	No	No	No	No	No	No
Test Date:	3/28/2024					

Product Description:	Fabric A - Square Pattern					
Modifications:	None					
NFPA 2112-2023 Section 7.1.2.5						
Testing for flame resistance as specified in Section 8.3						
ASTM D6413/D6413M, Standard Test Method for Flame Resistance of Textiles (Vertical Test), 2015						
Flame Test Preconditioning:	None					
Flame Test Conditioning:	None					
Specimen	1	2	3	4	5	Average
Afterflame Time (sec)	0.18	0.21	0.18	0.19	0.20	0.2
Melting?	No	No	No	No	No	No
Dripping?	No	No	No	No	No	No
Melting and Dripping?	No	No	No	No	No	No
Test Date:	3/28/2024					

Product Description:	Fabric A - Diamond Pattern
Modifications:	None
NFPA 2112-2023 Sections 7.1.3 and 7.1.4	
Testing for heat resistance and thermal shrinkage per Section 8.4	
Referencing ASTM F2894, Standard Test Method for Evaluation of Materials, Protective Clothing, and Equipment for Heat Resistance Using a Hot Air Circulating Oven, 2019.	
Method Of Sampling:	Samples cut from flat fabric
Preconditioning:	None
Conditioning:	In accordance with ASTM D1776
Dimensions of test specimens:	15x15in
Testing Temperature (°C):	260 +8/-0
Time of exposure:	5min
Optional Stretching frame used:	No
Air Velocity (m/sec):	1.2 to 1.4
Observations	
Ignition, deformation, degradation, delamination, melting, dripping, flaking, hole formation, separation, and splitting	
Specimens	List any observations:
1	Color changed from bright to darker, dull orange along the edges; center area with diamonds darkened considerably as orange color between the diamonds became darker, and the black perimeter within each diamond became more noticeable
2	Color changed from bright to darker, dull orange along the edges; center area with diamonds darkened considerably as orange color between the diamonds became darker, and the black perimeter within each diamond became more noticeable
3	Color changed from bright to darker, dull orange along the edges; center area with diamonds darkened considerably as orange color between the diamonds became darker, and the black perimeter within each diamond became more noticeable
Test Date:	3/27/2024

Product Description:	Fabric A - Polygon Pattern
Modifications:	None
NFPA 2112-2023 Sections 7.1.3 and 7.1.4	
Testing for heat resistance and thermal shrinkage per Section 8.4	
Referencing ASTM F2894, Standard Test Method for Evaluation of Materials, Protective Clothing, and Equipment for Heat Resistance Using a Hot Air Circulating Oven, 2019.	
Method Of Sampling:	Samples cut from flat fabric
Preconditioning:	None
Conditioning:	In accordance with ASTM D1776
Dimensions of test specimens:	15x15in
Testing Temperature (°C):	260 +8/-0
Time of exposure:	5min
Optional Stretching frame used:	No
Air Velocity (m/sec):	1.2 to 1.4
Observations	
Ignition, deformation, degradation, delamination, melting, dripping, flaking, hole formation, separation, and splitting	
Specimens	List any observations:
1	Color changed from bright to darker, dull orange along the edges; center area with polygons darkened considerably as orange color between the polygons became darker, and the black perimeter within each polygon became more noticeable
2	Color changed from bright to darker, dull orange along the edges; center area with polygons darkened considerably as orange color between the polygons became darker, and the black perimeter within each polygon became more noticeable
3	Color changed from bright to darker, dull orange along the edges; center area with polygons darkened considerably as orange color between the polygons became darker, and the black perimeter within each polygon became more noticeable
Test Date:	3/27/2024

Product Description:	Fabric A - Square Pattern
Modifications:	None
NFPA 2112-2023 Sections 7.1.3 and 7.1.4	
Testing for heat resistance and thermal shrinkage per Section 8.4	
Referencing ASTM F2894, Standard Test Method for Evaluation of Materials, Protective Clothing, and Equipment for Heat Resistance Using a Hot Air Circulating Oven, 2019.	
Method Of Sampling:	Samples cut from flat fabric
Preconditioning:	None
Conditioning:	In accordance with ASTM D1776
Dimensions of test specimens:	15x15in
Testing Temperature (°C):	260 +8/-0
Time of exposure:	5min
Optional Stretching frame used:	No
Air Velocity (m/sec):	1.2 to 1.4
Observations	
Ignition, deformation, degradation, delamination, melting, dripping, flaking, hole formation, separation, and splitting	
Specimens	List any observations:
1	Color changed from bright to darker, dull orange along the edges; center area with squares darkened considerably as orange color between the squares became darker, and the black perimeter within each square became more noticeable
2	Color changed from bright to darker, dull orange along the edges; center area with squares darkened considerably as orange color between the squares became darker, and the black perimeter within each square became more noticeable
3	Color changed from bright to darker, dull orange along the edges; center area with squares darkened considerably as orange color between the squares became darker, and the black perimeter within each square became more noticeable
Test Date:	3/27/2024

Product Description:	Fabric B - Diamond Pattern					
Modifications:	None					
NFPA 2112-2023 Section 7.1.2.5						
Testing for flame resistance as specified in Section 8.3						
ASTM D6413/D6413M, Standard Test Method for Flame Resistance of Textiles (Vertical Test), 2015						
Flame Test Preconditioning:	None					
Flame Test Conditioning:	None					
Length Direction						
Specimen	1	2	3	4	5	Average
Afterflame Time (sec)	0.18	0.18	0.16	0.00	0.00	0.1
Melting?	No	No	No	No	No	No
Dripping?	No	No	No	No	No	No
Melting and Dripping?	No	No	No	No	No	No
Test Date:	3/28/2024					

Product Description:	Fabric B - Polygon Pattern					
Modifications:	None					
NFPA 2112-2023 Section 7.1.2.5						
Testing for flame resistance as specified in Section 8.3						
ASTM D6413/D6413M, Standard Test Method for Flame Resistance of Textiles (Vertical Test), 2015						
Flame Test Preconditioning:	None					
Flame Test Conditioning:	None					
Length Direction						
Specimen	1	2	3	4	5	Average
Afterflame Time (sec)	0.29	0.16	0.19	0.25	2.50	0.7
Melting?	No	No	No	No	No	No
Dripping?	No	No	No	No	No	No
Melting and Dripping?	No	No	No	No	No	No
Test Date:	3/28/2024					

Product Description:	Fabric B - Square Pattern					
Modifications:	None					
NFPA 2112-2023 Section 7.1.2.5						
Testing for flame resistance as specified in Section 8.3						
ASTM D6413/D6413M, Standard Test Method for Flame Resistance of Textiles (Vertical Test), 2015						
Flame Test Preconditioning:	None					
Flame Test Conditioning:	None					
Length Direction						
Specimen	1	2	3	4	5	Average
Afterflame Time (sec)	2.44	3.79	0.23	4.26	0.81	2.3
Melting?	No	No	No	No	No	No
Dripping?	No	No	No	No	No	No
Melting and Dripping?	No	No	No	No	No	No
Test Date:	3/28/2024					

Product Description:	Fabric B - Diamond Pattern
Modifications:	None
NFPA 2112-2023 Sections 7.1.3 and 7.1.4	
Testing for heat resistance and thermal shrinkage per Section 8.4	
Referencing ASTM F2894, Standard Test Method for Evaluation of Materials, Protective Clothing, and Equipment for Heat Resistance Using a Hot Air Circulating Oven, 2019.	
Method Of Sampling:	Samples cut from flat fabric
Preconditioning:	None
Conditioning:	In accordance with ASTM D1776
Dimensions of test specimens:	15x15in
Testing Temperature (°C):	260 +8/-0
Time of exposure:	5min
Optional Stretching frame used:	No
Air Velocity (m/sec):	1.2 to 1.4
Observations	
Ignition, deformation, degradation, delamination, melting, dripping, flaking, hole formation, separation, and splitting	
Specimens	List any observations:
1	Overall specimen changed color from black to darker black; white threads also darkened, especially between the diamond openings; some diamond openings tore open.
2	Overall specimen changed color from black to darker black; white threads also darkened, especially between the diamond openings; some diamond openings tore open.
3	Overall specimen changed color from black to darker black; white threads also darkened, especially between the diamond openings; some diamond openings tore open.
Test Date:	3/27/2024

Product Description:	Fabric B - Polygon Pattern
Modifications:	None
NFPA 2112-2023 Sections 7.1.3 and 7.1.4	
Testing for heat resistance and thermal shrinkage per Section 8.4	
Referencing ASTM F2894, Standard Test Method for Evaluation of Materials, Protective Clothing, and Equipment for Heat Resistance Using a Hot Air Circulating Oven, 2019.	
Method Of Sampling:	Samples cut from flat fabric
Preconditioning:	None
Conditioning:	In accordance with ASTM D1776
Dimensions of test specimens:	15x15in
Testing Temperature (°C):	260 +8/-0
Time of exposure:	5min
Optional Stretching frame used:	No
Air Velocity (m/sec):	1.2 to 1.4
Observations	
Ignition, deformation, degradation, delamination, melting, dripping, flaking, hole formation, separation, and splitting	
Specimens	List any observations:
1	Overall specimen changed color from black to darker black; white threads also darkened, especially between the polygon openings
2	Overall specimen changed color from black to darker black; white threads also darkened, especially between the polygon openings
3	Overall specimen changed color from black to darker black; white threads also darkened, especially between the polygon openings
Test Date:	3/27/2024

Product Description:	Fabric B - Square Pattern
Modifications:	None
NFPA 2112-2023 Sections 7.1.3 and 7.1.4	
Testing for heat resistance and thermal shrinkage per Section 8.4	
Referencing ASTM F2894, Standard Test Method for Evaluation of Materials, Protective Clothing, and Equipment for Heat Resistance Using a Hot Air Circulating Oven, 2019.	
Method Of Sampling:	Samples cut from flat fabric
Preconditioning:	None
Conditioning:	In accordance with ASTM D1776
Dimensions of test specimens:	15x15in
Testing Temperature (°C):	260 +8/-0
Time of exposure:	5min
Optional Stretching frame used:	No
Air Velocity (m/sec):	1.2 to 1.4
Observations	
Ignition, deformation, degradation, delamination, melting, dripping, flaking, hole formation, separation, and splitting	
Specimens	List any observations:
1	Overall specimen changed color from black to darker black; white threads also darkened, especially between the square openings
2	Overall specimen changed color from black to darker black; white threads also darkened, especially between the square openings
3	Overall specimen changed color from black to darker black; white threads also darkened, especially between the square openings
Test Date:	3/27/2024

Product Description:	Fabric D					
Modifications:	None					
NFPA 2112-2023 Section 7.1.2.5						
Testing for flame resistance as specified in Section 8.3						
ASTM D6413/D6413M, Standard Test Method for Flame Resistance of Textiles (Vertical Test), 2015						
Flame Test Preconditioning:	None					
Flame Test Conditioning:	None					
Length Direction						
	1	2	3	4	5	Average
Afterflame Time (sec)	0.17	11.29	0.40	0.00	0.00	2.4
Melting?	No	No	No	No	No	No
Dripping?	No	No	No	No	No	No
Melting and Dripping?	No	No	No	No	No	No
Width Direction						
Specimen	1	2	3	4	5	Average
Afterflame Time (sec)	0.51	0.17	0.37	0.29	0.18	0.3
Melting?	No	No	No	No	No	No
Dripping?	No	No	No	No	No	No
Melting and Dripping?	No	No	No	No	No	No
Test Date:	3/28/2024					

Product Description:	Fabric D
Modifications:	Two specimens tested.
NFPA 2112-2023 Sections 7.1.3 and 7.1.4	
Testing for heat resistance and thermal shrinkage per Section 8.4	
Referencing ASTM F2894, Standard Test Method for Evaluation of Materials, Protective Clothing, and Equipment for Heat Resistance Using a Hot Air Circulating Oven, 2019.	
Method Of Sampling:	Samples cut from flat fabric
Preconditioning:	None
Conditioning:	In accordance with ASTM D1776
Dimensions of test specimens:	15x15in
Testing Temperature (°C):	260 +8/-0
Time of exposure:	5min
Optional Stretching frame used:	No
Air Velocity (m/sec):	1.2 to 1.4
Observations	
Ignition, deformation, degradation, delamination, melting, dripping, flaking, hole formation, separation, and splitting	
Specimens	List any observations:
1	Color changed from HV Yellow to green; fabric immediately stiffened upon removal from oven and became brittle; specimen observed to shrink dramatically; malodorous upon removal
2	Color changed from HV Yellow to green; fabric immediately stiffened upon removal from oven and became brittle; specimen observed to shrink dramatically; malodorous upon removal
3	NA - limited sample - did not test a third specimen
Test Date:	3/27/2024

Product Description:	Fabric E					
Modifications:	Only one specimen tested					
NFPA 2112-2023 Section 7.1.2.5						
Testing for flame resistance as specified in Section 8.3						
ASTM D6413/D6413M, Standard Test Method for Flame Resistance of Textiles (Vertical Test), 2015						
Flame Test Preconditioning:	None					
Flame Test Conditioning:	None					
Length Direction						
	1	2	3	4	5	Average
Afterflame Time (sec)	0.18	-	-	-	-	0.2
Melting?	No	-	-	-	-	None
Dripping?	No	-	-	-	-	None
Melting and Dripping?	No	-	-	-	-	None
Test Date:	3/28/2024					

Product Description:	Fabric E
Modifications:	Only one specimen tested
NFPA 2112-2023 Sections 7.1.3 and 7.1.4	
Testing for heat resistance and thermal shrinkage per Section 8.4	
Referencing ASTM F2894, Standard Test Method for Evaluation of Materials, Protective Clothing, and Equipment for Heat Resistance Using a Hot Air Circulating Oven, 2019.	
Method Of Sampling:	Samples cut from flat fabric
Preconditioning:	None
Conditioning:	In accordance with ASTM D1776
Dimensions of test specimens:	3x6in
Testing Temperature (°C):	260 +8/-0
Time of exposure:	5min
Optional Stretching frame used:	No
Air Velocity (m/sec):	1.2 to 1.4
Observations	
Ignition, deformation, degradation, delamination, melting, dripping, flaking, hole formation, separation, and splitting	
Specimens	List any observations:
1	Color changed from Hi Vis Yellow to dark brown; appeared to have shrunk
2	(no 2nd specimen to test)
3	(no 3rd specimen to test)
Test Date:	3/27/2024



A Report

on

**Heat Transfer Performance (HTP) of Fabric “A”
3 Mesh Pattern Types, Diamond, Polygon, Square**

from

Textile Protection and Comfort Center (T-PACC)
College of Textiles
North Carolina State University
Raleigh, North Carolina 27695-8301

May 8th, 2024

Heat Transfer Performance (HTP) of Fabric “A”

Fabric “A” in multiple mesh configurations was submitted to the Textile Protection and Comfort Center (T-PACC) in the College of Textiles at North Carolina State University. These items were evaluated for thermal protection properties when exposed to a convective/ radiant energy source for a short duration. The purpose of this report is to identify the material and present the results.

Test Materials

Multiple test specimens of each test item were prepared for testing. Preconditioning and conditioning was performed by North Carolina State University. The heat transfer performance of each sample was measured according to *NFPA 2112-2023: Flame-Resistant Clothing For Industrial Personnel Against Short-Duration Thermal Exposures From Fire, Sec 8.2*.

Three styles of venting patterns were cut into the material with the following specifications:

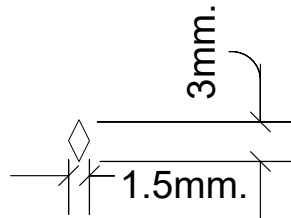
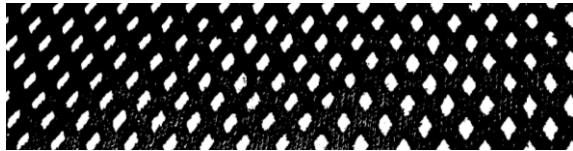
Sample ID

Fabric “A”

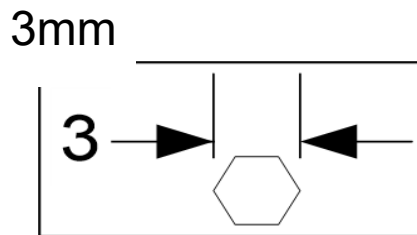
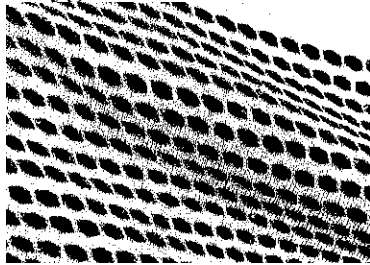
Description

FR Cotton, interlock knit

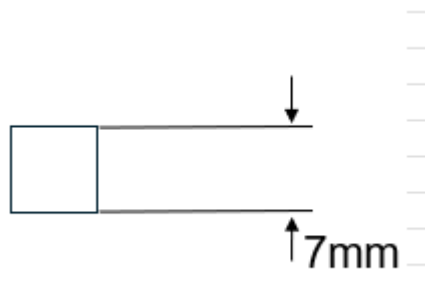
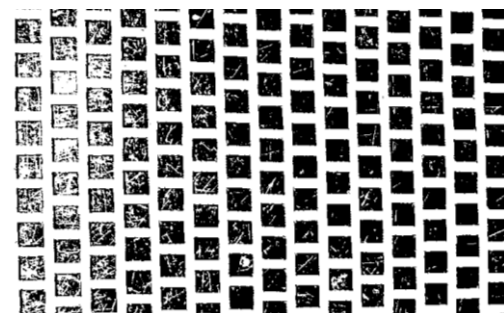
Diamond Pattern:



Polygon Pattern:



Square Pattern:



Test Results

Table 1: HTP Test Results-Fabric “A” (3 Pattern Types), Diamond Polygon, Square

Sample Name	Rep	Spaced HTP Value	Contact HTP Value
Fabric “A” Diamond Mesh	1	3.0	2.8
Fabric “A” Diamond Mesh	2	2.9	3.0
Fabric “A” Diamond Mesh	3	3.0	3.0
Average		3.0	2.9
Fabric “A” Polygon Mesh	1	2.6	2.7
Fabric “A” Polygon Mesh	2	3.0	3.2
Fabric “A” Polygon Mesh	3	2.8	3.0
Average		2.8	2.9
Fabric “A” Square Mesh	1	1.5	1.9
Fabric “A” Square Mesh	2	1.5	2.0
Fabric “A” Square Mesh	3	1.7	2.7
Average		1.6	2.2

Caveat

These data characterize the properties of materials or assemblies in response to thermal energy under controlled laboratory conditions and should not be used to appraise the safety benefits or risks of materials, products, or assemblies under actual fire conditions. They are the result of a particular laboratory exposure; extrapolations to other types of heat exposures or different combinations of radiant and convective assaults cannot be made. The correlation between this laboratory measurement of a protective index and field protective performance is unknown, and no claims are made. While there are many precedents for using the Stoll criteria to predict human tissue tolerance to thermal exposure, this practice is not without scientific controversy.



A Report

on

**Heat Transfer Performance (HTP) of Fabric “B”
3 Mesh Pattern Types, Diamond, Polygon, Square**

from

Textile Protection and Comfort Center (T-PACC)
College of Textiles
North Carolina State University
Raleigh, North Carolina 27695-8301

May 8th, 2024

Heat Transfer Performance (HTP) of Fabric “B”

Fabric “B” in multiple mesh configurations was submitted to the Textile Protection and Comfort Center (T-PACC) in the College of Textiles at North Carolina State University. These items were evaluated for thermal protection properties when exposed to a convective/ radiant energy source for a short duration. The purpose of this report is to identify the material and present the results.

Test Materials

Multiple test specimens of each test item were prepared for testing. Preconditioning and conditioning was performed by North Carolina State University. The heat transfer performance of each sample was measured according to *NFPA 2112-2023: Flame-Resistant Clothing For Industrial Personnel Against Short-Duration Thermal Exposures From Fire, Sec 8.2*.

Three styles of venting patterns were cut into the material with the following specifications:

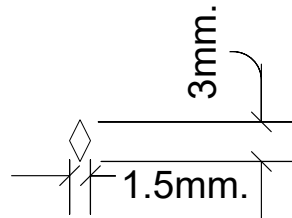
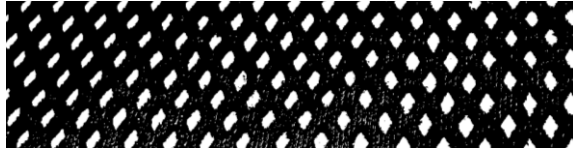
Sample ID

Fabric “B”

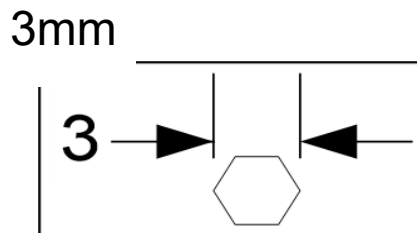
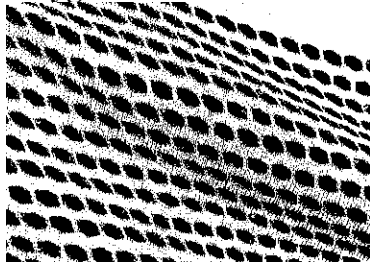
Description

Cotton blend

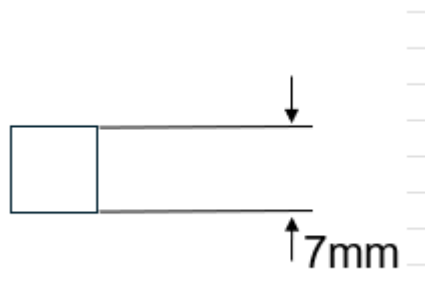
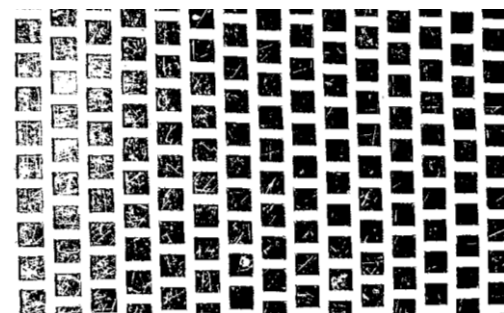
Diamond Pattern:



Polygon Pattern:



Square Pattern:



Test Results

Table 1: HTP Test Results-Fabric “B” (3 Pattern Types), Diamond Polygon, Square

Sample Name	Rep	Spaced HTP Value	Contact HTP Value
Fabric “B” Diamond Mesh	1	2.8	3.8
Fabric “B” Diamond Mesh	2	3.1	3.1
Fabric “B” Diamond Mesh	3	3.0	3.4
Average		3.0	3.4
Fabric “B” Polygon Mesh	1	2.6	3.3
Fabric “B” Polygon Mesh	2	2.7	3.3
Fabric “B” Polygon Mesh	3	2.8	3.1
Average		2.7	2.2
Fabric “B” Square Mesh	1	1.6	2.3
Fabric “B” Square Mesh	2	1.4	2.0
Fabric “B” Square Mesh	3	1.5	2.3
Average		1.5	2.2

Caveat

These data characterize the properties of materials or assemblies in response to thermal energy under controlled laboratory conditions and should not be used to appraise the safety benefits or risks of materials, products, or assemblies under actual fire conditions. They are the result of a particular laboratory exposure; extrapolations to other types of heat exposures or different combinations of radiant and convective assaults cannot be made. The correlation between this laboratory measurement of a protective index and field protective performance is unknown, and no claims are made. While there are many precedents for using the Stoll criteria to predict human tissue tolerance to thermal exposure, this practice is not without scientific controversy.



A Report

on

Heat Transfer Performance (HTP) of Fabric “D”

from

Textile Protection and Comfort Center (T-PACC)
College of Textiles
North Carolina State University
Raleigh, North Carolina 27695-8301

May 8th, 2024

Heat Transfer Performance (HTP) of Fabric “D”

Fabric “D” in was submitted to the Textile Protection and Comfort Center (T-PACC) in the College of Textiles at North Carolina State University. This item was evaluated for thermal protection properties when exposed to a convective/ radiant energy source for a short duration. The purpose of this report is to identify the material and present the results.

Test Materials

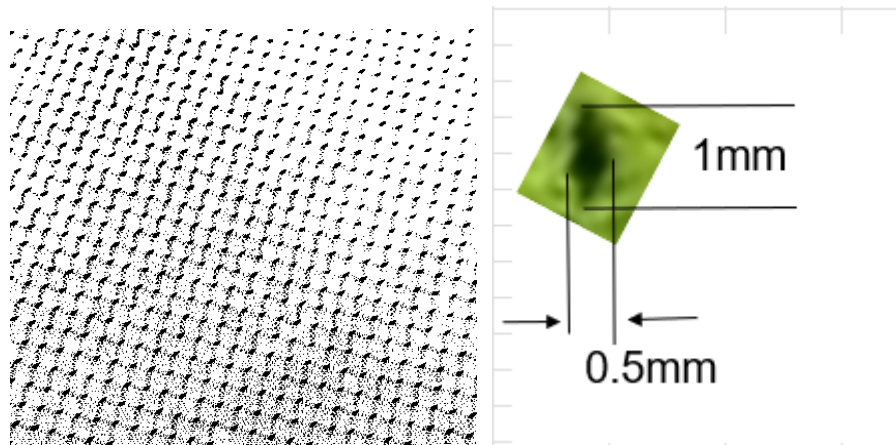
Multiple test specimens of each test item were prepared for testing. Preconditioning and conditioning was performed by North Carolina State University. The heat transfer performance of each sample was measured according to *NFPA 2112-2023: Flame-Resistant Clothing For Industrial Personnel Against Short-Duration Thermal Exposures From Fire, Sec 8.2*.

Sample ID

Fabric “D”

Description

Modacrylic Rich



Test Results

Table 1: HTP Test Results-Fabric “D”

Sample Name	Rep	Spaced HTP Value	Contact HTP Value
Fabric “D”	1	4.9	6.6
Fabric “D”	2	4.0	5.8
Fabric “D”	3	5.1	6.8
Average		4.7	6.4

Caveat

These data characterize the properties of materials or assemblies in response to thermal energy under controlled laboratory conditions and should not be used to appraise the safety benefits or risks of materials, products, or assemblies under actual fire conditions. They are the result of a particular laboratory exposure; extrapolations to other types of heat exposures or different combinations of radiant and convective assaults cannot be made. The correlation between this laboratory measurement of a protective index and field protective performance is unknown, and no claims are made. While there are many precedents for using the Stoll criteria to predict human tissue tolerance to thermal exposure, this practice is not without scientific controversy.



A Report

on

Heat Transfer Performance (HTP) of Fabric “E”

from

Textile Protection and Comfort Center (T-PACC)
College of Textiles
North Carolina State University
Raleigh, North Carolina 27695-8301

May 8th, 2024

Heat Transfer Performance (HTP) of Fabric “E”

Fabric “E” was submitted to the Textile Protection and Comfort Center (T-PACC) in the College of Textiles at North Carolina State University. This item was evaluated for thermal protection properties when exposed to a convective/ radiant energy source for a short duration. The purpose of this report is to identify the material and present the results.

Test Materials

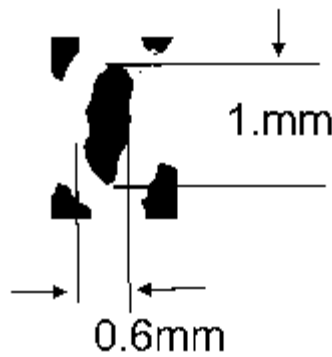
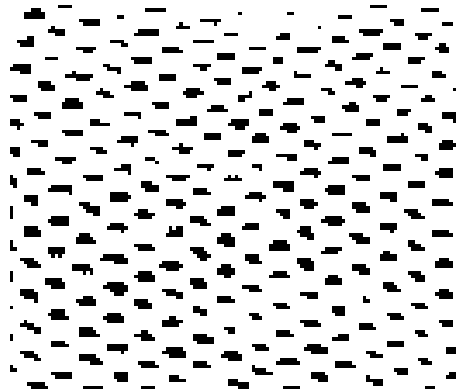
Multiple test specimens of each test item were prepared for testing. Preconditioning and conditioning was performed by North Carolina State University. The heat transfer performance of each sample was measured according to *NFPA 2112-2023: Flame-Resistant Clothing For Industrial Personnel Against Short-Duration Thermal Exposures From Fire, Sec 8.2*.

Sample ID

Fabric “E”

Description

Composition unavailable



Test Results

Table 1: HTP Test Results-Fabric “E”

Sample Name	Rep	Spaced HTP Value	Contact HTP Value
Fabric “E”	1	4.3	4.6
Fabric “E”	2	5.0	5.1
Fabric “E”	3	5.4	5.1
Average		4.9	5.0

Caveat

These data characterize the properties of materials or assemblies in response to thermal energy under controlled laboratory conditions and should not be used to appraise the safety benefits or risks of materials, products, or assemblies under actual fire conditions. They are the result of a particular laboratory exposure; extrapolations to other types of heat exposures or different combinations of radiant and convective assaults cannot be made. The correlation between this laboratory measurement of a protective index and field protective performance is unknown, and no claims are made. While there are many precedents for using the Stoll criteria to predict human tissue tolerance to thermal exposure, this practice is not without scientific controversy.