MEMORANDUM

TO: NFPA Technical Committee on Flash Fire Protective Garments
FROM: Jeanne Moreau
DATE: March 9, 2010
SUBJECT: NFPA 2112 A11 ROP Letter Ballot

The ROP letter ballot for NFPA 2112 is attached. The ballot is for formally voting on whether or not you concur with the committee’s actions on the proposals. Reasons must accompany all negative and abstention ballots.

Please do not vote negatively because of editorial errors. However, please bring such errors to my attention for action.

Please complete and return your ballot as soon as possible but no later than Tuesday, March 23, 2010. As noted on the ballot form, please submit the ballot to Jeanne Moreau-Correia, e-mail to jmoreaucorreia@nfpa.org or fax to 617-984-7110.

The return of ballots is required by the Regulations Governing Committee Projects.

Attachment: Proposals
## Technical Committee on Flash Fire Protective Garments

### Recommendation

Review entire document to:
1) Update any extracted material by preparing separate proposals to do so, and
2) review and update references to other organizations documents, by preparing proposal(s) as required.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 2113, Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire, 2007 edition.

2.3 Other Publications.

2.3.1 AATCC Publications. American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709.


2.3.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.


2.3.3 GSA Publications. U.S. General Services Administration, 1800 F Street, N.W., Washington, DC 20405.


2.3.4 ISO Publications. International Organization for Standardization, 1, rue de Varembé, Case postale 56, CH-1211 Geneva 20, Switzerland.


2.4 References for Extracts in Mandatory Sections.


C.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.


NFPA 2113, Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire, 2007 edition.

C.1.2 Other Publications.

C.1.2.1 AATCC Publications. American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709.


AATCC 16, Colorfastness to Light (Option 3), 2004.


AATCC 132, Colorfastness to Dry Cleaning, 2009.

C.1.2.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.


ASTM D 3776, Test Methods for Mass Per Unit Area (Weight) of Woven Fabric, 2009.


ASTM F 1731, Standard Practice for Body Measurements and Sizing of Fire and Rescue Services Uniforms and Other Thermal Hazard Protective Clothing, 1996.


C.1.2.3 GSA Publications. U.S. General Services Administration, 1800 F Street, N.W., Washington, DC 20405.


C.1.2.4 ISO Publications. International Organization for Standardization, 1, rue de Varembé, Case postale 56, CH-1211, Geneve 20, Switzerland.


C.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.


3.3.2 Agents.

3.3.2.1 Biological Agents. Biological materials that are capable of causing an acute disease or long-term damage to the human body. [1991, 2005]

3.3.2.2 Radiological Agents. Radiation associated with x-rays, alpha, beta, and gamma emissions from radioactive isotopes, or other materials in excess of normal background radiation levels. [1991, 2005]

3.3.7 Component. Any material, part, or subassembly used in the construction of the compliant protective ensemble or any element of the protective ensemble. [1971, 2007]

3.3.8 Drip. A flow of liquid that lacks sufficient quantity or pressure to form a continuous stream and runs or falls in drops. [1914, 2002]

3.3.17 Hazardous Materials Emergencies. Incidents involving the release or potential release of hazardous materials chemicals into the environment that can cause loss of life, personnel injury, or damage to property and the environment. [1971, 2007]

3.3.19 Interlining. Any textile that is intended for incorporated into any garment article of wearing apparel as a layer between outer and inner layers. [1975, 1999, 2004]

3.3.22 Model. The collective term used to identify a group of individual elements or items of the same basic design and components from a single manufacturer produced by the same manufacturing and quality assurance procedures that are covered by the same certification. [1971, 2007]

3.3.24* Product Label. A label or marking affixed to a product by the manufacturer containing compliant statements, certification statements, manufacturer or model information, or similar data that provides general information, warnings, instructions for care and maintenance, and other information. [1971, 2007]

Substantiation: To conform to the NFPA Regulations Governing Committee Projects.

NFPA 1914 was withdrawn and the requirements merged into NFPA 1911. However, NFPA 1911 does not contain the definition for “drip” that was previously extracted from 1914. Therefore the TC modified the existing definition to reflect the usage in the standard.

The following extract tags can be updated editorially:

3.3.4 Certification/Certified
3.3.5 Certification Organization  
3.3.6 Compliance/Compliant  
3.3.29 Separate  
3.3.10.1 Textile Fabric  
3.3.13 Follow-Up Program  
3.3.12* Flash Fire  
3.3.21 Melt  


Committee Meeting Action: Accept

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2112-2  Log #2  
(Document Title)  
Final Action: Reject

Submitter: Roger F. Parry, The DuPont Company  
Recommendation: Revise text to read as follows:  
Standard on Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire.  
Substantiation: "Flash fires", or vapor cloud fires, are a very small subset of actual fire types experienced in industrial environments with fire hazards.  
The potential fires that exist can be in the form of pressurized flammable line breaks (jet fires), flammable liquid spills (pool fires), and fireballs (from Boiling Liquid Expanding Vapor Explosions or flammable material container BLEVE). The purpose of this standard is to provide minimum specification requirements to address all of these industrial thermal hazards. This goal is better served with the single term "fire", which encompasses all of the noted hazards.  
Committee Meeting Action: Reject  
Committee Statement: The TC recognizes that there are other types of incidents that may be considered when selecting garments. However, NFPA 2112 was developed specifically to address garments used for protection in short-duration thermal exposures with the intent of not contributing to burn injury of the wearer. The TC believes that the use of the term "flash fire" best captures this intention.

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2112-3  Log #3  
(A.1.1.2.1, 1.3.5, 2.2, 3.3.18, 5.1.8, 7.1.5, A.1.2.1, A.1.2.2, A.1.2.3, A.5.2.1(5), Table B.1, Index)  
Final Action: Reject

Submitter: Roger F. Parry, The DuPont Company  
Recommendation: (Apply to all occurrences within the NFPA 2112 standard) "...flash fire...".  
Substantiation: "Flash fires", or vapor cloud fires, are a very small subset of actual fire types experienced in industrial environments with fire hazards. The potential fires that exist can be in the form of pressurized flammable line breaks (jet fires), flammable liquid spills (pool fires), and fireballs (from Boiling Liquid Expanding Vapor Explosions or flammable material container BLEVE). The purpose of this standard is to provide minimum specification requirements to address all of these industrial thermal hazards. This goal is better served with the single term "fire", which encompasses all of the noted hazards.  
Committee Meeting Action: Reject  
Committee Statement: The TC recognizes that there are other types of incidents that may be considered when selecting garments. However, NFPA 2112 was developed specifically to address garments used for protection in short-duration thermal exposures with the intent of not contributing to burn injury of the wearer. The TC believes that the use of the term "flash fire" best captures this intention.
Submitter: James Douglas Dale, University of Alberta

Recommendation: Revise text to read as follows:

1.1 “…garments ensembles”
1.3.1 “…new flame-resistant garments ensembles.”
1.3.3 “…flame-resistant garments ensembles ……..garment ensemble…”
7.1.5 “Specimen garments ensembles……test for the material ensemble …”

Substantiation: In 1.1, 1.3.1 and 1.3.3 the text uses the word “garments”, yet in 8.5.4.2 (Manikin Test) the manikin is dressed in a specified weight of 100 percent cotton underwear briefs and short-sleeve crew-neck T-shirts before the garment is placed on the manikin. Are we now not testing an “ensemble”, as the performance requirement is for the combination of the underwear and the garment? Not the garment alone. The Manikin test is not a test of fabrics. In the context of NFPA 2112 it is a test of fabrics made into garments of a standard design and size and provides a measurement of garment and clothing ensemble performance, not just fabric performance.

7.1.5 is contained in a section 7.1 Fabric Requirements. 7.1.5 is NOT a fabric test, but an ensemble test consisting of prescribed underclothes and a loosely defined garment in ASTM F 1930. There are interactions between fabric characteristics and the design, layout, cutting and stitching of a garment. None of the latter are specified in F 1930. Statement 7.1.5 should appear in a separate section “Ensemble Requirements”.

Committee Meeting Action: Reject

Committee Statement: The submitter states that the Manikin test is not a test of the fabric. The TC believes that the Manikin test is designed to test the fabric by putting it in a standardized garment to compare performance in such a way that certain design variables are excluded. Therefore, the use of the word “garment” is appropriate as defined in Chapter 3.

Submitter: Technical Committee on Flash Fire Protective Garments,

Recommendation: Revise text to read as follows:

1.2.1* This standard shall provide minimum requirements for the design, construction, evaluation, and certification of flame-resistant garments for use by industrial personnel, with the intent of not contributing to the burn injury of the wearer, providing a degree of protection to the wearer, and reducing the severity of burn injuries resulting from short-duration thermal exposures or accidental exposure to hydrocarbon flash fires.

Substantiation: The TC recognizes that there are other types of incidents that may be considered when selecting garments. However, NFPA 2112 was developed specifically to address garments used for protection in short-duration thermal exposures with the intent of not contributing to burn injury of the wearer. The TC referenced short-duration thermal exposures in the Purpose statement to clarify to users of the standard that garments are not limited to hydrocarbon flash fires.

Committee Meeting Action: Accept
<table>
<thead>
<tr>
<th>2112-6 Log #23</th>
<th>Final Action: Reject</th>
</tr>
</thead>
</table>

**Submitter:** James Douglas Dale, University of Alberta  
**Recommendation:** See Substantiation.  
**Substantiation:** Potential changes to ASTM F 1930. ASTM F 1930 is out for ballot. If approved the title will change. The word Flash will be dropped because laboratories can now produce exposure durations up to 20 seconds. A new Section may be approved which will change the numbering of some of the existing sections. If NFPA 2112 makes reference to specific sections of F 1930, then editorial changes may be required.  
**Committee Meeting Action:** Reject  
**Committee Statement:** There is no specific change proposed by the submitter.
Component Recognition/Component Recognized. A system whereby a certification organization determines that a manufacturer has demonstrated the ability to produce a material, component, or product assembly that complies with the applicable requirements of this standard and establishes a follow-up program conducted by the certification organization as a check on the methods the manufacturer uses to determine continued compliance of listed materials, components, and product subassemblies with the applicable requirements of this standard. Add new subsection to 4.1 (recommended to be positioned after current paragraph 4.1.6):

4.1.X Certification organizations shall be permitted to provide component recognition for materials, components, and product subassemblies in accordance with the following requirements.

4.1.X.1 Certification organizations shall only provide component recognition for those materials, components, and product subassemblies where specific design and performance criteria can be directly applied, where the specific criteria is not dependent on material, component, or product subassembly conformance to other criteria in this standard, and where the responsibility for the material, component, or product subassembly can be attributed to a single manufacturer.

A.4.1.X.1 Only those materials, components, and product subassemblies that can be separately tested to specific requirements in this standard can be subjected to component recognition. For example, an outer shell material can be independently evaluated for flame resistance, heat resistance, thermal shrinkage resistance, tear strength, tensile strength, cleaning shrinkage, and water absorption resistance, and thus can be component recognized. Similarly, glove moisture barriers can be component recognized in some instances because even though the requirement specifies testing of the glove composite and seams, the conditioning used to qualify the moisture barrier specifies a particular material lay-up for testing both liquid penetration resistance and viral penetration resistance that is independent of the glove construction. It is also possible that the manufacturer of the glove moisture barrier is also responsible for the construction of the glove moisture barrier seams, when provided as an insert. In contrast, the toe reinforcement of footwear cannot be subjected to applicable testing without the mounting of the toe reinforcement in the footwear toe and thus cannot be component recognized. In the case of a garment composite, while it is possible to independently test a composite consisting of outer shell, moisture barrier, and thermal barrier for thermal protective performance and total heat loss testing, unless all three layers are provided by the same manufacturer, then component recognition cannot be applied.

4.1.X.2 Certification organizations that provide component recognition shall meet all of the requirements specified in Section 4.2, Certification Program, and Section 4.3, Inspection and Testing.

4.1.X.3 Certification organizations that provide component recognition shall require manufacturers of materials, components, and product subassemblies that are subject to component recognition to meet the applicable requirements specified in Section 4.4, Manufacturers’ Quality Assurance Program.

4.1.X.4 Materials, components, and product subassemblies that meet the respective applicable requirements of this standard shall be listed.

Add new paragraph to Section 4.3 (insert after current paragraph 4.3.2)

4.3.X If requested by the manufacturer submitting for certification, the certification organization shall accept component recognition for those materials, components, or product subassemblies that have been component recognized by a different certification organization. This organization shall meet (1) the requirements of Section 4.2, Certification Program, and (2) provide evidence of compliance for its conformity with the requirements for a certification organization.

4.3.Y The certification organization shall request from the submitting manufacturer, as part of a product certification that uses the component recognition for a material, component or product assembly listed by a different certification organization, a copy of the test report or test data which demonstrates compliance of the material, component or product subassembly with the applicable requirements of this standard.

Substantiation: Component recognition is a practice used in the fire and emergency services protective clothing industry to help spread costs and responsibilities for product testing and quality assurance practices. This practice is also used for flame-resistant garments used for protection of industrial personnel against accidental flash fires. This proposal formalizes the practice of component recognition as part of the standard. The proposed changes to NFPA 1971 help to ensure that component recognition practices are consistently applied by certification organizations and provide the intended benefits to the fire and emergency services.

Committee Meeting Action: Accept
Add new definitions:

3.3.X Garment Composite. The layers of materials comprising the majority of the garment’s construction

3.3.Y* Insulation Material. A fabric that consists of one or more non-separable layers that is used for protection against cold or enhanced thermal insulation.

A.3.3.Y Insulation Material. Examples of insulation materials are textile batting(s) alone or batting(s) that are quilted to a woven face cloth. For example, an insulation material consisting of two layers are considered non-separable by the quilting that combines the two layers.

3.3.Z Shell Fabric. The outermost separable fabric layer of a protective garment, not including trim, hardware, reinforcing material, pockets, wristlet material, emblems, or accessories.

Reorganize Chapter 7 criteria as follows to accommodate multilayer garment requirements.

7.1 Single-Layer Flame-Resistant Garments.

7.1.1 Fabric Requirements.

7.1.1.1 Fabric utilized in the construction of single-layer flame-resistant garments shall be tested for thermal protective performance (TPP) as specified in Section 8.2, and shall have a “spaced” TPP rating of not less than 25 J/cm² (6.0 cal/cm²) and a “contact” TPP rating of not less than 12.6 J/cm² (3.0 cal/cm²).

7.1.1.2 Fabric and reflective striping utilized in the construction of single-layer flame-resistant garments shall be tested for flame resistance as specified in Section 8.3, and shall have a char length of not more than 100 mm (4 in.) and an afterflame of not more than 2 seconds, and shall not melt and drip.

7.1.1.3 Fabric utilized in the construction of single-layer flame-resistant garments, excluding manufacturer’s labels, 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.

7.1.1.4 Fabric, other textile materials, and reflective striping, other than those items described in 7.1.1.4.1 and 7.1.1.4.2, used in the construction of single-layer 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.

7.1.1.4.1 Labels and emblems shall not be required to be tested for heat resistance.

7.1.1.4.2 Interlinings, collar stays, elastics, closures, and hook and pile fasteners, when not in direct contact with the skin, shall not be required to be tested for heat resistance.

7.1.1.5 Specimen garments shall be tested for overall flash fire exposure as specified in Section 8.5 as a qualification test for the material and shall have an average predicted body burn rating of not more than 50.

7.1.2 Thread Requirements. Specimens of all sewing thread utilized in the construction of single-layer flame-resistant garments, excluding embroidery, shall be made of an inherently flame-resistant fiber, shall be tested for heat resistance as specified in Section 8.6, and shall not melt.

7.1.3 Hardware Requirement. Specimens of hardware used in the construction of single-layer flame-resistant garments, including but not limited to buttons, fasteners, and closures, shall be individually tested for heat resistance in their original form as specified in Section 8.4; shall not melt and drip, separate, or ignite; and shall remain functional.

7.1.4 Label Requirement. Specimen labels used in the construction of single-layer flame-resistant garments shall be tested for printing durability as specified in Section 8.7 and shall remain legible.

7.2 Multi-Layer Flame-Resistant Garments.

7.2.1 Fabric Requirements.

7.2.1.1 Garment composites utilized in the construction of multi-layer flame-resistant garments shall be tested for thermal protective performance (TPP) as specified in Section 8.2, and shall have a “spaced” TPP rating of not less than 25 J/cm² (6.0 cal/cm²) and a “contact” TPP rating of not less than 12.6 J/cm² (3.0 cal/cm²).

7.2.1.2 Fabric shell, linings, insulation material, reflective striping, and other fabrics utilized in the construction of multi-layer flame-resistant garments shall be tested for flame resistance as specified in Section 8.3, and shall have a char length of not more than 100 mm (4 in.) and an afterflame of not more than 2 seconds, and shall not melt and drip.

7.2.1.3 Fabric shell utilized in the construction of multi-layer flame-resistant garments 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.

7.2.1.4 Fabric shell, linings, reflective striping, and other fabrics, other than those items described in 7.2.1.4.1 and 7.2.1.4.2, 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.
The committee accepts the concept of adding a definition for cold weather insulation so that these materials may be accepted in the committee action. The restructuring of chapter 7 was also rejected on this basis.

The committee addressed the possibility of cold weather insulation materials being stand-alone garments through the addition of labeling, design and performance requirements. It is the intent of the committee that garments are tested in any intended configuration. For example, a jacket submitted for testing with a zip-in liner where the manufacturer indicates that the liner is not a stand-alone garment, the garment will be tested with the liner zipped in, and the shell alone. If the manufacturer indicates that the liner may be worn alone, then the liner will also be tested. The committee rejects the complete exclusion of insulation from the thermal shrinkage resistance requirement because it addresses only the material documented in the substantiation. A blanket exception for this class of materials does not account for products of other manufacturers that may exhibit high thermal shrinkage. However, the committee agrees that some allowance may be acceptable for cold weather insulation materials in regards to the thermal shrinkage because these materials are not anticipated to be stand-alone protective garments. The committee recognizes that there is no technical basis for increasing the thermal shrinkage allowance to 20%, but intends to develop the technical documentation and mandatory language further in preparation for the Report on Comments.
Revise text to read as follows:

A fabric that consists of one or more non-separable layers that is used for protection against cold or enhanced thermal insulation.

Examples of insulation materials are textile batting(s) alone or batting(s) that are quilted to a woven face cloth. For example, an insulation material consisting of two layers are considered non-separable by the quilting that combines the two layers.

Fabric utilized in the construction of flame-resistant garments, excluding manufacturer’s labels, interlinings, and 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.

Material technologies exist where the material does not melt, separate, drip, or ignite during heat resistance testing, but where shrinkage can exceed 10% as required in thermal shrinkage measurements under the exact same thermal conditions. NFPA 2112 already provides exclusions for certain materials, such as labels for thermal shrinkage measurement. It also excludes the heat resistance testing of interlinings for heat resistance testing, when not in direct contact with the skin.

The requirements for thermal shrinkage resistance, and exclusions of certain materials from these requirements, recognize the positioning and potential hazards to the wearer of protective garments when exposed to accidental flash fire. Concerns exist for garments that readily shrink (when exposed to the high heat of a flash fire) since the layer of insulating air surrounding the individual wearer may be reduced and result in faster heat transfer, which may cause burn injury. Nevertheless, materials that are not directly exposed to or are shielded from the flash fire by other materials will not sustain the same levels of heat exposure.

An important test for demonstrating specific performance of garment materials relative to flash fire heat exposures is the manikin test, described in Section 8.5 of the standard. In this test, standard design coveralls are constructed of the garment materials and exposed to a 3 second simulated flash fire with an average exposure energy of 84 kW/m² over the manikin body (Figure 1). Garments are assessed for the prediction of burn injury by the use of numerous sensors that are placed at different locations on the manikin body. This test acts as a more realistic evaluation of the overall garment performance and can further reveal garments that create hazards to the wearer if an abnormal amount of shrinkage takes place.

To illustrate the utility of the manikin test to quantify thermal shrinkage concerns for flash fire exposure, the data in Table 1 are presented. These data show very little burn injury for garments that include linings, which would shrink beyond the maximum 10% now proscribed in the standard. Figures 2 through 5 provide diagrams showing the location of predicted burn injuries for sample garments tested for each material combination. Given that the maximum allowable predicted total body burn injury cannot exceed 50%, these data show a relatively high level of protection for the garment material system.

Tables 2, 3, and 4 provide further information about sample materials used in this testing against other criteria in the standard.
(a) Aramid Shell Material Based Systems – Before/After Exposure
(b) Flame Retardant Treated Cotton/Nylon Material Based System – Before/After Exposure Figure 1 – Photographs of Flash Fire Test at University of Alberta
Table 1 – Example of Manikin Data for Fabrics That Do Not Pass NFPA 2112 Thermal Shrinkage Resistance Requirement

<table>
<thead>
<tr>
<th>Shell Material</th>
<th>Lining Material</th>
<th>Measured Thermal Shrinkage for Lining (%)*</th>
<th>Manikin Predicted Burn Injury**</th>
<th>Figure Showing Predicted Burn Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 oz/yd² Aramid</td>
<td>Aramid/modacrylic/PET blend with Aramid facecloth (batt weight 120 g/m²)</td>
<td>IS: 4.0/3.6, CB: 0.0/0.0, UA: 10.8/2.6</td>
<td>2.10 6.15 8.25</td>
<td>Figure 2</td>
</tr>
<tr>
<td>6 oz/yd² Aramid</td>
<td>Aramid/modacrylic/PET blend with Aramid facecloth (batt weight 150 g/m²)</td>
<td>IS: 3.2/1.4, CB: 1.7/0.0, UA: 5.0/1.7</td>
<td>0.65 6.50 7.15</td>
<td>Figure 3</td>
</tr>
<tr>
<td>11.0 oz/yd² flame retardant treated cotton/nylon</td>
<td>Aramid/modacrylic/PET blend with Flame retardant treated cotton/nylon facecloth (batt weight 120 g/m²)</td>
<td>IS: 0.5/0.0, CB: 0.0/0.0, UA: 0.0/0.0</td>
<td>4.80 3.50 8.30</td>
<td>Figure 4</td>
</tr>
<tr>
<td>11.0 oz/yd² flame retardant treated cotton/nylon</td>
<td>Aramid/modacrylic/PET blend with Flame retardant treated cotton/nylon facecloth (batt weight 150 g/m²)</td>
<td>IS: 0.0/0.4, CB: 0.0/0.0, UA: 0.0/0.0</td>
<td>3.65 3.50 7.15</td>
<td>Figure 5</td>
</tr>
</tbody>
</table>

* Shrinkage measured along specific seams – IS (inseam), CB (center back), UA (underarm); first measurement is for shell material; second measurement is for lining material
** Percentage of total manikin surface reaching criteria for 2nd and 3rd degree burn; since the hands and feet do not contain sensors, 88 percent is the maximum percentage of the total manikin surface which may burn when all sensors are working; 7 percent of the total manikin surface represents the unprotected head of the manikin
<table>
<thead>
<tr>
<th>Lining Material**</th>
<th>Afterflame (sec) †</th>
<th>Char length (in.) †</th>
<th>Melting or dripping? †</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Warp</td>
<td>Fill</td>
<td>Warp</td>
</tr>
<tr>
<td>Room Temperature Conditioning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120 g/m²/Aramid</td>
<td>0.0</td>
<td>0.0</td>
<td>1.12</td>
</tr>
<tr>
<td>150 g/m²/Aramid</td>
<td>0.0</td>
<td>0.0</td>
<td>1.22</td>
</tr>
<tr>
<td>120 g/m²/FR treated cotton</td>
<td>0.0</td>
<td>0.0</td>
<td>1.00</td>
</tr>
<tr>
<td>150 g/m²/FR treated cotton</td>
<td>0.0</td>
<td>0.0</td>
<td>1.25</td>
</tr>
<tr>
<td>After 100X Industrial Laundry Cycles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120 g/m²/Aramid</td>
<td>0.0</td>
<td>0.0</td>
<td>0.85</td>
</tr>
<tr>
<td>150 g/m²/Aramid</td>
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<td>0.0</td>
<td>0.57</td>
</tr>
<tr>
<td>120 g/m²/FR treated cotton</td>
<td>0.0</td>
<td>0.0</td>
<td>1.07</td>
</tr>
<tr>
<td>150 g/m²/FR treated cotton</td>
<td>0.0</td>
<td>0.0</td>
<td>0.95</td>
</tr>
</tbody>
</table>

* Testing in accordance with NFPA 2112-2007, Section 8.3; room temperature conditioning and laundering per 8.1.2 and 8.1.3, respectively; all data are the average of 5 replicates in each direction.
† NFPA 2112-2007 requires fabrics have after flame times that do not exceed 2 seconds in either direction, char lengths that do not exceed 4 inches in either direction, and that specimens not exhibit melting or dripping.
It is further illustrative to point out that the Canadian Standard (CAN/CGSB-155.20-2000), *Workwear for Protection against Hydrocarbon Flash Fire* establishes separate requirements for multi-layer flash fire protective garments. CAN/CGSB-155.20-2000 has many requirements that are parallel to those in NFPA 2112. However, in this standard, insulation materials are excluded from the thermal shrinkage resistance requirement (paragraph 7.2.4.). Insulation materials are defined as garment “component(s) that provide protection against the cold.”

Insulation materials provide value to industrial flash fire protection where additional thermal insulation is a requirement or where garments are used in cold temperature environments. However, NFPA 2112 currently makes no special provisions for addressing the specific criteria for multi-layer garments.

The proposed exclusion of insulation materials from the thermal shrinkage requirement in NFPA 2112 does not constitute a safety hazard as other criteria, namely flame resistance, heat resistance, and thermal protective performance still apply to the insulation material.

A review of the certified product listings and identified recognized components (materials that comply with the applicable requirements of the standard but are not certified) from the two organizations providing certification services (UL and Safety Equipment Institute) do not show any insulated materials or materials that could be considered to be used for protection against cold weather or enhanced thermal insulation.

While it is possible that existing insulation materials could be certified to create garments (e.g., thermal barriers used in firefighter protective clothing), these types of insulation material are extremely expensive for what is customary in this industry. As a consequence, industry organizations that require insulated garments for flash fire protection are using non-certified products. Some of these products include materials that would not pass the flame and heat resistance requirements of NFPA 2112 and thus represent a serious danger to the wearer.

Committee Meeting Action:  Accept in Principle in Part

Revise text to read as follows:

3.3.X* Cold Weather Insulation Material. A fabric that consists of one or more non-separable layers that is used for protection in a low temperature environment, against cold or enhanced thermal insulation.

A.3.3.X Cold Weather Insulation Material. Examples of insulation materials are textile batting(s) alone or batting(s) that are attached quilted to a woven face cloth. For example, an insulation material consisting of two layers are considered non-separable by the attachment quilting that combines the two layers.

Cold weather insulation material as defined in this standard does not preclude the use of intermediate layers for additional protection against thermal hazards.

Committee Statement: The committee accepts the concept of adding a definition for cold weather insulation so that these materials may be considered for specification and testing under the scope of NFPA 2112. The committee rejects the complete exclusion of insulation from the thermal shrinkage resistance requirement because it addresses only the material documented in the substantiation. A blanket exception for this class of materials does not account for products of other manufacturers that may exhibit high thermal shrinkage.
<table>
<thead>
<tr>
<th>Lining Material</th>
<th>Heat Resistance† Melting, Ignition, Dripping or Separation</th>
<th>% Thermal Shrinkage Resistance‡ Room Temp. Conditioning</th>
<th>After 3X Laundry Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 g/m²/Aramid</td>
<td>None</td>
<td>24.31</td>
<td>28.13</td>
</tr>
<tr>
<td>150 g/m²/Aramid</td>
<td>None</td>
<td>38.20</td>
<td>23.15</td>
</tr>
<tr>
<td>120 g/m²/FR treated cotton</td>
<td>None</td>
<td>24.07</td>
<td>21.30</td>
</tr>
<tr>
<td>150 g/m²/FR treated cotton</td>
<td>None</td>
<td>21.52</td>
<td>26.04</td>
</tr>
</tbody>
</table>

* Testing in accordance with NFPA 2112-2007, Section 8.4; room temperature conditioning and laundering per 8.1.2 and 8.1.3, respectively; all data are the average of 3 replicates.
† NFPA 2112-2007 requires fabrics not to melt, ignite, drip or separate during and after heat resistance testing in a forced air circulating oven at 500°F (260°C for 5 minutes).
‡ NFPA 2112-2007 requires fabrics not to exhibit shrinkage of more than 10% in either direction; shaded boxes represent non-compliant results.
<table>
<thead>
<tr>
<th>Shell Material</th>
<th>Lining Material</th>
<th>TPP Rating with Contact (cal/cm²)†</th>
<th>TPP Rating with Spacer (cal/cm²)‡</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Room temp. cond.</td>
<td>After 3X laundry cycles</td>
</tr>
<tr>
<td>200 g/m² Aramid</td>
<td>120 g/m² Aramid</td>
<td>21.5</td>
<td>23.0</td>
</tr>
<tr>
<td></td>
<td>150 g/m² Aramid</td>
<td>22.6</td>
<td>24.9</td>
</tr>
<tr>
<td>375 g/m² FR</td>
<td>120 g/m² FR treated cotton</td>
<td>18.9</td>
<td>19.1</td>
</tr>
<tr>
<td>treated cotton</td>
<td>150 g/m² FR treated cotton</td>
<td>19.7</td>
<td>20.2</td>
</tr>
</tbody>
</table>

* Testing in accordance with NFPA 2112-2007, Section 8.2; room temperature conditioning and laundering per 8.1.2 and 8.1.3, respectively; all data are the average of 3 replicates.
† NFPA 2112-2007 requires a minimum TPP value of 3.0 cal/cm² for contact testing.
‡ NFPA 2112-2007 requires a minimum TPP value of 6.0 cal/cm² for spacer-based testing.
Figure 2 – Example of Manikin Test Results for Aramid Shell with Aramid/modacrylic/ PET Blend Liner with Aramid Facecloth (Example 1)
Figure 3 – Example of Manikin Test Results for Aramid Shell with Aramid/modacrylic/ PET Blend Liner with Aramid Facecloth (Example 2)
Figure 4 – Example of Manikin Test Results for Flame Retardant Treated Cotton/Nylon Shell with Aramid/modacrylic/PET Blend Liner with Flame Retardant Treated Cotton/Nylon Facecloth (Example 1)
Figure 5 – Example of Manikin Test Results for Flame Retardant Treated Cotton/Nylon Shell with Aramid/modacrylic/ PET Blend Liner with Flame Retardant Treated Cotton/Nylon Facecloth (Example 2)
Technical Committee on Flash Fire Protective Garments,

Recommendation: Adopt the preferred definition from the NFPA Glossary of Terms as follows:

3.3.9 Emblem(s). Shields, heraldry, or printing that designates a governmental entity or a specific organization; rank, title, position, or other professional status that is painted, screened, embroidered, sewn, glued, bonded, or otherwise attached in a permanent manner to station/ work uniform garments. [1975, 2009]

Substantiation: This definition is the preferred definition from the Glossary of Terms. Changing the secondary definition to the preferred definition complies with the Glossary of Terms Project.

Committee Meeting Action: Reject
Committee Statement: NFPA 2112 is not limited to work/station uniforms, and therefore the additional text extracted from NFPA 1975 is not appropriate.

Glossary of Terms Technical Advisory Committee / Marcelo Hirschler,

Recommendation: Revise text to read as follows:

3.3.11 Flame resistance (protective apparel). The property of a material whereby combustion is prevented, terminated, or inhibited following application of a flaming or non-flaming source of ignition, with or without subsequent removal of the ignition source.

A.3.3.11 Flame resistance. Flame resistance can be an inherent property of the textile material, or it can be imparted by specific treatment.

Substantiation: It is important to have consistent definitions of terms within NFPA. The term flame resistance is widely used in the documents associated with protective apparel. NFPA definitions should be in a single sentence. Most NFPA definitions of “flame resistance” and uses of the term are in the documents associated with firefighters/first responders. In general, for other uses the term has been replaced and previous references to flame resistance are now being replaced by references to materials that meet the requirements of NFPA 701. It is likely that the documents associated with first responders would like to retain this concept and therefore the definition is being modified with a qualifier and with an annex note for the second sentence. Also, a recommendation is being made that NFPA 1500 be the primary document responsible. The definition is included in NFPA 1851, 1951, 1971, 1975, 1977, 2112 and 2113.

The committee was created by NFPA Standards Council to provide consistency in terminology throughout the NFPA documents.

Committee Meeting Action: Reject
Committee Statement: The addition of the parenthetical reference to "protective apparel" does not clarify the definition in NFPA 2112. The definition refers to a material property, not specifically to apparel.
3.3.12 Flash Fire. A fire that spreads rapidly through a diffuse fuel, such as dust, gas, or the vapors of an ignitable liquid, without the production of damaging pressure. A rapid oxidation process, which is a chemical reaction resulting in the evolution of light and heat in varying intensities. [921, 2004 2008]

"Flash fires", or vapor cloud fires, are a very small subset of actual fire types experienced in industrial environments with fire hazards. The potential fires that exist can be in the form of pressurized flammable line breaks (jet fires), flammable liquid spills (pool fires), and fireballs (from Boiling Liquid Expanding Vapor Explosions or flammable material container BLEVE). The purpose of this standard is to provide minimum specification requirements to address all of these industrial thermal hazards. This goal is better served with the single term "fire", which encompasses all of the noted hazards (with the definition taken from previously identified NFPA standard).

Committee Meeting Action: Reject

Committee Statement: The TC recognizes that there are other types of incidents that may be considered when selecting garments. However, NFPA 2112 was developed specifically to address garments used for protection in short-duration thermal exposures with the intent of not contributing to burn injury of the wearer. The TC believes that the use of the term "flash fire" best captures this intention, and therefore the definition for flash fire should be maintained as written.

2112-13 Log #CP2
(3.3.17 Hazardous Materials Emergencies)

Submitter: Technical Committee on Flash Fire Protective Garments,

Recommendation: Adopt the preferred definition from the NFPA Glossary of Terms as follows:

3.3.17 Hazardous Materials Emergencies. Incidents involving the release or potential release of hazardous materials. [1971, 2007]

Substantiation: This definition is the preferred definition from the Glossary of Terms. Changing the secondary definition to the preferred definition complies with the Glossary of Terms Project.

Committee Meeting Action: Accept
2112-14 Log #CP7 Final Action: Accept
(5.1.8)

**Submitter:** Technical Committee on Flash Fire Protective Garments,

**Recommendation:** Revise text to read as follows:
5.1.8 The following statement shall be printed legibly on the product label in letters at least 2.5 mm (0.10 in.) high:
THIS FLAME RESISTANT GARMENT MEETS
THE REQUIREMENTS OF NFPA 2112,
STANDARD ON FLAME RESISTANT GARMENTS
FOR PROTECTION OF INDUSTRIAL PERSONNEL
AGAINST FLASH FIRE, 2012 EDITION.
NFPA 2113 REQUIRES UPPER AND LOWER
BODY COVERAGE.

**Substantiation:** The Committee added a statement to the product label to make it clear to the user that garments manufactured certified to NFPA 2112 should also be selected in accordance with NFPA 2113, Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire, section 4.3.2, thereby providing upper and lower body coverage.

**Committee Meeting Action:** Accept

**Committee Statement:** The TC didn't have any hard data to support the change. Interested parties are encouraged to submit data on this topic.

2112-15 Log #18 Final Action: Reject
(5.1.9)

**Submitter:** Jeffrey O. Stull, International Personnel Protection, Inc.

**Recommendation:** Revise text to read as follows:
- Add to list (9) Additional warnings

**Substantiation:** The manufacturer should be permitted to include additional warnings pertinent to the limitations of the product, e.g., “Does not provide protection from molten metals or liquid chemical splashes.”

**Committee Meeting Action:** Reject

**Committee Statement:** NFPA standards represent the minimum standards for safety. As such, section 5.1.9 does not preclude manufacturers from providing additional warnings. In addition, including "additional warnings" in this list would result in requiring manufacturers to include additional warnings.

2112-16 Log #13 Final Action: Reject
(Chapter 7 and 8)

**Submitter:** Jeffrey O. Stull, International Personnel Protection, Inc.

**Recommendation:** Revise text to read as follows:
- Consideration should be given to requirements for gloves, footwear, and eye/face protection. For gloves, requirements similar to those established in NFPA 1977 for work gloves could be considered with the addition of a thermal manikin hand testing. For footwear, requirements based on ASTM F2413 could be augmented by flame and heat resistance requirements for the overall footwear. For face and eye protection, requirements in ANSI Z87.1 could be supplemented by heat and flame resistance testing, or manikin testing to demonstrate safe use.

**Substantiation:** The scope of the standard is limited to garments but could be applied to other apparel items that equally could contribute to burn injury if inadequately specified.

**Committee Meeting Action:** Reject

**Committee Statement:** The submitter did not provide a specific change in the proposal. As currently written, the additional equipment is outside the scope of NFPA 2112.

2112-17  Log #22
(Chapter 7 and 8)

Final Action: Reject

Submitter: James Douglas Dale, University of Alberta

Recommendation: Clarification needed; see 4 below.

8.5.1 Application. The manikin test shall apply to garments made from flame-resistant fabrics.

Substantiation: 7.1.1 states “Fabric utilized in the construction…..”, similarly in 7.1.2. Does this apply to all fabric including the “flame-resistant garment labels” mentioned in 8.2.3.1, 8.2.3.2 and 8.2.3.3? In 7.1.3 and 7.1.4.1 labels are excluded from “heat resistance” testing, but not from the thermal protective performance test in 7.1.1.

8.5.1 Application. The manikin test shall apply to flame-resistant garment fabrics. Needs clarification. The Manikin test is not a test of fabrics. In the context of NFPA 2112 it is a test of fabrics made into garments of a standard design and size and provides a measurement of garment and clothing ensemble performance, not just fabric performance.

Committee Meeting Action: Reject

Committee Statement: The TC believes that the Manikin test is designed to test the fabric by putting it in a standardized garment to compare performance in such a way that certain design variables are excluded. Therefore, the application statement as currently written is appropriate.

2112-18  Log #6
(7.1.1)

Final Action: Accept

Submitter: Roger F. Parry, The DuPont Company

Recommendation: Revise text to read as follows:

7.1.1 Fabric utilized in the construction of flame-resistant garments shall be tested for thermal protective performance (TPP) heat transfer performance (HTP) as specified in Section 8.2, and shall have a "spaced" TPP HTP rating of not less than 25 J/cm\(^2\) (6.0 cal/cm\(^2\)) and a "contact" TPP HTP rating of not less than 12.6 J/cm\(^2\) (3.0 cal/cm\(^2\)).

Substantiation: An ASTM standard currently exists (ASTM F2700-08) that duplicates the test method currently in the 2007 edition of NFPA 2112.

Replacement of the 8.2 testing TPP method with the ASTM F2700-08 method within the text significantly simplifies the testing section, adds clarity to the specification requirement, and provides applicable scope information regarding the application of this test method (the test method does not predict thermal protective capabilities of a material).

Committee Meeting Action: Accept
Fabric and reflective striping utilized in the construction of flame-resistant garments shall be tested for flame resistance as specified in Section 8.3, and shall have a char length of not more than 100 mm (4 in.) and an afterflame of not more than 2 seconds, and shall not melt and drip.

The current flame resistance requirements is modeled after the fire service requirements that used in various NFPA standards under the project for Fire and Emergency Services Protective Clothing and Equipment. The relaxation of the flame resistance requirement to a 150 mm (6 in.) char length does not create any hazard to the wearer as materials providing this performance perform within criteria for manikin testing. Moreover, the proposed change in criteria is consistent with work uniform requirements for electrical utilities established in ASTM F1506.

The submitter has not supplied any technical substantiation to change the maximum char length from 4 in. to 6 in. Char length is an indicator of a material’s thermal decomposition and propensity to support combustion. The Committee encourages any interested parties to submit char length data to support the 4" or 6" maximum during the Report on Comments phase.

ASTM F1506 describes clothing that is outside the scope of NFPA 2112, and therefore it isn't appropriate to correlate the requirements of the two standards.

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6.3 Slide Fastener Tape Requirements. All slide fastener tape utilized in the construction of flame-resistant garments shall be made of an inherently flame-resistant fiber.

The TC updated the wording to "slide fastener" to be consistent with existing specifications. The concern of the submitter was to prevent the use of flammable or meltable slide fastener tape. The TC added a design requirement to chapter 6 to require inherently flame resistant materials for slide fastener tape to address this concern. However, the TC believes that testing of slide fasteners, including the tape, is accomplished in section 7.3.
2112-21 Log #21
(7.1.5, 8.5.5, and Table B.1)

Final Action: Accept in Principle

Submitter: James Douglas Dale, University of Alberta

Recommendation: Revise text to read as follows:

7.1.5 "...predicted body burn rating of not more than 50 percent based on the total surface area covered by sensors, excluding hands and feet."

Similar wording should be added to all of 8.5.5 Report and Table B.1 (Manikin testing (7.1.5))

Substantiation: 7.1.5 states ........predicted body burn rating of not more than 50. Implicit in this statement is that 50 means 50 %, but based on what? Area? ASTM F 1930 gives TWO alternate reporting areas. 12.5.1 of F 1930 bases it on the total area covered by sensors, not including hands and feet, while 12.5.2 of F 1930 bases it on the area covered by the test specimen only. The first reporting method requires a higher performance level than the second. This reporting method needs to be clarified in NFPA 2112. Can NFPA documents refer to specific statements in other standards? If yes, then the sections in ASTM F 1930 could be stated (12.5.1 and 12.5.2).

Committee Meeting Action: Accept in Principle

Revise text to read as follows:

7.1.5 "...predicted body burn rating of not more than 50 percent based on the total surface area covered by sensors, excluding hands and feet."

Table B.1 - Line "Manikin Testing"

Column 2 - Description of Test Method
The fabric is made into a standardized coverall design and placed on an instrumented manikin that is dressed in cotton underwear. The manikin is subjected to an overall flame and heat exposure averaging 84 kW/m² (2.0 cal/cm²·sec) for 3 seconds. Sensors embedded in the manikin’s skin predict whether a second- or third-degree burn will occur at that specific location. A computer program determines the percentage of the body that would sustain second- or third-degree burns. This percentage is related to a body burn rating.

Column 3 - Application of Test Method
This test provides an overall evaluation of how the fabric performs in a standardized coverall design. NFPA 2112 requires a body burn prediction rating of 50 percent or less of the surface area covered by sensors (hands and feet are excluded). Lower percent body burn predictions indicate greater protection provided by the fabric.

Committee Statement: The TC agrees that clarification on the test method is needed, and developed additional text to Annex B.1 to address the concern of the submitter. In addition, the TC recognized that the actual data represents a prediction of the percentage of the manikin body that would sustain burn injuries, and therefore removed references to a rating.

2112-22 Log #14
(7.5)

Final Action: Reject

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.

Recommendation: New text to read as follows:

7.5 Garment Requirement. When garments utilize reflective striping for enhanced daytime or nighttime visibility, the reflective striping used in the construction of the garments shall conform to the requirements of ANSI 107, American National Standard for High Visibility Safety Apparel and Headwear. Reference should be made to ANSI 107 in Chapter 2.

Substantiation: If high visibility materials are used for high visibility purposes, then additional criteria should be specified.

Committee Meeting Action: Reject

Committee Statement: The selection of garments for daytime or nighttime visibility is outside the scope of NFPA 2112. This topic is more appropriately addressed in NFPA 2113.
2112-23 Log #11 Final Action: Reject

(8.1.3)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.

Recommendation: Revise text to read as follows:

8.1.3* Washing and Drying Procedure. Where required, specimens shall be subjected to the specified number of cycles of washing and drying in accordance with the manufacturer’s cleaning instructions. Where no specific instructions are provided, the following procedure shall be used:

Substantiation: All manufacturers are required to provide cleaning instructions with their products. These cleaning instructions are intended to provide the maximum service life and appropriate procedures based on the materials of construction. It is appropriate that flame resistance and other performance properties be tested based on the instructions provided by the manufacturer.

Committee Meeting Action: Reject

Committee Statement: Manufacturers may have unique laundering techniques. NFPA 2112 must provide a standard laundering method for test agencies to follow.

2112-24 Log #CP5 Final Action: Accept

(Table 8.1.3)

Submitter: Technical Committee on Flash Fire Protective Garments,

Recommendation: Add text to read as follows:

† Carry-over shall be accomplished with agitation.

Substantiation: The standard was not clear as to whether the carry-over was performed with or without agitation. The footnote provides a clear requirement.

Committee Meeting Action: Accept

2112-25 Log #CP6 Final Action: Reject

(Table 8.1.3)

Submitter: Technical Committee on Flash Fire Protective Garments,

Recommendation: Revise text to read as follows:

Line 17, Rinse (3rd) - Extend final rinse period from 2 minutes to 4 minutes:

Rinse 2 4 38 100 High

Substantiation: The TC made the proposal because there is concern that the current 2 minute rinse cycle may not be long enough to remove the detergent and residual detergent can impact flame testing.

Committee Meeting Action: Reject

Committee Statement: The TC rejects the proposal because no hard data was presented. Interested parties are encouraged to submit data on this topic.
8.2 Thermal Protective Heat Transfer Performance (TPP HTP) Test.
8.2.1 Application. This test method shall apply to flame resistant garment fabrics.
8.2.2 Specimens.
8.2.2.1 TPP HTP testing shall be conducted on three specimens measuring 150 mm ± 5 mm x 150 mm ± 5 mm (6 in. ± 1/4 in. x 6 in. ± 1/4 in.) and shall consist of all layers representative of the garment to be tested. Three specimens are for testing in the spaced configuration and three specimens are for testing in the contact configuration.
8.2.2.2 Specimens shall consist of all layers used in the construction of the flame-resistant garment, excluding any areas with special reinforcements.
8.2.2.3 Specimens shall not include seams.
8.2.2.4 Specimens shall not be stitched to hold individual layers together.
8.2.2.5 Specimen Preparation.
8.2.2.5.1 Fabrics that are designated on the flame-resistant garment label to be washed, specimens shall be tested before and after three cycles of washing and drying as specified in 8.1.3.
8.2.2.5.2 Fabrics that are designated on the flame-resistant garment label to be dry-cleaned, specimens shall be tested before and after three cycles of dry cleaning as specified in 8.1.4.
8.2.2.5.3 Fabrics that are designated on the flame-resistant garment label to be either washed or dry-cleaned, specimens shall be tested before and after three cycles of washing and drying as specified in 8.1.3, or after three cycles of dry cleaning as specified in 8.1.4.
8.2.5 Procedure.
8.2.5.1 Heat transfer performance testing shall be performed in accordance with ASTM F2700, Standard Test Method for Unsteady State Heat Transfer Evaluation of Flame Resistant Materials for Clothing with Continuous Heating.
8.2.5.2 Single layer specimen heat transfer performance testing shall use the Relaxed Single Layer configuration in ASTM F2700 for testing in spaced and contact orientation.
8.2.5.3 Multilayer specimen heat transfer performance testing shall use the Multiple Layer Samples configuration in ASTM F2700 for testing in spaced and contact orientation.
8.2.6 Report.
8.2.6.1 The individual test TPP HTP rating of each specimen shall be reported separately for both "spaced" and "contact" tests.
8.2.6.2 The individual average TPP HTP ratings for both "spaced" and "contact" tests shall also be reported.
8.2.6.3 If a TPP HTP rating is greater than 60, then the TPP HTP rating shall be reported as ">60."
8.2.7 Interpretation.
8.2.7.1 Pass or fail determinations shall be separately based on the individual average TPP HTP ratings for both "spaced" and "contact" tests.
8.2.7.2 If an individual result from any test set varies more than ±10 percent from the average result, the results from the test set shall be discarded and another set of specimens shall be tested.

<table>
<thead>
<tr>
<th>Thermal protective performance (TPP)</th>
<th>Heat transfer performance (HTP)</th>
</tr>
</thead>
</table>
| A 150 mm (6 in.) square fabric specimen is placed on a specimen holder that suspends the specimen horizontally over two Meker burners and a radiant panel. The heat and flame source is adjusted to provide an exposure heat flux of \( \Phi \) 84 kW/m² (2.0 cal/cm²·sec). A weighted sensor containing a copper calorimeter is placed on top of the specimen and measures the heat transfer through the specimen. A water-cooled shutter between the specimen and heat source is withdrawn to begin the exposure. The test measures the amount of time with continuous heating for heat breakthrough resistance (using an arbitrary criteria of heat through the specimen to cause a second-degree burn). This time is multiplied by the exposure heat flux to provide a TPP HTP rating. TPP HTP ratings are measured with the sensor both in "contact" with the specimen and "spaced" 6 mm (1/4 in.) away from the specimen. Note that this test method does not result in a burn injury prediction. The heat remaining in a test sample is not accounted for which would.
otherwise contribute to a predicted skin burn injury.

(Column 4) This test is used to measure the unsteady state heat transfer properties of the thermal insulation provided by garment materials. The TPP HTP test uses an exposure heat flux that is representative of flash a JP4 (Jet Fuel) pool fire environments. NFPA 2112 requires that specimens have a TPP HTP rating of 12.6 J/cm² (3.0cal/cm²) or more when measured in "contact," simulating direct contact with the skin, and 25 J/cm² (6.0 cal/cm²) or more when measured "spaced," simulating an air gap between the skin and the garment material. Higher TPP HTP ratings indicate better unsteady state heat transfer performance for this test but do not correlate to improved predicted skin burn injury performance.

(Add to C.1.2.2)


Substantiation: An ASTM standard currently exists (ASTM F2700-08) that duplicates the test method currently in the 2007 edition of NFPA 2112.

Replacement of the 8.2 testing TPP method with the ASTM F2700-08 method within the text significantly simplifies the testing section, adds clarity to the specification requirement, and provides applicable scope information regarding the application of this test method (the test method does not predict thermal protective capabilities of a material).

Committee Meeting Action: Accept

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2112-27 Log #16 Final Action: Reject
(8.3.11)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
Introduce procedures for the specific testing of closure tape materials.
Substantiation: Closure tape materials are currently not addressed in the standard. These same materials should be tested for flame resistance.
Committee Meeting Action: Reject
Committee Statement: The TC believes that testing of slide fastener tape is addressed in section 7.3. The TC addressed the submitter's concern regarding flame resistance of slide fastener tape by adding a design requirement to Chapter 6 as shown in proposal 2112-20 (Log #15).

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2112-28 Log #17 Final Action: Accept in Principle
(8.5.5.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
8.5.5.1 The percent total body burn, excluding untested areas, for each specimen shall be reported as the body burn rating.
Substantiation: It is unclear whether total body burn includes the entire body or just the portions of the body that contain sensors.
Committee Meeting Action: Accept in Principle
Revise text to read as follows:
8.5.5.1 The predicted percent total body burn based on the total surface area covered by sensors, excluding hands and feet, for each specimen shall be reported as the body burn rating.

Committee Statement: The TC agrees that clarification on the test method is needed, as evidenced in action on Proposal 2112-21 (Log #21). The TC further correlated action on this log with Proposal 2112-21 (Log #21) to reflect that the actual data represents a prediction of the percentage of the manikin body that would sustain burn injuries, and therefore removed references to a rating.
A.3.3.12 Flash Fire. A flash is the result of combustion, or the chemical process of rapid oxidation (burning) that requires an ignition source, a flammable substance or fuel, and oxygen (usually from air). In an industrial environment, different types of fires may result from a variety of different events. "Jet" fires typically arise from line breaks or ruptures of pressurized flammable materials. These fires can create high velocity, directed "jets", which may project flames in any direction for considerable distances, depending on the characteristics of the source, and burn until the fuel is exhausted or the break is isolated. A pool, or running pool fire, arises from the ignition of spills and leaks of flammable liquids. The size and intensity is dependent on the amount of material involved and typically extends upward from the surface of the pool. These fires also continue until the fuel is exhausted and the source of the leak isolated. A flash, or vapor cloud fire arises from the release or presence of a hydrocarbon, gas or atmosphere containing combustible finely divided particles (e.g., coal dust or grain) that contains a concentration above the lower explosive limit of the chemical. Both hydrocarbon and dust flash fires generate temperatures from 540°C to 1040°C (1000°F to 1900°F). A flash fire depends on the size of the gas or vapor cloud, and when ignited, the flame front expands outward in the form of a fireball. The resulting effect of the fireball's energy with respect to radiant heat significantly enlarges the hazard areas around the gas released.

Substantiation: "Flash fires", or vapor cloud fires, are a very small subset of actual fire types experienced in industrial environments with fire hazards. The potential fires that exist can be in the form of pressurized flammable line breaks (jet fires), flammable liquid spills (pool fires), and fireballs (from Boiling Liquid Expanding Vapor Explosions or flammable material container BLEVE). The purpose of this standard is to provide minimum specification requirements to address all of these industrial thermal hazards. This goal is better served with the single term "fire", which encompasses all of the noted hazards. The proposed elaboration in the annex adds additional clarity to the scope of the term "fire" within the standard.

Committee Meeting Action: Accept in Principle
Revise text to read as follows:

A.1.2.1 Users are cautioned that flammable clothing can contribute to the severity of burn injuries through its ignition and continued burning after exposure to flash fire. Short-duration thermal exposures can arise from other fire types in industrial environments. These include, but are not limited to, jet flames, liquid fires (pool fires or running liquid fires), solids fires (fires of solid materials or dust fires), warehouse fires, fires associated with oxygen.

Committee Statement: The list of types of fires is extracted from Center for Chemical Process Safety document "Guidelines for the Consequence Analysis of Chemical Releases". The TC rejected modifications to A.3.3.12 because the definition 2112-12 (Log #4) was rejected, therefore the current annex material is more appropriate.