Why Buy Certified?

Understanding Standards
NFPA 2112 and ASTM F1506
and Why Certification Matters
When Selecting FR PPE

May 3, 2018
Occupational Health & Safety,
DuPont™ Protection Solutions
Overview

• Workplace burn injuries
• History of FR PPE standards
• What tests are done to meet standards and certifications
• How to tell if a garment is certified
• Why buy certified?
Types of workplace burn threats

Fire/Heat/Flame
Arc Flash
Molten Metal
Combustible Dust
What factors influence the severity of a burn injury?

- contact time
- temperature
- fabric type / weight / design of FR garment
- air gap between FR garment and skin
- undergarments
- location of burn
- age and gender of victim
PPE for burn threats
History of industrial workplace safety standards organizations

- UL 1894
- NEC 1897
- US Dept. of Labor 1913
- AATCC 1921
- NFPA 1896
- ASTM 1898
- ANSI 1918
- OSHA 1970
History of FR PPE industry and standards
Evolution of NFPA 2112 and thermal manikin test

1960’s Naval Air Development Center – first thermal manikin (outdoor)

1960’s Alice Stoll burn experiments

1975 DuPont™ commercial thermal manikin (Thermo-Man®)

1980’s evaluation of burned garments, hospital records and eyewitness data

1992 NCSU academic thermal manikin (PyroMan™)

2000 ASTM F1930 thermal manikin testing standard
# History of FR PPE tests and standards

<table>
<thead>
<tr>
<th>1960’s</th>
<th>1970’s</th>
<th>2000’s</th>
<th>TODAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st military thermal manikin testing</td>
<td>1st commercial thermal manikin lab (Thermo-Man®)</td>
<td>NFPA 2112 version #1 with TPP test (2001)</td>
<td>NFPA 2112 version #4 with HTP test</td>
</tr>
<tr>
<td>Stoll Burn Curve</td>
<td>Military standards (vertical flame)</td>
<td>ASTM F1506 version #1 with seam slippage test (2000)</td>
<td>ASTM F1506 version #13</td>
</tr>
<tr>
<td>Nomex® commercialized</td>
<td></td>
<td></td>
<td>worldwide network of FR PPE test labs</td>
</tr>
</tbody>
</table>
NFPA National Fire Protection Association

• founded in 1896
• provider of global non-profit codes and standards
• 300 separate codes/standards
• 250 technical committees
• 9000 volunteers
• no enforcement
ASTM American Society for Testing and Materials

• founded in 1898
• provides global non-profit voluntary consensus standards
• over 12,000 standards
• 30,000 worldwide members
• 140 technical committees
• no enforcement
What is an industry consensus standard? Three types:

- Certification standard
- Performance standard
- Test method
National consensus standard

OSHA definition 1910.2(g)

any standard adopted by a nationally recognized standards organization

agreed to by persons interested and affected by the scope or provisions of the standard

formulated in a manner which afforded an opportunity for diverse views to be considered

designated as such a standard by Federal agencies
What does OSHA say about consensus standards?

Standard Interpretation Publication:
Industry Consensus Standard NFPA 70E
July 25, 2003

*With respect to the General Duty Clause, industry consensus standards may be evidence that a hazard is "recognized" and that there is a feasible means of correcting such a hazard.*
OSHA

uses consensus standards as a basis for mandatory safety and health standards (29 CFR 1910.132 PPE General Requirements)
### FR PPE legal requirements

<table>
<thead>
<tr>
<th>Agencies create workplace standards and codes (not laws)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSHA operates under the US Department of Labor</td>
</tr>
<tr>
<td>OSHA regulations/requirements are federal laws</td>
</tr>
<tr>
<td>State requirements / laws</td>
</tr>
<tr>
<td>Virginia Occupational Safety and Health Program (VOSH)</td>
</tr>
<tr>
<td>Penalties: citations, fines, criminal charges or other penalties</td>
</tr>
</tbody>
</table>

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Three types of industry consensus standards

Certification standard
Performance standard
Test method
NFPA 2112 Certification for finished garment

ASTM F1506 Performance standard on components

ASTM D6413 Test method for vertical flame on fabric
The required tests for consensus standards can be completed in two ways:

**Third party certification**

All testing done by independent agency

**Self-certification**

Testing can be done by manufacturer or independent agency (or combination)

ASTM F1506
3rd party certification organizations cannot be owned or controlled by manufacturer or vendor.

Main business should be certification work.

Must be accredited for PPE with ISO 17065.
## FR PPE apparel specifications

<table>
<thead>
<tr>
<th>Standard</th>
<th>End use</th>
<th>Certification type</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFPA 2112</td>
<td>FR Industrial Garment Certification</td>
<td>third party</td>
</tr>
<tr>
<td>ASTM F1506</td>
<td>Flame and Arc Protective Garment</td>
<td>self</td>
</tr>
<tr>
<td></td>
<td>Certification</td>
<td></td>
</tr>
<tr>
<td>NFPA 1971</td>
<td>Structural Fire Fighting</td>
<td>third party</td>
</tr>
<tr>
<td>NFPA 1975</td>
<td>Emergency Services (station wear)</td>
<td>third party</td>
</tr>
<tr>
<td>NFPA 1977</td>
<td>Wildland Fire Fighting</td>
<td>third party</td>
</tr>
<tr>
<td>NFPA 70E</td>
<td>Industrial Electricity</td>
<td>self</td>
</tr>
<tr>
<td>ASTM F2733</td>
<td>FR Rainwear</td>
<td>self</td>
</tr>
<tr>
<td>ANSI 107</td>
<td>FR High Visibility Certification</td>
<td>third party*</td>
</tr>
</tbody>
</table>
Standards committee makeup

- Value chain: fiber, yarn, fabric, knit, and garment producers
- Product end users / specifiers
- Higher education institutes
- Testing facilities
- Safety/training providers
- Safety consultants
- 3rd party certification providers
When are standards updated?

reviewed at least every 5 years
Why are standards updated?

- New testing protocol
- Post-incident learnings
- New scientific discovery
- New material offerings
Today’s focus is 2 industry consensus standards for FR garments

NPFA 2112
Standard on Flame-Resistant Clothing for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire

ASTM F1506
Standard Performance Specification for Flame Resistant and Electric Arc Rated Protective Clothing Worn by Workers Exposed to Flames and Electric Arcs
How are standards updated?

**NFPA 2112**
- public input
- creation of 1st draft
- public input on 1st draft
- committee revisions
- NFPA technical meeting vote
- issuance of standard

**ASTM F1506**
- input from public, companies, associations, government agencies
- task force draft
- subcommittee, main committee and Society approval by vote
What does it take to get a garment certified?
NFPA 2112 and ASTM F1506: both set performance values for FR garments
What is the difference between NFPA 2112 and ASTM F1506?

**NFPA 2112**
- Minimum requirements for thermal protection
  - Heat resistance
  - Flame resistance
  - High temp shrinkage resistance

**ASTM F1506**
- Thermal and arc plus performance of garments in use
  - Fabric break and tear (durability)
  - Colorfastness/laundry shrinkage
  - Flammability after washing
  - Arc rating

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NFPA

2112

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

2018
NFPA 2112 – What type of garments are included?

clothing

hoods

gloves
What garment types are excluded?

• wildland firefighting
• technical rescue
• structural firefighting
• single-use garments
• electrical flash
• radiological, biological or hazardous materials

These garments have other specific standards

NFPA 2112
Included components: fabric, sewing thread, snaps, zippers, hardware, labels, tape, patches, emblems/transfer films, interlining, and insulation
Certification of 1 FR garment
fabric, thread, zippers, snaps, 2 labels
(no underlayers, lining, buttons, tape, patches, transfer films)

54

individual tests
NFPA 2112 performance tests

<table>
<thead>
<tr>
<th>ASTM F2700 Heat transfer performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM D6413 Vertical flame</td>
</tr>
<tr>
<td>ASTM F2894 High temperature shrinkage</td>
</tr>
<tr>
<td>ASTM F1930 Thermal manikin</td>
</tr>
<tr>
<td>ASTM D7138 Non-melting thread</td>
</tr>
<tr>
<td>Label durability</td>
</tr>
</tbody>
</table>
Let’s step through each of the different tests
Why are tests done before and after laundering?

inherent Nomex® fiber

non-inherent flame retardant treated fiber
ASTM F2700
Heat Transfer Performance

- samples as received + laundered 3 times
- 3 contacted with hot surface
- 3 spaced above hot surface
- test result simulates heat moving through the garment resulting in a 2nd degree burn

HTP rating = time * heat
ASTM F2700 Heat Transfer Performance

The higher the HTP rating, the longer it would take for the wearer to be burned

Minimum requirements
Contact rating 3.0 cal/cm²
Spaced rating 6.0 cal/cm²
ASTM D6413 Vertical flame is a requirement for both NFPA 2112 and ASTM F1506
ASTM D6413 performance requirements

char length maximum 4.0 inches

afterflame maximum 2 seconds

no melting or dripping
ASTM F2894
Heat resistance in hot oven

- 3 samples 15” by 15” marked at 10” locations
- as received and laundered 3 times
- precondition samples to 70°F and 65% relative humidity for 8 hours
- sample suspended in oven and exposed for 5 minutes at 500°F
ASTM F2894 Heat resistance in hot oven

- no more than 10% shrinkage in either warp or fill direction
- no melting, dripping, separation or ignition
Other components: snaps, zippers, hardware, striping, patches, interlining
ASTM F1930 Manikin testing

- test a minimum of 3 garments
- garments sewn to specific pattern
- launder garment 1 time
- garment is placed on manikin over cotton undershirt and briefs
- heat exposure of 2 cal/(cm² * s) for 3 seconds
- thermal manikin is equipped with a minimum 100 surface heat sensors
- mathematical model calculates predicted body burn (2nd + 3rd degree)
ASTM F1930 Manikin testing

Maximum 50% predicted body burn
Sum of 2\textsuperscript{nd} and 3\textsuperscript{rd} degree burns
Excludes hands and feet
Thread melting temperature

- 3 samples at least 4” long
- preconditioned for four hours at 70F and 65% relative humidity
- heat to 500F

thread cannot melt
Other requirements

- limitations of use
- warranty information
- sizing chart
- storage recommendations
- donning and doffing procedures
- maintenance, repair, laundering and cleaning instructions
- criteria for retirement
Can you have partial certification or certification of only some components?

NFPA 2112 Section 4.1.6:
Manufacturers shall not claim compliance with a portion(s) or segment(s) of the requirements of this standard and shall not use the name or identification of this standard in any statements about their respective product(s) unless the product(s) is certified as compliant to this standard.

Section 4.2.5.1:
There shall be no conditional, temporary, or partial certifications
There is no partial certification

- no conditional, temporary or partial certifications
- all components must be certified together
- manufacturers cannot use any label or reference to certification unless all requirements are met
1. Scope

1.1 This performance specification identifies minimum performance requirements to determine the (a) arc rating of fabrics, (b) flame resistance of fabrics and subassemblies, (c) minimum durability of the fabrics and subassemblies, (d) the garment construction and performance requirements, and (e) the garment labeling requirements for the completed protective clothing worn by workers exposed to flames and electric arcs.

1.1.1 The minimum requirements for garment labeling intended to provide end users with adequate information to select garments with the appropriate arc rating to protect clothing for their individual hazards.

1.2 This performance specification does not address requirements related to this performance in an arc hazard environment.

1.3 The performance specification does not address performance related to chemical exposure.

1.4 This performance specification does not address performance related to electrical exposure.

1.5 This standard should be used to evaluate and determine the properties of materials, products, or assemblies in heat and flame under controlled laboratory conditions. Results do not predict performance in actual fire situations. These results are for comparative purposes only. The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

1.6 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

1.7 The following precautionary caveats apply to this performance specification:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.1</td>
<td>The minimum requirements for garment labeling intended to provide end users with adequate information to select garments with the appropriate arc rating to protect clothing for their individual hazards. [ \text{Arc Rating} ]</td>
</tr>
<tr>
<td>1.2</td>
<td>This performance specification does not address requirements related to this performance in an arc hazard environment.</td>
</tr>
<tr>
<td>1.3</td>
<td>This performance specification does not address performance related to chemical exposure.</td>
</tr>
<tr>
<td>1.4</td>
<td>This performance specification does not address performance related to electrical exposure.</td>
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<tr>
<td>1.5</td>
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</tr>
<tr>
<td>1.6</td>
<td>The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.</td>
</tr>
<tr>
<td>1.7</td>
<td>The following precautionary caveats apply to this performance specification:</td>
</tr>
</tbody>
</table>
What products and materials are included?

- fabrics
- knits
- non-woven limited use or disposable products
- sewing thread
- fasteners, closures, zippers, snaps or buttons
- patches (new and repairs)
What is excluded?

• Rainwear
• Hand protection
ASTM F1506 performance tests

- ASTM D5034 Breaking load
- ASTM D1424 Tear resistance
- ASTM D3786 Bursting strength (knits)
- Laundering colorfastness
- Laundering dimensional change
- ASTM D6413 Vertical flame
- ASTM F1959 Arc rating
Certification of 1 FR garment
fabric, thread, zippers, snaps, 2 labels
(no underlayers, lining, buttons, tape, patches, transfer films)

55

individual tests

ASTM F1506
Let’s look at each of these tests in more detail
ASTM D5034 Breaking load
ASTM D5034 Breaking load

Minimum breaking load value depends on fabric weight

40 lbf for 6.0 oz/yd²

a higher value is better
ASTM D1424
Tear resistance

• A pre-notched and conditioned sample is secured with clamps in the tester

• A pendulum swings down and applies force to tear the material
ASTM D1424 Tear resistance

5 samples in each direction (warp and fill) are averaged

Minimum tear resistance value depends on fabric weight

4.0 lbf for 6.0 oz/yd² fabric

a higher value is better
Laundering colorfastness

Fabric color is compared before and after washing or dry cleaning

Colorfastness class must be reported but there is no minimum standard

ASTM F1506
Laundring colorfastness grey scale

scale of 1 - 5  higher class value is better

ASTM F1506
AATCC 135 (or 158) Laundry shrinkage

- Samples cut 15” by 15” and marked at 10” noting warp and fill direction
- Washed/dried or dry cleaned 5 times
- Maximum 5% shrinkage in any direction
ASTM D6413

Vertical flame

Same testing procedure as NFPA 2112

Samples tested as received (AR) and after at least 25 laundering cycles

Maximum char length is 6.0 inches
Maximum time of afterflame is 2 seconds
No melting or dripping allowed
ASTM F1959 Arc rating

Two types of measurements:

1. Arc Thermal Performance Value (ATPV): the amount of energy exposed to a material that gives a 50% chance of a 2nd degree burn through the fabric.

2. Breakopen Threshold Energy (EBT): the amount of energy exposed to the garment that gives a 50% chance of fabric breakopen.

Afterflame lasts no longer than 5 seconds.

<table>
<thead>
<tr>
<th>incident energy (cal/cm²)</th>
<th>category</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-8</td>
<td>1</td>
</tr>
<tr>
<td>8-25</td>
<td>2</td>
</tr>
<tr>
<td>25-40</td>
<td>3</td>
</tr>
<tr>
<td>over 40</td>
<td>4</td>
</tr>
</tbody>
</table>
How do you know if a garment is certified?

<table>
<thead>
<tr>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online tools</td>
</tr>
<tr>
<td>Garment tags and labels</td>
</tr>
<tr>
<td>Hang tags</td>
</tr>
<tr>
<td>Supplier provided test reports</td>
</tr>
</tbody>
</table>
UL Online Certifications Directory
## Search results

You may choose to [Refine Your Search](#).

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Category Name</th>
<th>Link to File</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUPONT PROTECTION TECHNOLOGIES</td>
<td>Flame-resistant Clothing for Protection of Industrial Personnel Against Short-duration Thermal Exposures from Fire</td>
<td>QGWB.MH49984</td>
</tr>
<tr>
<td>DUPONT PROTECTION TECHNOLOGIES</td>
<td>Liquid-splash-protective Clothing and Ensembles for Hazardous Materials Emergencies</td>
<td>QGTT.MH49984</td>
</tr>
<tr>
<td>DUPONT PROTECTION TECHNOLOGIES</td>
<td>Protective Ensembles and Elements for First Responders to Hazardous Materials Emergencies and CBRN Terrorism Incidents</td>
<td>QGTE.MH49985</td>
</tr>
<tr>
<td>DUPONT PROTECTION TECHNOLOGIES</td>
<td>Vapor-protective Ensembles and Elements for Hazardous Materials Emergencies and CBRN Terrorism Incidents</td>
<td>QGWV.MH61888</td>
</tr>
<tr>
<td>E I DUPONT DE NEMOURS &amp; CO INC</td>
<td>Plastics - Component</td>
<td>QMFZ2.E34739</td>
</tr>
<tr>
<td>E I DUPONT DE NEMOURS &amp; CO INC</td>
<td>Plastics, Proprietary - Component</td>
<td>QMTP2.E203875</td>
</tr>
<tr>
<td>E I DUPONT DE NEMOURS &amp; CO INC</td>
<td>System Components, Electrical Insulation - Component</td>
<td>QBS2.E57692</td>
</tr>
</tbody>
</table>

Model number information is not published for all product categories. If you require information about a specific model number, please contact [Customer Service](#) for further assistance.
Locate certified model numbers
Labeling Requirements for NFPA 2112

- must have at least one attached inside label
- can have multiple labels inside and outside
- certification organization label, symbol or identifying mark
- printed in English (supplemental languages permitted)
MORE Labeling Requirements for NFPA 2112

- product model name or number
- manufacturer’s name
- manufacturer’s address
- country of manufacture
- manufacturer’s garment identification number, lot number, or serial number
- size
- fiber content for each layer
- DO NOT REMOVE
- international symbol for “read instructions before use”
Labeling requirements for ASTM F1506

• manufacturer’s name
• fabric identifier (fabric producer, style number or brand)
• size
• care instructions
• fiber content
• arc rating
Garment Tags
Garment hang tags
Claims do not equal certification

Meets Standard……
Complies with ……
Flash fire rated

List of test results that does not include all required tests

Standards included that do not apply
Ask for the test report

ASTM F1506: This report (product specs and testing results) shall be made available to the purchaser of garments meeting this performance specification by the garment manufacturer.
Supplier reported test data: self and third party results

<table>
<thead>
<tr>
<th>Typical Physical Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight</strong> (±5%) (oz/sq yd)</td>
</tr>
<tr>
<td>(g/sq meter)</td>
</tr>
<tr>
<td><strong>Weave</strong></td>
</tr>
<tr>
<td><strong>Standard Colors</strong></td>
</tr>
<tr>
<td>Medium Blue</td>
</tr>
<tr>
<td><strong>Construction</strong> (ends/inch x picks/inch)</td>
</tr>
<tr>
<td><strong>Vertical Flammability</strong> ASTM D6413</td>
</tr>
<tr>
<td>Char Length (inches W x F)</td>
</tr>
<tr>
<td>After Flame (seconds W x F)</td>
</tr>
<tr>
<td><strong>Thermal Protective Performance</strong> (cal/cm²) NFPA 2112</td>
</tr>
<tr>
<td><strong>Flash Fire Exposure (Manikin Test)</strong> ASTM F1930</td>
</tr>
<tr>
<td>(% body burn [2.0 cal/cm² sec] at 3 seconds)</td>
</tr>
<tr>
<td><strong>Arc Thermal Performance</strong> ATPV (cal/cm²) ASTM F1959</td>
</tr>
<tr>
<td><strong>Tensile Strength</strong> (lb, W x F) ASTM D5034</td>
</tr>
<tr>
<td><strong>Elnendorf Tear</strong> (lb, W x F) ASTM D1424</td>
</tr>
<tr>
<td><strong>Dimensional Stability</strong> (% at 5x) 140°F, AATCC 135</td>
</tr>
<tr>
<td><strong>Air Permeability</strong> ([#]/f/min) ASTM D737</td>
</tr>
<tr>
<td><strong>Washing Colorfastness</strong> (rating*) AATCC 61</td>
</tr>
<tr>
<td><strong>Wicking</strong> (inches at 15 min W x F)</td>
</tr>
<tr>
<td><strong>Pilling Resistance</strong> (rating*) ASTM D3512, 60 min</td>
</tr>
<tr>
<td><strong>Heat Resistance</strong> (500°F, 5 min) NFPA 2112</td>
</tr>
<tr>
<td><strong>Thermal Shrinkage Resistance</strong> (% [500°F, 5 min] NFPA 2112)</td>
</tr>
</tbody>
</table>
Certification does not guarantee protection

Only a thorough hazard assessment to identify burn threats can confirm if the FR PPE is appropriate for the job conditions of each individual job.
Certification does not guarantee compliance

Only a thorough hazard assessment to identify burn threats can confirm if the FR PPE is appropriate for the job conditions of each individual job.
Standards are MINIMUM levels of protection

NFPA 2112 only addresses one level of energy and one exposure duration time.

Protection level of all certified garments is not equal – some may just meet minimum requirements and some may greatly exceed them.

Each work environment is different – be sure to get the appropriate level of protection.
Synergy of components

The science behind short duration fires and arc flashes are complicated events.

There are many facets to protection that cannot be duplicated with just one test or one measurement.

This is why the standards exist, to look at protection from multiple angles and standpoints, to consider how all of the parts and pieces work together during an emergency as well as in use day to day.
Partner with suppliers that value product stewardship, their reputation and brands.
Thermal apparel is a self-regulating, self-policing industry

- Certification and standards agencies do not have enforcement authority.
- Self certification can be done by manufacturer, supplier or importer.
- Buyer must rely on certifying agency reputation and capabilities.
- Buyers should request test reports.
- Buyers should confirm label matches procurement documents.

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Conclusions

• Not all commercial FR PPE is certified.

• Certification is a long and costly process.

• Tests and standards for FR PPE have been developed & refined over 60 years to best replicate product performance in a real world heat, flame or arc event.

• The value of certification is knowing your FR PPE will perform as designed and represented in a heat or flame emergency.
Thank you for your time and interest. We welcome your questions and comments.

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nomex.com
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