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NFPA 1971 Protective Clothing for Structural Fire Fighting 1986

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

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The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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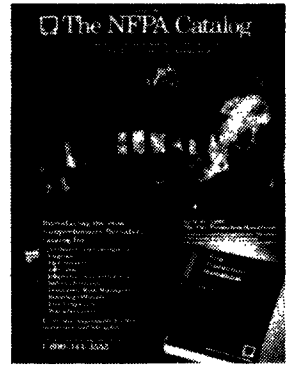

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NFPA 1971

Standard on

Protective Clothing for Structural Fire Fighting

1986 Edition

This edition of NFPA 1971, *Standard on Protective Clothing for Structural Fire Fighting*, was prepared by the Technical Committee on Protective Equipment for Fire Fighters and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 19-22, 1986, in Atlanta, Georgia. It was issued by the Standards Council on June 11, 1986, with an effective date of July 1, 1986, and supersedes all previous editions.

The 1986 edition of this standard has been approved by the American National Standards Institute.

Origin and Development of NFPA 1971

The original work on this project was done by the Sectional Committee on Protective Equipment for Fire Fighters that was a part of the Committee on Fire Department Equipment. In 1973, the Sectional Committee released a tentative standard, NFPA 19A-T, *Tentative Standard on Protective Clothing for Fire Fighters*. The Sectional Committee continued its work, and with the cooperation of the Program for Fire Services Technology of the National Bureau of Standards, developed NFPA 1971, *Standard on Protective Clothing for Structural Fire Fighting*. NFPA 1971 was adopted as a standard at the Fall Meeting in Pittsburgh, Pennsylvania on November 18, 1975.

Since that time, the Sectional Committee has been removed from the Committee on Fire Department Equipment, and made a full technical committee.

The 1981 edition of NFPA 1971 represented a complete editorial reworking of the 1975 edition to make the document more usable by both the fire service and protective clothing manufacturers.

The 1986 edition incorporates a complete revision of the document to include more performance requirements and less specifications. Separate performance and testing chapters were written.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

Contents

NFPA 1971

Standard on

Protective Clothing for Structural Fire Fighting

1986 Edition

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.

Information on referenced publications can be found in Chapter 6.

Chapter 1 Administration

1-1* Scope.

1-1.1 This standard specifies minimum design and performance criteria and test methods for protective clothing designed to protect fire fighters against adverse environmental effects during structural fire fighting.

1-1.2 This standard does not apply to specialized protective clothing for aircraft rescue and fire fighting, hazardous materials emergencies, or wildland fire fighting, and does not provide criteria for proximity, approach, or entry clothing or criteria for protection from chemical, radiological, or biological agents.

1-2* Purpose.

1-2.1 The purpose of this standard is to provide minimum performance requirements for structural fire fighting protective clothing.

1-3 Definitions.

Approach Clothing. Protective clothing designed to provide protection from radiant heat.

Approved.* Acceptable to the "authority having jurisdiction."

Cargo Pockets. Pockets located on the protective garment exterior.

Char. The formation of a brittle residue when material is exposed to thermal energy.

Collar Lining. That part of collar fabric composite that is next to the skin when the collar is closed in the raised position.

Compliant. Meeting or exceeding all applicable requirements of this standard.

Drip. To run or fall in drops or blobs.

Entry Clothing. Protective clothing that is designed to provide protection from conductive, convective, and radiant heat and permit entry into flames.

Hardware. Nonfabric components of protective clothing including those made of metal or plastic material.

May. This term is used to state a permissive use, or an alternative method to a specified requirement.

Melt. To change from solid to liquid, or become consumed, by action of heat.

Moisture Barrier.* That component layer designed to prevent the transfer of liquid water from the environment to the thermal barrier.

Outer Shell. That outside facing component layer with the exception of trim, hardware, and reinforcing material.

Protective Clothing. Protective garments configured as a coat and trousers, or as a coverall and designed to provide protection to the fire fighter's body.

Protective Coat. Protective garment designed and configured to provide protection to upper torso and arms, excluding the hands and head.

Protective Coverall. Protective garment designed and configured to provide protection to the torso, arms, and legs, excluding the head, hands, and feet.

Protective Garment. Protective coat, protective trouser, or protective coverall.

Protective Trouser. Provides protection to lower torso and legs excluding the feet.

Protective Uniform Pant. A pant designed and configured to be both the thermal barrier of a protective trouser, and a station/work uniform.

Proximity Clothing. Reflective protective clothing that is designed to provide protection against conductive, convective, and radiant heat.

Shall. Indicates a mandatory requirement.

Should. This term, as used in the Appendix, indicates a recommendation or that which is advised but not required.

Structural Fire Fighting. The activities of rescue, fire suppression, and property conservation in buildings, enclosed structures, vehicles, vessels, or like properties that are involved in a fire or emergency situation.

Thermal Barrier. That component layer designed to provide thermal protection.

Trim. Retroflective and flourescent material permanently attached to the outer shell for visibility enhancement.

Winter Liner. An optional component layer designed to provide added insulation against cold.

1-4 General.

1-4.1 Manufacturers of protective clothing meeting the requirements of this standard shall provide a written statement that the protective clothing manufactured by that company and provided to the purchaser meets or exceeds the requirements of this standard. The manufacturer shall furnish to the purchaser upon request the laboratory data showing individual values upon which the statement is based.

1-4.2* The manufacturer shall provide to the purchaser, on request, guidelines for garment maintenance, inspection, and retirement.

1-4.3 Protective garments shall meet all applicable design and performance requirements specified in this standard.

Chapter 2 Design Requirements

2-1* Garment Requirements.

2-1.1 A sample garment shall have at least the applicable design requirements specified in this chapter when inspected by the testing laboratory as specified in Chapter 4 of this standard.

2-1.2* The garment shall consist of a composite of an outer shell, moisture barrier, and thermal barrier.

2-1.3* Protective garments shall have a means of securing moisture barrier and thermal barrier to the outer shell.

2-1.4 The garment, including the front closure, shall be constructed in a manner that provides secure and complete moisture and thermal protection. If nonpositive fasteners, such as snaps or hook and pile tape, are utilized in garment closures, a positive locking fastener such as hooks and dees or zippers shall also be utilized.

2-1.5* Moisture barriers and thermal barriers shall extend to within 3 in. (76.2 mm) of the outer shell at the cuffs and hems of protective garments. At the neck, the coat moisture barrier and thermal barrier shall extend to neckline seam. At the waist, the trouser moisture barrier and thermal barrier shall extend to the waistline seam.

2-1.6* Cargo pockets where provided shall have a means of drainage of water, and shall have flaps with a means of fastening them in the closed position.

2-1.7 Trim utilized to meet visibility requirements shall not be less than 2 in. (50.8 mm) wide and shall have retroreflective and fluorescent surfaces. Retroreflective surface of trim shall not be less than 0.625 in. (15.9 mm) wide. Fluorescent and retroreflective areas of trim shall appear to be continuous for the length of the trim, with gaps between areas of retroreflectivity of not more than 0.125 in. (3.2 mm).

2-1.8 Trim affixed to protective garments exceeding the visibility requirements specified in 3-8.1 and 3-8.2 of this standard may be obscured by components such as, but not limited to, pockets, storm flaps, and reinforcing patches as long as the minimum trim required in 2-2.5, 2-2.6, 2-2.7, 2-3.3, 2-3.4, and 2-3.5 is not obscured.

2-1.9 Labeling Requirements.

2-1.9.1 Only protective garments meeting all applicable requirements of this standard specified herein shall be labeled as meeting the requirements of NFPA 1971.

2-1.9.2* The outer shell and each separable layer of each protective garment shall have a label permanently and conspicuously attached to the inside upon which at least the following warnings and information are printed:

"NFPA 1971 REQUIRES LABORATORY CERTIFICATION. THIS STRUCTURAL FIRE FIGHTING PROTECTIVE GARMENT MEETS THE REQUIREMENTS OF NFPA STANDARD 1971.

WARNING

OUTER SHELL, MOISTURE BARRIER, AND THERMAL BARRIER MEETING ALL REQUIREMENTS OF NFPA 1971 MUST BE UTILIZED AND ALL GARMENT CLOSURES MUST BE FASTENED WHEN IN USE. DO NOT KEEP THIS GARMENT IN DIRECT CONTACT WITH FLAMES OR MOLTEN METAL. DO NOT USE FOR PROXIMITY OR FIRE ENTRY APPLICATIONS OR FOR PROTECTION FROM CHEMICAL, RADIOLOGICAL OR BIOLOGICAL AGENTS. KEEP CLEAN—SOILING WILL REDUCE PROTECTIVE QUALITIES. MAINTAIN AND ALTER ONLY IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. NO PROTECTIVE CLOTHING CAN PROVIDE COMPLETE PROTECTION FROM ALL CONDITIONS—USE EXTREME CARE FOR ALL EMERGENCY OPERATIONS. FAILURE TO COMPLY WITH THESE INSTRUCTIONS MAY RESULT IN SERIOUS INJURY OR DEATH."

Manufacturer's name
Manufacturer's address
Country of manufacture
Manufacturer's garment identification number
Date of manufacture
Size
Cleaning and drying instructions
Fiber contents

"DO NOT REMOVE THIS LABEL"

2-2 Additional Requirements for Protective Coats.

2-2.1* Protective coats shall provide protection as specified to the upper torso, neck, arms, and wrists, excluding the hands and head.

2-2.2 Protective coat hardware shall not penetrate through the outer shell, moisture barrier, and thermal barrier to contact the wearer's body when the coat is worn with closures fastened, unless the hardware is completely covered by external closure flaps.

2-2.3* Each protective coat sleeve shall have a resilient wristlet meeting requirements as specified in 3-2.3 of this standard.

2-2.4 Protective coats shall have a composite collar not less than 4.0 in. (101.6 mm) in height at any point with a closure system. Collar and closure system shall consist of an outer shell, moisture barrier, and thermal barrier that meet all performance requirements as specified in Chapter 3 of this standard.

2-2.5* Protective coat trim configuration shall include a circumferential band around the coat and each wrist.

2-2.6 Protective coat trim shall have not less than 325 sq in. (2097 sq cm) of fluorescent area.

2-2.7 Protective coat trim shall include not less than 125 sq in. (806.5 sq cm) of fluorescent area visible from the front and 125 sq in. (806.5 sq cm) of fluorescent area visible from the rear when the garment is properly closed and is laid on a flat inspection surface.

2-3 Additional Requirements for Protective Trousers.

2-3.1* Protective trousers shall provide protection as specified to the lower torso and legs, excluding the ankles and feet.

2-3.1.1 The thermal barrier of the protective trousers may be configured as a protective uniform pant. When configured in this manner, the protective uniform pant component shall meet all requirements for thermal barriers specified in Chapters 2 and 3 of this standard, and the entire protective trouser with outer shell, moisture barrier, and protective uniform pant as the thermal barrier assembled shall meet the requirements specified in 1-4.3 of this standard. Also, the protective uniform pant shall meet all requirements specified in NFPA 1975, *Standard on Station/Work Uniforms for Fire Fighters.*

2-3.2 Protective trouser hardware shall not penetrate through the outer shell, moisture barrier, and thermal barrier to contact the wearer's body when trouser is worn with closures fastened, unless the hardware is located on the waistband or hardware is completely covered by external closure flaps.

2-3.3 Protective trouser trim shall include a circumferential band around each leg between the hem and knee.

2-3.4 Protective trouser trim shall have not less than 80 sq in. (520.0 sq cm) of fluorescent area.

2-3.5 Protective trouser trim shall include not less than 40 sq in. (260.0 sq cm) of fluorescent area visible from the front and 40 sq in. (260.0 sq cm) of fluorescent area visible from the rear when the garment is properly closed and is laid on a flat inspection surface.

2-4 Additional Requirements for Protective Coverall.

2-4.1 That portion of the protective coverall that corresponds to the protective coat shall meet all requirements of Section 2-2.

2-4.2 That portion of the protective coverall that corresponds to the protective trouser shall meet all requirements of Section 2-3 of this chapter.

Chapter 3 Performance Requirements

3-1 Garment Requirements.

3-1.1 The protective garment fabric composite consisting of outer shell, moisture barrier, and thermal barrier shall have an average Thermal Protective Performance (TPP) of not less than 35.0 when tested as specified in Section 5-1 of this standard before and after five cycles of washing and drying in accordance with the procedure specified in Section 5 of AATCC 135, 1 III, B, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

3-1.2 All seams shall possess a breaking strength of not less than 80 percent of the fabric when tested in accordance with ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabric,* with the machine operated at a rate of 12 in./min (304.8 mm/min).

3-2 Textiles.

3-2.1 Outer shell, moisture barrier, thermal barrier, collar linings, wristlets, winter liner fabric, and trim shall be individually tested for flame resistance and shall have an average char length of not more than 4.0 in. (101.6 mm), an average afterflame of not more than 2.0 seconds, and shall not melt or drip when tested in accordance with Method 5903, *Flame Resistance of Cloth; Vertical,* of Federal Test Method Standard 191A, *Textile Test Methods.* The flame resistance testing shall be conducted both before and after five cycles of washing and drying in accordance with the procedure specified in Section 5 of AATCC 135, 1, III, B, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

3-2.2 Outer shell, moisture barrier, thermal barrier, collar linings, and winter liner fabric shall be individually tested and shall not shrink more than 10.0 percent in any direction when tested as specified in Section 5-2 of this standard. The thermal shrinkage test shall be conducted both before and after five cycles of washing and drying in accordance with the procedure specified in Section 5 of AATCC 135, 1, III, B, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

3-2.3 Outer shell, moisture barrier, thermal barrier, collar linings, and winter liner fabric, and other materials used in construction — including but not limited to padding, reinforcement, wristlets, labels, interfacing, binding, hanger loops, and emblems, but ex-

cluding trim, and hook and pile fasteners when not placed in direct contact with the body — shall be individually tested for heat resistance and shall not melt, separate, or ignite when tested as specified in Section 5-3 of this standard. The heat resistance testing shall be conducted both before and after five cycles of washing and drying in accordance with the procedure specified in Section 5 of AATCC 135, 1, III, B, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*.

3-2.4 Outer shell, moisture barrier, thermal barrier, collar linings, and winter liner fabric shall be individually tested for cleaning shrinkage resistance and shall not shrink more than 5.0 percent in any direction after five cleaning and drying cycles in accordance with AATCC 135, 1, III, B, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*.

3-2.5 All dyed fabrics used in manufacturing protective clothing shall be tested for colorfastness and shall exhibit a rating of "Good" for laundering when tested in accordance with Method 5605, *Colorfastness of Combined Laundering and Bleaching of Textile Materials*, Launderometer Method, without bleach, of Federal Test Method Standard 191A, *Textile Test Methods*.

3-2.6 All dyed fabrics used in manufacturing protective clothing shall be tested for crock resistance and shall exhibit a rating of "Good" for crocking when tested in accordance with Method 5651, *Crocking of Woven and Knitted Cloth; Standard sample; Munsell Scale Method*, of Federal Test Method Standard 191A, *Textile Test Methods*.

3-3 Outer Shell Requirements.

3-3.1 Outer shell fabric shall be tested for tear resistance and shall have a tear strength of not less than 22.0 lb (10 kg) when tested as specified in Section 5-4 of this standard.

3-3.2 Outer shell fabric shall be tested for char resistance and shall not char when tested as specified in 3-2.3 of this chapter. The char resistance testing shall be conducted both before and after five cycles of washing and drying in accordance with the procedure specified in Section 5 of AATCC Test Method 135, 1, III, B, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*.

3-3.3 Outer shell fabric shall be tested for water spray resistance and shall have a water spray resistance rating of not less than 90 before, and not less than 70 after, five cycles of washing and drying in accordance with the procedure specified in Section 5 of AATCC Test Method 135, 1, III, B, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*, when tested in accordance with Method 5526, *Water Resistance of Cloth with Hydroplobic Finish, Spray Method*, of Federal Test Method Standard 191A, *Textile Test Methods*.

3-3.4* Outer shell fabric shall be tested for water absorption resistance and shall have a water absorption of not more than 15.0 percent when tested in accordance with Method 5504, *Water Resistance of Coated Cloth; Spray Absorption Method*, of Federal Test Method Standard 191A, *Textile Test Methods*. The water absorption resistance testing shall be conducted both before and after five cycles of washing and drying in accordance with the procedure specified in Section 5 of AATCC Test Method 135, 1, III, B, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*.

3-3.5* Dyed outer shell fabric shall be tested for lightfastness and shall exhibit a color change of not less than a minimum gray scale of "2" when tested in accordance with AATCC Test Method 16E, *Colorfastness to Light: Water-Cooled Xenon-Arc Lamp, Continuous Light*, for 20-hour exposure.

3-4 Moisture Barrier Requirements.

3-4.1 Moisture barrier shall be tested for tear resistance and shall have a tear strength of not less than 5.0 lb (2.3 kg) when tested as specified in Section 5-4 of this standard.

3-4.2 The moisture barrier fabric shall be tested for water penetration resistance and shall have a minimum water penetration resistance of 25 psi when tested in accordance with Method 5512, *Water Resistance of Coated Cloth; High Range, Hydrostatic Pressure Method*, and 1 psi for five minutes when tested in accordance with Method 5516, *Water Resistance of Cloth: Water Permeability, Hydrostatic Pressure Method*, both Methods of Federal Test Method Standard 191A, *Textile Test Methods*. The water penetration resistance testing shall be conducted both before and after five cycles of washing and drying in accordance with the procedure specified in Section 5 of AATCC Test Method 135, 1, III, B, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*. Appearance of water drops shall constitute failure.

3-4.3 Moisture barrier seams shall have a water resistance of not less than 1 psi for five minutes when tested in accordance with Method 5516, *Water Resistance of Cloth: Water Permeability, Hydrostatic Pressure Method*, of Federal Test Method Standard 191A, *Textile Test Methods*. The water resistance testing shall be conducted both before and after five cycles of washing and drying in accordance with the procedure specified in Section 5, AATCC 135, 1, III, B, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*. Test shall be performed on the seam in the orientation it is placed in the finished garment. Appearance of water drops shall constitute failure.

3-5 Thermal Barrier Requirements.

3-5.1 Thermal barrier shall be tested for tear resistance and shall have a tear strength of not less than 5.0 lb (2.3 kg) when tested as specified in Section 5-4 of this standard.

3-6 Winter Liner Requirements.

3-6.1 When provided, the winter liner shall be tested for tear resistance and shall have a tear strength of not less than 5.0 lb (2.3 kg) when tested as specified in Section 5-4 of this standard.

3-7 Thread Requirements.

3-7.1 All thread utilized in the construction of the garments shall not ignite, melt or char when tested to a temperature of 500°F in accordance with Method 1534, *Melting Point of Synthetic Fibers*, of Federal Test Method Standard 191A, *Textile Test Methods*.

3-8 Visibility Requirements for Trim.

3-8.1 Protective coat trim when tested as specified in Section 5-5 of this standard shall have a total coefficient of luminous intensity (CIL) of not less than 270.

3-8.2 Protective trouser trim when tested as specified in Section 5-5 of this standard shall have a total coefficient of luminous intensity (CIL) of not less than 75.

3-9 Hardware Requirements.

3-9.1 All hardware finish shall be free of rough spots, burrs, or sharp edges.

3-9.2 All hardware shall be tested for corrosion resistance and shall pass without corrosion a 20-hour salt spray test in accordance with ASTM B 117, *Salt Spray (Fog) Testing*. Salt spray shall be 5 percent saline solution.

3-9.3 All hardware shall be tested for heat resistance and shall not ignite and shall remain functional when tested as specified in Section 5-3 of this standard.

3-9.4 Snap Requirements.

3-9.4.1 Snaps shall meet the requirements of MS 27980D, *Fastener, Snap*.

3-9.5 Fastener Tape Requirements.

3-9.5.1* Fastener tape shall meet the requirements of MIL-F-21840, *Fastener Tapes, Hook and Pile, Synthetic*.

3-9.6 Zipper Requirements.

3-9.6.1 Zippers shall meet the requirements of FED-V-F-106D, *Fasteners, Interlocking, Slide*.

3-9.7 Hooks and Dees Requirements.

3-9.7.1 Hooks and dees shall be non-ferrous and shall conform to the design of Figure 3-9.7.1.

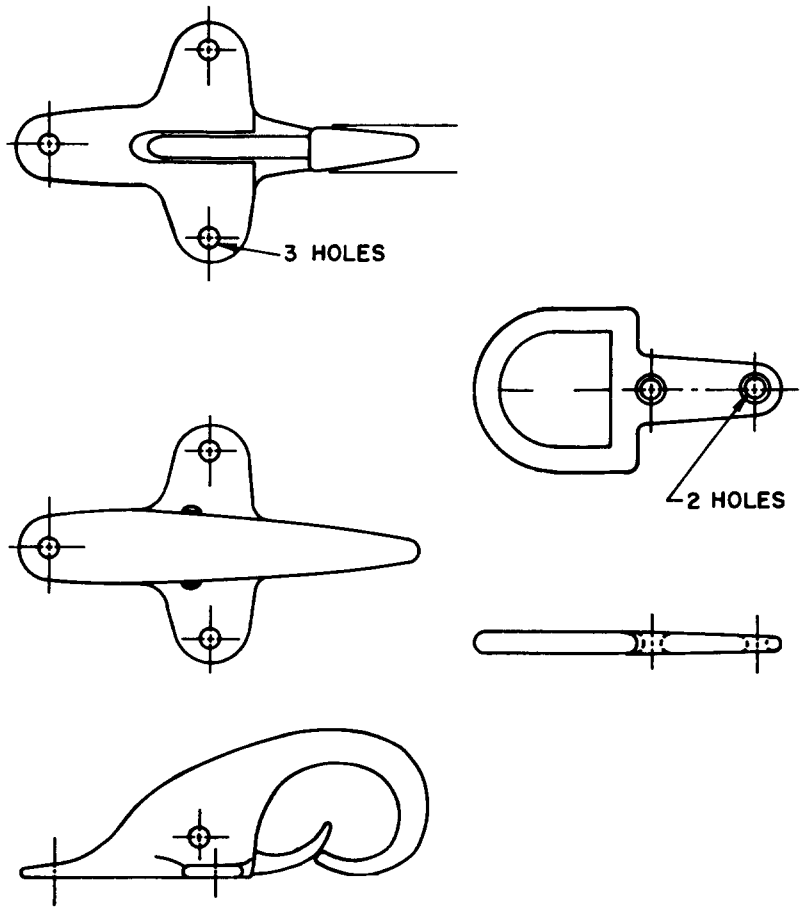

Figure 3-9.7.1 Hook and Dee Ring (Inward Facing)
Not to Scale

3-10 Label Requirements.

3-10.1 All labels shall be clearly legible to the eye before and after five cycles of washing and drying in accordance with the procedure specified in Section 5 of AATCC 135, 1, III, B; *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*. Labels not meeting specimen size requirements for the procedure listed above shall be sewn to a support fabric of required size.

3-11 Collar Lining Requirement.

3-11.1 Collar lining material shall have a breaking strength of not less than 35 pounds (15.9 kg) when tested in accordance with Method 5100, *Strength and Elongation of Woven Cloth; Grab Method*, of Federal Test Method Standard 191A, *Textile Test Methods*.

3-11.2 Collar lining may be included in the protective garment collar fabric composite for testing as required in 3-1.1 of this standard.

Chapter 4 Testing and Inspection

4-1 Sampling.

4-1.1 Sampling levels for testing and inspection shall be sufficient to assure that all garments delivered meet all applicable requirements specified in this standard.

4-2 Testing.

4-2.1 Testing for determining compliance with the performance requirements specified in Chapter 3 of this standard shall be performed on samples from each material lot used in construction of the garments to be delivered.

4-2.2 All samples shall be preconditioned in accordance with Section 4, *Atmosphere Conditions for Testing*, of Federal Test Method Standard 191A, *Textile Test Methods*. Testing shall begin within five minutes after removal from preconditioning.

4-2.3 Test specimens shall be prepared in accordance with the test methods specified in Chapter 5 of this standard, or in referenced test method documents specified in Chapter 3 of this standard. Referenced test documents shall be modified as follows:

4-2.3.1 Seam strength testing specified in 3-1.2 of this standard shall be performed on test specimens sewn in all configurations utilized in construction of the manufactured garments.

4-2.3.2 Seam water resistance testing specified in 3-4.3 of this standard shall be performed on test specimens constructed in all configurations utilized in construction of the garment manufactured in accordance with the purchaser's specifications.

4-3 Inspection.

4-3.1 Inspection for determining compliance with the design requirements specified in Chapter 2 of this standard shall be performed on a garment manufactured in accordance with the purchaser's specifications.

Chapter 5 Test Methods

5-1* Thermal Protective Performance Test.

5-1.1 All samples to be tested shall be preconditioned first by placement in circulating air oven for not less than four hours at 120°F ± 5°F (49°C ± 2°C), and then conditioned in accordance with Section 4, "Atmospheric Conditions for Testing," of Federal Test Method Standard 191A, *Textile Test Methods*, with a relative humidity of 65 percent ± 5 percent. Samples shall be tested not more than five minutes after removal from conditioning.

5-1.2 Thermal protective performance (TPP) testing shall be performed in accordance with ASTM D 4108, *Thermal Protective Performance of Materials for Clothing, Open Flame Method*, with the following modifications:

5-1.2.1 Specimens shall consist of protective clothing composites measuring 6 × 6 ± 1/16 in. (152.4 × 152.4 ± 1.6 mm) consisting of outer shell, moisture barrier, and thermal barrier.

5-1.2.2 Apparatus shall consist of specimen holder assembly, specimen holder assembly support, thermal flux source, protective shutter, sensor assembly, and recorder.

5-1.2.3 Specimen holder assembly shall consist of upper and lower mounting plates. Specimen holder mounting plates shall be 8 × 8 ± 1/16 × 1/4 ± 1/32 in. (203.2 × 203.2 ± 1.6 × 6.4 ± 0.8 mm). The lower specimen mounting plate shall have centered a 4 × 4 ± 1/16 in. (101.6 × 101.6 ± 1.6 mm) hole. The upper specimen mounting plate shall have centered a 5 1/8 × 5 1/8 ± 1/16 in. (130.2 × 130.2 ± 1.6 mm) hole. The lower specimen mounting plate shall have a 1 ± 1/16 in. high × 1/8 ± 1/32 in. (25.4 ± 1.6 × 3.2 ± 0.8 mm) thick steel post welded to each corner 1/4 ± 1/16 in. (6.4 ± 1.6 mm) from each side and perpendicular to the plane of the plate. The upper sample mounting plate shall have a corresponding hole in each corner so that the upper specimen mounting plate fits over the lower specimen mounting plate.

5-1.2.4 Specimen holder assembly support shall consist of a steel frame that rigidly holds and positions in a reproducible manner the specimen holder assembly and specimen relative to the thermal flux. Specimen holder assembly support shall be securely clamped at the edges such that specimen shrinkage is prevented. Sensor assembly shall consist of 5 1/4 × 5 1/4 × 1/2 in. (133.3 × 133.3 × 12.8 mm) heat-resistant block that fits without binding into hole of upper specimen mounting plate and shall be uniformly weighted such that complete sensor assembly, including copper calorimeter, weighs 1000 ± 10 grams (2.2 lb ± 0.022 lb).

5-1.2.5 Thermal flux source shall consist of a convective thermal flux source and a radiant thermal flux source.

The convective thermal flux source shall consist of two Meker or Fisher burners affixed beneath the specimen holder assembly opening, and subtended at a nominal 45 degree angle from the vertical so that the flames converge at a point immediately beneath the specimen. The radiant thermal flux source shall consist of nine quartz infrared tubes affixed beneath and centered between the burners.

5-1.2.6 A protective shutter shall be placed between the thermal flux source and the specimen. The protective shutter shall be capable of completely dissipating thermal load from thermal flux source for the time periods before and after specimen exposure. The protective shutter shall be controlled by means of an automatic timer with a resolution of not less than 0.10 second.

5-1.2.7 Specimens shall be exposed to a thermal flux of 2.0 ± 0.1 cal/cm²/sec as measured with the copper calorimeter. The copper calorimeter shall be the only heat sensor used in setting the 2.0 cal/cm²/sec exposure condition. The total heat flux shall be calculated directly from the temperature response of the copper calorimeter and calorimeter constants. Other heat-sensing devices shall not be used to reference or adjust the heat flux read by the copper calorimeter. The 2.0 cal/cm²/sec exposure shall be determined directly and only from the voltage output of the thermocouples, using the measured temperature rise of the copper calorimeter, the area and mass of the calorimeter, and the heat capacity of copper to calibrate the incoming heat flux. The radiant load shall be set on 1.0 cal/cm²/sec as measured using a calibrated commercial radiometer.

5-1.2.8 The sensor assembly shall be fitted into the opening in the top plate of the specimen holder and be in contact with the surface of the thermal barrier normally facing the wearer.

5-1.2.9 If the individual results vary more than ± 5 percent from the average result, the result shall be discarded and another set of specimens shall be tested.

5-1.2.10 The individual test results of each specimen shall be reported. The average value for each sample and the pass/fail result shall be calculated and reported.

5-2* Thermal Shrinkage Resistance Test.

5-2.1 Thermal shrinkage resistance testing shall be conducted on three specimens of each fabric, and each fabric shall be tested separately.

5-2.2 All specimens to be tested shall be conditioned in accordance with Section 4, *Atmospheric Conditions for Testing,* of Federal Test Method Standard 191A, *Textile Test Methods*, at a relative humidity of 65 percent ± 5 percent. Specimens shall be tested not more than five minutes after removal from conditioning.

5-2.3 Each specimen shall be 15 × 15 ± 0.5 in. (381 × 381 ± 13 mm) and shall be cut from the fabric lot to be utilized in the construction of the protective garment.

5-2.4 Specimen marking and measurements shall be conducted in accordance with the procedure specified in AATCC Test Method 135, 1, III, B, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

5-2.5 The forced circulating air oven shall achieve and maintain an air temperature of 500° + 10/-0°F (260° + 3/-0°C) for a period of not less than five minutes. Oven recovery time after door is closed shall not exceed one minute.

5-2.6 The specimen shall be suspended by two metal hooks near each top corner with a 12 ± 0.5 in. (305 ± 12.7 mm) separation between hooks. The entire specimen shall be exposed to the circulating air so that it is not less than 2 in. (50.8 mm) from any oven surface or other specimen, and airflow is parallel to the plane of the material.

5-2.7 Specimens, mounted as specified in 5-2.6 of this section, shall be placed in the circulating air oven for 5 + 0.15/-0 minutes. Specimen exposure time shall begin when oven has recovered to an air temperature of 500° + 10/-0°F (260° + 3/-0°C).

5-2.8 Results shall be reported as the average of all three specimens.

5-3* Heat, Char, and Ignition Resistance Test.

5-3.1 The fabric specimen to be tested shall be conditioned in accordance with Section 4, *Atmospheric Conditions for Testing,* of Federal Test Method Standard 191A, *Textile Test Methods*, at a relative humidity of 65 percent ± 5 percent. Specimens shall be tested not more than five minutes after removal from conditioning.

5-3.2 Specimen length shall be 6 in. (152.4 mm), except for textiles utilized in the garment in length less than 6 in. (152.4 mm), where length shall be the same as utilized in garment. Specimen width shall be 6 in. (152.4 mm), except for textiles utilized in garment in width less than 6 in. (152.4 mm), where width shall be the same utilized in garment. Specimen shall be suspended in oven utilizing metal clips.

5-3.2.1 Oven testing of seam seal materials shall be done on a specimen consisting of two 3 × 6 in. (76.2 × 152.4 mm) pieces of moisture barrier fabric utilized in garment, sewn together and with seam sealing material applied.

5-3.3 The forced circulating air oven shall achieve and maintain an air temperature of 500° + 10/-0°F (260° + 3/-0°C) for a period of not less than five minutes. Oven recovery time after door is closed shall not exceed one minute.

5-3.4 The fabric specimen shall be suspended by metal hook(s) at the top and centered in the oven so that the entire specimen is not less than 2 in. (50.8 mm) from any oven surface or other specimen, and airflow is parallel to the plane of the material.

5-3.5 Hardware and accessory material specimens shall be supported or freely suspended in the center of the oven so that they are not less than 2 in. (50.8 mm) from any

oven surface or other specimen and are exposed to the circulating air.

5-3.6 Specimens, mounted as specified in 5-3.4 of this section, shall be placed in the circulating air oven for 5 + 0.15/-0 minutes. Specimen exposure time shall begin when oven has recovered to an air temperature of 500° + 10/-0°F (260° + 3/-0°C).

5-3.7 Results shall be reported as pass or fail.

5-4 Tear Resistance Testing.

5-4.1 The specimen shall be a 3 × 6 in. (76.2 × 152.4 mm) rectangle. The long dimension shall be parallel to the warp for warp tests and parallel to the filling for filling tests. No two specimens for warp tests shall contain the same warp yarns, nor shall any two specimens for filling tests contain the same filling yarns. The specimen shall be taken no nearer the selvage than one-tenth of the width of the cloth. An isosceles trapezoid having an altitude of 3 in. (76.2 mm) and bases of 1 and 4 in. (25.4 and 101.6 mm) in length, respectively, shall be marked on each specimen, with the aid of a template. A cut ⅜ in. (9.5 mm) in length shall then be made in the center of a line perpendicular to the 1-in. (25.4-mm) edge.

5-4.2 Apparatus shall consist of a straining mechanism, two clamps for holding specimens, and load and elongation recording mechanisms, wherein the specimen is held between two clamps and strained by a uniform movement of the pulling clamp.

5-4.2.1 Straining mechanism shall be of such capacity that the maximum load required to break the specimen shall be not greater than 85 percent or less than 15 percent of the manufacturer's rated capacity.

5-4.2.2 Clamps shall be designed such that the six ounces (170 g) of weight are distributed evenly across the complete width of the sample. The clamps shall have two jaws on each clamp. The design of the clamps shall be such that one gripping surface or jaw may be an integral part of the rigid frame of the clamp or be fastened to allow a slight vertical movement, while the other gripping surface or jaw shall be completely moveable. The dimensions of the immovable jaw of each clamp parallel to the application of the load shall measure 1 in. (25.4 mm), and the dimension of the jaw perpendicular to this direction shall measure 3 in. (76.2 mm) or more. The face of the movable jaw of each clamp shall measure 1 in. × 3 in. (25.4 × 76.2 mm). Each jaw face shall have a flat, smooth gripping surface. All edges that might cause a cutting action shall be rounded to a radius of not more than 1/64 in. (0.4 mm). In cases where a cloth tends to slip when being tested, the jaws shall be faced with rubber or other material to prevent slippage. The distance between the jaws shall be 1 in. (25.4 mm) at the start of the test.

5-4.2.3 Recorder shall consist of calibrated dial, scale, or chart used to indicate applied load and elongation. Error shall not exceed 2 percent up to and including a 50-pound (22.7-kg) load and 1 percent over a 50-pound (22.7-kg) load at any reading within its loading range. All machine attachments for determining maximum loads shall be disengaged during test.

5-4.3 The specimen shall be clamped along the nonparallel sides of the trapezoid so that these sides lie along the lower edge of the upper clamp and the upper edge of the lower clamp with the cut halfway between the clamps. The short trapezoid base shall be held taut and the long trapezoid base shall lie in the folds. The strain mechanism shall be started and the force necessary to tear the cloth shall be observed by means of the recording device. Five specimens in each of the warp and filling directions shall be tested from each sample unit. If a specimen slips between the jaws, breaks in or at the edges of the jaws, or, if for any reason attributable to faulty technique, an individual measurement falls markedly below the average test results for the sample unit, such result shall be discarded and another specimen shall be tested.

5-4.4 The tear strength shall be the average of the five highest peak loads of resistance registered for inches of separation of the tear. The tear strength shall be reported to the nearest 0.1 lb (45.4 g).

5-5 Retroreflectivity Test.

5-5.1 Trim to meet visibility requirements of this standard shall be tested for retroreflectivity in accordance with ASTM E 809, *Standard Practice for Measuring Photometric Characteristics of Retroreflectors*, with a test distance of 50 ft (15.2 m), observation angle of 0.2 degrees, entrance angle of -4.0 degrees, and a photoreceptor angular aperture and source angular aperture of 0.1 degrees. Projector exit aperture shall be a circle with a diameter of 1 in. (25.4 mm). Retroreflector reference angle shall be 90 degrees. Datum mark shall be placed as specified by the trim manufacturer. The trim test sample shall consist of a 12 × 12 in. (305 × 305 mm) composite made up of multiple strips of trim.

5-5.2 Coefficient of luminous intensity (CIL) for trim shall be calculated by the following equation where coefficient of retroreflectivity (CPL) is measured in accordance with 5-5.1:

$$CIL = CPL \times (\text{Total area in sq ft of trim utilized on garment})$$

Chapter 6 Referenced Publications

6-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference shall be the current edition as of the date of the NFPA issuance of this document.

6-1.1* AATCC Publications.

Technical Manual of the American Association of Textile Chemists and Colorists, Volume 59, 1984.

AATCC 135, 1, III, B, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*, 1978.

AATCC Test Method 16E, *Colorfastness to Light: Water-Cooled Xenon-Arc Lamp, Continuous Light*, 1983.

6-1.2* ASTM Publications.

Annual Book of ASTM Standards, Volume 07.01 Textiles - Yarns, Fabric, General Test Methods, 1985.

Annual Book of ASTM Standards, Volume 07.02 Textiles - Fibers, Zippers, 1985.

Annual Book of ASTM Standards, Volume 02.05 Metallic and Onorganic Coatings; Metal Powders, Sintered P/M Structural Parts, 1984.

ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabric*, 1981.

ASTM E 809, *Standard Practice for Measuring Photometric Characteristics of Retroreflectors*, 1981.

ASTM B 117, *Salt Spray (Fog) Testing*, 1979.

ASTM D 4108, *Thermal Protective Performance of Materials for Clothing by Open-Flame Method*, 1982.

6-1.3* GSA Publications.

Federal Specification FED-V-F-106D, *Fasteners, Interlocking, Slide*, Jan. 15, 1976.

Federal Specification FF-R-556D, *Rivet, Solid, Small; Rivet, Split, Small; Rivet, Tubular, Small; Burr and Caps, Rivet; General Purpose*, July 17, 1981.

Federal Test Method Standard 191A, *Textile Test Methods*, July 20, 1978.

6-1.4* Navy Publications.

MS 27980D, *Fastener, Snap*, Sept. 24, 1981.

MIL-F-21840, *Fastener Tapes, Hook and Pile, Synthetic*, Sept. 30, 1981.

6-1.5 NFPA Publication.

NFPA 1975, *Standard on Station/Work Uniforms for Fire Fighters*, 1985 Edition.

Appendix A

This Appendix is not part of the requirements of this NFPA document, but is included for information purposes only.

A-1-1 Organizations responsible for specialized functions including wildland fire fighting, hazardous materials response, and crash fire/rescue should use protective clothing and equipment specifically designed for those activities.

A-1-2 This standard is not designed to be utilized as a purchase specification. It is prepared as far as practical in terms of required performance, avoiding restricting design of garments. Purchasers should specify departmental requirements for closures, pockets, trim patterns, etc. Tests specified in this standard should not be deemed as defining or establishing performance levels for protection from all structural fire fighting environments.

A-1-3 Approved. The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment, or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

A-1-3 Moisture Barrier. The term "Vapor Barrier" utilized in previous editions of NFPA 1971 has been changed to "Moisture Barrier" to represent more accurately the test methods, Federal Standard Test Method 191-5512 and Federal Standard Test Method 191-5516, specified in this standard. Purchasers wishing to specify additional requirements for vapor resistance should contact fabric suppliers for assistance with establishing specifications. Moisture barriers might not prevent the passage of chemical, biological, or radiological agents through the garment; such incidents should be handled with appropriate chemical protective clothing and procedures.

A-1-4.2 Purchaser should maintain protective clothing only in accordance with manufacturer's instructions. Maintainance should include regular inspection, proper repair, and retirement when appropriate. Protective clothing that is retired should be destroyed.

A-2-1 Purchasers of protective clothing should realize that fire fighters must wear many items of protective clothing and equipment. Any interference by one item of another's use might result in inefficient operations or unsafe situations. Chest girth, sleeve length, and coat length should be required for protective coats; waist girth, inseam length, and crotch rise should be required for protective trousers; chest girth, sleeve length, waist girth, outseam length from underarm to pant cuff, and trunk length from base of neck to crotch fold should be required for protective coveralls. Since manufacturer's patterns vary, to assure proper fit, measurement for sizing should be done by manufacturer's representative or by a trained person in accordance with manufacturer's instructions.

A-2-1.2 Purchasers might wish to specify additional reinforcement or padding in high-wear or load-bearing areas such as pockets, cuffs, knees, elbows, and shoulders. Padding could include additional thermal barrier material meeting requirements as specified herein. Reinforcing material could include outer shell material or leather. Purchasers are cautioned that additional weight caused by excessive reinforcement or padding could lead to fatigue or result in injury.

A-2-1.3 Fastener system should be specified by the purchaser. Fastener system methods can include (but are not limited to) stitching the thermal barrier and moisture barrier into the coat in the neck, or into the trouser in the waist area with snap or hook and pile fasteners securing

the remainder; entirely stitching the thermal barrier and moisture barrier to the outer shell; entirely securing the thermal barrier and moisture barrier to a component part of the outer shell with snap fasteners or fastener tape; or zipping the thermal barrier and vapor barrier to the outer shell.

A-2-1.5 Purchaser should consider water resistance testing of seam between coat body and collar in accordance with 2-1.3.

A-2-1.6 Purchasers should specify pockets large enough to carry tools and items normally carried. Placement should allow for access to the pockets while wearing SCBA. Specifying ballooned pockets will increase capacity, but could interfere with maneuverability. Ballooning only the back edges could minimize the maneuverability problem. Divided pockets could be desired, as well as pockets for specific items, such as SCBA facepieces and radios.

A-2-1.9.2 Protective clothing should be kept clean. Protective qualities will be reduced if fabric is contaminated with flammable materials such as soot or oil. For special cases involving hard to remove soil, the garment manufacturer should be contacted for special instructions. Decontamination may not be possible when protective clothing is contaminated with chemical, radiological, or biological agents, and garments should be discarded in accordance with appropriate disposal procedures.

A-2-2.1 A protective ensemble consisting of both protective coat and protective trousers should be utilized for structural fire fighting in order to assure better protection for the fire fighter's torso and limbs. An overlap of not less than 8 in. (203.2 mm) of coat and trousers should be specified to assure better protection.

A-2-2.3 Purchasers should consider specifying wristlets with a thumb hole or bartack creating a thumb hole for wearer's thumb in order to assure protection when arms are in raised position.

A-2-2.5 A possible configuration for trim on coats or coveralls, in addition to the minimum requirements specified herein, is two 25 in. (635 mm) vertical stripes on the coat back intersecting the circumferential stripe (forming a "U") and a 30 in. (762 mm) vertical stripe down the center front.

A-2-3.1 Protective ensemble consisting of both protective coat and protective trousers should be utilized for structural fire fighting in order to assure better protection for the fire fighter's torso and limbs. An overlap of not less than 8 in. (203.2 mm) of coat and trousers should be specified to assure adequate protection. Utilizing ¾ length boots instead of protective trousers will significantly reduce leg, groin, and buttock protection.

A-3-3.4 Purchasers specifing garments with coated outer shells should investigate the following additional test methods for establishing purchasing requirements;

Method 5970, *Adhesion of Coatings*

Method 5512, *Water Resistance*

Method 5516, *Seam Water Leakage*

Method 5306, *Taber Abrasion*

All Methods of Federal Test Method Standard.

A-3-3.5 Protective clothing should have a minimum lightness in color of not less than Munsell value 7 for CIE source "C" when tested in accordance with ASTM D 1535 or ASTM E 308 (this includes white, yellow, and yellow-green). Light colors assist visibility, serve to reduce thermal loading from sunlight, and are easier to inspect for contamination with flammable materials such as soot or oil. For radiant heat protection from fire, color has a relatively small effect, and wetting or soiling decrease such effect. Only specialized reflective fabric will offer distinct improvement in radiant heat protection and then only when used on the outside of the outer shell.

A-3-9.5.1 Purchasers should consider including in specifications requirements for hook and pile fastener service life for dry and wet operation and thermal stability including shrinkage, melt, char, and drip requirements when tested in accordance with 5-2.2 and 5-3 of the text of this standard.

A-5-1 The requirements in Section 5-1 are not intended to establish the limiting working environment for fire fighting but are for establishing material performance requirements. If winter liners are included in purchase specifications, they should not be included in the test composite when this test is performed.

A-5-2 The requirements in Section 5-2 and Section 5-3 are not intended to establish the limiting working environment for fire fighting but are for establishing material performance requirements.

A-5-3 See A-5-2.

A-6-1.1 AATCC publications can be obtained from American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709.

A-6-1.2 ASTM publications can be obtained from American Society for Testing Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103.

A-6-1.3 GSA publications can be obtained from General Services Administration, Specifications Activity; Printed Materials Supply Division; Building 197, Naval Weapons Plant, Washington, DC 20407. Single copies are generally available without charge at the General Services Administration Business Centers in cities throughout the U.S.

A-6-1.4 Navy publications can be obtained from Navy Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

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SUBMITTING PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

Contact NFPA Standards Administration for final date for receipt of proposals on a specific document.

INSTRUCTIONS

Please use the forms which follow for submitting proposed amendments. Use a separate form for each proposal.

1. For each document on which you are proposing amendment indicate:
   (a) The number and title of the document
   (b) The specific section or paragraph.

2. Check the box indicating whether or not this proposal recommends new text, revised text, or to delete text.

3. In the space identified as "Proposal" include the wording you propose as new or revised text, or indicate if you wish to delete text.

4. In the space titled "Statement of Problem and Substantiation for Proposal" state the problem which will be resolved by your recommendation and give the specific reason for your proposal including copies of tests, research papers, fire experience, etc. If a statement is more than 200 words in length, the technical committee is authorized to abstract it for the Technical Committee Report.

5. Check the box indicating whether or not this proposal is original material, and if it is not, indicate source.

6. If supplementary material (photographs, diagrams, reports, etc.) is included, you may be required to submit sufficient copies for all members and alternates of the technical committee.

NOTE: The NFPA Regulations Governing Committee Projects in Paragraph 10-10 state: Each proposal shall be submitted to the Council Secretary and shall include:

(a) identification of the submitter and his affiliation (Committee, organization, company) where appropriate, and

(b) identification of the document, paragraph of the document to which the proposal is directed, and

(c) a statement of the problem and substantiation for the proposal, and

(d) proposed text of proposal, including the wording to be added, revised (and how revised), or deleted.

FORM FOR PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

Mail to: Secretary, Standards Council
National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269

Date 5/18/85 Name John B. Smith Tel. No. 617-555-1212

Address 9 Seattle St., Seattle, WA 02255

Representing (Please indicate organization, company or self) Fire Marshals Assn. of North America

1. a) Document Title: Protective Signaling Systems NFPA No. & Year NFPA 72D

   b) Section/Paragraph: 2-7.1 (Exception)

2. Proposal recommends: (Check one) ☐ new text
   ☐ revised text
   ☐ deleted text.

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted):

   Delete exception.

4. Statement of Problem and Substantiation for Proposal:

   A properly installed and maintained system should be free of ground faults. The occurrence of one or more ground faults should be required to cause a "trouble" signal because it indicates a condition that could contribute to future malfunction of the system. Ground fault protection has been widely available on these systems for years and its cost is negligible. Requiring it on all systems will promote better installations, maintenance and reliability.

5. ☒ This Proposal is original material.
   ☐ This Proposal is not original material; its source (if known) is as follows: _____

(Note: Original material is considered to be the submitter's own idea based on or as a result of his own experience, thought, or research and, to the best of his knowledge, is not copied from another source.)

I agree to give NFPA all and full rights, including rights of copyright, in this Proposal and I understand that I acquire no rights in any publication of NFPA in which this Proposal in this or another similar or analogous form is used.

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