NFPA 1976
Standard on Protective Clothing for Proximity Fire Fighting

1992 Edition

National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

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Protective Clothing for Proximity Fire Fighting

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This edition of NFPA 1976, *Standard on Protective Clothing for Proximity Fire Fighting*, was prepared by the Technical Committee on Fire Service Protective Clothing and Equipment and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 18-21, 1992 in New Orleans, LA. It was issued by the Standards Council on July 17, 1992, with an effective date of August 14, 1992.

The 1992 edition of this document has been approved by the American National Standards Institute.

Origin and Development of NFPA 1976

This document is the first from the Technical Committee on Fire Service Protective Clothing and Equipment to address speciality protective clothing for fire fighting operations other than structural fire fighting.

It is intended to provide thermal protection from high levels of radiant heat as well as thermal protection from conductive and convective heat present during proximity fire fighting operations such as those involving bulk flammable liquids and bulk flammable gases and during aircraft rescue and fire fighting.

The Subcommittee on Proximity Protective Clothing began their work in 1987 and passed their work on to the Technical Committee in January, 1991. This first edition was presented to Association at the 1992 Annual Meeting in New Orleans, LA.

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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.

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

Information on referenced publications can be found in Chapter 6 and Appendix B.

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 provide limb/torso protection for fire fighters against adverse environmental effects encountered during proximity fire fighting operations.

1-1.2 This standard specifies criteria for protection from convective and conductive heat that is equivalent to such requirements in NFPA 1971, *Standard on Protective Clothing for Structural Fire Fighting*, and, in addition, specifies criteria for protection from high levels of radiant heat for limited exposures.

1-1.3* Proximity protective garments meeting the requirements of this standard are intended to provide equivalent levels of protection to those specified in NFPA 1971, *Standard on Protective Clothing for Structural Fire Fighting*, with the exception of trim requirements. Criteria for the use of proximity protective clothing in structural fire fighting applications are specified in NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program.*

1-1.4* This standard does not address specialized protective clothing for fire entry, hazardous materials emergencies, or wildland fire fighting and does not provide criteria for protection from chemical, biological, or radiological agents.

1-1.5* This standard is not intended to be utilized as a detailed manufacturing or purchase specification, but shall be permitted to be referenced in purchase specifications as minimum requirements.

1-2 Purpose.

1-2.1* The purpose of this standard is to provide minimum performance requirements for proximity protective clothing worn by fire fighters primarily responsible for aircraft rescue and fire fighting, bulk flammable liquids fire fighting, flammable gas fire fighting, and similar situations releasing high levels of radiant heat.

1-2.2 Controlled laboratory tests used to determine compliance with the performance requirements of this standard shall not be deemed as establishing performance levels for all situations to which fire fighting personnel may be exposed.

1-2.3 Nothing herein is intended to restrict any jurisdiction or manufacturer from exceeding these minimum requirements.

1-3 Definitions.

Aircraft Rescue and Fire Fighting. The fire fighting actions taken to rescue persons and to control or extinguish fire involving or adjacent to aircraft on the ground. Such rescue and fire fighting actions are performed both inside and outside of aircraft.

Approach Fire Fighting. Limited, specialized exterior fire fighting operations at incidents involving fires producing very high levels of conductive, convective, and radiant heat, such as bulk flammable gas and bulk flammable liquid fires. Specialized thermal protection from exposure to high levels of radiant heat is necessary for the persons involved in such operations due to the limited scope of these operations and the greater distance from the fire that these operations are conducted. Not entry, proximity, or structural fire fighting. (*See also Entry Fire fighting, Proximity Fire Fighting, and Structural Fire Fighting.*)

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

Authority Having Jurisdiction.* The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

Cargo Pockets. Pockets located on the proximity protective garment exterior.

Certification/Certified. A system whereby a certification organization determines that a manufacturer has demonstrated the ability to produce a product that complies with the requirements of this standard, authorizes the manufacturer to use a label on listed products that comply with the 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 compliance with the requirements of this standard.

Certification Organization. An independent, third party organization that determines product compliance with the requirements of this standard with a labeling/listing/follow-up program.

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.

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

Composite. The layer or layers that provide the protection required of the outer shell, moisture barrier, and thermal barrier.

Drip. To run or fall in drops or blobs.

Entry Fire Fighting. *Extraordinarily* specialized fire fighting operations that can include the activities of rescue, fire suppression, and property conservation at incidents involving fires producing very high levels of conductive, convective, and radiant heat; such as aircraft fires, bulk flammable gas fires, and bulk flammable liquid fires. Highly specialized thermal protection from exposure to extreme levels of conductive, convective, and radiant heat is necessary for persons involved in such extraordinarily specialized operations due to the scope of these operations and that *direct entry into flames is made*. Usually these operations are exterior operations. Not structural fire fighting. (*See also Approach Fire Fighting, Proximity Fire Fighting, and Structural Fire Fighting.*)

Follow-Up Program. The sampling, inspections, tests, or other measures conducted by the certification organization on a periodic basis to determine the continued compliance of products listed that are being produced by the manufacturer to the requirements of this standard.

Hardware. Non-fabric components of proximity protective clothing including those made of metal or plastic material.

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

Interface Area. An area of the body not protected by a proximity protective garment, helmet, gloves, footwear, or SCBA facepiece; the area where the proximity protective garments and the helmet, gloves, footwear, or SCBA facepiece meet, i.e., the proximity protective coat/helmet/SCBA facepiece area, the proximity protective coat/glove area, and the proximity protective trouser/footwear area.

Interface Component. Item(s) designed to provide limited protection to interface areas.

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Listed.* Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

Major A Seams. See Seams.

Major B Seams. See Seams.

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

Minor Seams. See Seams.

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

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

Product Label. A label or marking affixed to the proximity protective clothing garment by the manufacturer containing general information, warnings, care, maintenance, or similar data. This product label is not the certification organization's label, symbol, or identifying mark; however, the certification organization's label, symbol, or identifying mark may be attached to it or be part of it. (*See also Labeled.*)

Protective Wristlet. The interface component that provides limited protection to the proximity protective coat/glove interface area.

Proximity Fire Fighting. Specialized fire fighting operations that can include the activities of rescue, fire suppression, and property conservation at incidents involving fires producing very high levels of conductive, convective, and radiant heat; such as aircraft fires, bulk flammable gas fires, and bulk flammable liquid fires. Specialized thermal protection from exposure to high levels of radiant heat, as well as thermal protection from conductive and convective heat, is necessary for persons involved in such operations due to the scope of these operations and the close distance to the fire that these operations are conducted although direct entry into flame is NOT made. Usually these operations are exterior operations but might be combined with interior operations. Not structural fire fighting, but might be combined with structural fire fighting operations. Not entry fire fighting. (*See also Approach Fire Fighting, Entry Fire Fighting, and Structural Fire Fighting.*)

Proximity Head Protection. A radiant reflective protective item that includes, or is used in conjunction with, head impact protection and is designed to provide protection to the head, face, and neck areas against radiant, convective, and conductive heat.

Proximity Protective Clothing. Radiant reflective protective garments configured as a coat and trousers, or as a coverall, and interface components that are designed to provide protection for the fire fighter's body from conductive, convective, and radiant heat.

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

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

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

Proximity Protective Trouser. Proximity protective garment designed to provide protection for the lower torso and legs, excluding the feet.

Seams.

Major A Seams. Those outer shell seam assemblies where rupture could reduce the protection of the garment by exposing the moisture barrier, thermal barrier, the wearer's station/work uniform, other clothing, or skin.

Major B Seams. Those moisture barrier or thermal barrier seam assemblies were rupture could reduce the protection of the garment by exposing the next layer of the garment, the wearer's station/work uniform, other clothing, or skin.

Minor Seams. Those remaining seam assemblies that are not classified as Major A or Major B seams.

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 portion of the composite designed to provide thermal protection.

Trim. Retroreflective and fluorescent material permanently attached to the outer shell for visibility enhancement. Retroreflective materials enhance nighttime visibility, and fluorescent materials improve daytime visibility.

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

1-4 Units.

1-4.1 In this standard, values for measurement are followed by an equivalent in parentheses, but only the first stated value shall be regarded as the requirement. Equivalent values in parentheses shall not be considered as the requirement as these values might be approximate.

Chapter 2 Certification

2-1 General.

2-1.1 Proximity protective garments that are labeled as being compliant with this standard shall meet or exceed all applicable requirements specified in this standard and shall be certified.

2-1.2 All certification shall be performed by an approved certification organization.

2-1.3 Compliant proximity protective garments shall be labeled and listed. Such proximity protective garments shall also have a garment label that meets the requirements specified in Section 2-5 of this chapter.

2-2 Certification Program.

2-2.1* The certification organization shall not be owned or controlled by manufacturers or vendors of the product being certified. The certification organization shall be primarily engaged in certification work and shall not have a monetary interest in the product's ultimate profitability.

2-2.2 The certification organization shall refuse to certify products to this standard that do not comply with all requirements of this standard.

2-2.3* The contractual provisions between the certification organization and the manufacturer shall specify that certification is contingent on compliance with all applicable requirements of this standard. There shall be no conditional, temporary, or partial certifications. Manufacturers shall not be authorized to use any label or reference to the certification organization on products that are not manufactured in compliance with all applicable requirements of this standard.

2-2.4* For certification, laboratory facilities and equipment for conducting proper tests shall be available, a program for calibration of all instruments shall be in place and operating, and procedures shall be in use to ensure proper control of all testing. Good practice shall be followed regarding the use of laboratory manuals, form data sheets, documented calibration and calibration routines, performance verification, proficiency testing, and staff qualification and training programs.

2-2.5 Manufacturers shall be required to establish and maintain a program of production inspection and testing that meets the requirements of Section 2-4 of this chapter.

2-2.6 The manufacturers and the certification organization shall evaluate any changes affecting the form, fit, or function of the certified product to determine its continual certification to this standard.

2-2.7* Product certifications shall include a follow-up inspection program, with at least 2 random and unannounced visits per 12-month period.

2-2.8 The certification organization shall have a program for investigating field reports alleging malperformance or failure of listed products.

2-2.9 The operating procedures of the certification organization shall provide a mechanism for the manufacturer to appeal decisions. The procedures shall include the presentation of information from both sides of a controversy to a designated appeals panel.

2-2.10 The certification organization shall be in a position to use legal means to protect the integrity of its name and label. The name and label shall be registered and legally defended.

2-3 Inspection and Testing.

2-3.1 Sampling levels for testing and inspection shall be established by the certification organization and the manufacturer to assure a reasonable and acceptable reliability at a reasonable and acceptable confidence level that products certified as being compliant with the standard are compliant.

2-3.2 Inspection for determining compliance with the design requirements specified in Chapter 3 of this standard shall be performed on a completed garment.

2-3.3 Testing for determining material and component compliance with the requirements specified in Chapter 4 of this standard shall be performed on samples representative of materials and components used in the actual construction of the proximity protective clothing. The certification organization shall be permitted to also use sample material cut from a representative proximity protective clothing.

2-4 Manufacturer's Quality Assurance Program.

2-4.1 The manufacturer shall provide and maintain a quality assurance program that includes a documented inspection and product recall system. The manufacturer shall have an inspection system to substantiate conformance to this standard.

2-4.2 The manufacturer shall maintain written inspection and testing instructions. The instructions shall prescribe inspection and test of materials, work in process, and completed articles. Criteria for acceptance and rejection of materials, processes, and final product shall be part of the instructions.

2-4.3 The manufacturer shall maintain records of all pass/fail tests. Pass/fail records shall indicate the disposition of the failed material or product.

2-4.4 The manufacturer's inspection system shall provide for procedures that assure the latest applicable drawings, specifications, and instructions are used for fabrication, inspection, and testing.

2-4.5 The manufacturer shall, as part of the quality assurance program, maintain a calibration program of all instruments used to ensure proper control of testing. The calibration program shall be documented as to the date of calibration and performance verification.

2-4.6 The manufacturer shall maintain a system for identifying the appropriate inspection status of component materials, work in process, and finished goods.

2-4.7 The manufacturer shall establish and maintain a system for controlling nonconforming material, including procedures for the identification, segregation, and disposition of rejected material. All nonconforming materials or products shall be identified to prevent use, shipment, and intermingling with conforming materials or products.

2-4.8 The manufacturer's quality assurance program shall be audited by the third party certification agency to determine that the program is sufficient to ensure continued product compliance with this standard.

2-5 Product Labeling.

2-5.1* The outer shell and each separable layer of each proximity protective garment shall have a product label permanently and conspicuously attached to each layer upon which at least the following warning and information are printed in at least $^{1}/_{16}$ in. (1.5 mm) high letters. At least one product label shall be conspicuously located inside the garment in all possible configurations of garment utilization.

"THIS PROXIMITY PROTECTIVE GARMENT MEETS THE REQUIREMENTS OF NFPA 1976, *STANDARD ON PROTECTIVE CLOTHING FOR PROXIMITY FIRE FIGHTING*, 1992 EDITION.

WARNING

FOR PROXIMITY FIRE FIGHTING OPERATIONS, BOTH PROXIMITY PROTECTIVE COAT AND PROXIMITY PROTECTIVE TROUSERS MUST BE WORN FOR LIMB/TORSO PROTECTION. OUTER SHELL, MOISTURE BARRIER, AND THERMAL BARRIER MEETING ALL REQUIREMENTS OF NFPA 1976 MUST BE UTILIZED, AND ALL GARMENT CLOSURES MUST BE FASTENED WHEN IN USE. DO NOT USE PROXIMITY PROTECTIVE COAT AND PROXIMITY PROTECTIVE TROUSERS ALONE FOR PROXIMITY FIRE FIREFIGHTING OPERATIONS; OTHER PROTECTIVE EQUIPMENT — HEAD PROTECTION, SCBA, GLOVES, FOOTWEAR, PASS — IS REQUIRED FOR PROTECTION. DO NOT KEEP THIS GARMENT IN DIRECT CONTACT WITH FLAMES. THIS GARMENT ALONE MAY NOT PROVIDE PROTECTION FOR FIRE ENTRY APPLICATIONS OR FOR PROTECTION FROM CHEMICAL, BIOLOGICAL, OR RADIOLOGICAL AGENTS. KEEP THIS GARMENT CLEAN AS SOILING WILL REDUCE PROTECTIVE QUALITIES.

— DO NOT USE CHLORINE BLEACH —

CHLORINE BLEACH WILL SIGNIFICANTLY COMPROMISE THE PROTECTION AFFORDED BY THE TEXTILE MATERIALS UTILIZED IN THE CONSTRUCTION OF THIS GARMENT. USERS MUST CLEAN, MAINTAIN, AND ALTER ONLY IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. DO NOT STORE IN DIRECT SUNLIGHT. NO PROTECTIVE CLOTHING CAN PROVIDE COMPLETE PROTECTION FROM ALL CONDITIONS. USE EXTREME CARE FOR ALL EMERGENCY OPERATIONS. FAILURE TO COMPLY WITH THESE WARNINGS 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

Garment material(s)

"DO NOT REMOVE THIS LABEL"

2-5.2 All portions of the required label shall be printed at least in English.

2-5.3 All labels shall be clearly legible to the eye both before and after being subjected to the procedure specified in Section 5-1 of this standard. Labels not meeting specimen size requirements for the procedure listed above shall be sewn to a support fabric of required size.

2-6* User Information.

2-6.1 Proximity protective clothing manufacturers shall provide the following instructions and information with each garment:

(a) Cleaning instructions,

(b) Maintenance criteria,

(c) Methods of repair,

(d) Warranty information,

(e) Retirement considerations.

2-6.2 Proximity protective clothing manufacturers shall furnish training materials that address, but are not limited to:

(a) Safety considerations,

(b) Storage conditions,

(c) Decontamination procedure.

Chapter 3 Design Requirements

3-1* Proximity Protective Garment Requirements.

3-1.1* A sample garment shall have at least the applicable design requirements specified in this chapter when inspected as specified in Chapter 2 of this standard.

3-1.2* Proximity protective garments shall consist of a composite of an outer shell, moisture barrier, and thermal barrier. This composite shall be permitted to be configured as a single layer or multiple layers.

3-1.3* Proximity protective garments shall NOT have non-radiant reflective material, including but not limited to trim, lettering, patches, name or number stencils, emblems, paint, or other marking mediums affixed to the outer shell reflective surfaces. In addition, proximity protective garments shall NOT have non-radiant reflective leather or other reinforcements affixed to the outer shell reflective surfaces other than when used as reinforcement of the sleeve and trouser leg cuffs only. Such reinforcements shall not exceed more than 1 in. (25 mm) over the reflective outer surface from the end of the cuff.

3-1.4* Proximity protective garments shall have a means of securing the moisture barrier and thermal barrier to the outer shell.

3-1.5 Proximity protective garments, including the front closure, shall be constructed in a manner that provides secure and complete moisture and thermal protection. If non-positive fasteners such as snaps or hook and pile tapes are utilized in the garment closure, a positive locking fastener, such as hooks and dees or a zipper, shall be utilized.

3-1.6 Snaps shall meet the requirements of MS 27980E, *Fastener, Snap.*

3-1.7* Fastener tape shall meet the requirements of MIL-F-21840G *Fastener Tapes, Hook and Pile, Synthetic,* excluding Class 2.

3-1.8 Zippers shall meet minimum requirements of FED-V-F-106F *Fasteners, Slide, Interlocking.* The minimum crosswise breaking strength of the zipper shall be size M of FED-V-F-106F.

3-1.9 Hooks and dees shall be nonferrous and shall conform to the design of Figure 3-1.9.

3-1.10* Moisture barriers and thermal barriers shall extend to within 3 in. (76.2 mm) of the outer shell at the cuffs and hems of proximity 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, as a minimum, to the waistline.

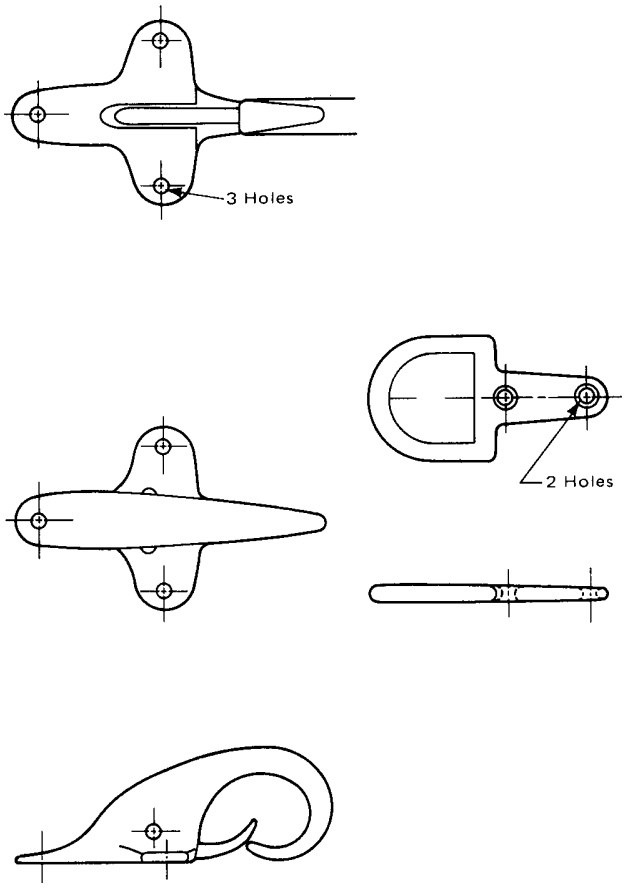


Figure 3-1.9 Hook and dee ring (inward facing) not to scale.

3-1.11* 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.

3-2 Additional Requirements for Proximity Protective Coats.

3-2.1* Proximity protective coats shall provide protection as specified to the upper torso, neck, arms, and wrists, excluding the hands and head.

3-2.2 Proximity 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.

3-2.3* Each proximity protective coat sleeve shall have a protective wristlet meeting requirements as specified in Section 6-2 of NFPA 1971, *Standard on Protective Clothing for Structural Fire Fighting*.

3-2.4 Proximity 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. The collar lining material shall not be reflective material. Collar and closure system shall consist of an outer shell, moisture barrier, and thermal barrier that meet all performance requirements as specified in Chapter 4 of this standard.

3-3 Additional Requirements for Proximity Protective Trousers.

3-3.1* Proximity protective trousers shall provide protection as specified to the lower torso and legs, excluding the ankles and feet.

3-3.2 Proximity 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 or above the waistline or hardware is completely covered by external closure flaps.

3-4 Additional Requirements for Proximity Protective Coverall.

3-4.1 That portion of the proximity protective coverall that corresponds to the proximity protective coat shall meet all requirements of Section 3-2 of this chapter.

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

Chapter 4 Performance Requirements

4-1 Proximity Protective Garment Requirements.

4-1.1 The proximity protective garment fabric composite consisting of outer shell, moisture barrier, and thermal barrier shall have an average thermal protective performance (TPP) of not less then 35 when tested as specified in Section 5-2 of this standard.

4-1.2 All seam assemblies shall be tested for breaking strength and shall demonstrate a sewn seam strength equal to or greater than 150 lb (675 N) force for Major A seams, 75 lb (337.5 N) for Major B seams, and 40 lb (180 N) force for minor seams when tested as specified in Section 5-9 of this standard.

4-1.2.1 Seam breaking strength shall be considered acceptable when the fabric strength is less than the required seam strength specified in 4-1.2, provided the fabric fails without failure of the seam below the applicable forces specified in 4-1.2.

4-2 Textiles.

4-2.1 Outer shell, moisture barrier, thermal barrier, collar linings, and winter liner fabric shall be individually tested for flame resistance, shall have an average char length of not more than 4.0 in. (101.6 mm) and an average afterflame of not more than 2.0 seconds, and shall not melt or drip when tested as specified in Section 5-10 of this standard.

4-2.2 Outer shell moisture barrier, thermal barrier, collar linings, and winter liner fabric shall be individually tested for thermal shrinkage resistance and shall not shrink more than 10.0 percent in any direction when tested as specified in Section 5-4 of this standard.

4-2.3 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, garment labels, interfacing, binding, hanger loops, and emblems, but excluding 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 5-5 of this standard.

4-2.3.1 Moisture barrier seam seal materials shall be tested for heat resistance and shall not drip or ignite when tested as specified in Section 5-5 of this standard.

4-2.4 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 when tested as specified in Section 5-11 of this standard.

4-3 Outer Shell Requirements.

4-3.1 The outer shell shall have a 100 percent radiant reflective minimum value of 20 when tested as specified in Section 5-3 of this standard.

4-3.2 Outer shell and collar lining fabrics shall be tested for tear resistance and shall have a tear strength of not less than 22 lb (99 N) when tested as specified in Section 5-6 of this standard.

4-3.3 Outer shell and collar lining fabric shall be tested for char resistance and shall not char when tested as specified in Section 5-5 of this standard.

4-3.4 Outer shell and collar lining fabrics shall be tested for water absorption resistance and shall have no more then 30 percent water absorption when tested as specified in Section 5-12 of this standard.

4-3.5 The outer shell shall show no signs of cracking on the face or delamination if the base fabric is a laminate when tested for wet flex as specified in Section 5-7 of this standard.

4-3.6 The outer shell shall show no evidence of separation of the coating or laminate from the base cloth when tested for adhesion after wet flex as specified in Section 5-8 of this standard.

4-3.7 The outer shell shall show no evidence of breaking, shattering, or cracking of the coating, laminate, or fabric when tested for flex at low temperature as specified in Section 5-13 of this standard.

4-3.8 The outer shell shall show no blocking, with a blocking rating of 1, when tested for resistance to high temperature blocking as specified in Section 5-14 of this standard.

4-4 Moisture Barrier Requirements.

4-4.1 Moisture barrier shall be tested for tear resistance and shall have a tear strength of not less than 5.0 lb (22.5 N) when tested as specified in Section 5-6 of this standard.

4-4.2 The moisture barrier fabric shall be tested for water penetration resistance and shall have a minimum water penetration resistance of 25 psi (1.76 kg/cm^2) when tested as specified in 5-15.2 of this standard and 1 psi (0.07 kg/cm^2) when tested as specified in 5-15.4 of this standard. Appearance of water drops shall constitute failure.

4-4.3 Moisture barrier seams shall be tested for water penetration resistance and shall have a minimum water penetration resistance of not less then 1 psi (0.07 kg/cm^2) when tested as specified in 5-15.4 of this standard.

4-5 Thermal Barrier Requirements.

4-5.1 Thermal barrier shall be tested for tear resistance and shall have a tear strength of not less than 5.0 lb (22.5 N) when tested as specified in Section 5-6 of this standard.

4-6 Winter Liner Requirements.

4-6.1 Where provided, the winter liner shall be tested for tear strength resistance and shall have a tear strength of not less than 5.0 lb (22.5 N) when tested as specified in Section 5-6 of this standard.

4-7 Thread Requirements.

4-7.1 All thread utilized in the construction of the garments shall be tested for heat resistance and shall not ignite, melt, or char when tested as specified in Section 5-16 of this standard.

4-8 Hardware Requirements.

4-8.1 All hardware finish shall be free of rough spots, burrs, or sharp edges.

4-8.2 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 5-17 of this standard. Metals inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, shall show no more than light surface corrosion or oxidation. Ferrous metals shall show no corrosion of the base metal.

4-8.3 All hardware shall be tested for heat resistance and shall not ignite and shall remain functional when tested as specified in Section 5-5 of this standard.

Chapter 5* Test Methods

5-1 Washing and Drying Procedure.

5-1.1 Specimens shall be subjected to 5 cycles of washing and drying in accordance with the procedure specified in Machine Cycle 1, Wash Temperature V, Drying Procedure Ai, of AATCC 135, *Dimensional Change in Automatic Home Laundering of Woven and Knit Fabrics*. A laundry bag shall not be used.

5-2* Thermal Protective Performance Test.

5-2.1 Specimens shall be tested both before and after being subjected to the procedure specified in Section 5-1 of this chapter.

5-2.2 All specimens to be tested shall be preconditioned by placement in a circulating air oven for not less then 4 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. Specimens shall be tested not more than 5 minutes after removal from conditioning.

5-2.3 Thermal protective performance (TPP) testing shall be performed in accordance with ASTM D 4108, *Standard Method for Thermal Protective Performance of Materials for Clothing by Open-Flame Method*, with the following modifications:

5-2.3.1 Specimens shall consist of proximity protective clothing composites measuring 6 × 6 in. ± $^1/_{16}$ in. (152.4 × 152.4 mm ± 1.6 mm) consisting of outer shell, moisture barrier, and thermal barrier. Collar lining fabric shall be permitted to be included in the proximity protective garment collar fabric composite specimen. Winter liners shall not be included in the test composite.

5-2.3.2 Apparatus shall consist of specimen holder assembly, specimen holder assembly support, thermal flux source, protective shutter, sensor assembly, and recorder.

5-2.3.3 Specimen holder assembly shall consist of upper and lower mounting plates. Specimen holder mounting plates shall be 8 × 8 in. ± $^1/_{16}$ in. × $^1/_4$ in. ± $^1/_{32}$ in. (203.2 × 203.2 mm ± 1.6 mm × 6.4 mm ± 0.8 mm). The lower specimen mounting plate shall have centered a 4 × 4 in. ± $^1/_{16}$ in. (101.6 × 101.6 mm ± 1.6 mm) hole. The upper specimen mounting plate shall have centered a 5$^1/_8$ × 5$^1/_8$ in. ± $^1/_{16}$ in. (130.2 × 130.2 mm ± 1.6 mm) hole. The lower specimen mounting plate shall have a 1 in. ± $^1/_{16}$ in. high × $^1/_8$ in. ± $^1/_{32}$ in. (25.4 mm ± 1.6 mm × 3.2 mm ± 0.8 mm) thick steel post welded to each corner $^1/_4$ in. ± $^1/_{16}$ in. (6.4 mm ± 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.

5-2.3.4 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 g ± 10 g (2.2 lb ±0.022 lb).

5-2.3.5 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 Meeker 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.

5-2.3.6 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.

5-2.3.7 Specimens shall be exposed to a thermal flux of 2.0 cal/cm^2/sec ± 0.1 cal/cm^2/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/cm^2/sec 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/cm^2/sec as measured using a calibrated commercial radiometer.

5-2.3.8 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.

5-2.3.9 If the individual test results vary more than ±8 percent from the average result, the result shall be discarded and another set of specimens shall be tested.

5-2.3.10 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.

5-3* Radiant Reflective Test.

5-3.1 All samples shall be preconditioned 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. All samples shall be conditioned by means of abrading the sample before removing it from the conditioned atmosphere. Samples shall be tested for radiant heat not more than five minutes after removal from conditioning.

5-3.2 The outer shell material test samples shall be 3 × 10 in. (7.6 × 25.4 cm) with the long dimension in the warp or wale direction.

5-3.3 All samples shall be conditioned on an oscillating drum abrasion apparatus as specified in Method 5304, Abrasion Resistance of Cloth; Oscillatory Method (Wyzenbeek) Method, of Federal Test Method Standard 191A, *Textile Test Methods*. The samples shall be mounted on the oscillating drum of the apparatus. The abradant shall be No. 6 hard textured cotton duck conforming to Type I of Federal Specification CCC-C-419, *Cloth, Duck, Unbleached, Plied-Yarns, Army and Numbered*, and shall be cut into strips $1^7/_8$ in. (4.7 cm) wide by 9 in. (22.9 cm) long with the long dimension in the warp or wale direction. The abradant shall be mounted in the specimen holding clamps under a tension of 3 lb (13.5 N) and a head load of 3 lb (1.36 kg). A new abradant shall be used for each test, and the contact area of the abradant shall be free of slubs, knots, or other weave imperfections. The test samples shall be subjected to 300 abrasion cycles.

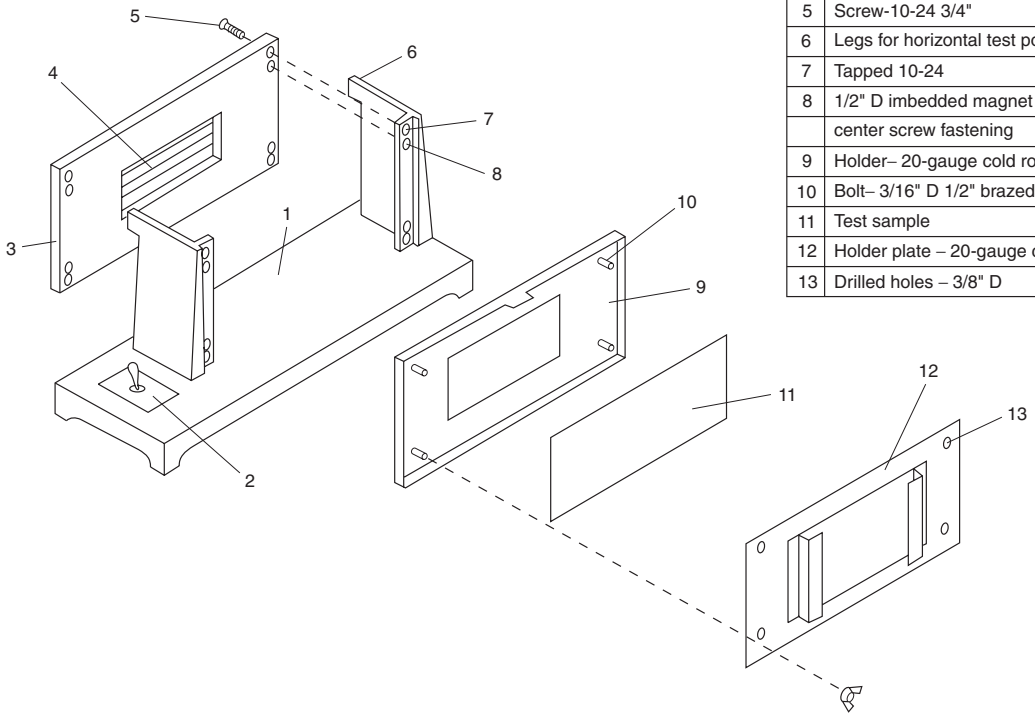
5-3.4* Apparatus shall consist of a vertically oriented radiant heat source, specimen holder assembly, protective shutter, sensor assembly, and recorder. The sensor block shall consist of a $5^1/_4 \times 5^1/_4 \times {}^1/_2$ in. (133.3 × 133.3 × 12.8 mm) heat resistant material that fits without binding into the bracket or rear plate. The sensor shall be in accordance with paragraph 6.5, the recorder shall be in accordance with paragraph 6.6, and the chart overlay shall be in accordance with all paragraphs of ASTM D 4108, *Standard Method for Thermal Protective Performance of Materials for Clothing by Open-Flame Method*.

5-3.5 The radiant apparatus, as shown in Figure 5-3.5, shall consist of a bank of five 500-watt, infrared, tubular, translucent quartz lamps having a 5 in. (12.7 cm) lighted length and a mean overall length of $8\ ^{13}/_{16}$ in. (22.4 cm). The lamps shall be mounted so that the lamp's surfaces are approximately 0.015 in. (0.381 mm) apart. The bank or array shall be mounted and centered behind a $2^1/_4 \times 5^1/_2$ in. (5.7 × 14.0 cm) cutout on $^1/_2$ in. (1.3 cm) transite board. A specimen holder and holder plate with a $2^1/_2$ by 5 in. (6.5 by 12.7 cm) center cut out shall be positioned so that the distance from the nearest lamp surface to the test specimen is exactly 1.0 in. (2.5 cm). The holder plate shall include a bracket to hold the copper calorimeter sensor assembly that will cover the complete cutout section. The quartz lamp shall be heated electrically and the power input controlled by means of a variac having a capacity of at least 25 amperes.

5-3.6* A protective shutter shall be placed between the radiant source and the specimen. The protective shutter shall be capable of completely reflecting radiant load for the time period before specimen exposure.

5-3.7 The sensor face shall be wiped immediately after each run, while hot, to remove any decomposition products that condense and could be a source of error. If a deposit collects and appears to be thicker than a thin layer of paint, or is irregular, the sensor surface shall be reconditioned. The cooled sensor shall be carefully cleaned with cleaning solution, making certain there is no ignition source nearby. If bare copper is showing, the surface shall be repainted with a thin layer of flat black spray paint. At least one calibration run shall be conducted before using the repainted sensor in a test run. The sensor shall be recalibrated after every sample run of five specimens. The sensor shall always approximate body temperature by contact with the hand prior to placing on the apparatus.

5-3.8 Specimens shall be exposed to a thermal flux of 2.0 cal/cm^2 ± 0.1 cal/cm^2 as measured with copper calorimeter. The copper calorimeter shall be the only heat sensor used in setting the 2.0 cal/cm^2/sec exposure condition. The total heat flux shall be calculated directly from the temperature response of the copper 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/cm^2/sec exposure shall be determined directly and only from the voltage output of the thermocouple, 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.



1	Cast aluminum apparatus body
2	Toggle switch-DPST
3	Transite-smooth surfaces
4	5 quartz lamps-500T3 115-125V
5	Screw-10-24 3/4"
6	Legs for horizontal test position
7	Tapped 10-24
8	1/2" D imbedded magnet
	center screw fastening
9	Holder– 20-gauge cold rolled steel
10	Bolt– 3/16" D 1/2" brazed flush
11	Test sample
12	Holder plate – 20-gauge cold rolled steel
13	Drilled holes – 3/8" D

Figure 5-3.5 Radiant apparatus.

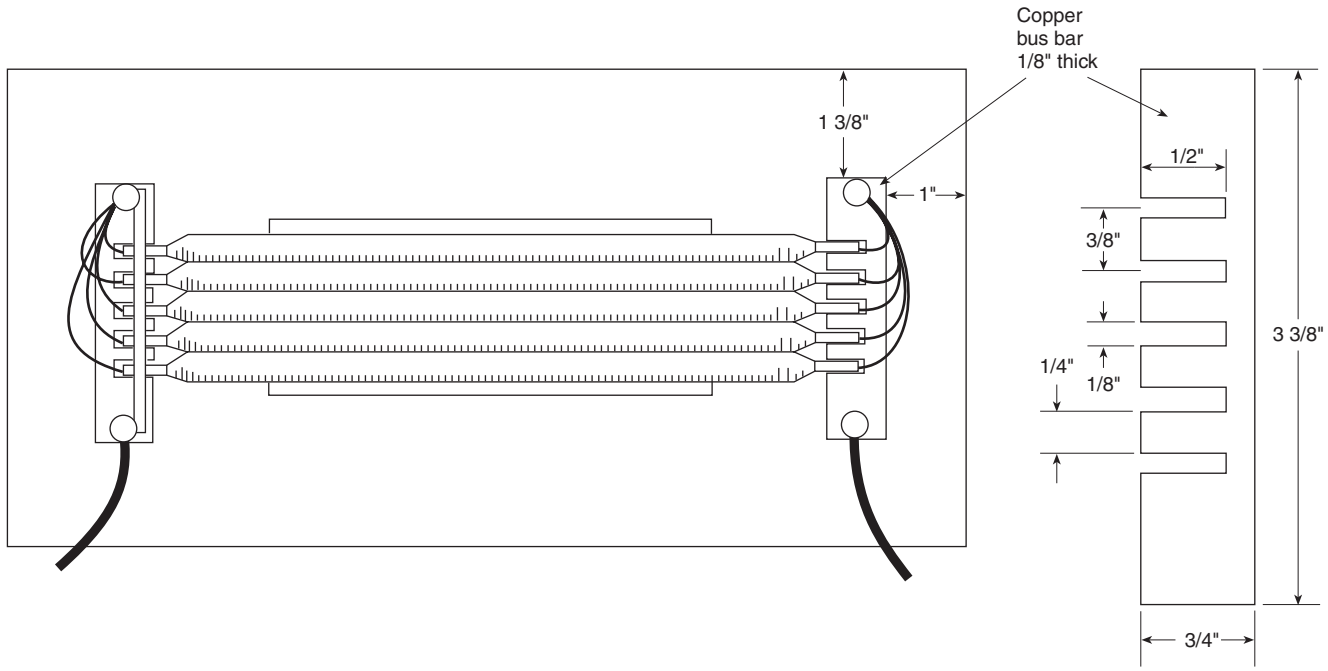


Figure 5-3.5 (continued) Detail 1 Position of quartz lamps on transite.

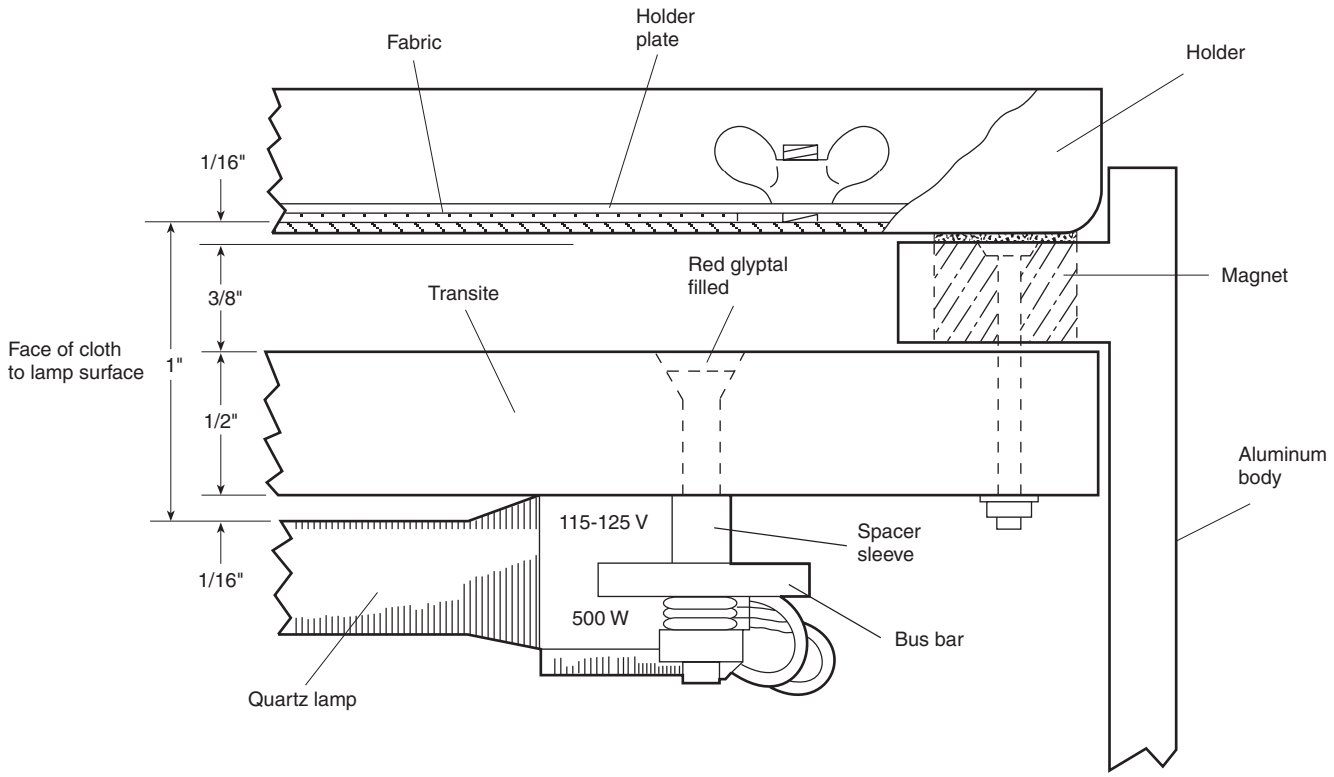


Figure 5-3.5 (continued) Detail 2 Sample position top view enlargement.

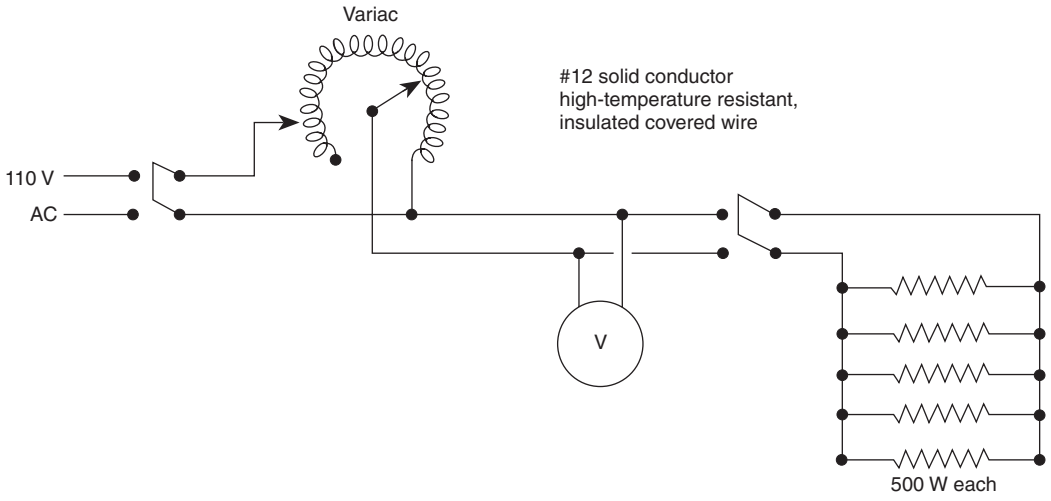


Figure 5-3.5 (continued) Detail 3 Schematic of electrical circuit.

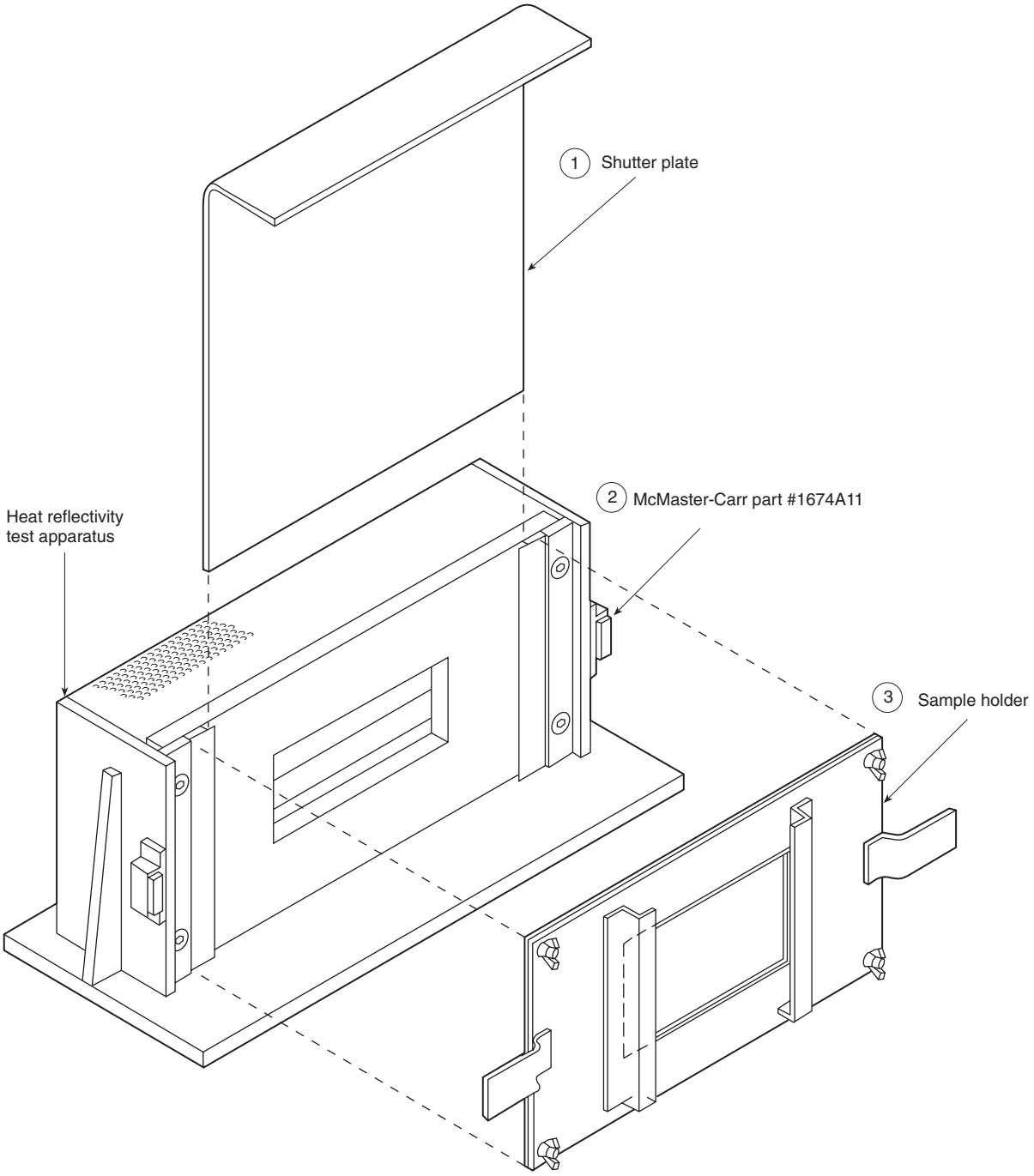


Figure 5-3.5 (continued) Detail 4.

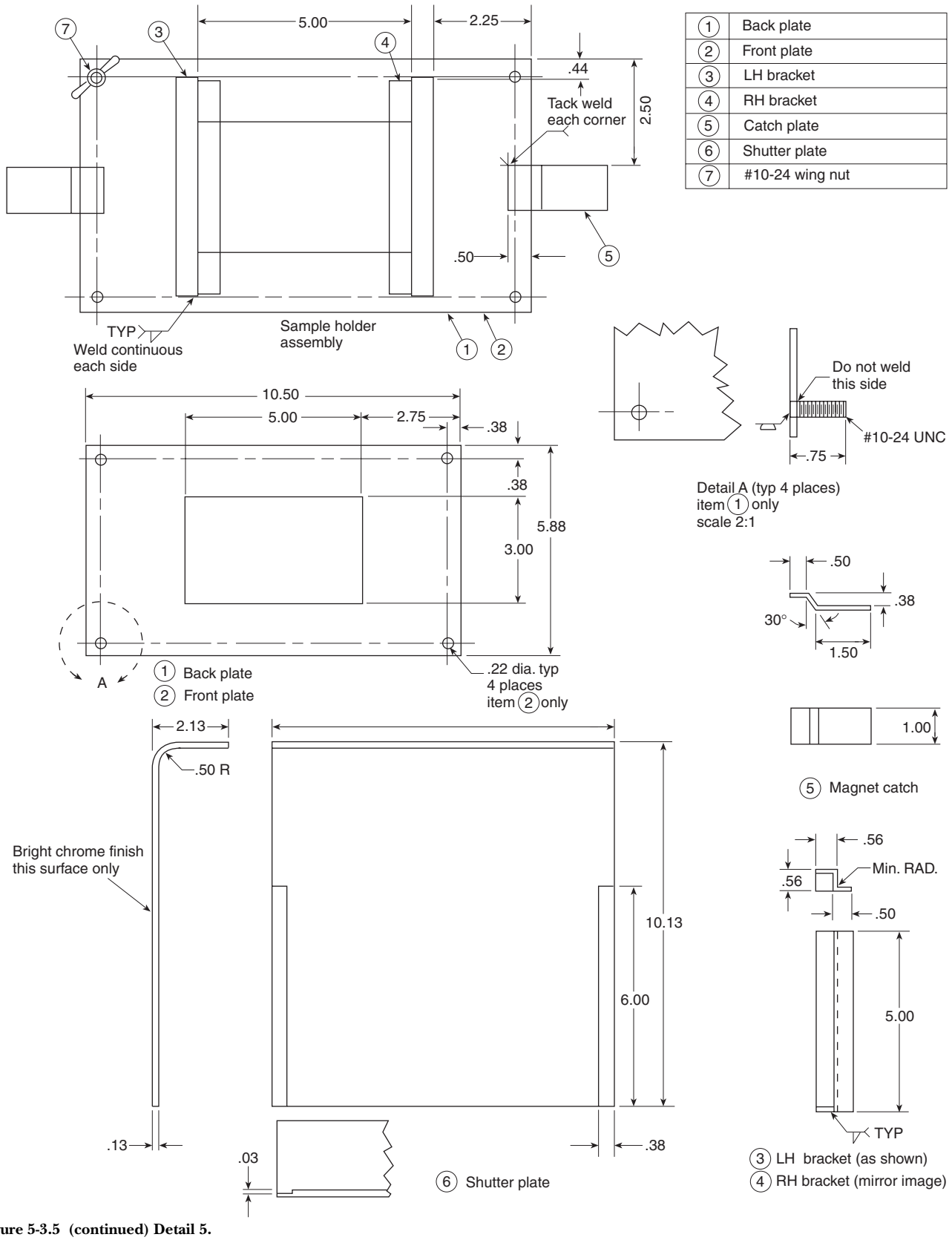


Figure 5-3.5 (continued) Detail 5.

5-3.9 The abraded specimens shall then be placed in the specimen holder so that the abraded area will be centered in the opening of the specimen holder. The sensing device shall be placed in contact with the back of the specimen holder and then both shall be placed in front of the heat source so that the distance from the specimen to the nearest edge of the lamp surface is exactly 1 in. (2.54 cm). A hand- or mechanical-operated shutter device shall be placed between the specimen holder containing the test specimen and the lamps to completely block the heat from reaching the specimen when lamps are first turned on. The lamps shall be turned on for a 60 second warm-up period. With the lamps still turned on, the shutter shall be removed from the front of the test specimen and the recorder started. The specimen shall be exposed to the heat for 25 seconds and then the current shall be turned off.

5-3.10* The radiant reflective value shall be graphically determined from the recorder chart of the sensor response and the overlay prepared in 5-3.4 of this section. The overlay shall be positioned on the recorder chart, matching the zero of the overlay with the start of the exposure. The horizontal axis shall be placed in line with the initial trace of the pen. While keeping the overlay square with the recorder chart, the time in seconds shall be read from the overlay chart where the sensor response curve and the overlay curve intersect. The time in seconds shall be called the radiant reflective value for the test specimen.

5-3.11 Five specimens shall be run, and the radiant reflective value determined. The average value of the five specimens shall be calculated and reported to determine pass/fail.

5-4* Thermal Shrinkage Resistance Test.

5-4.1 Thermal shrinkage resistance testing shall be conducted on three specimens of each fabric, and each fabric shall be tested separately.

5-4.2 Specimens shall be tested both before and after being subjected to the procedure specified in Section 5-1 of this chapter.

5-4.3 Specimens to be tested shall be preconditioned 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.

5-4.4 Each specimen shall be 15 × 15 in. ± 0.5 in. (381 × 381 mm ±13 mm) and shall be cut from the fabric lot to be utilized in the construction of the garment.

5-4.5 Specimen marking and measurements shall be conducted in accordance with the procedure specified in AATCC Test Method 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

5-4.6 The forced circulating air oven shall achieve and maintain an air temperature of 500°F +10°/–0°F (260°C +3°/–0°C) for a period of not less than five minutes. Oven recovery time after door is closed shall not exceed one minute.

5-4.7 The specimen shall be suspended by two metal hooks near each top corner with a 12 in. ± 0.5 in. (305 mm ± 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 air flow is parallel to the plane of the material.

5-4.8 Specimens mounted as specified in 5-4.7 of this section shall be placed in the circulating air oven for 5 minutes +0.15/–0 minutes. Specimen exposure time shall begin when oven has recovered to an air temperature of 500°F +10°/–0°F (260°C +3°/–0°C).

5-4.9 After removal from the oven, knit fabric shall be pulled to original dimensions and shall be allowed in relax for one (1) minute prior to measurement to determine pass/fail.

5-4.10 Results shall be reported as the average of all three specimens.

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

5-5.1 Fabric specimens shall be tested both before and after being subjected to the procedure specified in Section 5-1 of this chapter.

5-5.2 The fabric specimen to be tested shall be preconditioned 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.

5-5.3 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 the garment in widths less then 6 in. (152.4 mm), where width shall be the same as utilized in garment. Specimen shall be suspended in oven utilizing metal clips.

5-5.3.1 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.

5-5.4 The forced circulating air oven shall achieve and maintain an air temperature of 500°F +10°/–0°F (260°C +3°/–0°C) for a period of not less than five minutes. Oven recovery time after door is closed shall not exceed one minute.

5-5.5 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 air flow is parallel to the plane of the material.

5-5.6 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.

5-5.7 Specimens, mounted as specified in 5-5.5 of this section, shall be placed in the circulating air oven for 5 minutes +0.15/–0 minutes. Specimen exposure time shall begin when oven has recovered to an air temperature of 500°F +10°/–0°F (260°C +3°/–0°C).

5-5.8 Results shall be reported as pass or fail.

5-6 Tear Resistance Testing.

5-6.1 The specimen shall be a 3 × 6 in. (76.2 × 152.4 mm) rectangle. The long dimension shall be parallel to the warp or wale for warp and parallel to the filling or corse for the filling tests. No two specimens for warp or wale tests shall contain the same warp yarns, nor shall any two specimens for filling or corse 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 $^3/_8$ 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.

5-6.2 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. The test machine shall be operated at a rate of 12 in./min (304.8 mm/min).

5-6.2.1 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.

5-6.2.2 Clamps shall be designed such that the 6 oz (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 movable. 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 1×3 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.

5-6.2.3 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-lb (22.7-kg) load at any reading within its loading range. All machine attachments for determining maximum loads shall be disengaged during test.

5-6.3 The specimen shall be clamped along the non-parallel 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/wale and filling/corse 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.

5-6.4 The tear strength shall be the average of the five highest peak loads of resistance registered. The tear strength shall be reported to the nearest 0.1 lb (45.4 g).

5-7 Wet Flex.

5-7.1 All samples shall be preconditioned 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.

5-7.2 Test specimens shall be 4 in. (10.2 cm) wide by 8 in. (20.3 cm) long dimension parallel to the warp or wale direction and shall be from the fabric lot utilized in the construction of the proximity protective garment. Five (5) specimens from each sample unit shall be tested with no two specimens containing the same yarns.

5-7.3 The test specimen shall be immersed in water at 140°F ±5°F (60°C ± 2.8°C) for 15 minutes. Upon removal from the water it shall be placed on 2 layers of absorbent type blotters and covered by 2 additional layers. After placing the wet specimens between the blotters a 10 lb (4.5 kg) weight, a steel rod 3 in. (7.6 cm) in diameter and 5 in. (12.7 cm) long, shall be rolled over the test specimen for 4 complete cycles, 8 passes. The specimen shall be removed from between the blotters and placed in the flexing device as shown in Figure 5-7.3. The blotting paper shall conform to requirements detailed in Method 5500, Water Resistance of Cloth; Dynamic Absorption Method, of Federal Test Method Standard 191A, *Textile Test Methods*.

5-7.4 The flexing device as shown in the Figure 5-7.3 shall be used. This device shall have a suitable weight on the weight arm to produce a 3 to 3.5 lb (13.5 N to 15.75 N) tension on the specimen during flexing. The tensioning jaw or clamp shall be so located that, with tension jaw arm vertical, any point on the tensioning jaw would be the apex of a cone of motion generated between that point and the corresponding point of the moving jaw. The crank arms shall be equal in effective length and in angular phase so that the moving jaw connecting the two arms remains parallel to the tension jaw throughout a complete revolution of the arms. The specimen shall be placed in the device with the moving jaw at bottom dead center, the tension jaw arm vertical, and the face of the cloth down. Each jaw shall clamp the specimen across the entire width. The crank handle shall be turned at a rate of 50 revolutions ± 10 revolutions per minute of the crank arms and moving jaw during the test. A tray or board, flat black in color and sufficiently large to catch any particles that are removed from the fabric, shall be cleaned before each test and examined for material particles after each test. A motor-driven apparatus shall be permitted to be used in lieu of the manual device specified.

5-7.5 The specimens shall be taken directly from the blotter paper and laced in the flexing device with the warp or wale direction perpendicular to the jaw line. The distance between jaw lines shall be 5.25 in. (13.3 cm). The specimen shall be flexed for 1000 cycles and then removed from the apparatus and shall be visually inspected to determine pass/fail.

5-7.6 Any cracking or delamination closer than $^7/_8$ in. (22.4 mm) from either jaw line shall not be considered. Failure of any one specimen shall constitute failure of sample unit of product.

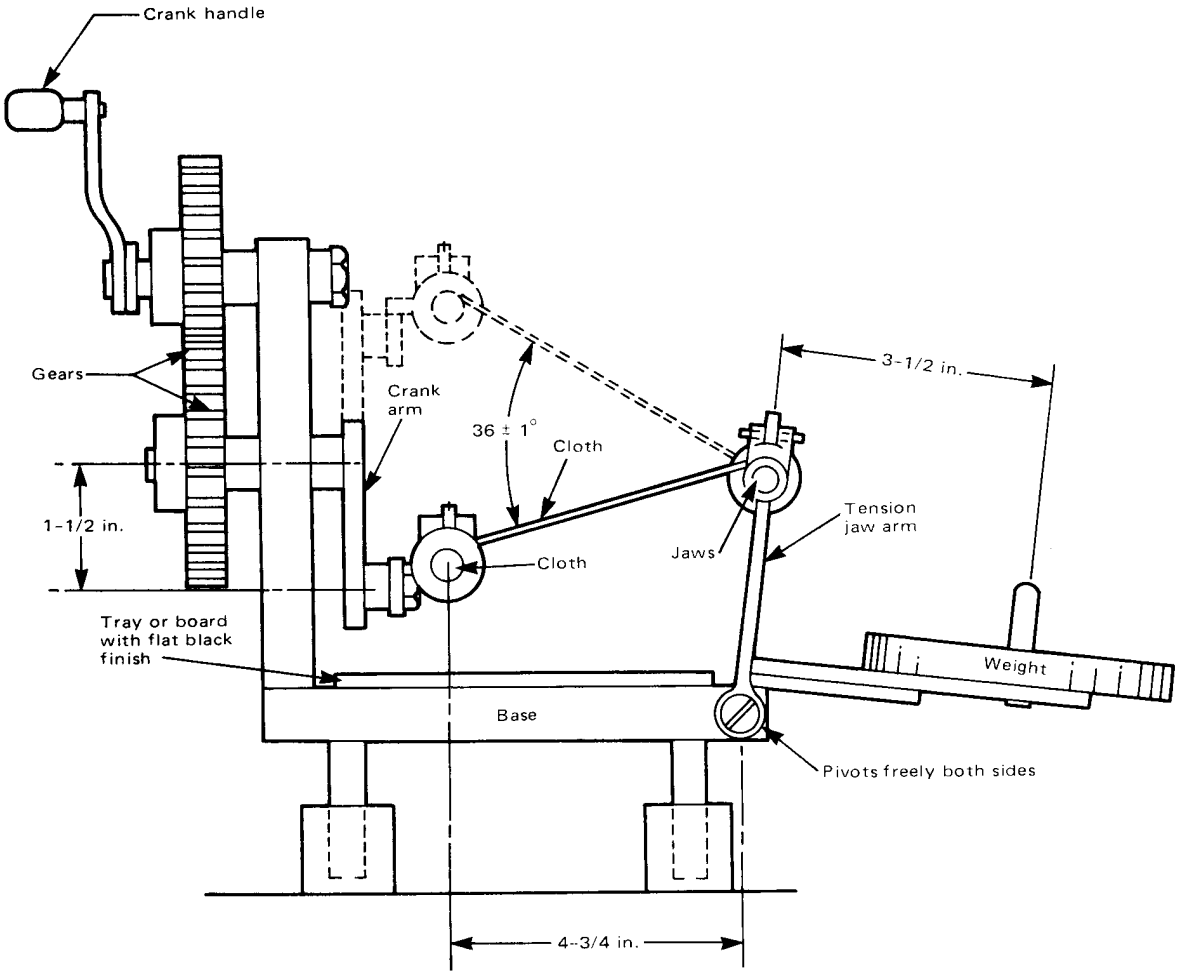


Figure 5-7.3(a) Flexing device — end view.

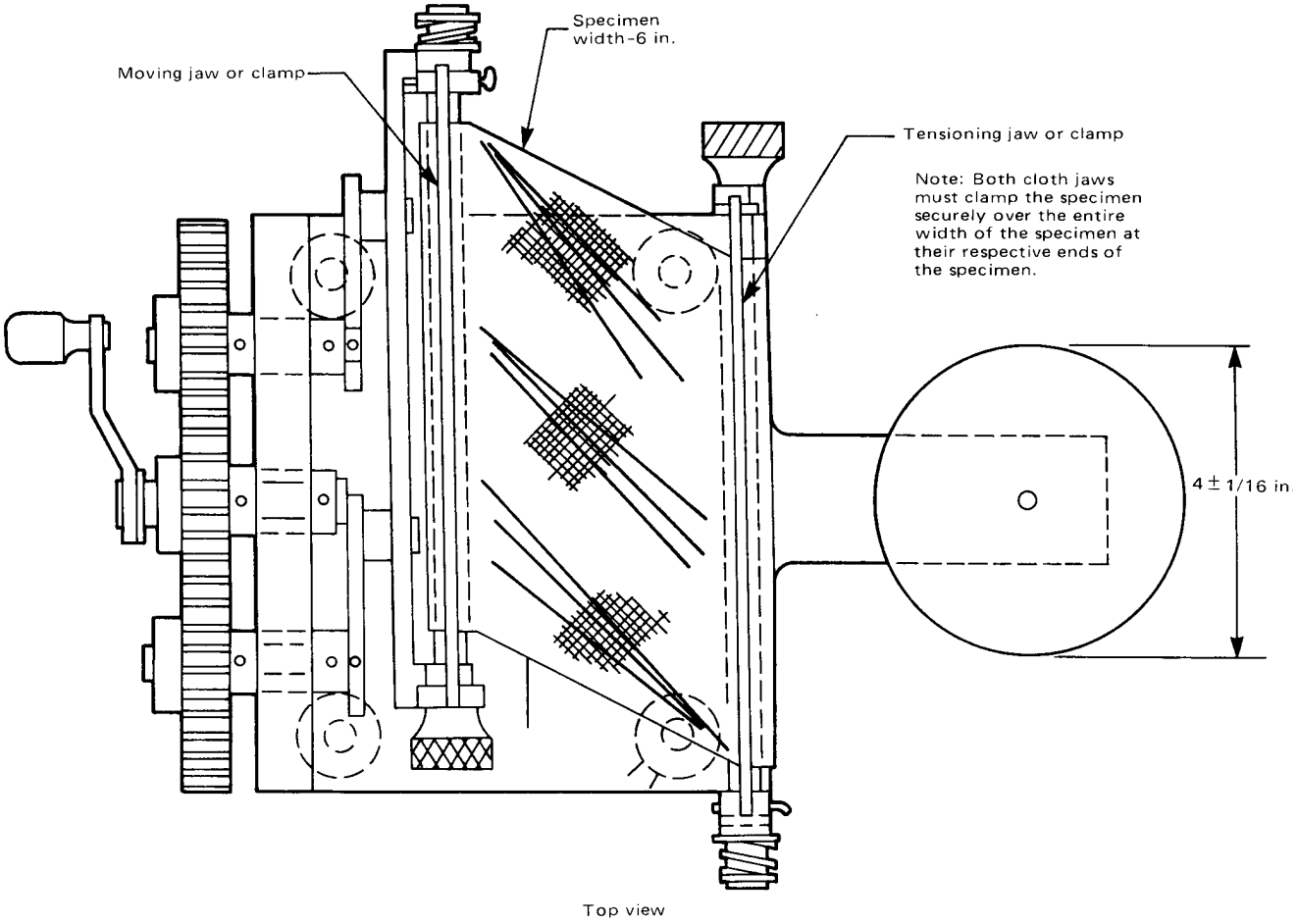


Figure 5-7.3(b) (continued) Flexing device — top view.

5-8 Adhesion after Wet Flex — Tape Method.

5-8.1 Immediately after each of the 5 specimens has completed the wet flex test in Section 5-7 of this chapter, the specimens shall be tested and evaluated for adhesion. This test shall be performed only on coated or laminated materials.

5-8.2 A razor cut design shall be symmetrically centered within the 4 × 8 in. (10.2 × 20.3 cm) specimen. Two "X" cuts and three horizontal cuts shall be made as shown in Figure 5-8.2 with a sharp razor blade through the coating or laminate and adhesive layers, but not through the base cloth.

5-8.3 The pressure sensitive tape used for testing the adhesion of the coating or the laminate shall have an adhesion value of not less than 2.75 lb per in. (1.150 N/cm) width or more than 3.50 lb per in. (0.191 N/cm) width. Five 1 × 8 in. (2.5 × 20.3 cm) specimens of the tape shall be tested using:

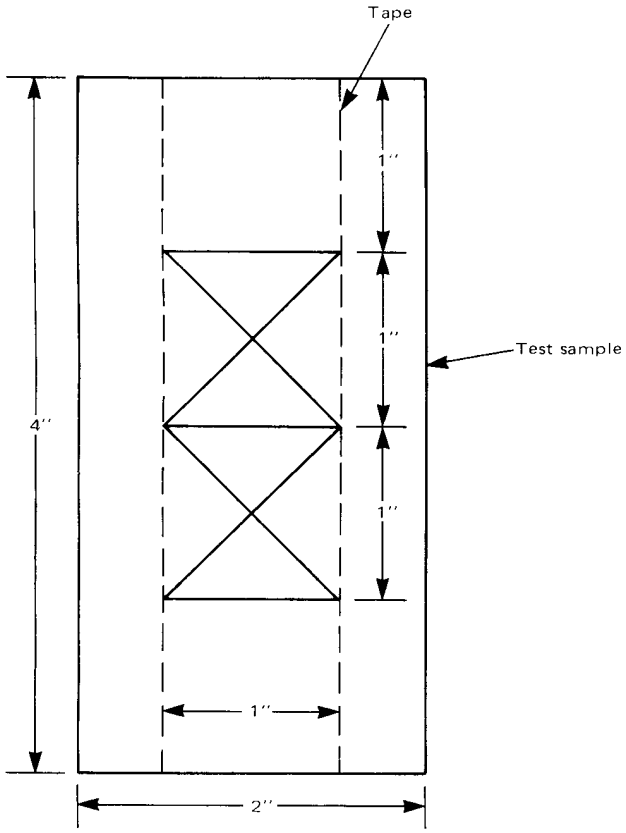
(a) A tensile testing machine as described in Method 5100, Strength and Elongation, Breaking of Woven Cloth; Grab Method, of Federal Test Method Standard 191A, *Textile Test Methods*, with the modification that all machine attachments for determining maximum load shall be disengaged and speed of the pulling clamp shall be 20 in. (50.8 cm) per minute.

(b) Five 2 × 4 in. (5.1 × 10.2 cm) steel plates conforming to Class 301 of Federal Specification QQ-S-766, *Steel Plate, Sheet, and Strip-Corrosion Resisting*, which have been polished to a No. 4 finish.

(c) A 1.5 in. (3.8 cm) wide steel roller weighing 10 lb ±2 oz (4.53 kg ± 0.06 kg).

5-8.3.1 Before each test, the steel plates shall be thoroughly cleaned with diacetone alcohol, methyl alcohol, or methyl ethyl ketone, using a clean piece of lintless wiping tissue. The tape shall be applied to the clean surface of the plate so that it covers the entire length of the plate and extends 4 in. (10.2 cm) beyond one end of the plate.

5-8.3.2 The tape shall be pressed down by passing the roller over it 6 times, 3 times in each direction. The free end of the tape shall be doubled back and 1 in. (2.5 cm) of the tape peeled off the plate. The plate shall be inserted and clamped in the bottom jaw of the tensile testing machine with the free end of the tape downward. The free end of the tape shall be looped upward and inserted and clamped in the upper jaw so as to peel the tape from the plate when the jaw motion is started. The minimum tension required to remove the remainder of the tape, except for the final 1 in. (2.5 cm), shall be the adhesion value and shall be determined by means of the autographic recording device.



NOTE: Solid lines indicate cut lines.

Figure 5-8.2 Showing "X" and horizontal cuts for adhesion of coating test.

5-8.4 Five 1 × 8 in. (2.5 × 20.3 cm) specimens of similar tape, taken from a lot of material which has passed the test as specified in Section 5-6 of this chapter, shall be used for testing the adhesion of the coating or laminate.

5-8.4.1 The apparatus and procedure shall be as specified in 5-8.3 of this section, but instead of the steel plates specified in 5-8.3(b), the test specimens used in Section 5-6 of this chapter shall be used for this test.

5-8.5 A moderate amount of specks on the tape of coating shall not constitute failure; however exposure of adhesive beneath a laminate shall constitute failure. The failure of one specimen shall constitute failure of the unit of product.

5-9 Seam Breaking Strength.

5-9.1 All seams shall be tested in accordance with ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics.*

5-9.2 The test machine shall be operated at a rate of 12 in./min (304.8 mm/min).

5-10 Flame Resistance.

5-10.1 Specimens shall be tested before and after being subjected to the procedure specified in Section 5-1 of this chapter.

5-10.2 Specimens shall be tested in accordance with Method 5903.1, Flame Resistance of Cloth; Vertical, of Federal Test Method Standard 191A, *Textile Test Methods.*

5-11 Shrinkage Resistance.

5-11.1 Specimens to be tested shall be subjected to the procedure as specified in Section 5-1 of this chapter.

5-11.2 Knit fabric specimens shall be pulled to original dimensions, released, and shall be allowed to relax for 1 minute prior to measurement.

5-11.3 Specimens shall then be measured to determine pass/fail.

5-12 Water Absorption Test.

5-12.1 Specimens shall be tested before and after being subjected to the procedure specified in Section 5-1 of this chapter.

5-12.2 Specimens shall be tested with the outer surface of the composite face up as oriented in the proximity protective garment in accordance with Method 5504, Water Resistance of Coated Cloth; Spray Absorption Method, of Federal Test Method Standard 191A, *Textile Test Methods.*

5-13 Flex at Low Temperature.

5-13.1 The test samples shall be 5 specimens, 1 × 4 in. (2.5 × 10.2 cm) with the long dimension in the warp or wale direction and shall be from the fabric lot utilized in the construction of the garment.

5-13.2 All samples shall be preconditioned 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 begin conditioning not more then 5 minutes after removal from preconditioning.

5-13.3 The test samples and jig as shown in Figure 5-13.3 shall be conditioned for 4 hours at a temperature of –25°F (–31.7°C).

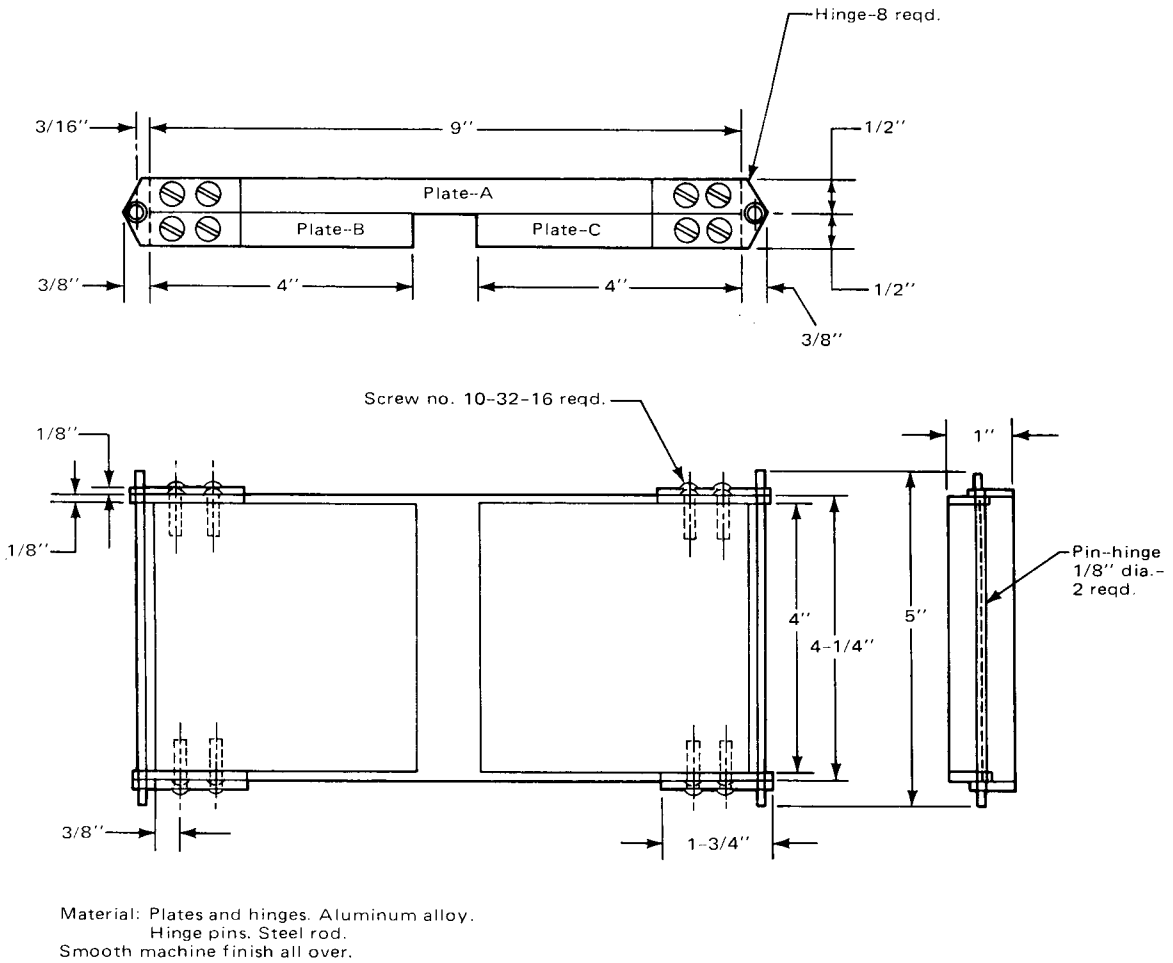
5-13.4 At the end of the conditioning period, with the jig and the test specimens still in the test atmosphere, the sample shall be placed in the open jig with the rod in the center of the fabric. The face of the fabric shall be positioned away from the rod. The jig shall be closed in less than 3 seconds so that the specimen is bent face out around the rod until the back of the specimen touches itself. The tested fabric shall be examined without magnification.

5-13.5 Failure of any one specimen shall constitute failure of sample unit of production.

5-14 Resistance to High Temperature Blocking.

5-14.1 All samples shall be preconditioned 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.

5-14.2 Blocking test procedure shall be as stated in Method 5872, Temperature, High, Effect on Cloth Blocking, of Federal Test Method Standard 191A, *Textile Test Methods.*



Material: Plates and hinges. Aluminum alloy.
Hinge pins. Steel rod.
Smooth machine finish all over.

Figure 5-13.3 Jig assembly—resistance to low temperature test.

5-14.3 The test specimen shall be examined to determine pass/fail. Failure to any one specimen shall constitute failure of the unit of product.

5-15 Water Penetration Resistance.

5-15.1 Specimens shall be tested both before and after being subjected to the procedure specified in Section 5-1 of this chapter.

5-15.2 Specimens shall be tested at 25 psi (1.76 kg/cm^2) in accordance with Method 5512, Water Resistance of Coated Cloth; High Range, Hydrostatic Pressure Method, of Federal Test Method Standard 191A, *Textile Test Methods*.

5-15.3 The specimen shall be examined to determine pass/fail.

5-15.4 Specimens shall be tested at 1 psi (0.07 kg/cm^2) for 5 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*.

5-15.5 The specimen shall be examined to determine pass/fail.

5-16 Thread Heat Resistance.

5-16.1 Specimens shall be tested to a temperature of 500°F (260°C) in accordance with Method 1534, Melting Point of Synthetic Fibers, of Federal Test Method Standard 191A, *Textile Test Methods*.

5-16.2 Specimens shall be examined to determine pass/fail.

5-17 Corrosion Resistance.

5-17.1 Specimens shall be tested in accordance with ASTM B 117, *Standard Method of Salt Spray (Fog) Testing*. Salt spray shall be 5 percent saline solution, and test exposure shall be for 20 hr.

5-17.2 Immediately following the test exposure and prior to examination, specimens shall be rinsed under warm, running tap water and dried with compressed air.

5-17.3 Specimens shall then be examined visually with the unaided eye to determine pass/fail.