NFPA 1977
Standard on Protective Clothing and Equipment for Wildland Fire Fighting

1998 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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NFPA 1977

Standard on

Protective Clothing and Equipment for Wildland Fire Fighting

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This edition of NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*, was prepared by the Technical Committee on Wildland Fire Fighting Protective Clothing and Equipment, released by the Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment, and acted on by the National Fire Protection Association, Inc., at its Annual Meeting held May 18–21, 1998, in Cincinnati, OH. It was issued by the Standards Council on July 16, 1998, with an effective date of August 5, 1998, and supersedes all previous editions.

This edition of NFPA 1977 was approved as an American National Standard on August 6, 1998.

Origin and Development of NFPA 1977

The Technical Committee on Fire Service Protective Clothing and Equipment began work on this standard in April 1989 in answer to requests from the wildland fire service to establish a standard covering the protective clothing and equipment used by fire fighters during wildland fire-fighting operations. A subcommittee was formed, the Subcommittee on Wildland Fire Fighting Protective Clothing and Equipment, to develop the document. Based on information studied by this subcommittee, the majority of documented injuries to wildland fire fighters are related to heat stress. The goal of this standard was to provide thermal protection for the wildland fire fighter against external heat sources with flame-resistant clothing and equipment while not inducing an extraordinary internal heat stress load.

The protection package encompassed by this standard consists of protective clothing and equipment for normal exposure limits, and an emergency fire shelter for severe exposure situations where serious injury or death can result.

The developmental work for the first edition was completed by the subcommittee in the spring of 1992 and presented to the Technical Committee for their action. This first edition was presented at the Annual Meeting in Orlando, FL, and issued with an effective date of August 20, 1993.

Since the first edition, the entire project for fire service protective clothing and equipment was reorganized by the Standards Council in January 1995. The new project has a Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment and seven technical committees operating within the project. The former standing Subcommittee on Wildland Fire Fighting Protective Clothing and Equipment was changed into the new Technical Committee on Wildland Fire Fighting Protective Clothing and Equipment and has the responsibility for the 1998 edition of NFPA 1977.

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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. A key to classifications is found at the back of this document.

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.

Committee Scope: This Committee shall have primary responsibility for documents on the design, performance, testing, and certification of protective clothing and protective equipment manufactured for fire and emergency services organizations and personnel, to protect against exposures encountered during emergency incident operations.

This Committee shall also have the primary responsibility for documents on the selection, care, and maintenance of such protective clothing and protective equipment by fire and emergency services organizations and personnel.

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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.

Committee Scope: This Committee shall have primary responsibility for documents on protective clothing and protective equipment, except respiratory protective equipment, that provides hand, foot, torso, limb and head protection, as well as interface protection for fire fighters or other emergency services responders during incidents involving wildland fire fighting operations. These operations include the activities of fire suppression and property conservation in forest, brush, grass, ground cover, and other such vegetation that is not within structures but that is involved in fire. Additionally, this committee shall have primary responsibility for documents on the selection, care, and maintenance of wildland fire fighting protective clothing and protective equipment by fire and emergency services organizations and personnel.

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Protective Clothing and Equipment for Wildland Fire Fighting

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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 7 and Appendix B.

Chapter 1 Administration

1-1 Scope.

1-1.1 This standard shall specify the minimum design, performance, testing, and certification requirements for protective clothing, helmets, gloves, and footwear that are designed to protect fire fighters against adverse environmental effects during wildland fire-fighting operations.

1-1.2 This standard shall specify the minimum design and certification requirements for fire shelters that are designed to protect fire fighters against adverse environmental effects during wildland fire-fighting operations.

1-1.3 This standard shall apply to design, manufacturing, and certification of new protective clothing and equipment. This standard shall not apply to wildland protective clothing, equipment, and fire shelters manufactured to previous editions of NFPA 1977.

1-1.4* This standard shall not apply to eye or respiratory protection for wildland fire-fighting operations and shall not apply to protection from structural, proximity, approach, or entry fire-fighting operations, nor from hazardous materials emergency operations. This standard shall not apply to protection from radiological or biological agents.

1-1.5 The requirements of this standard shall not apply to accessories that might be attached to any item of the wildland fire-fighting protective clothing or equipment unless specifically addressed herein.

1-1.6 Certification of wildland fire-fighting protective clothing and equipment to the requirements of this standard shall not preclude certification to additional appropriate standards where the protective clothing or equipment meet all applicable requirements of each standard.

1-1.7 Nothing herein shall be construed to restrict any jurisdiction or manufacturer from exceeding these minimum requirements.

1-2 Purpose.

1-2.1* The purpose of this standard shall be to provide minimum requirements for the design, construction, evaluation, testing, and certification of new protective clothing and equipment utilized during wildland fire-fighting operations.

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 wildland fire-fighting personnel can be exposed.

1-2.3 This standard is not intended to serve as a detailed manufacturing or purchase specification but shall be permitted to be referenced in purchase specifications as minimum requirements.

1-3 Definitions.

Accessories.* Those nonprimary protective items and equipment that are carried on the person of the wildland fire fighter in such a manner that they are located outside of the protective garments. These items include, but are not limited to, utility belts and harnesses, backpacks, radio packs, goggles, chain-saw chaps, fire shelter packs, and over-the-ear hearing protective devices but exclude closure devices.

Approved.* Acceptable to the authority having jurisdiction.

Authority Having Jurisdiction.* The organization, office, or individual responsible for approving equipment, an installation, or a procedure.

Back Length. Upper torso garment measurement at center back from bottom collar to bottom edge of garment.

Back Rise. Lower torso garment measurement from crotch seam to top of waistband at back center.

Bottom Circumference. Upper or lower torso garment measurement along bottom edge of the garment from folded edge to folded edge. Multiply this measurement by two to obtain circumference.

Brim. A part of the shell of the helmet that extends around the entire circumference of the helmet.

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 of 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 where the material is exposed to thermal energy.

Chest Circumference. Upper torso garment measurement from folded edge to folded edge, at base of armholes. Multiply this measurement by two to obtain circumference.

Chin Strap. An adjustable strap for the helmet that fits under the chin to secure the helmet to the head.

Collar Length. Upper torso garment measurement along top of collar from point-to-point.

Collar Width. Upper torso garment measurement at center back from top edge of unfolded collar to the bottom collar seam.

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

Component(s). All materials used in the construction of the various items of wildland fire-fighting protective clothing and equipment, including, but not limited to, thread, trim, bindings, zippers, buttons, labels, and hardware but excluding textile fabrics, interlinings, and emblems.

Composite. The layer or combination of layers of any item of protective clothing or equipment that provides the required protection.

Crown. The domed portion of the helmet that covers the head.

Crown Straps. That part of the suspension component of helmets that passes over the head.

Cuff. Finished edge of sleeve openings of protective garments.

Cuff Circumference. Torso garment cuff measurement along bottom of opening from folded edge to folded edge. Multiply this measurement by two to obtain circumference.

Drip. To run or fall in drops or blobs.

Ease. The size requirements and tolerance of garments that allows good fit and does not inhibit the natural body movements or the performance of job related tasks.

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 or wildland fire fighting. *(See also Proximity Fire Fighting, Structural Fire Fighting, and Wildland Fire Fighting.)*

Eyelets. Reinforced holes placed in the footwear upper throat through which laces are threaded to secure the footwear to the wearer.

Eyerow. The row of eyelets.

Face/Neck Shroud. An item of protective clothing that attaches to the helmet to provide minimum thermal protection to the face and neck area.

Face Protector. An optional accessory item, not attached to the helmet, that offers limited thermal protection to the face and neck area.

Fire Shelter. An item of protective equipment configured as an aluminized tent utilized for protection, by means of reflecting radiant heat, in a fire entrapment situation.

Flame Resistance. The property of a material whereby combustion is prevented, terminated, or inhibited following the application of a flaming or nonflaming source of ignition, with or without subsequent removal of the ignition source. Flame resistance can be an inherent property of a material, or it can be imparted by specific treatment. *(See also Inherent Flame Resistance.)*

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

Footwear. An item of protective clothing that is designed to provide minimum protection to the foot, ankle, and lower leg.

Footwear Upper. That part of protective footwear including, but not limited to, the toe, vamp, quarter, shaft, and top line but excluding the sole, heel, and insole.

Front Length. Upper torso garment measurement from bottom collar seam to the bottom edge of the garment at front edge.

Front Rise. Lower torso garment measurement from crotch seam to top of waistband at front center.

Garment. Items of protective clothing configured as a jacket, shirt, trouser, or one-piece garment that are designed to provide minimum protection to the upper and lower torso, arms, and legs, excluding the head, hands, and feet.

Gloves. An item of protective clothing that is designed to provide minimum protection to the fingers, thumb, hand, and wrist.

Goggle Clip. A component of the helmet to retain the strap of goggle or headlamp.

Hardware. Nonfabric components of the protective clothing and equipment including, but not limited to, those made of metal or plastic.

Headform. A test device that simulates the configuration of the human head.

Heel Breast. The forward face of the footwear heel.

Helmet. An item of protective equipment that is designed to provide minimum protection to the head.

Inherent Flame Resistance. Flame resistance that is derived from the essential characteristics of the fiber or polymer.

Inseam Length. Lower torso garment measurement along inseam from crotch seam to bottom edge of cuff.

Insole. The part of protective footwear next to the bottom of the foot.

Interlining. Any textile fabric that is intended for incorporation into any protective garment as a layer between the protective layers.

Jacket. A protective garment, with or without a detachable cold weather liner, designed to be worn outside of the protective trousers to provide minimum protection to the upper torso and arms, excluding the hands and head.

Knee Circumference. Lower torso garment measurement 356 mm (14 in.) below crotch seam, from folded edge to folded edge. Multiply this measurement by two to obtain circumference.

Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is 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.

Liner. A detachable lining component designed to be worn inside a protective clothing item or helmet to provide warmth.

Lining. Any material that is permanently attached and used to cover or partially cover the inside surface area of a protective clothing item.

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

Lower Torso. Area of body below the waist including the legs but excluding the ankles and feet.

Manufacturer. The entity that assumes the liability and provides the warranty for the compliant product.

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

Nape Device. A component of the helmet that is located below the Bitragion Inion Arc used to aid in helmet retention.

Neck Circumference. Upper torso measurement from folded edge to folded edge at the midpoint of the collar width with the garment front closure closed at the top and the top edges of the collar in horizontal alignment. Multiply this measurement by two to obtain the circumference.

Neck Shroud. See Face/Neck Shroud.

One-Piece Garment. A single-piece protective garment designed to provide minimum protection to the upper and lower torso, arms, and legs, excluding the head, hands, and feet.

Peak. An integral part of the helmet shell extending forward over the eyes only.

Pockets.

Front Waist Pocket(s). Slanted or side seam opening pockets that open to the exterior, located at or near the front waist of a garment.

Patch Pocket(s). Pockets located on the exterior of protective garments.

Product Label. A label or marking affixed to each compliant item of a protective clothing or equipment or fire shelter by the manufacturer. Such labels contain compliance statements, certification statements, general information, care, maintenance, or similar data. The product label is not the certification organization's label, symbol, or identifying mark; however, the certification organization's label, symbol, or identifying mark can be attached to it or be part of the product label.

Protective Clothing. Any material or combination of materials used in an item of clothing designed to provide minimum protection from the inherent risks of wildland fire fighting.

Protective Footwear. See Footwear.

Protective Garment. See Garment.

Protective Glove. See Gloves.

Protective Helmet. See Helmet.

Protective Jacket. See Jacket.

Protective One-Piece Garment. See One-Piece Garment.

Protective Shirt. See Shirt.

Protective Trouser. See Trousers.

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. Specialty 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 or wildland fire fighting. *(See also Entry Fire Fighting, Structural Fire Fighting, and Wildland Fire Fighting.)*

Radiant Protective Performance (RPP). The resistance of a material to radiant heat, measured in seconds, when exposed to a vertically oriented radiant heat source, positioned at a specific horizontal distance from the vertical placement of the protective material, sufficient to cause a second-degree burn to human tissue.

Retroreflective Markings. A material that reflects light back to the light source.

Sample. Protective clothing or equipment items taken from a manufacturer's current production lot. *(See also Specimen.)*

Seams.

Seam Assembly. The composite structure obtained where fabric(s) are joined by the means of a sewn seam.

*Major Seams.** Those seams assembly constructions where rupture exposes the wearer to immediate danger.

*Minor Seams.** Those seam assembly constructions where rupture does not expose the wearer to immediate danger.

Seat Circumference. Lower torso garment measurement from 1 in. (2.5 cm) above bottom of fly curve from folded edge to folded edge. Multiply this measurement by two to obtain circumference.

Separate. A material response evidenced by splitting or delamination.

Sewn Seam Strength. The maximum resistance to rupture of the junction formed by stitching together two or more planar structures, such as textile fabrics.

Shall. Indicates a mandatory requirement.

Shank. Reinforcement to the shank area of protective footwear designed to provide additional support to the instep.

Shell. A helmet without the suspension system, accessories, and fittings.

Shirt. A protective garment, without a cold weather liner, that is designed to provide minimum protection to the upper torso and arms, excluding the head and hands, worn over undergarments or other clothing and usually tucked into the trousers.

Should. Indicates a recommendation or that which is advised but not required.

Shroud. See Face/Neck Shroud.

Sleeve Length. Upper-torso garment measurement from center back at bottom of collar seam diagonally across back and down sleeve to bottom edge of cuff. In other specified instances, it is a measurement from center sleeve setting seam at shoulder to bottom edge of sleeve.

Specimen. The item that undergoes testing. In some cases, the specimen is also the sample.

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

Textile Fabric. A planar structure consisting of yarns or fibers.

Thermal Protective Performance (TPP). The resistance, measured in seconds, of a sample specimen to a combination of convective and radiant heat sufficient to cause second-degree burns to human tissue when the sample specimen is exposed to a convective and radiant heat source positioned at a specific vertical distance from a horizontal placement of the sample specimen.

Thigh Circumference. Lower torso garment measurement at crotch line from folded edge to folded edge. Multiply this measurement by two to obtain circumference.

Throat. The center of the footwear entrance area behind the gusset, from its top line to the lowest point where it attaches to the vamp.

Top Line. The top edge of the footwear that includes the tongue, gusset, quarter, collar, and shaft.

Trim. Material attached to the exterior surface of protective clothing or equipment to enhance visibility. Retroreflective materials enhance night time visibility, and fluorescent materials enhance daytime visibility.

Trousers. A protective garment designed to provide minimum protection to the lower torso and legs, excluding the feet, worn over undergarments or other clothing.

Upper Torso. Area of body above the waist and extending to the shoulders, including the arms and wrists but excluding the hands.

Vertical Circumference. One-piece garment measurement from junction of shoulder/collar seam down to the bottom of the crotch. Multiply this measurement by two to obtain circumference.

Waist Circumference. A garment measurement from top edge of waistband from folded edge to folded edge. Multiply this measurement by two to obtain circumference.

Wear Surface. A footwear term for the bottom of the sole, including the heel.

Wildland Fire Fighting. The activities of fire suppression and property conservation in woodlands, forests, grasslands, brush, prairies, and other such vegetation, or any combination of vegetation, that is involved in a fire situation but is not within buildings or structures.

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 can be approximate.

Chapter 2 Certification

2-1 General.

2-1.1 All individual items of protective clothing and equipment that are labeled as being compliant with this standard shall meet or exceed all applicable requirements of specified in this standard and shall be certified. Manufacturers shall not claim compliance with a portion(s) or segment(s) of the requirements of this standard and shall not use the name or identification of this standard, NFPA 1977, in any statements about their respective products unless the product is certified to this standard.

2-1.2 The face/neck shroud shall be certified to the requirements specified in Sections 4-6 and 5-5 with a specific compliant wildland fire-fighting protective helmet(s), and shall be so labeled and listed.

2-1.3 All certification shall be performed by a certification organization that meets at least the requirements specified in Section 2-2, and that is accredited for personal protective equipment in accordance with ANSI Z34.1, *American National Standard for Third-Party Certification Programs for Products, Processes, and Services*.

2-1.4* All individual compliant items of protective clothing and equipment shall be labeled and listed and shall also have a product label. The product labels shall meet the applicable requirements for the specific item as specified in 3-1.1, 3-2.1, 3-3.1, 3-4.1, 3-5.1, or 3-6.1.

2-1.5 The certification organization's label, symbol, or identifying mark shall be attached to the product label or shall be part of the product label.

2-1.6 The certification organization shall not certify any item of wildland fire-fighting protective clothing or equipment to the 1993 edition of this standard on or after 1 March 1999.

2-1.7 The certification organization shall not permit any manufacturer to label any item of wildland fire fighting protective clothing or equipment as compliant with the 1993 edition of this standard on or after 1 March 1999.

2-1.8 The certification organization shall require manufacturers to remove all certification labels and product labels indicating compliance with the 1993 edition of this standard from all items of wildland fire-fighting protective clothing or equipment that are under the control of the manufacturer on 1 March 1999. The certification organization shall verify this action is taken.

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 the requirements of this standard.

2-2.3* The contractual provisions between the certification organization and the manufacturer shall specify that a listing 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* The certification organization shall have laboratory facilities and equipment available for conducting proper tests, a program for calibration of all instruments shall be in place and operating, and procedures shall be used to ensure proper control of all testing. Good practice shall be followed regarding the use of laboratory manuals, form data sheets, documented calibration routines, performance verification, proficiency testing, and staff qualification and training programs.

2-2.5 The certification organization shall require the manufacturer to establish and maintain a program of production inspection and testing that at least meets the requirements specified in Sections 2-4 or 2-5. The certification organization shall audit the manufacturer's quality assurance program to ensure that the quality assurance program provides continued product compliance with this standard.

2-2.6 The certification organization and the manufacturer 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* The certification organization shall have a follow-up inspection program of the manufacturing facilities of the certified product, with at least two random and unannounced visits per 12-month period. As part of the follow-up inspection program, the certification organization shall select sample product at random from the manufacturer's production line, from the manufacturer's in-house stock, or from the open market. Sample product shall be inspected and tested by the certification organization to verify the product's continued compliance.

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 certification organization shall require the manufacturer to have a product recall system as part of the manufacturer's quality assurance program.

2-2.10 The certification organization's operating procedures 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.

2-2.11 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 For both initial certification and recertification of wildland fire-fighting protective clothing and equipment, the certification organization shall conduct both inspection and testing as specified in this section.

2-3.2 All inspections, evaluations, conditioning, and testing for certification or for recertification shall be conducted by the certification organization.

2-3.3 Any inspection, evaluation, conditioning, or testing conducted by a product manufacturer shall not be used in the certification or recertification process.

2-3.4 Sampling levels for inspection to determine compliance with this standard shall be established by the certification organization and the manufacturer to ensure a reasonable and acceptable reliability at a reasonable and acceptable confidence level that products certified as being compliant with the standard are compliant.

2-3.5 Inspection by the certification organization shall include a review of all product labels to ensure that all required label attachment, compliance statements, certification statements, and other product information are at least as specified in Section 3-1.

2-3.6 Inspection by the certification organization shall include a review of the user information required by Section 3-2 to ensure that the information has been developed and is available.

2-3.7 Inspection by the certification organization for determining compliance with the design requirements specified in Chapter 4 shall be performed on whole and complete items of wildland fire-fighting protective clothing and equipment.

2-3.8 Testing conducted by the certification organization in accordance with the testing requirements of Chapter 6, for determining product compliance with the applicable performance requirements specified in Chapter 5, shall be performed on whole and complete items of wildland fire-fighting protective clothing and equipment or sample specimens of items that are representative of materials and construction of the protective clothing or equipment items. The certification organization also shall be permitted to use sample materials cut or taken from a representative product.

2-3.9 Where wildland fire-fighting protective clothing or equipment is equipped with an accessory or accessories, certification testing shall include accessories and each accessory shall be certified as complying with the applicable requirements of Section 4-7.

2-3.10 Any change in the design, construction, or material of a compliant wildland fire-fighting protective clothing and equipment shall necessitate new inspection and testing to verify compliance to all applicable requirements of this standard that the certification organization determines can be affected by such change. This recertification shall be conducted before labeling the modified product as being compliant with this standard.

2-3.11 The certification organization shall not allow any modifications, pretreatment, conditioning, or other such special processes of any product or any product component, including accessories, prior to the product's submission for evaluation and testing by the certification organization. The certification organization shall accept, from the manufacturer for evaluation and testing for certification, only wildland fire-fighting protective clothing and equipment products or product components that are the same in every respect to the actual final product or component. Other than as specifically permitted herein, the certification organization shall not allow the substitution, repair, or modification of any product or any product component during testing.

2-4 Recertification.

2-4.1 All individual items of wildland fire-fighting protective clothing and equipment that are labeled as being compliant with this standard shall undergo recertification on an annual basis. This recertification shall include inspection

and evaluation to all design requirements and testing to all performance requirements as required by this standard on all manufacturer models and components.

2-4.1.1 Any change that affects an item's performance under the design or performance requirements of this standard shall constitute a different model.

2-4.1.2 For the purpose of this standard, models shall include each unique pattern, style, or design of the individual item.

2-4.2 Samples of manufacturer models and components for recertification shall be acquired from the manufacturer or component supplier during random and unannounced visits as part of the follow-up inspection program.

2-4.3 The manufacturer shall maintain all design and performance inspection and test data from the certification organization used in the recertification of manufacturer models and components. The manufacturer shall provide such data, on request, to the purchaser or authority having jurisdiction.

2-5 Manufacturer's Quality Assurance Program.

2-5.1 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.

2-5.2 The manufacturer shall maintain written inspection and testing instructions. The instructions shall prescribe inspection and test materials, work in progress, and completed articles. Criteria for acceptance and rejection of materials, processes, and the final product shall be part of the instructions.

2-5.3 The manufacturer shall maintain records of all pass/fail tests. Pass/fail records shall indicate the disposition of the failed material or product.

2-5.4 The manufacturer's inspection system shall provide for procedures that ensure the latest applicable drawings, specifications, and instructions are used for fabrication, inspection, and testing.

2-5.5 The manufacturer shall, as a 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.

2-5.6 The manufacturer shall maintain a system for identifying the appropriate inspection status of component materials, work in process, and finished goods.

2-5.7 The manufacturer shall establish and maintain a system for controlling non-conforming 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.

2-5.8 The manufacturer's quality assurance program shall be audited by a third-party certification agency to determine that the program is sufficient to ensure continued product compliance with this standard.

2-6* ISO Registration for Manufacturers.

2-6.1 The manufacturer shall provide and operate a quality assurance program that meets the requirements of this section and that includes a product recall system as specified in 2-2.9.

2-6.2 The manufacturer shall be registered to ISO 9001, *Quality Systems — Model for Quality Assurance in Design, Development, Production, Installation, and Servicing.*

2-6.3 All wildland fire-fighting protective clothing and equipment components shall be required to be assembled in a facility that is registered at least to ISO 9002, *Quality Systems — Model for Quality Assurance in Production, Installation, and Servicing.*

2-6.4 The ISO registration requirements shall have an effective date of 1 September 2000.

2-6.5 Until 1 September 2000, or until the date the manufacturer becomes ISO registered, whichever date occurs first, the manufacturer shall comply with Section 2-5.

Chapter 3 Labeling and Information

3-1 Protective Garments.

3-1.1 Product Labeling Requirements.

3-1.1.1 Each garment shall have a product label or labels permanently and conspicuously attached. At least one product label shall be conspicuously located inside each garment when the garment is properly assembled with all layers and components in place.

3-1.1.2 Configuration of the product label and attachment of the product label shall not interfere with the legibility of any printed portion of the product label.

3-1.1.3 Multiple label pieces shall be permitted in order to carry all statements and information required to be on the product label.

3-1.1.4* The certification organization's label, symbol, or identifying mark shall be permanently attached to the product label or shall be part of the product label.

3-1.1.5 All worded portions of the required product label shall be printed at least in English.

3-1.1.6 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product label(s).

3-1.1.7 The following statement shall be printed legibly on the product label and all letters shall be at least 2.5 mm ($^{3}/_{32}$ in.) high.

"THIS WILDLAND FIRE-FIGHTING PROTECTIVE GARMENT MEETS THE GARMENT REQUIREMENTS OF NFPA 1977, STANDARD ON PROTECTIVE CLOTHING AND EQUIPMENT FOR WILDLAND FIRE FIGHTING, 1998 EDITION."

3-1.1.8 At least the following information shall also be printed legibly on the product label with all letters at least 1.6 mm ($^{1}/_{16}$ in.) high:

(a) Manufacturer's name, identification, or designation
(b) Manufacturer's address
(c) Country of manufacture
(d) Manufacturer's garment identification number, lot number, or serial number
(e) Month and year of manufacture (not coded)
(f) Model or style name, number, or design
(g) Size
(h) Garment materials and percent content

(i) Cleaning precautions
(j) The following statement: "DO NOT REMOVE THIS LABEL."

3-1.2 User Information.

3-1.2.1 The garment manufacturer shall provide at least the user information that is specified in 3-1.2.4 with each garment.

3-1.2.2 The garment manufacturer shall attach the required user information, or packaging containing the user information, to the garment in such a manner that it is not possible to use the garment without being aware of the availability of the information.

3-1.2.3 The required user information, or packaging containing the user information, shall be attached to the garment so that a deliberate action is necessary to remove it. The garment manufacturer shall provide notice that the user information is to be removed ONLY by the end user.

3-1.2.4 The garment manufacturer shall provide at least the following instructions and information with each garment:

(a) Pre-use information
    1. Safety considerations
    2. Limitations of use
    3. Garment marking recommendations and restrictions
    4. A statement that most performance properties of the garment cannot be tested by the user in the field
    5. Warranty information
(b) Preparation for use
    1. Sizing/adjustment
    2. Recommended storage practices
(c) Inspection frequency and details
(d) Don/doff
    1. Donning and doffing procedures
    2. Sizing and adjustment procedures
    3. Interface issues
(e) Proper use consistent with NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program,* and Title 29, *Code of Federal Regulations,* Part 1910.132, "Personal Protective Equipment"
(f) Maintenance and cleaning
    1. Cleaning instructions and precautions with a statement advising users not to use garments that are not thoroughly cleaned and dried
    2. Maintenance criteria and methods of repair where applicable
    3. Decontamination procedures
(g) Retirement and disposal criteria and considerations

3-2 Protective Helmet.

3-2.1 Product Labeling Requirements.

3-2.1.1 Each helmet shall have a product label or labels permanently and conspicuously attached. At least one product label shall be conspicuously located on or inside each helmet when the helmet is properly assembled with all components in place.

3-2.1.2 Configuration of the product label and attachment of the product label shall not interfere with the legibility of any printed portion of the product label.

3-2.1.3 Multiple label pieces shall be permitted in order to carry all the statements and information required to be on the product label.

3-2.1.4* The certification organization's label, symbol, or identifying mark shall be permanently attached to the product label or shall be part of the product label.

3-2.1.5 All worded portions of the required product label shall be printed at least in English.

3-2.1.6 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product label(s).

3-2.1.7 The following statement shall be printed legibly on the product label and all letters shall be at least 2.5 mm ($^{3}/_{32}$ in.) high.

"THIS WILDLAND FIRE-FIGHTING PROTECTIVE HELMET MEETS THE HELMET REQUIREMENTS OF NFPA 1977, STANDARD ON PROTECTIVE CLOTHING AND EQUIPMENT FOR WILDLAND FIRE FIGHTING, 1998 EDITION."

3-2.1.8 At least the following information shall also be printed legibly on the product label with all letters at least 2 mm ($^{1}/_{16}$ in.) high:

(a) Manufacturer's name, identification, or designation
(b) Manufacturer's address
(c) Country of manufacture
(d) Manufacturer's helmet identification number, lot number, or serial number
(e) Month and year of manufacture (not coded)
(f) Model or style name, number, or design
(g) Helmet size or size range
(h) Nominal weight of helmet
(i) Cleaning precautions
(j) The following statement: "DO NOT REMOVE THIS LABEL."

3-2.2 User Information.

3-2.2.1 The helmet manufacturer shall provide at least the user information that is specified in 3-2.2.4 with each helmet.

3-2.2.2 The helmet manufacturer shall attach the required user information, or packaging containing the user information, to the helmet in such a manner that it is not possible to use the helmet without being aware of the availability of the information.

3-2.2.3 The required user information, or packaging containing the user information, shall be attached to the helmet so that a deliberate action is necessary to remove it. The helmet manufacturer shall provide notice that the user information is to be removed ONLY by the end user.

3-2.2.4 The helmet manufacturer shall provide at least the following instructions and information with each helmet:

(a) Pre-use information
    1. Safety considerations
    2. Limitations of use
    3. Helmet marking recommendations and restrictions
    4. A statement that most performance properties of the helmet cannot be tested by the user in the field
    5. Warranty information

(b) Preparation for use
    1. Sizing/adjustment
    2. Recommended storage practices
(c) Inspection frequency and details
(d) Don/doff
    1. Donning and doffing procedures
    2. Sizing and adjustment procedures
    3. Interface issues
(e) Proper use consistent with NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program,* and Title 29, *Code of Federal Regulations,* Part 1910.132, "Personal Protective Equipment"
(f) Maintenance and cleaning
    1. Cleaning instructions and precautions with a statement advising users not to use helmets that are not thoroughly cleaned and dried
    2. Maintenance criteria and methods of repair where applicable
    3. Decontamination procedures
(g) Retirement and disposal criteria and considerations

3-3 Protective Gloves.

3-3.1 Product Label Requirements.

3-3.1.1 Each glove shall have a product label or labels permanently and conspicuously attached. At least one product label shall be conspicuously located on or inside each glove when the glove is properly assembled with all components in place.

3-3.1.2 Configuration of the product label and attachment of the product label shall not interfere with the legibility of any printed portion of the product label.

3-3.1.3 Multiple label pieces shall be permitted in order to carry all the statements and information required to be on the product label.

3-3.1.4* The certification organization's label, symbol, or identifying mark shall be permanently attached to the product label or shall be part of the product label.

3-3.1.5 All worded portions of the required product label shall be printed at least in English.

3-3.1.6 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product labels.

3-3.1.7 The following statement shall be printed legibly on the product label. All letters shall be at least 2.5 mm ($^{3}/_{32}$ in.) high.
"THIS WILDLAND FIRE FIGHTING PROTECTIVE GLOVE MEETS THE GLOVE REQUIREMENTS OF NFPA 1977, STANDARD ON PROTECTIVE CLOTHING AND EQUIPMENT FOR WILDLAND FIRE FIGHTING, 1998 EDITION."

3-3.1.8 At least the following information shall also be printed legibly on the product label with all letters at least 2 mm ($^{1}/_{16}$ in.) high:
(a) Manufacturer's name, identification, or designation
(b) Manufacturer's address
(c) Country of manufacture
(d) Manufacturer's glove identification number, lot number, or serial number
(e) Month and year of manufacture (not coded)
(f) Model or style name, number, or design
(g) Glove size or size range
(h) Cleaning precautions
(i) The following statement: "DO NOT REMOVE THIS LABEL."

3-3.2 User Information.

3-3.2.1 The glove manufacturer shall provide at least the user information that is specified in 3-3.2.4 with each glove.

3-3.2.2 The glove manufacturer shall attach the required user information, or packaging containing the user information, to the glove pair in such a manner that it is not possible to use the gloves without being aware of the availability of the information.

3-3.2.3 The required user information, or packaging containing the user information, shall be attached to the glove pair so that a deliberate action is necessary to remove it. The glove manufacturer shall provide notice that the user information shall be removed ONLY by the end user.

3-3.2.4 The glove manufacturer shall provide at least the following instructions and information with each glove:
(a) Pre-use information
    1. Safety considerations
    2. Limitations of use
    3. Glove marking recommendations and restrictions
    4. A statement that most performance properties of the glove cannot be tested by the user in the field
    5. Warranty information
(b) Preparation for use
    1. Sizing/adjustment
    2. Recommended storage practices
(c) Inspection frequency and details
(d) Don/doff
    1. Donning and doffing procedures
    2. Sizing and adjustment procedures
    3. Interface issues
(e) Proper use consistent with NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program* and Title 29, *Code of Federal Regulations,* Part 1910.132, "Personal Protective Equipment"
(f) Maintenance and cleaning
    1. Cleaning instructions and precautions with a statement advising users not to use gloves that are not thoroughly cleaned and dried
    2. Maintenance criteria and methods of repair where applicable
    3. Decontamination procedures
    4. Instructions for frequency and method of user testing for water resistance
(g) Retirement and disposal criteria and considerations

3-3.2.5 The manufacturer shall make available to prospective purchasers and the purchaser a chart illustrating the hand dimension ranges specified in 4-3.4.2.

3-4 Protective Footwear.

3-4.1 Product Label Requirements.

3-4.1.1 Each footwear pair shall have a product label or labels permanently and conspicuously attached to each boot half pair. At least one product label shall be conspicuously located

on or inside each boot when the boot is properly assembled with all components in place.

3-4.1.2 Configuration of the product label and attachment of the product label shall not interfere with the legibility of any printed portion of the product label.

3-4.1.3 Multiple label pieces shall be permitted in order to carry all the statements and information required to be on the product label.

3-4.1.4* The certification organization's label, symbol, or identifying mark shall be permanently attached to the product label or shall be part of the product label.

3-4.1.5 All worded portions of the required product label shall be printed at least in English.

3-4.1.6 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product labels.

3-4.1.7 The following statement shall be printed legibly on the product label. All letters shall be at least 2.5 mm ($^{3}/_{32}$ in.) high.
"THIS WILDLAND FIRE-FIGHTING PROTECTIVE FOOTWEAR MEETS THE FOOTWEAR REQUIREMENTS OF NFPA 1977, STANDARD ON PROTECTIVE CLOTHING AND EQUIPMENT FOR WILDLAND FIRE FIGHTING, 1998 EDITION."

3-4.1.8 At least the following information shall also be printed legibly on the product label with all letters at least 2 mm ($^{1}/_{16}$ in.) high:

(a) Manufacturer's name, identification, or designation
(b) Manufacturer's address
(c) Country of manufacture
(d) Manufacturer's footwear identification number, lot number, or serial number
(e) Month and year of manufacture (not coded)
(f) Model or style name, number, or design
(g) Footwear size and width
(h) Cleaning precautions
(i) The following statement: "DO NOT REMOVE THIS LABEL."

3-4.2 User Information.

3-4.2.1 The footwear manufacturer shall provide at least the user information that is specified in 3-4.2.4 with each footwear pair.

3-4.2.2 The footwear manufacturer shall attach the required user information, or packaging containing the user information, to the boot pair in such a manner that it is not possible to use the boots without being aware of the availability of the information.

3-4.2.3 The required user information, or packaging containing the user information, shall be attached to the boot pair so that a deliberate action is necessary to remove it. The footwear manufacturer shall provide notice that the user information is to be removed ONLY by the end user.

3-4.2.4 The footwear manufacturer shall provide at least the following instructions and information with each footwear pair:

(a) Pre-use information
    1. Safety considerations
    2. Limitations of use
    3. Boot marking recommendations and restrictions
    4. A statement that most performance properties of the boots cannot be tested by the user in the field
    5. Warranty information
(b) Preparation for use
    1. Sizing/adjustment
    2. Recommended storage practices
(c) Inspection frequency and details
(d) Don/doff
    1. Donning and doffing procedures
    2. Sizing and adjustment procedures
    3. Interface issues
(e) Proper use consistent with NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program,* and Title 29, *Code of Federal Regulations,* Part 1910.132, "Personal Protective Equipment"
(f) Maintenance and cleaning
    1. Cleaning instructions and precautions with a statement advising users not to use boots that are not thoroughly cleaned and dried
    2. Maintenance criteria and methods of repair where applicable
    3. Decontamination procedures
(g) Retirement and disposal criteria and considerations

3-4.2.5 Manufacturers shall be required to establish and provide, upon request, a size conversion chart for each model or style of protective footwear based on toe length, arch length, and foot width as measured on the Brannock Scientific Foot Measuring Device.

3-5 Fire Shelter.

3-5.1 Shelter Product Label Requirements.

3-5.1.1 Each fire shelter shall have a product label or labels located on the shelter flap and shall have a second product label(s) located inside the clear polyvinyl shelter package so that the label can be read without opening the polyvinyl shelter package.

3-5.1.2 Configuration of the product label and attachment of the product label shall not interfere with the legibility of any printed portion of the product label.

3-5.1.3 Multiple label pieces shall be permitted in order to carry all the statements and information required to be on the product label.

3-5.1.4* The certification organization's label, symbol, or identifying mark shall be permanently attached to the product label or shall be part of the product label.

3-5.1.5 No product label shall be attached to the outside reflective surface of the fire shelter.

3-5.1.6 All worded portions of the required product label shall be printed at least in English.

3-5.1.7 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product labels.

3-5.1.8 The following statement shall be printed legibly on the product label. All letters shall be at least 2.5 mm ($^{3}/_{32}$ in.) high.

"THIS FIRE SHELTER MEETS THE FIRE SHELTER REQUIREMENTS OF NFPA 1977, STANDARD ON PROTECTIVE CLOTHING AND EQUIPMENT FOR WILDLAND FIRE FIGHTING, 1998 EDITION."

3-5.1.9 At least the following information shall also be printed legibly on the product label with all letters at least 2 mm ($^1/_{16}$ in.) high:

(a) Manufacturer's name
(b) Manufacturer's address
(c) Manufacturer's number, lot, or serial number
(d) Country of manufacture
(e) Date of manufacture, not coded
(f) The following statement: "DO NOT REMOVE THIS LABEL."

3-5.2 Carrying Case Product Label Requirements.

3-5.2.1 Each fire shelter carrying case shall have a product label or labels permanently and conspicuously attached.

3-5.2.2 Configuration of the product label and attachment of the product label shall not interfere with the legibility of any printed portion of the product label.

3-5.2.3 Multiple label pieces shall be permitted in order to carry all the statements and information required to be on the product label.

3-5.2.4* The certification organization's label, symbol, or identifying mark shall be permanently attached to the product label or shall be part of the product label.

3-5.2.5 All worded portions of the required product label shall be printed at least in English.

3-5.2.6 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product labels.

3-5.2.7 The following statement shall be printed legibly on the product label. All letters shall be at least 2.5 mm ($^3/_{32}$ in.) high.
"THIS FIRE SHELTER CARRYING CASE MEETS THE CARRYING CASE REQUIREMENTS OF NFPA 1977, STANDARD ON PROTECTIVE CLOTHING AND EQUIPMENT FOR WILDLAND FIRE FIGHTING, 1998 EDITION."

3-5.2.8 At least the following information shall also be printed legibly on the product label with all letters at least 2 mm ($^1/_{16}$ in.) high:

(a) Manufacturer's name
(b) Manufacturer's address
(c) Manufacturer's number, lot number, or serial number
(d) Country of manufacture
(e) Date of manufacture, not coded
(f) The following statement: "DO NOT REMOVE THIS LABEL."

3-5.3 Carrying Case Liner Product Label Requirements.

3-5.3.1 Label information shall be permanently and distinctively marked by a mold-in process in raised letters 6 mm ($^1/_4$ in.) high and 5 mm ($^3/_{16}$ in.) wide onto the liner wall.

3-5.3.2 At least the following information shall be included:

(a) Fire shelter liner
(b) Compliance with NFPA 1977–1998 edition
(c) Manufacturer's name
(d) Manufacturer's address
(e) Manufacturer's liner identification number, lot number, or serial number
(f) Country of manufacture
(g) Certification organization's label, symbol, or identifying mark

3-5.3.3 Multiple label pieces shall be permitted in order to carry all the statements and information required to be on the product label.

3-5.3.4* The certification organization's label, symbol, or identifying mark shall be permanently attached to the product label or shall be part of the product label.

3-5.3.5 All worded portions of the required product label shall be printed at least in English.

3-5.3.6 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product labels.

3-5.3.7 The following statement shall be printed legibly on the product label. All letters shall be at least 2.5 mm ($^3/_{32}$ in.) high.
"THIS FIRE SHELTER CARRYING CASE LINER MEETS THE CARRYING CASE LINER REQUIREMENTS OF NFPA 1977, STANDARD ON PROTECTIVE CLOTHING AND EQUIPMENT FOR WILDLAND FIRE FIGHTING, 1998 EDITION."

3-5.3.8 At least the following information shall also be printed legibly on the product label with all letters at least 2 mm ($^1/_{16}$ in.) high:

(a) Manufacturer's name
(b) Manufacturer's address
(c) Manufacturer's number, lot number, or serial number
(d) Country of manufacture
(e) Date of manufacture, not coded
(f) The following statement: "DO NOT REMOVE THIS LABEL."

3-5.4 User Information.

3-5.4.1 The fire shelter manufacturer shall provide at least the user information that is specified in 3-5.4.4 with each shelter.

3-5.4.2 The fire shelter manufacturer shall attach the required user information, or packaging containing the user information, to the shelter package in such a manner that it is not possible to put the shelter in the carrying case without being aware of the availability of the information.

3-5.4.3 The required user information, or packaging containing the user information, shall be attached to the shelter package so that a deliberate action is necessary to remove it. The fire shelter manufacturer shall provide notice that the user information shall be removed ONLY by the end user.

3-5.4.4* The fire shelter manufacturer shall provide at least the following instructions and information with each shelter:

(a) Pre-use information
    1. Safety considerations
    2. Limitations of use
    3. A statement that most protective properties of the shelter cannot be tested by the user in the field
    4. Warranty information

(b) Recommended storage practices
(c) Inspection frequency and details
(d) Deployment of shelter
(e) Maintenance and cleaning
(f) Retirement and disposal

3-6 Protective Face/Neck Shroud.

3-6.1 Product Labeling Requirements.

3-6.1.1 Each face/neck shroud shall have a product label or labels permanently and conspicuously attached. At least one product label shall be conspicuously located inside each face/neck shroud when the shroud is properly assembled with all layers and components in place.

3-6.1.2 Configuration of the product label and attachment of the product label shall not interfere with the legibility of any printed portion of the product label.

3-6.1.3 Multiple label pieces shall be permitted in order to carry all statements and information required to be on the product label.

3-6.1.4* The certification organization's label, symbol, or identifying mark shall be permanently attached to the product label or shall be part of the product label.

3-6.1.5 All worded portions of the required product label shall be printed at least in English.

3-6.1.6 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product label(s).

3-6.1.7 The following statement shall be printed legibly on the product label with all letters shall be at least 2.5 mm ($^3/_{32}$ in.) high.
"THIS WILDLAND FIRE FIGHTING PROTECTIVE FACE/NECK SHROUD MEETS THE SHROUD REQUIREMENTS OF NFPA 1977, STANDARD ON PROTECTIVE CLOTHING AND EQUIPMENT FOR WILDLAND FIRE FIGHTING, 1998 EDITION."

3-6.1.8 At least the following information shall also be printed legibly on the product label with all letters at least 2 mm ($^1/_{16}$ in.) high:

(a) Manufacturer's name, identification, or designation
(b) Manufacturer's address
(c) Country of manufacture
(d) Manufacturer's shroud identification number, lot number, or serial number
(e) Month and year of manufacture (not coded)
(f) Model or style name, number, or design
(g) Size
(h) Shroud materials and percent content
(i) Cleaning precautions
(j) The following statement: "DO NOT REMOVE THIS LABEL."

3-6.2 User Information.

3-6.2.1 The face/neck shroud manufacturer shall provide at least the user information that is specified in 3-6.2.4 with each shroud.

3-6.2.2 The shroud manufacturer shall attach the required user information, or packaging containing the user information, to the shroud in such a manner that it is not possible to use the shroud without being aware of the availability of the information.

3-6.2.3 The required user information, or packaging containing the user information, shall be attached to the shroud so that a deliberate action is necessary to remove it. The garment manufacturer shall provide notice that the user information is to be removed ONLY by the end user.

3-6.2.4 The garment manufacturer shall provide at least the following instructions and information with each garment.

(a) Pre-use information
    1. Safety considerations
    2. Limitations of use
    3. Shroud marking recommendations and restrictions
    4. A statement that most performance properties of the shroud cannot be tested by the user in the field
    5. Warranty information
(b) Preparation for use
    1. Sizing/adjustment
    2. Recommended storage practices
(c) Inspection frequency and details
(d) Don/doff
    1. Donning and doffing procedures
    2. Sizing and adjustment procedures
    3. Interface issues
(e) Proper use consistent with NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program,* and Title 29, *Code of Federal Regulations,* Part 1910.132, "Personal Protective Equipment"
(f) Maintenance and cleaning
    1. Cleaning instructions and precautions with a statement advising users not to use shrouds that are not thoroughly cleaned and dried
    2. Maintenance criteria and methods of repair where applicable
    3. Decontamination procedures
(g) Retirement and disposal criteria and considerations

Chapter 4 Design Requirements

4-1* Protective Garment Design Requirements.

4-1.1 Sample garments shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 2-3.

4-1.2 All collars on jackets, shirts, and one-piece garments shall remain upright after extension into a vertical position.

4-1.3* Jackets, shirts, and one-piece garments shall not have turn-up cuffs. Sleeve cuffs shall have a closure system that can be adjusted to provide a snug and secure fit around the wrist while wearing a glove that is compliant with the glove requirements of this standard.

4-1.4* Where provided, all pockets that open to the exterior of garments, other than front waist pockets, shall have a cover or closure system.

4-1.5* Any pass-through openings in garments shall have a means of fastening them in a closed position.

4-1.6 Bottoms of upper-torso garments shall be designed so that the bottom edge conforms to the respective front and back lengths specified in Table 4-1.15.1(a). No portion of the bottom garment edge shall be less than the respective minimum front and back length measurement.

4-1.6.1 With an upper torso garment prepared as specified in 4-1.15.5, a line shall be formed between the two lowest points on the garment bottom edge. Minimum front and back lengths shall extend to that line as a minimum.

4-1.7 All snaps shall meet the requirements of MS 27980F, *Fasteners, Snap, Style 2*, of Fasteners, Snap, MIL-F-10884G.

4-1.8 Fastener tape shall meet the requirements of A-A-55126, Fastener Tapes, Hook and Pile, Synthetic.

4-1.9 Zippers shall meet the requirements of V-F-106F, *Fasteners, Slide Interlocking*.

4-1.10 All thread used to manufacture garments shall be made of inherently flame-resistant fiber.

4-1.11 All garments that encompass the neck area shall have a closure system at the neckline.

4-1.12 All closure systems shall not come into direct contact with the body. Hardware of any garment shall not come into direct contact with the wearer's body.

4-1.13 All garment hardware finish shall be free of rough spots, burrs, or sharp edges.

4-1.14 One-piece garment torso closure systems shall extend from the top of crotch area to top of garment at the neck.

4-1.15* Size Requirements.

4-1.15.1 Manufacturers shall produce garments in accordance with the minimum sizing requirements indicated in Tables 4-1.15.1(a), 4-1.15.1(b), 4-1.15.1(c), and 4-1.15.1(d).

4-1.15.2 Size requirements for tall sizes for upper-torso measurements as specified in Tables 4-1.15.1(a) and 4-1.15.1(c) shall have an additional 25 mm (1 in.) added to the sleeve length dimension and an additional 38 mm ($1^1/_2$ in.) added to the front and back length dimensions.

4-1.15.3 Garments shall be permitted for sizes midway between those specified, provided that they meet dimensional requirements that are midway between the respective values for corresponding even sizes specified in Tables 4-1.15.1(a), 4-1.15.1(b), 4-1.15.1(c), and 4-1.15.1(d).

4-1.15.4 Garments shall be permitted to be custom made, provided that the individual is measured for all dimensions cited in the sizing tables and that the garment provides the minimum ease specified in Table 4-1.15.4.

Table 4-1.15.1(a) Minimum Sizing Requirements for Protective Upper-Torso Garments (in.)

	Garment Size	XS	S	M	L	XL	2XL	
*	Neck size	$13–13^1/_2$	$14–14^1/_2$	$15–15^1/_2$	$16–16^1/_2$	$17–17^1/_2$	$18–18^1/_2$	**
A	Collar length	$14^3/_4$	$15^3/_4$	$16^3/_4$	$17^3/_4$	$18^3/_4$	$19^3/_4$	1
B	Collar width	3	3	3	3	3	3	0
C	Front length	26	27	28	29	30	31	1
D	Back length	28	29	30	31	32	33	1
E	Sleeve length	$30^1/_2$	$31^1/_2$	$32^1/_2$	$33^1/_2$	$34^1/_2$	$35^1/_2$	1
F	Cuff	$12^1/_2$	13	$13^1/_2$	14	$14^1/_2$	15	$^1/_2$
G	Chest	39	43	47	51	55	59	4
H	Waist	33	37	41	45	49	53	4
I	Bottom	39	43	47	51	55	59	4

Note: To convert measurements to millimeters multiply by 25.
*See upper torso measurements in Figure 4-1.15.5(a).
**The amount of change between two consecutive garment sizes for the dimension measured.

Table 4-1.15.1(b) Minimum Sizing Requirements for Men's Lower-Torso Protective Garments (in.)

*	Garment Size	26	28	30	32	34	36	38	40	**
A	Waist	26	28	30	32	34	36	38	40	2
B	Seat	37	39	41	43	45	47	49	51	2
C	Thigh	25	26	27	28	29	30	31	32	1
D	Knee	$17^1/_2$	$18^1/_4$	19	$19^3/_4$	$20^1/_2$	$21^1/_4$	22	$22^3/_4$	$^3/_4$
E	Cuff	17	18	$18^1/_2$	19	$19^1/_2$	20	$20^1/_2$	21	$^1/_2$
F	Front rise	$11^1/_8$	$11^7/_{16}$	$11^3/_4$	$12^1/_{16}$	$12^5/_{16}$	$12^5/_8$	$12^{15}/_{16}$	$13^1/_4$	$^5/_{16}$
G	Back rise	$16^5/_8$	$16^{15}/_{16}$	$17^1/_4$	$17^9/_{16}$	$17^7/_8$	$18^3/_{16}$	$18^1/_2$	$18^{13}/_{16}$	$^5/_{16}$
H	Inseam	Shall be cut to order or provided in 1-in. increments between 28–36 in.								

Note: To convert measurements to millimeters multiply by 25.
*See lower torso measurements in Figure 4-1.15.5(b).
**The amount of change between two consecutive garment sizes for the dimension measured.

Table 4-1.15.1(c) Minimum Sizing Requirements forWomen's Lower-Torso Protective Garments (in.)

*	Garment Size	23	25	27	29	31	33	35	37	**
A	Waist	23	25	27	29	31	33	35	37	2
B	Seat	37	39	41	43	45	47	49	51	2
C	Thigh	25	26	27	28	29	30	31	32	1
D	Knee	$17^1/_2$	$18^1/_4$	19	$19^3/_4$	$20^1/_2$	$21^1/_4$	22	$22^3/_4$	$^3/_4$
E	Bottom	$17^1/_2$	18	$18^1/_2$	19	$19^1/_2$	20	$20^1/_2$	21	$^1/_2$
F	Front rise	$11^1/_8$	$11^7/_{16}$	$11^3/_4$	$12^1/_{16}$	$12^3/_8$	$12^{11}/_{16}$	13	$13^5/_{16}$	$^5/_{16}$
G	Back	$16^{11}/_{16}$	17	$17^5/_{16}$	$17^5/_8$	$17^{15}/_{16}$	$18^1/_4$	$18^9/_{16}$	$18^7/_8$	$^5/_{16}$
H	Inseam	Shall be cut to order or provided in 1-in. increments between 28–36 in.								

Note: To convert measurements to millimeters multiply by 25.
*See lower torso measurements in Figure 4-1.15.5(b).
**The amount of change between two consecutive garment sizes for the dimension measured.

Table 4-1.15.1(d) Minimum Sizing Requirements for Protective One-Piece Garments (in.)

*	Garment Size		XS	S	M	L	XL	**
	Chest		32	36	40	44	48	
A	Neck size		7	$7^1/_2$	8	$8^1/_2$	9	
B	Collar length		$14^3/_4$	$15^3/_4$	$16^3/_4$	$17^3/_4$	$18^3/_4$	1
C	Collar width		3	3	3	3	3	0
D	Sleeve length		$30^1/_2$	$31^1/_2$	$32^1/_2$	$33^1/_2$	$34^1/_2$	1
E	Cuff, sleeve		$12^1/_2$	13	$13^1/_2$	14	$14^1/_2$	$^1/_2$
F	Chest		32	36	40	44	48	4
G	Seat		37	41	45	49	53	4
H	Thigh		25	27	29	31	33	2
I	Knee		$17^1/_2$	19	$20^1/_2$	22	$23^1/_2$	$1^1/_2$
J	Bottom		$17^1/_2$	$18^1/_2$	$19^1/_2$	$20^1/_2$	$21^1/_2$	1
K	Vertical	S	—	—	69	$71^1/_2$	74	
	circumference	R	$63^1/_2$	$63^1/_2$	71	$73^1/_2$	76	—
		T	$65^1/_2$	$65^1/_2$	73	$75^1/_2$	78	
	Height range	S	—		64–67			—
		R	63–66		$67^1/_2$–72			
		T	$66^1/_2$–69		$72^1/_2$–75			

Note: To convert measurements to millimeters multiply by 25.
*See respective upper and lower torso measurements in Figures 4-1.15.5(a) and (b).
**The amount of change between two consecutive garment sizes for the dimensions measured.

S = Short size.
R = Regular size.
T = Tall size.

Table 4-1.15.4 Ease

Dimension	Men	Women
Upper Torso Garment		
Neck circumference	+1	+1
Chest circumference	+6	+6
Hip circumference	+6	+6
Bottom circumference	+6	+6
Cuff circumference	+6	+6
Amount of front and back length extending below top of hip line	+6	+6
Lower Torso Garment		
Waist circumference	+1	+1
Seat circumference	+6	+7
Thigh circumference	+6	+6

Table 4-1.15.4 Ease *(Continued)*

Dimension	Men	Women
Knee circumference	+6	+6
Bottom circumference	+11	+11
Rise (front and back)	+6	+11
One-Piece Garment		
Neck circumference	+1	+1
Chest circumference	+6	+6
Cuff circumference	+6	+6
Seat circumference	+6	+7
Thigh circumference	+6	+6
Knee circumference	+6	+6
Bottom circumference	+11	+11
Vertical circumference	+10	+10

4-1.15.5 Garments shall be closed, laid flat, smoothed, and gently stretched when measured as defined in Section 1-3, and as specified in Section 4-1 and in Figures 4-1.15.5(a), (b), and (c).

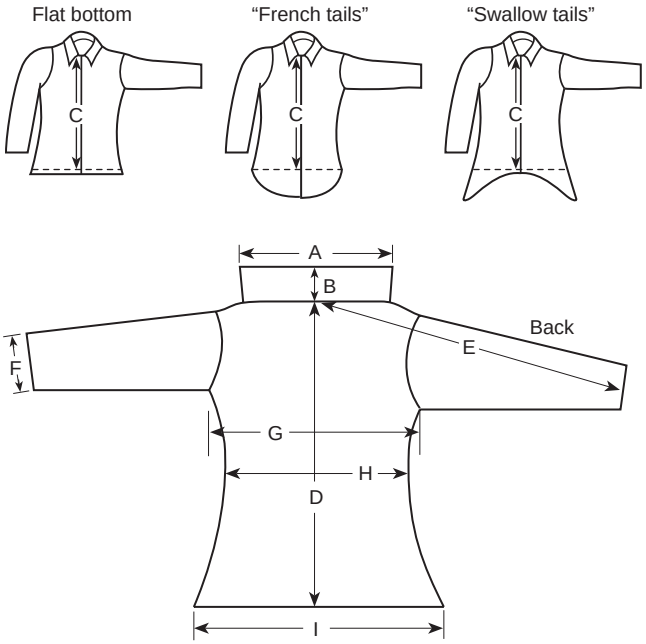


Figure 4-1.15.5(a) Upper-torso measurements.

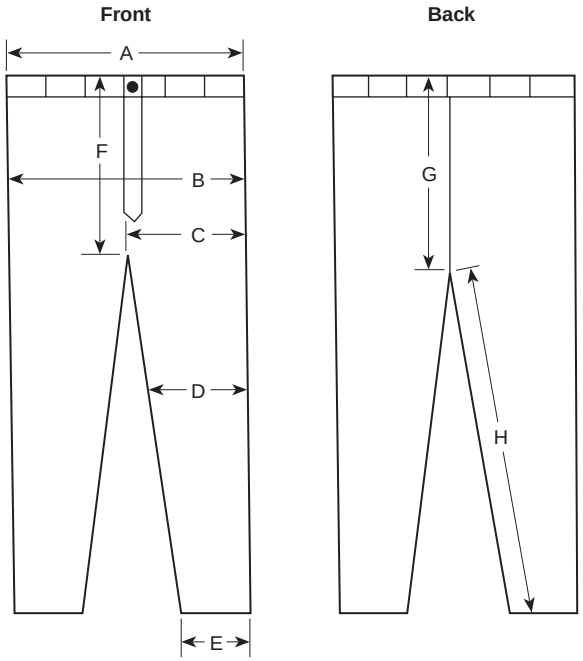
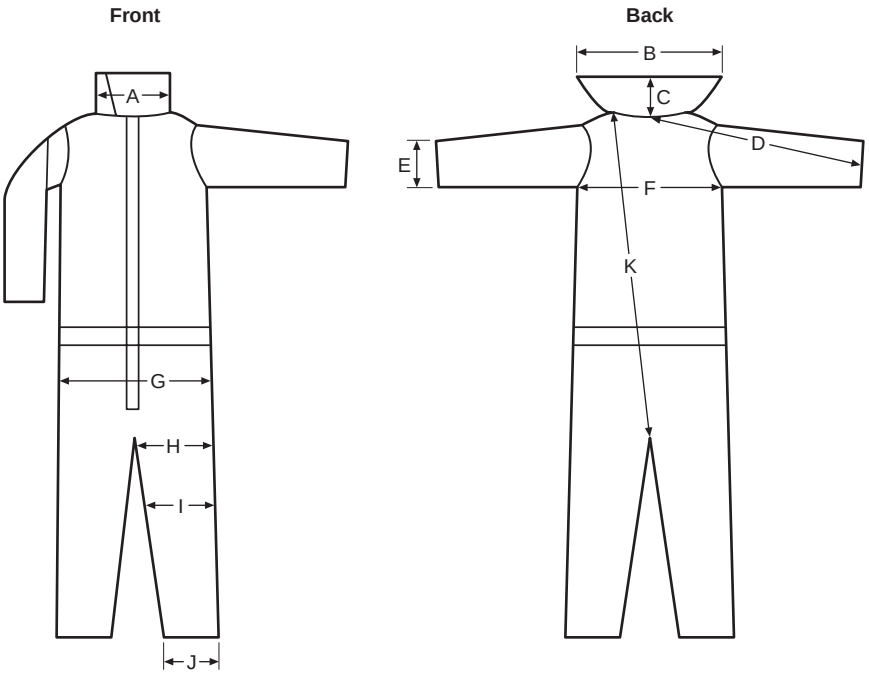


Figure 4-1.15.5(b) Lower-torso measurements.



A. Neck
B. Collar length
C. Collar width
D. Sleeve length
E. Cuff
F. Chest
G. Seat
H. Thigh
I. Knee
J. Bottom
K. Vertical circumference

Figure 4-1.15.5(c) One-piece garment torso measurements.

4-1.16 The minimum seam allowance for all Major seams shall be at least 10 mm ($^3/_8$ in.), and all Minor seams shall be at least 6 mm ($^1/_4$ in.).

4-2 Protective Helmet Design Requirements.

4-2.1 Sample helmets shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 2-3.

4-2.2 Helmets shall be designed to consist of at least a shell with a brim or peak, a means of absorbing energy, suspension system with sweatband, chin strap, nape device, goggle clips, and retroreflective markings. Provisions shall be made for ventilation between the head and the helmet shell.

4-2.3 All materials used in the helmet construction that are designed to come in contact with the wearer's head or skin shall be known to be nonirritating to normal skin.

4-2.4 The helmet complete with energy-absorbing system, suspension system with sweatband, chin strap, nape device, goggle clips, and retroreflective markings shall not weigh more than 570 g (20 oz).

4-2.5 The helmet shall be generally dome shaped. The area under the peak or the front of the brim shall be permitted to be covered only with a nonconducting, nonflammable, antiglare material. Clips for headlamps or goggles shall be permanently attached with at least one clip at the rear of the helmet, and one clip on each side of the helmet. Clips shall be suitably located to retain straps and shall not be attached more than 55 mm ($2^3/_{16}$ in.) above the lower edge of the helmet.

4-2.6 Suspension shall contain a nape device and shall be removable and replaceable. The suspension shall be adjustable in $^1/_8$ hat size or smaller increments. When the suspension is adjusted to the maximum designated size, there shall be sufficient clearance between the shell and the suspension to provide ventilation.

4-2.7 A sweatband shall be provided that shall cover at least the forehead portion of the suspension system. Sweatbands shall be either removable and replaceable or shall be integral with the suspension.

4-2.8 The helmet shall be designed so that the distance between the top of the head and the underside of the shell cannot be adjusted to less clearance than the manufacturer's requirements for that specific helmet.

4-2.9 Chin straps shall be provided that attach to the helmet shell. Both chin and nape straps shall not be less than 13 mm ($^1/_2$ in.) in width.

4-2.10 All helmets shall have retroreflective markings on the exterior of the shell. A minimum of 2580 mm^2 (4 $in.^2$) of retroreflective markings shall be visible when the helmet is viewed from the sides, front, and rear. The retroreflective markings shall be placed above the goggle or headlamp clips so as not to be obscured by any clip, or the strap retained by the clips.

4-2.11 Accessories.

4-2.11.1 Cold weather liners, where provided, shall meet the applicable requirements specified in Section 5-1.

4-2.11.2 Accessories shall be permitted to be mounted through the use of openings provided along the lower edge of the helmet shell. These openings in the shell, where provided, shall be designed with an inner wall that shall extend below the electrical test line as determined in 6-10.2.1.

4-2.11.3 The openings in helmet shells provided for mounting of accessories shall be permitted to be filled by gaskets or other means, provided the helmet will continue to meet the requirements specified in Section 5-2.

4-2.11.4 The addition of helmet accessories shall not interfere with the function of the helmet or its component parts and shall not degrade the helmet's performance below the requirements of this standard.

4-3 Protective Glove Design Requirements.

4-3.1 Sample gloves shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 2-3.

4-3.2 Glove bodies shall be designed such that they closely conform to the wrist or are adjustable at the wrist and shall extend a minimum of 25 mm (1 in.) past the wrist crease. The location of the wrist crease shall be as shown in Figure 4-3.2.

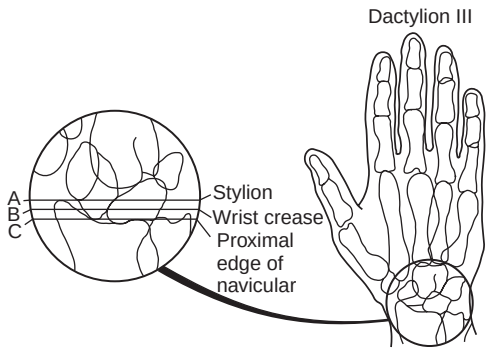


Figure 4-3.2 Anatomical landmarks at base of hand.

4-3.3 All thread used to manufacture gloves shall be made of inherently flame-resistant fiber.

4-3.4 Sizing.

4-3.4.1 In order to label or otherwise indicate that a glove complies with the requirements of this standard, the manufacturer shall provide gloves in not less than five separate and distinct sizes. The manufacturer shall provide the purchaser with the hand dimension ranges specified in 4-3.4.2. Custom sized gloves outside of the ranges specified in this section shall be permitted in addition to the required five sizes.

4-3.4.2 The glove size indicated on the product label shall be determined by the hand dimensions given in Tables 4-3.4.2(a) through (e).

4-4 Protective Footwear Design Requirements.

4-4.1 Sample footwear shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 2-3.

Table 4-3.4.2(a) Sizing for Extra-Small (XS) Glove

Range			mm	(in.)
Hand Length			**163–173**	**(6.40–6.79)**
Hand Circumference			**163–203**	**(6.40–7.97)**
	Mid-Size Value		**Range to Be Accommodated**	
	mm	**(in.)**	**mm**	**(in.)**
Digit 1 circumference	62	(2.43)	56–67	(2.20–2.65)
Digit 2 circumference	61	(2.39)	55–66	(2.17–2.61)
Digit 3 circumference	61	(2.39)	55–66	(2.18–2.61)
Digit 4 circumference	57	(2.24)	51–63	(2.02–2.46)
Digit 5 circumference	50	(1.97)	45–55	(1.76–2.17)
Digit 1 length	49	(1.94)	44–55	(1.72–2.17)
Digit 2 length	64	(2.54)	58–71	(2.26–2.80)
Digit 3 length	73	(2.87)	67–79	(2.64–3.10)
Digit 4 length	68	(2.67)	61–74	(2.41–2.92)
Digit 5 length	51	(2.00)	45–57	(1.78–2.23)
Hand circumference	183	(7.19)	163–202	(6.43–7.94)
Hand length	168	(6.59)	163–172	(6.41–6.78)

Table 4-3.4.2(b) Sizing for Small (S) Glove

Range			mm	(in.)
Hand Length			**17.25–18.25**	**(6.79–7.19)**
Hand Circumference			**17.25–21.25**	**(6.79–8.37)**
	Mid-Size Value		**Range to Be Accommodated**	
	mm	**(in.)**	**mm**	**(in.)**
Digit 1 circumference	64	(2.52)	58–70	(2.29–2.74)
Digit 2 circumference	63	(2.48)	57–69	(2.26–2.70)
Digit 3 circumference	63	(2.48)	58–69	(2.27–2.70)
Digit 4 circumference	59	(2.33)	54–65	(2.11–2.56)
Digit 5 circumference	52	(2.06)	47–57	(1.85–2.26)
Digit 1 length	53	(2.09)	47–59	(1.87–2.32)
Digit 2 length	69	(2.71)	62–76	(2.44–2.98)
Digit 3 length	77	(3.04)	66–78	(2.58–3.08)
Digit 4 length	72	(2.83)	49–60	(1.92–2.37)
Digit 5 length	54	(2.14)	49–60	(1.92–2.37)
Hand circumference	193	(7.58)	173–212	(6.83–8.33)
Hand length	178	(6.99)	173–182	(6.80–7.18)

Table 4-3.4.2(c) Sizing for Medium (M) Glove

Range			mm	(in.)
Hand Length			**183–193**	**(7.19–7.58)**
Hand Circumference			**183–223**	**(7.19–8.76)**
	Mid-Size Value		**Range to Be Accommodated**	
	mm	**(in.)**	**mm**	**(in.)**
Digit 1 circumference	70	(2.76)	64–77	(2.50–3.01)
Digit 2 circumference	68	(2.69)	63–73	(2.48–2.88)
Digit 3 circumference	68	(2.69)	63–74	(2.46–2.91)
Digit 4 circumference	63	(2.50)	58–69	(2.28–2.72)
Digit 5 circumference	56	(2.22)	51–62	(2.00–2.43)
Digit 1 length	56	(2.22)	50–63	(1.97–2.46)
Digit 2 length	71	(2.80)	65–77	(2.56–3.04)
Digit 3 length	81	(3.18)	76–86	(2.97–3.38)
Digit 4 length	76	(3.00)	71–81	(2.81–3.18)

Table 4-3.4.2(c) Sizing for Medium (M) Glove *(Continued)*

Range			mm	(in.)
Hand Length			**183–193**	**(7.19–7.58)**
Hand Circumference			**183–223**	**(7.19–8.76)**
	Mid-Size Value		**Range to Be Accommodated**	
	mm	**(in.)**	**mm**	**(in.)**
Digit 5 length	58	(2.28)	52–64	(2.03–2.52)
Hand circumference	203	(7.97)	183–223	(7.22–8.72)
Hand length	188	(7.38)	183–192	(7.19–7.57)

Table 4-3.4.2(d) Sizing for Large (L) Glove

Range			mm	(in.)
Hand Length			**193–203**	**(7.58–7.97)**
Hand Circumference			**193–233**	**(7.58–9.15)**
	Mid-Size Value		**Range to Be Accommodated**	
	mm	**(in.)**	**mm**	**(in.)**
Digit 1 circumference	73	(2.86)	66–79	(2.61–3.11)
Digit 2 circumference	70	(2.77)	65–75	(2.57–2.97)
Digit 3 circumference	71	(2.80)	65–77	(2.57–3.02)
Digit 4 circumference	66	(2.60)	60–72	(2.38–2.82)
Digit 5 circumference	59	(2.30)	53–64	(2.09–2.52)
Digit 1 length	59	(2.31)	52–65	(2.06–2.56)
Digit 2 length	75	(2.95)	69–81	(2.71–3.19)
Digit 3 length	85	(3.36)	80–91	(3.16–3.57)
Digit 4 length	80	(3.16)	76–85	(2.98–3.35)
Digit 5 length	61	(2.41)	55–68	(2.17–2.66)
Hand circumference	213	(8.37)	193–232	(7.61–9.12)
Hand length	198	(7.78)	193–202	(7.59–7.96)

Table 4-3.4.2(e) Sizing for Extra-Large (XL) Glove

Range			mm	(in.)
Hand Length			**203–213**	**(7.97–8.37)**
Hand Circumference			**203–243**	**(7.97–9.55)**
	Mid-Size Value		**Range to Be Accommodated**	
	mm	**(in.)**	**mm**	**(in.)**
Digit 1 circumference	75	(2.96)	69–82	(2.70–3.21)
Digit 2 circumference	73	(2.85)	67–78	(2.65–3.06)
Digit 3 circumference	74	(2.90)	68–79	(2.67–3.12)
Digit 4 circumference	69	(2.70)	63–74	(2.48–2.92)
Digit 5 circumference	61	(2.39)	55–66	(2.17–2.60)
Digit 1 length	61	(2.41)	55–68	(2.16–2.66)
Digit 2 length	79	(3.09)	73–85	(2.86–3.33)
Digit 3 length	84	(3.32)	85–95	(3.35–3.76)
Digit 4 length	65	(2.55)	80–89	(3.14–3.51)
Digit 5 length	65	(2.55)	59–71	(2.30–2.80)
Hand circumference	223	(8.76)	203–242	(8.01–9.51)
Hand length	208	(8.17)	203–212	(7.98–8.36)

4-4.2* Footwear shall consist of a sole with heel, upper, insole, and shank. The quarter section of the boot shall be designed to provide an adjustable, snug fit for support around the ankle and lower leg.

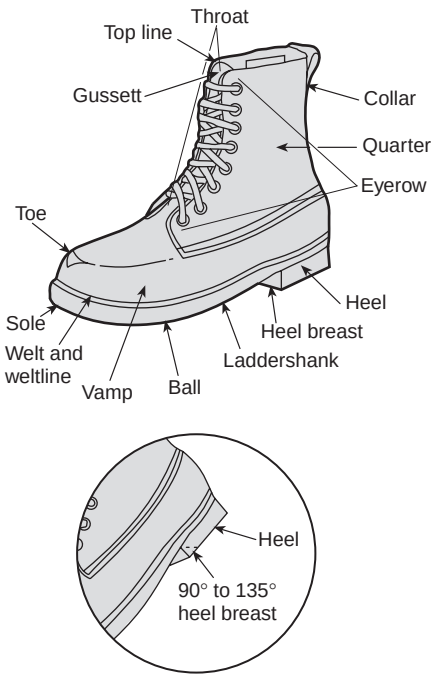


Figure 4-4.2 Footwear terms.

4-4.3 Heel breast shall not be less than 13 mm ($^1/_2$ in.). Heel breasting angle shall not be less than 90 degrees nor more than 135 degrees relative to the sole and as shown in Figure 4-4.2.

4-4.4 Footwear height shall be a minimum of 200 mm (8 in.). The height shall be determined by measuring inside the boot from the center of the insole at the heel up to a perpendicular reference line extending across the width of the boot at the lowest point of the top line. Removable insole inserts shall not be removed prior to measurement.

4-4.5 Metal parts shall not penetrate from the outside into the inside at any point, unless covered.

4-4.6 Where used, there shall be a minimum of four metal stud hooks on each side of the eyerow and they shall meet the requirements of 5-4.2 and 5-4.8.

4-4.7 Eyelets shall be constructed of coated steel, solid brass, brass-coated nickel, or nickel.

4-4.8 All thread used to manufacture footwear shall be made of inherently flame-resistant fiber.

4-4.9 Sizing.

4-4.9.1* Protective footwear shall be available in all of the following sizes:

Men's: 5-13, including half sizes and a minimum of three widths.

Women's: 5-10, including half sizes and a minimum of three widths.

4-4.9.2 Manufacturers shall be required to establish and provide, upon request, a size conversion chart for each model or style of protective footwear based on toe length, arch length, and foot width as measured on the Brannock Foot Measuring Device.

4-4.9.3 Full and half sizes, in each of the three required widths, shall be accomplished by individual and unique lasts to provide proper fit.

4-5* Protective Shelter Design Requirements.

4-5.1 The fire shelter shall conform to USDA Forest Service Specification 5100-320G, *Shelter, Fire.*

4-5.2* The fire shelter shall be enclosed in a carrying case liner. The fire shelter carrying case liner shall conform to USDA Forest Service Specification 5100-00323B, *Liner, Fire Shelter, Carrying Case.*

4-5.3* The fire shelter, enclosed in a carrying case liner, shall be enclosed in a carrying case. The carrying case shall conform to USDA Forest Service Specification 5100-322D, *Case, Carrying, Fire Shelter.*

4-6 Face/Neck Shroud Design Requirements.

4-6.1 Sample face/neck shrouds shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 2-3.

4-6.2 Face/neck shrouds shall be designed to cover and provide the limited protection to the face and neck areas, as specified within this section, that do not receive primary protection from the helmet.

4-6.3 Shrouds shall be measured to determine the areas of coverage. The shroud shall be donned properly in the position that it is intended to be worn, as specified by the manufacturer, on an ISO Size J Headform. In this position, the shroud shall provide a minimum coverage on each side, measured downward from the reference plane at the coronal plane, of 200 mm (8 in.). The shroud shall provide a minimum coverage in the back, measured downward from the reference plane at the rear mid-sagittal plane, of 210 mm ($8^1/_4$ in.) and shall provide a minimum coverage in the front, measured downward from the reference plane at the front mid-sagittal plane, of 200 mm (8 in.). The face opening shall not be considered as a gap in coverage.

4-6.4 The shroud shall be designed with a face opening. The shroud face opening shall not exceed 170 mm ($6^3/_4$ in.) when measured along the reference plane. The bottom of the shroud face opening shall not exceed 40 mm ($1^1/_2$ in.) when measured downward from the reference plane at the front mid-sagittal plane.

4-6.5 Shrouds shall have a closure system. The closure system shall not come in contact with the face or neck when the shroud is positioned as specified in 4-6.4.

4-6.6* The shroud shall attach to the helmet.

4-6.7 All snaps shall meet the requirements of MS 27980F, *Fasteners, Snap, Style 2 of Fasteners, Snap,* MIL-F-10884G.

4-6.8 Fastener tape shall meet the requirements of A-A-55126, *Fastener Tapes, Hook and Pile, Synthetic.*

4-6.9 Zippers shall meet the requirements of V-F-106F, *Fasteners, Slide, Interlocking.*

4-6.10 All thread used to manufacturer face/neck shrouds or face/neck shroud components shall be made of inherently flame-resistant fiber.

4-7 Accessory Design Requirements.

4-7.1 All hardware, brackets, and snaps or other fasteners of any accessories shall be free of rough spots, burrs, or sharp edges.

4-7.2 Any accessories attached to any wildland fire-fighting protective clothing or equipment item shall not interfere with the function(s) of the item or with the function(s) of any of the item's component parts.

4-7.3 Where any wildland fire-fighting protective clothing or equipment item is provided with an accessory or accessories that are attached to or integrated with the item, the item shall meet all of the design and performance requirements of this standard with accessories installed. In all cases, such accessories shall not degrade the performance of the protective clothing or equipment item below the requirements of this standard.

4-7.4* Face Protectors.

4-7.4.1 Face protectors shall be an optional accessory, but where provided, face protectors shall be designed to cover and provide limited thermal protection to the face and neck area without interfering with the wearer's vision.

4-7.4.2 Where the face protector incorporates a closure system, such closure systems shall not come into direct contact with a wearer's body.

4-7.4.3 Face protectors shall not attach to the protective helmet.

Chapter 5 Performance Requirements

5-1* Protective Garment Performance Requirements.

5-1.1 Specimens of garment textile fabrics or specimens of garment composites shall be tested for radiant protective performance as specified in Section 6-2, Radiant Protective Performance (RPP), and shall have an average RPP value of not less than eight.

5-1.2 Specimens of garment textile fabrics or specimens of garment composites, collar linings, cold weather liners where provided, trim, lettering, and other materials used in garment construction — including, but not limited to, linings, padding, reinforcements, bindings, hanger loops, emblems, and patches, but excluding hook and pile fasteners, elastic and interlinings where not in direct contact with the skin — shall be individually tested for resistance to flame as specified in Section 6-3, Flame Resistance Test, and shall not have a char length of more than 100 mm (4 in.) average, shall not have an afterflame of more than 2 seconds average, and shall not melt or drip.

5-1.2.1 Small specimens — such as hanger loops, emblems, and patches — that are not large enough to meet the specimen size requirements in 6-3.2.1 shall be tested for resistance to flame as specified in Section 6-3, Flame Resistance Test, and shall not be totally consumed, shall not have an afterflame of more than 2 seconds average, and shall not melt or drip.

5-1.3 Specimens of garment textile fabrics and interlinings or specimens of garment composites, cold weather liners where provided, and collar linings shall be individually tested for resistance to heat as specified in Section 6-4, Heat and Thermal Shrinkage Resistance Test, and shall not shrink more than 10 percent in any direction.

5-1.4 Specimens of garment textile fabrics and interlinings, or specimens of garment composites, cold weather liners where provided, trim, lettering, and other materials used in garment construction — including, but not limited to, padding, reinforcements, labels, wristlets, collars, closures, fasteners, bindings, hanger loops, emblems, and patches, but excluding hook and pile fasteners and elastic where not in direct contact with the skin — shall be individually tested for resistance to heat as specified in Section 6-4, Heat and Thermal Shrinkage Resistance Test, and shall not melt, drip, separate, or ignite. In addition, garment textile fabrics shall not char.

5-1.5 Specimens of all garment hardware shall be individually tested for resistance to heat as specified in Section 6-4, Heat and Thermal Shrinkage Resistance Test, and shall not ignite and shall remain functional.

5-1.6 Specimens of the garment composite shall be tested for evaporative heat transfer as specified in Section 6-5, Total Heat Loss Test, and shall have a total heat loss of not less than 450 W/m^2.

5-1.7* Specimens of garment textile fabrics, collar linings, and cold weather liners where provided shall be individually tested for resistance to tearing as specified in Section 6-6, Tear Resistance Test, and shall have a tear strength of not less than 22 N (5 lbf).

5-1.8 Specimens of garment textile fabrics, cold weather liners where provided, and collar linings shall be individually tested for resistance to shrinkage as specified in Section 6-7, Cleaning Shrinkage Resistance Test, and shall not shrink more than 5 percent in any direction.

5-1.9 Specimens of all garment seam assemblies shall be tested for strength as specified in Section 6-8, Seam Breaking Strength Test.

5-1.9.1 Specimens of woven garment seam assemblies and specimens of seam assemblies that contain at least one woven material shall demonstrate a sewn seam strength equal to or greater than 315 N (70 lbf) force for Major seams, 225 N (50 lbf) force for Minor seams.

5-1.9.2 Where the fabric strength is less than the required seam strength specified in 5-1.9.1, providing the fabric fails without failure of the seam below the applicable forces specified in 5-1.9.1, the seam breaking strength shall be considered acceptable.

5-1.10 All sewing thread utilized in the construction of garments shall be tested for resistance to melting as specified in Section 6-9, Thread Heat Resistance Test, and shall not ignite, melt, or char.

5-1.11 Specimens of all garment product labels shall be tested for legibility as specified in Section 6-32, Label Durability and Legibility Test One, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

5-2 Protective Helmet Performance Requirements.

5-2.1* Specimen helmets shall be tested for electrical insulation as specified in Section 6-10, Electrical Insulation Test, and shall not have any electrical leakage exceed 3 mA. Where sample

helmet(s) have no permanent metallic hardware mounted to helmet shell, such helmets shall be tested to Test Procedure A. Where sample helmet(s) have permanent metallic hardware mounted to helmet shell, such helmets shall be tested to Test Procedure B.

5-2.2 Specimen helmets shall be tested for resistance to top impact as specified in Section 6-11, Top Impact Resistance Test (Force), and shall have no specimen transmit an average force of more than 3780 N (850 lbf). No individual specimen shall transmit a force of more than 4450 N (1000 lbf). Disengagement of, deformation of, or damage to the helmet shell or component parts shall not in itself constitute failure.

5-2.3 Specimen helmets shall be tested for penetration resistance as specified in Section 6-12, Helmet Physical Penetration Resistance Test, and the penetration striker shall not make contact with the headform as indicated by the contact indicator.

5-2.4 Specimen helmets, and any antiglare material, where provided as permitted in 4-2.4, shall be tested for flame resistance as specified in Section 6-13, Helmet Flammability Test, and shall not show any visible afterflame time greater than 5 seconds.

5-2.5 Specimen helmets shall be tested for heat resistance as specified in Section 6-18, Heat Distortion Test, and shall not have any deformation of the brim or peak exceed 25 percent of its length.

5-2.6 Specimen helmets shall be tested for suspension system separation as specified in Section 6-15, Suspension System Retention Test. The force required to separate any individual attachment point of the suspension assembly from the helmet shell and each adjusting mechanism of the suspension system assembly, shall not be less than 22 N (5 lbf). There shall not be any failure of any adjusting mechanism to function properly.

5-2.7 Specimens of helmet trim shall be tested for retroreflectivity as specified in Section 6-16, Retroreflectivity Test, and shall have a coefficient of retroreflection (R_a) of not less than 100 cd/lux/m^2 (100 cd/fc/ft^2).

5-2.8 Specimens of each helmet chin strap shall be tested for retention system separation as specified in Section 6-17, Retention System Test, and shall have no failure of any mechanism to function properly, and the chin strap shall not exhibit any breakage and shall not stretch or slip more than 38 mm ($1^1/_2$ in.).

5-2.9 Specimen helmets with goggle or headlamp clips shall be tested for attachment strength as specified in Section 6-19, Goggle and Headlamp Clip Attachment Test, and shall not release from the shell, and shall not deflect more than 6 mm ($^1/_4$ in.) from their original position.

5-2.10 Specimens of all helmet product labels shall be tested for legibility as specified in Section 6-33, Label Durability and Legibility Test Two, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

5-3 Protective Gloves Performance Requirements.

5-3.1 Specimen gloves shall be tested for heat as specified in Section 6-14, Glove Heat Resistance Test, and shall not separate, melt, ignite, or drip, and shall not shrink more than 10 percent in either direction after testing.

5-3.2 Specimen gloves shall be tested for flame resistance as specified in Section 6-20, Glove Flame Resistance Test, and shall not melt or drip, shall not have any afterflame of more than 2 seconds, shall not have any char length in excess of 100 mm (4 in.), and the consumed materials shall not exceed 50 percent of the specimen's original weight.

5-3.3 Specimen gloves shall be tested for resistance to conductive heat as specified in Section 6-21, Conductive Heat Resistance Test, and shall have a second-degree burn time of not less than 7 seconds, and the pain time shall not be less than 4 seconds.

5-3.4 Specimen gloves shall be tested for thermal protective performance (TPP) as specified in Section 6-22, Thermal Protective Performance (TPP) Test, and shall have an average TPP of not less than 20.

5-3.5 Specimen gloves shall be tested for resistance to cutting as specified in Section 6-23, Cut Resistance Test, and the materials used for the outer surfaces of the glove shall not be cut through at any point of the test specimen.

5-3.6 Specimen gloves shall be tested for resistance to puncture as specified in Section 6-24, Puncture Resistance Test, and shall have a puncture force of not less than 45 N (10 lbf).

5-3.7 Specimen gloves shall be tested for dexterity as specified in Section 6-25, Dexterity Test, and shall demonstrate a dexterity test timing not exceeding 140 percent of baseline time.

5-3.8 Specimen gloves shall be tested for grip as specified in Section 6-26, Grip Test, and shall demonstrate a weight-pulling capacity of not less than 80 percent of the bare-handed control values.

5-3.9 Gloves shall be tested for fit as specified in Section 6-30, Glove Fit Test, and shall have glove fit determined by the finger length, finger circumference, glove circumference, and crotch offset as follows:

(a) The thumb and index finger of the hand shall reach the ends of the thumb and index finger of the glove.

(b) The middle and ring fingers of the glove shall be permitted to extend beyond the fingers of the hand no more than 10 mm ($^3/_8$ in.).

(c) The little finger of the glove shall be permitted to extend beyond the little finger of the hand no more than 13 mm ($^1/_2$ in.).

(d) The finger crotches of the glove shall be offset from the finger crotches of the hand no more than 13 mm ($^1/_2$ in.).

(e) The glove shall not constrict the fingers or the hand in circumference.

(f) Excess circumference of the glove over the fingers and hand shall be permitted, but shall not exceed 10 mm ($^3/_8$ in.) for any finger, or 38 mm ($1^1/_2$ in.) for the hand as a whole.

5-3.10 Specimens of all glove product labels shall be tested for legibility as specified in Section 6-32, Label Durability and Legibility Test One, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

5-3.11 All sewing thread utilized in the construction gloves shall be tested for resistance to melting as specified in Section 6-9, Thread Heat Resistance Test, and shall not ignite, melt, or char.

5-4 Protective Footwear Performance Requirements.

5-4.1 Specimen footwear shall be tested for resistance to heat as specified in Section 6-4, Heat and Thermal Shrinkage Resistance Test, and, excluding laces, shall have no part of the footwear melt, shall have no delamination of any part of the footwear, and shall have all accessories remain functional.

5-4.2 Specimens of footwear metal parts shall be tested for resistance to corrosion as specified in Section 6-27, Corrosion Resistance Test. Metals inherently resistant to corrosion — including but not limited to stainless steel, brass, copper, aluminum, and zinc — shall show no more than light surface-type corrosion or oxidation. Ferrous metals shall show no corrosion of the base metals. Accessories shall remain functional.

5-4.3 Specimen footwear shall be tested for resistance to cut as specified in Section 6-23, Cut Resistance Test, and shall not cut completely through the footwear material under an applied load of 8.2 kg (18 lb).

5-4.4 Specimen footwear shall be tested for resistance to puncture as specified in Section 6-24, Puncture Resistance Test, and shall have a puncture force of not less than 59 N (13 lbf).

5-4.5 Specimens of footwear sole and heel composites, excluding the sole and heel composites of caulked boots, shall be tested for resistance to abrasion as specified in Section 6-31, Footwear Abrasion Test, and shall have an abrasion resistance rating of not less than 100 NBS index.

5-4.6 Specimen footwear shall be tested for resistance to conductive heat as specified in Section 6-28, Footwear Conductive Heat Resistance Test, and the footwear inside sole surface temperature shall not exceed 44°C (111°F).

5-4.7 Specimens of footwear sole composites shall be tested for slip resistance as specified in ASTM F 489, *Standard Test Method for Using a James Machine*, and shall have a minimum static coefficient of friction value of 0.5.

5-4.8 Specimens of footwear eyelets and stud hooks shall be tested for attachment strength as specified in Section 6-29, Eyelet and Stud Post Attachment Test, and shall have a minimum detachment strength of 294 N (66 lbf).

5-4.9 Specimens of footwear, with accessories other than laces in place, shall be tested for resistance to flame as specified in Section 6-34, Flame Resistance Test for Footwear, and shall not have an afterflame greater than 2 seconds, and shall not melt, drip, or ignite.

5-4.10 Specimens of all footwear product labels shall be tested for legibility as specified in Section 6-32, Label Durability and Legibility Test One, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

5-4.11 All sewing thread utilized in the construction footwear shall be tested for resistance to melting as specified in Section 6-9, Thread Heat Resistance Test, and shall not ignite, melt, or char.

5-5 Face/Neck Shroud Performance Requirements.

5-5.1 Specimens of face/neck shroud textile fabrics or specimens of face/neck shroud composites shall be tested for radiant protective performance as specified in Section 6-2, Radiant Protective Performance (RPP) Test, and shall have an average RPP value of not less than 8.

5-5.2 Specimens of face/neck shroud textile fabrics or specimens of face/neck shroud composites, and other materials used in face/neck shroud construction — including, but not limited to, linings, padding, reinforcements, and bindings, but excluding hook and pile fasteners, elastic and interlinings where not in direct contact with the skin — shall be individually tested for resistance to flame as specified in Section 6-3, Flame Resistance Test One, and shall not have a char length of more than 100 mm (4 in.) average, shall not have an afterflame of more than 2 seconds average, and shall not melt or drip.

5-5.2.1 Small specimens that are not large enough to meet the specimen size requirements in 6-3.1 shall be tested for resistance to flame as specified in Section 6-3, Flame Resistance Test One, and shall not be totally consumed, shall not have an afterflame of more than 2 seconds average, and shall not melt or drip.

5-5.3 Specimens of face/neck shroud textile fabrics and interlinings or specimens of face/neck shroud composites shall be individually tested for resistance to heat as specified in Section 6-4, Heat and Thermal Shrinkage Resistance Test, and shall not shrink more than 10 percent in any direction.

5-5.4 Specimens of face/neck shroud textile fabrics and interlinings or specimens of face/neck shroud composites and other materials used in face/neck shroud construction — including, but not limited to, padding, reinforcements, labels, closures, fasteners, and bindings, but excluding hook and pile fasteners and elastic where not in direct contact with the skin — shall be individually tested for resistance to heat as specified in Section 6-4, Heat and Thermal Shrinkage Resistance Test, and shall not melt, drip, separate, or ignite. In addition, garment textile fabrics shall not char.

5-5.5 Specimens of all face/neck shroud hardware shall be individually tested for resistance to heat as specified in Section 6-4, Heat and Thermal Shrinkage Resistance Test, and shall not ignite and shall remain functional.

5-5.6 Specimens of face/neck shroud textile fabrics or specimens of face/neck shroud composites shall be individually tested for resistance to tearing as specified in Section 6-6, Tear Resistance Test, and shall have a tear strength of not less than 22 N (5 lbf).

5-5.7 Specimens of face/neck shroud textile fabrics or specimens of face/neck shroud composites shall be individually tested for resistance to shrinkage as specified in Section 6-7, Cleaning Shrinkage Resistance Test, and shall not shrink more than 5 percent in any direction.

5-5.8 Specimens of all face/neck shroud seam assemblies shall be tested for strength as specified in Section 6-8, Seam Breaking Strength Test.

5-5.8.1 Specimens of woven face/neck shroud seam assemblies and specimens of seam assemblies that contain at least one woven material shall demonstrate a sewn seam strength equal to or greater than 222 N (50 lbf).

5-5.8.2 Where the fabric strength is less than the required seam strength specified in 5-5.8.1, providing the fabric fails without failure of the seam below the force specified in 5-5.8.1, the seam breaking strength shall be considered acceptable.

5-5.9 All sewing thread utilized in the construction of face/neck shrouds shall be tested for resistance to melting as specified in Section 6-9, Thread Heat Resistance Test, and shall not ignite, melt, or char.

5-5.10 Specimens of all face/neck shroud product labels shall be tested for legibility as specified in Section 6-32, Label Durability and Legibility Test One, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

Chapter 6 Test Methods

6-1 Preconditioning.

6-1.1 Room Temperature Conditioning Procedure for Garments, Trim, Helmets, Gloves, and Footwear.

6-1.1.1 Garment, glove, and footwear specimens shall be conditioned at a temperature of 21°C, ±3°C (70°F, ±5°F) and a relative humidity of 65 percent, ±5 percent, until equilibrium is reached, as determined in accordance with ASTM D 1776, *Standard Practice for Conditioning Textiles for Testing*, or for at least 24 hours, whichever is shorter. Specimens shall be tested within 5 minutes after removal from conditioning.

6-1.2 Laundering Preconditioning.

6-1.2.1 Textile fabrics specified to be laundered shall be laundered and dried for testing in accordance with the procedures specified in Machine Cycle 3, Wash Temperature II, and Drying Procedure Aiii of AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*.

6-1.2.2* For textile fabrics that are specified as sensitive to high-phosphate AATCC 124 detergent, a substitute test detergent shall be permitted to be used for the washings.

6-1.2.3 A 1.8 kg ± 0.1 kg (4 lb ± 0.2 lb) load shall be used. A laundry bag shall not be used.

6-1.3 Low Temperature Environmental Conditioning Procedure for Helmets.

6-1.3.1 Specimens shall be conditioned by exposing them to a temperature of –18°C, ±1°C (0°F, ±2°F) for at least 4 hours. The impact/penetration test shall be completed within 15 seconds, ±5 seconds after removal from the cold temperature environment, or the specimens shall be reconditioned before testing.

6-1.4 Radiant Heat Environmental Conditioning Procedure for Helmets.

6-1.4.1 Sample helmets shall be conditioned by exposing the area to be impacted/penetrated to a radiant heat source. The test area to be impacted/penetrated shall be as specified in Figure 6-1.4.1.

6-1.4.2 The area to be impacted/penetrated shall be exposed to an irradiance of 1.0 W/cm^2, ±0.1 W/cm^2 for a length of time determined by exposure of a radiant heat transducer. The heat source shall be removed and the helmet shall be tested. The helmet shall be impacted/penetrated in 15 seconds, ±5 seconds after removal from the conditioning environment, or the helmet shall be cooled to room temperature and reconditioned before testing.

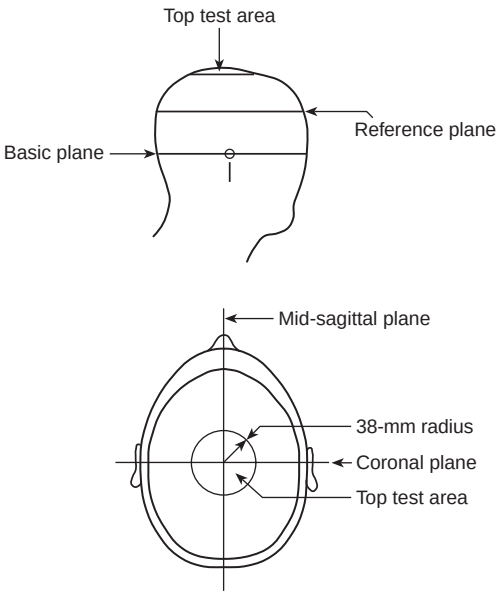


Figure 6-1.4.1 Helmet test area and landmarks.

6-1.4.3 The radiometer shall have a spectral response flat within ±3 percent over a range of at least 1.0 μm to 10.1 μm (0.00004 in. to 0.0004 in.) and an overall accuracy of at least ±5 percent of the reading.

6-1.4.4 The radiant panel shall have an effective radiating surface at least 150 mm, ±6 mm (6 in., ±$^1/_4$ in.) square. The spectral radiant emittance curve of the radiant panel shall be that of a blackbody at a temperature of 1000°K, ±200°K (1340°F, ±360°F).

6-1.4.5 The radiant heat transducer shown in Figure 6-1.4.5 shall be constructed from sheet copper, ASTM B 152, *Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar*, Type 110 ETP, half hard, 0.64 mm, ±0.05 mm (0.025 in., ±0.002 in.) thick and 508 mm, ±0.5 mm (2 in., ±0.02 in.) square. A constantan wire 0.81 mm, ±0.05 mm (0.032 in., ±0.002 in.) in diameter and an iron wire of the same diameter shall be silver soldered near the edges of the copper sheet on the same side, as shown in Figure 6-1.4.5. The side of the copper sheet opposite that with the wires attached shall be painted flat black. The resulting transducer is a Type J thermocouple that shall be used in conjunction with appropriate instrumentation to monitor the heat exposure to which the helmet is to be subjected.

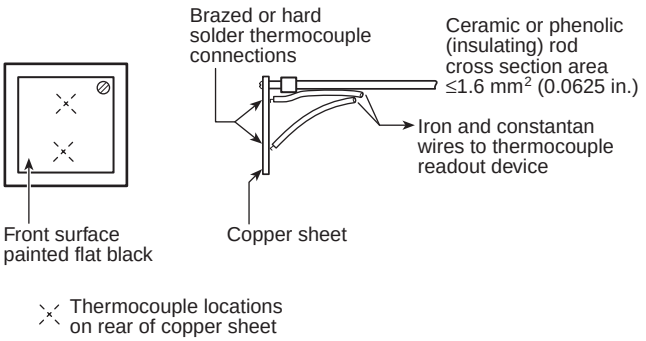


Figure 6-1.4.5 Radiant heat transducer.

6-1.4.6 Sample helmets shall be mounted in the position to be conditioned. The point of impact or penetration on the helmet shell shall be determined in accordance with the specific test to be performed. The helmet shall be removed temporarily, and a radiometer shall be located at that point perpendicular to and facing away from the helmet surface.

6-1.4.7 The radiant panel shall be introduced in front of the radiometer with its effective radiating surface parallel to the plane tangent to the helmet surface at the center of the impact/penetration site on the helmet. The radiant panel shall be adjusted to obtain a stable uniform irradiance of 1.0 W/cm^2, ±0.1 W/cm^2 over a minimum 75-mm (3-in.) diameter circle located on the above plane and centered at the center of impact or penetration. Stability shall be achieved when the irradiance changes by less than 10 percent during a 3-minute period.

6-1.4.8* The radiometer shall be replaced with the radiant heat transducer. The center of the transducer shall be positioned with its center coincident with the center of the impact/penetration site on the helmet and parallel to the plane tangent to the helmet surface at that point. The flat black surface of the transducer shall face the radiant panel. The time required for the transducer to reach a temperature of 177°C (350°F) shall be recorded. That time shall be 1 minute, +5/−0 seconds. A closed insulated chamber shall be required to achieve this exposure time.

6-1.4.9 The chamber and helmet shall be stabilized at 25°C, ±5°C (77°F, ±9°F). The helmet shall be positioned in the chamber in the same position specified in 6-1.4.6. The helmet shall be subjected to the exposure conditions specified in 6-1.4.1 for the time recorded in 6-1.4.8. The exposure time shall be not less than the time recorded in 6-1.4.8, nor more than 5 seconds longer than that time.

6-1.5 Wet Conditioning Procedure for Helmets.

6-1.5.1 Sample specimens shall be conditioned by immersing them in water at a temperature of 20°C to 28°C (68°F to 82°F) for at least 4 hours but not more than 24 hours. The specimen shall be tested within 10 minutes after removal from water.

6-2 Radiant Protective Performance (RPP) Test.

6-2.1 Application.

6-2.1.1 This test method shall apply to protective garment and face/neck shroud materials.

6-2.1.2 Modifications to this test method for testing garment materials shall be as specified in 6-2.8.

6-2.1.3 Modifications to this test method for testing face/neck shroud materials shall be as specified in 6-2.9.

6-2.2 Specimens.

6-2.2.1 Radiant protective performance testing shall be conducted on three specimens. Specimens shall measure 100 mm × 200 mm, ±6 mm (4 in. × 8 in., ±$^1/_4$ in.) with the long dimension in the warp or wale direction and shall consist of all layers representative of the clothing item to be tested.

6-2.3 Sample Preparation.

6-2.3.1 Specimens shall be tested before and after five laundering cycles as specified in 6-1.2 and then preconditioning as specified in 6-1.1.

6-2.4 Apparatus.

6-2.4.1 The apparatus shall consist of a vertically oriented radiant heat source, specimen holder assembly, protective shutter, sensor assembly, and recorder as shown in Figure 6-2.4, Details A through E.

6-2.4.1.1 The vertically oriented radiant heat source, shall consist of a bank of five 500-W, infrared, tubular, translucent quartz lamps having a 125 mm (5 in.) lighted length and a mean overall length of 225 mm ($8^{13}/_{16}$ in.). The lamps shall be mounted so that the lamp's surfaces are approximately 0.4 mm (0.015 in.) apart. The bank or array shall be mounted and centered behind a 55 mm × 140 mm ($2^1/_4$ × $5^1/_2$ in.) cutout on 125 mm (5 in.) transite board. The sensor block shall consist of a 135 × 135 × 15 mm ($5^1/_4$ in. × $5^1/_4$ in. × $^1/_2$ in.) heat-resistant material that fits without binding into the bracket or rear plate. The quartz lamp shall be heated electrically and the power input controlled by means of a Variac™ having a capacity of at least 25 A.

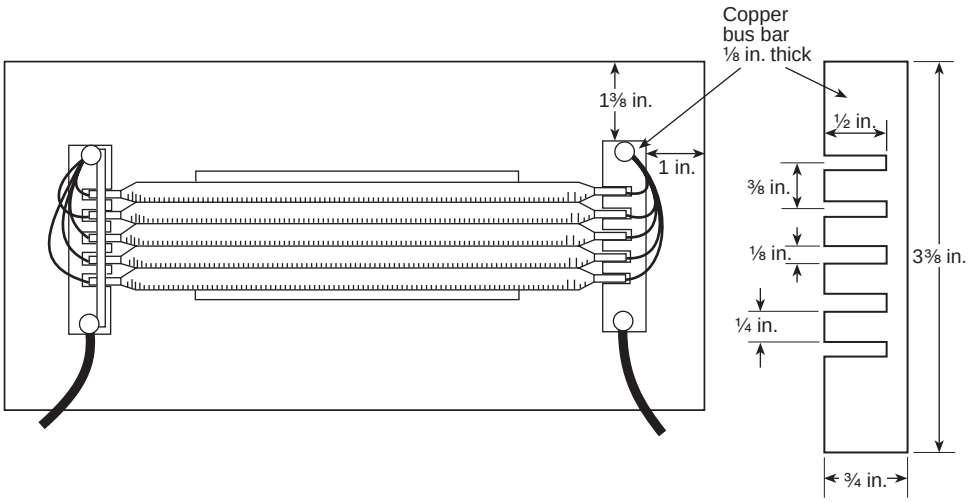


Figure 6-2.4 Detail A Position of quartz lamps on transite.

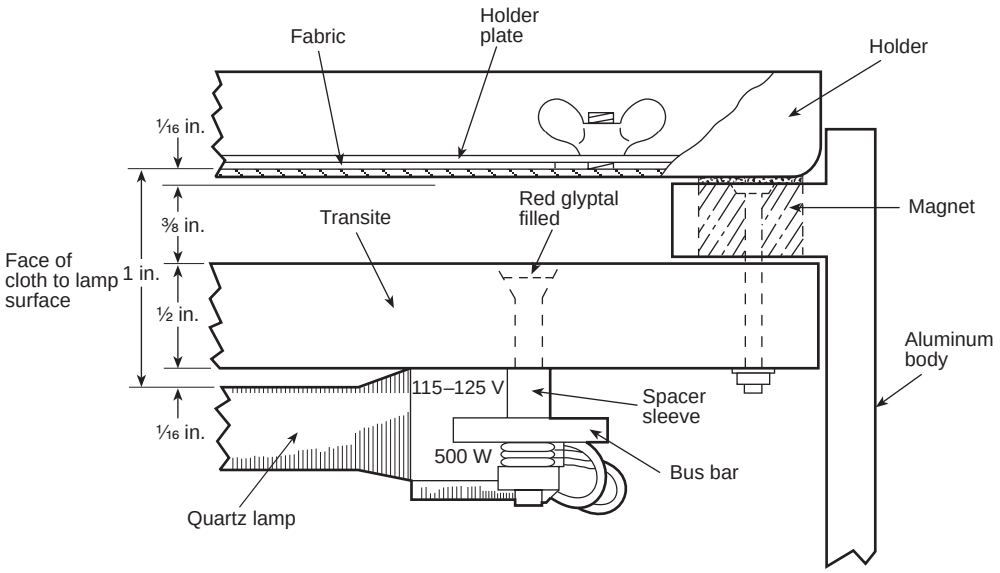


Figure 6-2.4 Detail B Sample position top view enlargement.

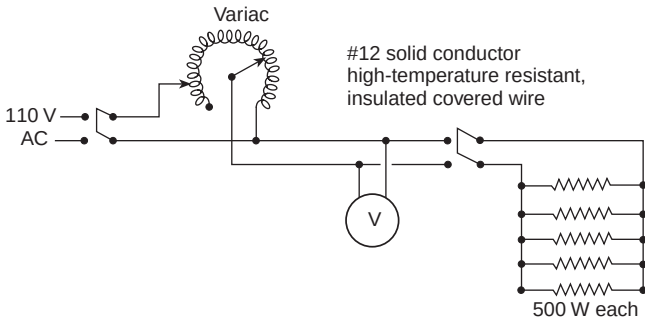


Figure 6-2.4 Detail C Schematic of electrical circuit.

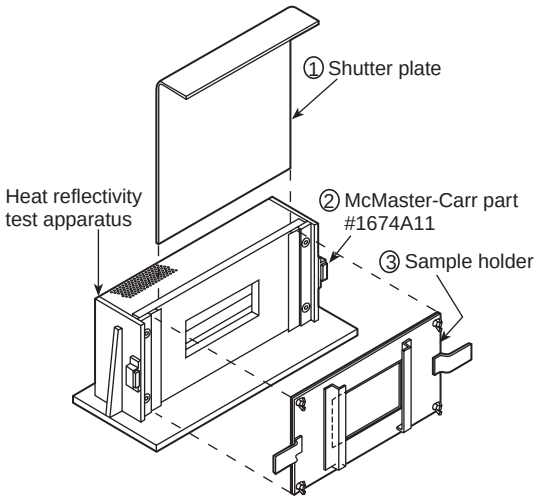


Figure 6-2.4 Detail D.

6-2.4.1.2 The specimen holder assembly shall consist of a specimen holder and holder plate. The specimen holder and holder plate with a 65 m × 125 mm ($2^1/_2$ in. × 5 in.) center cutout shall be positioned so that the distance from the nearest lamp surface to the test specimen is exactly 25 mm (1 in.). The holder plate shall include a bracket to hold the copper calorimeter sensor assembly that will cover the complete cutout section.

6-2.4.1.3 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.

6-2.4.1.4 The sensor assembly shall consist of 135 mm × 135 mm × 15 mm ($5^1/_4$ in. × $5^1/_4$ in. × $^1/_2$ in.) heat-resistant block that fits without binding the sample holder. The sensor shall be a copper calorimeter mounted in an insulating block. The calorimeter shall conform to the specifications provided in Figure 6-22.4.1.10. The sensor shall be coated with a flat black paint.

6-2.4.1.5 The recorder shall be any strip chart recorder with full-scale deflection of at least 150°C (300°F) or 10 mV and sufficient sensitivity and scale divisions to read exposure time to ± 0.1 second. Alternatively, an equivalent automated data acquisition system meeting or exceeding the sensitivity and accuracy requirements of the strip chart recorder shall be permitted to be used instead of a strip chart recorder.

6-2.5 Procedures.

6-2.5.1 The total thermal heat flux shall be set at 21 kW/m^2, ±4 kW/m^2 (0.5 cal/cm^{2}sec ±0.1 cal/cm^{2}sec) using the copper calorimeter-based sensor assembly. Prior to testing, the sensor assembly shall be used to measure the total heat flux by placing the calorimeter facing toward the vertically oriented radiant heat source. The response of the calorimeter shall be recorded for at least 10 seconds. The lowest temperature point on the curve where the response is linear shall be chosen, and the increase in sensor temperature for 10 seconds of heating shall be determined. The initial reading from the 10-second reading shall be subtracted to obtain the increase. The response shall

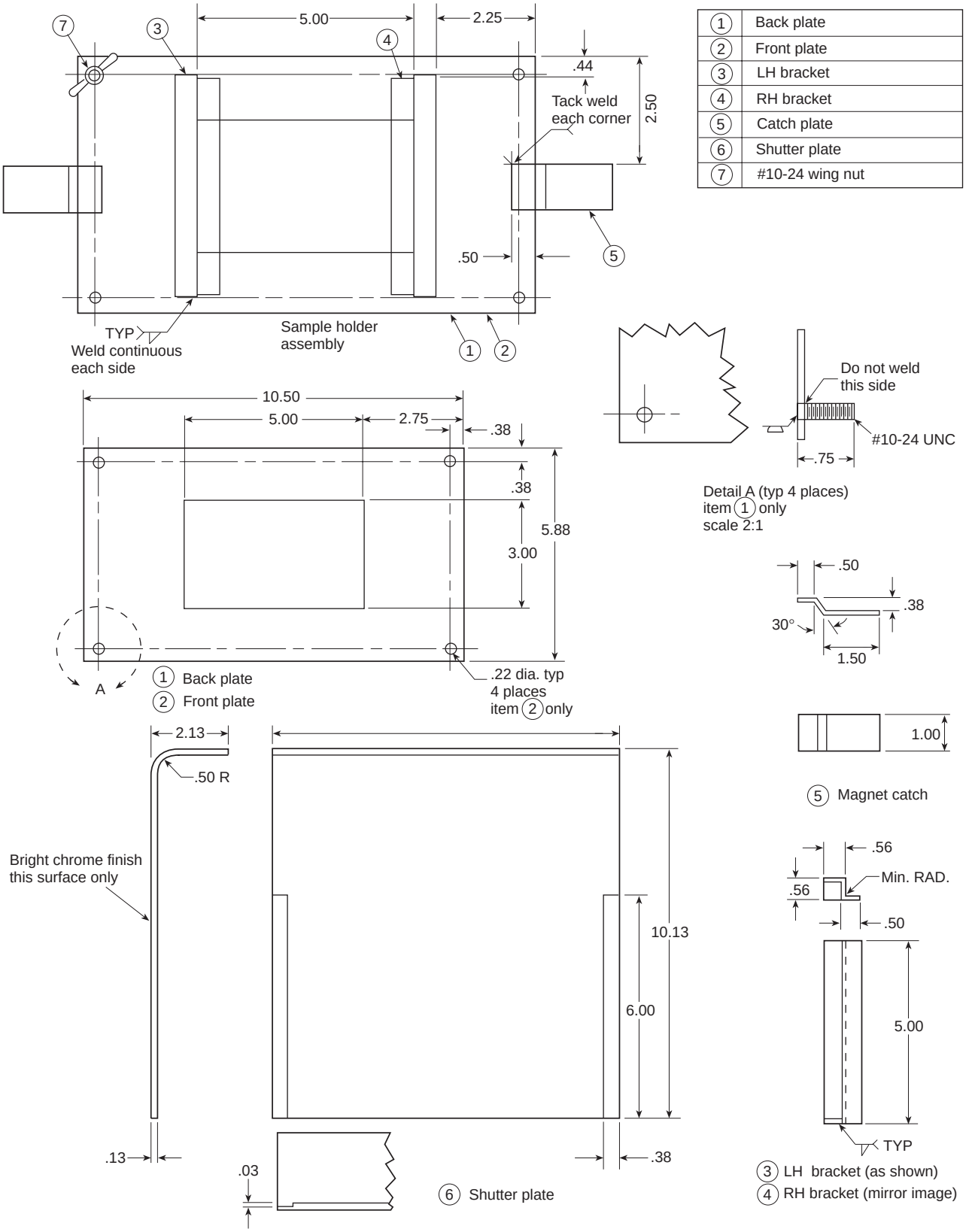


Figure 6-2.4 Detail E.

be 21 kW/m^2 (0.5 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 areas and mass of the calorimeter, and the heat capacity of the copper to calculate the incoming heat flux.

6-2.5.2 Specimens shall be mounted by placing the outside surface of the material facing toward the vertically oriented radiant heat source in the specimen holder. Subsequent layers, if any, shall be placed behind the outside layer in the order used in the composite, with the surface to be worn toward the skin facing away from the vertically oriented radiant heat source. With the protective shutter engaged, the specimens shall be placed in the specimen holder.

6-2.5.3 The sensor assembly 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 25 mm (1 in.). 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.

6-2.5.4 The protective shutter shall be retracted and chart paper movement on the recorder shall be started using a chart speed consistent with the preparation of the overlay described in 6-2.5.7.1. The start time of the exposure shall be indicated. The exposure shall be continued for 30 seconds and then the current shall be turned off. The protective shutter shall be engaged (closed), the recorder shall be stopped, the calorimeter shall be removed and cooled, and then the specimen holder and exposed specimen shall be removed.

6-2.5.5 After each exposure, the calorimeter shall be cooled to 33°C, ±1°C (90.8°F, ±1.8°F) before the next heat flux determination. The sensor shall be cooled after exposure with a jet of air or by contact with a cold surface.

6-2.5.6 The sensor face shall be wiped immediately after each run, while hot, to remove any decomposition products which 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 acetone or petroleum solvent, making certain there is no ignition source nearby. If copper is showing on the copper calorimeter, the surface shall be completely repainted with a thin layer of flat black spray paint. At least one calibration run shall be performed comparing the testing copper calorimeter with the calibration copper calorimeter.

6-2.5.7 Preparation of Human Tissue Burn Tolerance Overlay.

6-2.5.7.1 Tolerance Overlay. The thermal end point shall be determined with a plot of energy versus the time to cause a second-degree burn in human tissue as shown in Table 6-2.5.7.1 that corresponds to the recorder scale shall be plotted on recorder chart paper. ΔT°C, ΔT°F, or DmV, columns 6, 7, or 8, shall be plotted on the vertical axis and the corresponding time, column 1, shall be plotted on the horizontal axis. Chart units speed for a graph directly comparable to the recorder sensor trace shall be used. If pen deflection is from left to right and paper movement down, the plot shall be from right to left with origin at lower right. If recorder trace differs, the graph shall be adjusted accordingly. An exact transparent duplicate shall be made for the overlay. The overlay shall be compared with the original to ensure change in the overlay size.

Table 6-2.5.7.1 Human Tissue[a] Tolerance to Second-Degree Burn

Exposure Time	Heat Flux		Total Heat		Calorimeter[b] Equivalent		
(sec)	cal/cm^{2}sec	kW/m^2	cal/cm^2	kWs/m^2	ΔT°F	ΔT°C	ΔmV
1	1.2	50	1.20	50	16.0	8.9	0.46
2	0.73	31	1.46	61	19.5	10.8	0.57
3	0.55	23	1.65	69	22.0	12.2	0.63
4	0.45	19	1.80	75	24.0	13.3	0.69
5	0.38	16	1.90	80	25.3	14.1	0.72
6	0.34	14	2.04	85	27.2	15.1	0.78
7	0.30	13	2.10	88	28.0	15.5	0.80
8	0.274	11.5	2.19	92	29.2	16.2	0.83
9	0.252	10.6	2.27	95	30.2	16.8	0.86
10	0.233	9.8	2.33	98	31.1	17.3	0.89
11	0.219	9.2	2.41	101	32.1	17.8	0.92
12	0.205	8.6	2.46	103	32.8	18.2	0.94
13	0.194	8.1	2.52	106	33.6	18.7	0.97
14	0.184	7.7	2.58	108	34.3	19.1	0.99
15	0.177	7.4	2.66	111	35.4	19.7	1.02
16	0.168	7.0	2.69	113	35.8	19.8	1.03
17	0.160	6.7	2.72	114	36.3	20.2	1.04
18	0.154	6.4	2.77	116	37.0	20.6	1.06
19	0.148	6.2	2.81	118	37.5	20.8	1.08
20	0.143	6.0	2.86	120	38.1	22.6	1.17
25	0.122	5.1	3.05	128	40.7	22.6	1.17
30	0.107	4.5	3.21	134	42.8	23.8	1.23

[a]Stroll, A. M., and Chianta, M. A., "Method and Rating System for Evaluation of Thermal Protection," *Aerospace Medicine*, vol. 40, 1968, pp. 1232–1238.
[b]Iron/constantan thermocouple.

6-2.5.7.2 Computer Processing of the Data. The information provided in Table 6-2.5.7.1 shall be permitted to be used as the criteria of performance in the software of a computer program. In this case, the sensor response shall be compared with the thermal response, either pain sensation or second-degree burn in human tissue to determine the thermal end points. The product of the time to a second-degree burn in human tissue and the exposure energy heat flux shall be the RPP rating.

6-2.5.8 Determination of Test Results.

6-2.5.8.1 The time to the second-degree burn shall be graphically determined from the recorder chart of the sensor response and criterion overlay prepared in 6-2.5.7.1. The overlay shall be positioned on the recorder chart, matching the zero of the overlay with the exposure start time resulting from heat transfer. The horizontal axis (time) shall be placed in line with the initial trace of the pen, keeping the overlay square with the recorder chart. The time to the second-degree burn shall be read to the nearest 0.1 second from the overlay chart at the point when the sensor response curve and the tissue tolerance curve cross. If the sensor response curve and the tissue tolerance curves do not cross, "no burn" shall be recorded as the test result.

6-2.5.8.1.1 If a computer software program is used, the sensor response shall be compared with the data describing the human tissue heat tolerance to determine when these values are the same. The time from the start of the exposure to the time when these values are the same shall be the exposure time.

6-2.5.8.2 The RPP rating shall be calculated as the product of exposure energy heat flux and time to burn.

$$\text{RPP rating} = F \times T$$

where:

F = exposure heat flux, cal/cm^{2}sec
T = time to burn (sec)

6-2.6 Report.

6-2.6.1 The individual test RPP rating of each specimen shall be reported. The average RPP rating shall be calculated and reported. If a RPP rating is greater than 60, then the RPP rating shall be reported as >60.

6-2.7 Interpretation.

6-2.7.1 Pass of fail determinations shall be based on the average reported RPP rating of all specimens tested.

6-2.7.2 If an individual result from any test set varies more than ±8 percent from the average result, the results from the test set shall be discarded and another set of specimens shall be tested.

6-2.8 Specific Requirements for Testing Garment Materials.

6-2.8.1 Specimens shall consist of all layers used in the construction of the garment, excluding any areas with special reinforcements. Specimens shall not include seams. Specimens shall not be stitched to hold individual layers together.

6-2.8.2 Samples for conditioning shall be at least 1 m (1 yd) square of each material.

6-2.8.3 Testing shall be performed as described in 6-2.2 through 6-2.7.

6-2.9 Specific Requirements for Testing Face/Neck Shroud Materials.

6-2.9.1 Specimens shall consist of materials from the portion of the face/neck shroud that covers the neck and facial area. Specimens shall not include seams. Specimens shall not be stitched to hold individual layers together.

6-2.9.2 Samples for conditioning shall include face/neck shroud material which is a minimum of 100 × 200 mm, ±6 mm (4 in. × 8 in., $\pm^1/_4$ in.) with the long dimension in the warp or wale direction.

6-2.9.3 Testing shall be performed as described in 6-2.2 through 6-2.7.

6-3 Flame Resistance Test One.

6-3.1 Application.

6-3.1.1 This test method shall apply to protective garment and face/neck shroud textiles.

6-3.1.2 Modifications to this test method for testing woven textile materials shall be as specified in 6-3.8.

6-3.1.3 Modifications to this test method for testing knit textile materials shall be as specified in 6-3.9.

6-3.1.4 Modifications to this test method for testing nonwoven textile materials shall be as specified in 6-3.10.

6-3.1.5 Modifications to this test method for testing trim materials shall be as specified in 6-3.11.

6-3.1.6 Modifications to this test method for testing lettering which is transfer film shall be as specified in 6-3.12.

6-3.1.7 Modifications to this test method for testing small specimens not meeting the specimen size requirements of 6-3.2.1 shall be as specified in 6-3.13.

6-3.2 Specimens.

6-3.2.1 Specimens shall consist of a 75 mm × 300 mm (3 in. × 12 in.) rectangle with the long dimension parallel to either the warp or filling direction; the wale or coarse direction; or machine or cross machine direction of the material. Each individual layer of multilayer material systems or composites shall be separately tested.

6-3.3 Sample Preparation.

6-3.3.1 Specimens of garment textile fabrics and face/neck shroud textile fabrics shall be tested both before and after being subjected to 100 laundering cycles as specified in 6-1.2.

6-3.3.2 Specimens of trim and lettering shall be tested both before and after being subjected to 5 laundering cycles as specified in 6-1.2.

6-3.3.3 All specimens to be tested shall be conditioned as specified in 6-1.1.

6-3.4 Apparatus.

6-3.4.1 The test apparatus specified in Method 5903.1, Flame Resistance of Cloth; Vertical, of FED-STD-191A, *Textile Test Methods*, shall be used.

6-3.5 Procedure.

6-3.5.1 Flame resistance testing shall be performed in accordance with Method 5903.1, Flame Resistance of Cloth; Vertical, of FED-STD-191A, *Textile Test Methods*.

6-3.5.2 Each specimen shall be examined for evidence of melting or dripping.

6-3.6 Report.

6-3.6.1 After-flame time and char length shall be reported for each specimen. The average after-flame time and char length for each material shall be calculated and reported. The after-flame time shall be reported to the nearest 0.2 second and the char length to the nearest 3 mm ($^1/_8$ in.).

6-3.6.2 Observations of melting or dripping for each specimen shall be reported.

6-3.7 Interpretation.

6-3.7.1 Pass/fail performance shall be based on any observed melting or dripping, the average after-flame time, and average char length.

6-3.7.2 Failure in either direction shall constitute failure of the material.

6-3.8 Specific Requirements for Testing Woven Textile Materials.

6-3.8.1 Five specimens from each of the warp and filling directions shall be tested. No two warp specimens shall contain the same warp yarns, and no two filling specimens shall contain the same filling yarns.

6-3.8.2 Samples for conditioning shall be at least 1 m (1 yd) square of each material.

6-3.8.3 Testing shall be performed as described in 6-3.2 through 6-3.7.

6-3.9 Specific Requirements for Testing Knit Textiles Materials.

6-3.9.1 Five specimens from each of the two directions shall be tested.

6-3.9.2 Samples for conditioning shall include material which is a minimum of 75 mm × 300 mm (3 in. × 12 in.).

6-3.9.3 Testing shall be performed as described in 6-3.2 through 6-3.7 above.

6-3.10 Specific Requirements for Testing Nonwoven Textile Materials.

6-3.10.1 Five specimens from each of the machine and cross machine directions shall be tested.

6-3.10.2 Samples for conditioning shall be at least 1 m (1 yd) square of each material.

6-3.10.3 Testing shall be performed as described in 6-3.2 through 6-3.7.

6-3.11 Specific Requirements for Testing Trim Materials.

6-3.11.1 Five trim specimens for flammability test shall be at least 50 mm (2 in.) wide and no more than 75 mm (3 in.) wide. When trim material specimens are not wide enough to fit into the test frame, a narrower test frame of sufficient width to accommodate the available trim width shall be constructed. The cut edge of the trim specimen shall be oriented such that it is exposed directly to the burner flame.

6-3.11.2 Samples for conditioning shall include material sewn onto a 1 m (1 yd) square ballast material no closer than 50 mm (2 in.) apart in parallel strips. The ballast material shall be as specified in AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*. Specimens shall be removed from the ballast material prior to testing.

6-3.11.3 Testing shall be performed as described in 6-3.2 through 6-3.7.

6-3.12 Specific Requirements for Testing Lettering that Is Transfer Film.

6-3.12.1 Lettering that is transfer film shall be applied to outer shell material meeting the requirements of this standard for testing as specified in 6-3.13.2.

6-3.12.2 Letter specimens for flammability testing shall be at least 50 mm (2 in.) wide and no more than 75 mm (3 in.) in width. Samples shall be selected where lettering is most dense.

6-3.12.3 Samples for conditioning shall be outer shell material 1 m (1 yd) square.

6-3.12.4 Testing shall be performed as described in 6-3.2 through 6-3.7, but the char length shall not be measured.

6-3.13 Specific Requirements for Testing Small Materials.

6-3.13.1 Five specimens attached to the textile layer as used in the protective garments shall be tested. The specimens shall be attached to the textile layer such that the bottom (exposure) edge of the item coincides with the bottom (exposure) edge of the textile support layer.

6-3.13.2 Samples for conditioning shall be 1 m (1 yd) square of the textile layer on which the small specimens are attached.

6-3.13.3 Testing shall be performed as described in 6-3.2 through 6-3.7, but the char length shall not be measured.

6-4 Heat and Thermal Shrinkage Resistance Test.

6-4.1 Application.

6-4.1.1 This test method shall apply to protective garment and face/neck shroud textiles and to hardware.

6-4.1.2 Modifications to this test method for testing garment and face/neck shroud textiles shall be as specified in 6-4.8.

6-4.1.3 Modifications to this test method for testing hardware shall be as specified in 6-4.9.

6-4.1.4 Modifications to this test method for testing footwear shall be as specified in 6-4.10.

6-4.1.5 Modifications to this test method for testing helmets shall be as specified in 6-4.11.

6-4.2 Specimens.

6-4.2.1 Both heat and thermal shrinkage resistance testing shall be conducted on a minimum of three specimens for each garment and face/neck shroud textile. Each separable layer of multilayer material systems or composites shall be tested as an individual layer.

6-4.2.2 Only heat resistance testing shall be conducted on a minimum of three specimens for each hardware item.

6-4.2.3 Only heat resistance testing shall be conducted on a minimum of three specimens for each helmet.

6-4.3 Sample Preparation.

6-4.3.1 All specimens to be tested shall be conditioned as specified in 6-1.1.

6-4.4 Apparatus.

6-4.4.1 The test oven shall be a horizontal flow circulating oven with minimum interior dimensions so that the specimens can be suspended and are at least 50 mm (2 in.) from any interior oven surface or other test specimens.

6-4.4.2 The test oven shall have an airflow rate of 38 m/min to 76 m/min (125 ft/min to 250 ft/min) at the standard temperature and pressure of 21°C (70°F) at 1 atmosphere, measured at the center point of the oven.

6-4.4.3 A test thermocouple shall be positioned so that it is level with the horizontal centerline of a mounted sample specimen. The thermocouple shall be equidistant between the vertical centerline of a mounted specimen placed in the middle of the oven and the oven wall where the airflow enters the test chamber. The thermocouple shall be an exposed bead, Type J or Type K, No. 30 AWG thermocouple. The test oven shall be heated and the test thermocouple stabilized at 260°C, +6°/–0°C (500°F, +10°/–0°F) for a period of not less than 30 minutes.

6-4.5 Procedure.

6-4.5.1 Specimen marking and measurements shall be conducted in accordance with the procedure specified in AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

6-4.5.2 The specimen shall be suspended by metal hooks at the top and centered in the oven so that the entire specimen is not less than 50 mm (2 in.) from any oven surface or other specimen, and air is parallel to the plane of the material.

6-4.5.3 The oven door shall not remain open more than 15 seconds. The air circulation shall be shut off while the door is open and turned on when the door is closed. The total oven recovery time after the door is closed shall not exceed 30 seconds.

6-4.5.4 The specimen, mounted as specified, shall be exposed in the test oven for 5 minutes, +0.15/–0.0 minutes. The test exposure time shall begin when the test thermocouple recovers to a temperature of 260°C, +6°/–0°C, (500°F, +10°/–0°F).

6-4.5.5 Immediately after the specified exposure, the specimen shall be removed and examined for evidence of ignition, melting, dripping, or separation.

6-4.5.6 After the specified exposure, the specimen also shall be measured to determine pass/fail. Knit fabric shall be pulled to its original dimensions and shall be allowed to relax for 1 minute prior to measurement to determine pass/fail.

6-4.6 Report.

6-4.6.1 Observations of ignition, melting, dripping, or separation shall be reported for each specimen.

6-4.6.2 The percent change in the width and length dimensions of each specimen shall be calculated. Results shall be reported as the average of all three specimens in each dimension.

6-4.7 Interpretation.

6-4.7.1 Any evidence of ignition, melting, dripping, or separation on any specimen shall constitute failing performance.

6-4.7.2 The average percent change in both dimensions shall be used to determine pass/fail performance. Failure in any one dimension constitutes failure for the entire sample.

6-4.7.3 Vertical distortion greater than 25 percent of the original length of the brim or peak shall constitute failing performance.

6-4.8 Specific Requirements for Testing Garment and Face/Neck Shroud Textiles.

6-4.8.1 Samples for conditioning shall be at least 1 m (1 yd) square of each material.

6-4.8.2 Each specimen shall be 380 mm × 380 mm, ±13 mm (15 in. × 15 in., $\pm^{1}/_{2}$ in.) and shall be cut from the fabric to be utilized in the construction of the item.

6-4.8.3 Specimens shall be tested both before and after five cycles of washing and drying as specified in 6-1.2.

6-4.8.4 Testing shall be performed as specified in 6-4.2 through 6-4.7.

6-4.8.5 Any evidence of charring on any specimen of garment or face/neck shroud textiles shall also constitute failing performance in addition to the provisions of 6-4.7.1.

6-4.9 Specific Requirements for Testing Hardware.

6-4.9.1 A minimum of three complete hardware items shall be tested.

6-4.9.2 Observations of hardware condition following heat exposure shall be limited to ignition.

6-4.9.3 Hardware shall be evaluated for functionality within 10 minutes following removal from the oven.

6-4.9.4 Testing shall be performed as specified in 6-4.2 through 6-4.7. Thermal shrinkage shall not be measured.

6-4.10 Specific Testing Requirements for Footwear.

6-4.10.1 Samples for conditioning shall be whole boots. Conditioning shall be performed as specified in 6-1.1.

6-4.10.2 The footwear specimen for testing shall be size 9.

6-4.10.3 Footwear specimens shall include sole, heel, and upper. Footwear specimens shall be filled with dry vermiculite. Any closures shall be fastened.

6-4.10.4 The test thermocouple shall be positioned so that it is level with the horizontal centerline of a footwear test specimen. The thermocouple shall be equidistant between the vertical centerline of a footwear test specimen placed in the middle of the oven and the oven wall where the airflow enters the test chamber.

6-4.10.5 The minimum dimensions for the test oven specified in 6-4.4.1 shall be 610 mm × 610 mm × 610 mm (24 in. × 24 in. × 24 in.).

6-4.10.6 The protective footwear test specimen shall be placed in the center of the test oven with the centerline of the front of the specimen facing the airflow.

6-4.10.7 Following removal from the oven, the specimen shall be allowed to cool at room temperature for not less than 5 minutes, +15/–0 seconds.

6-4.10.8 Testing shall be performed as specified in 6-4.2 through 6-4.7. Thermal shrinkage shall not be measured.

6-4.10.9 Each tested specimen shall be reconditioned as specified in 6-1.1 and then re-examined inside and outside for separation and functionality.

6-4.11 Specific Testing Requirements for Helmets.

6-4.11.1 Specimens shall be conditioned as specified in 6-1.1.

6-4.11.2 The test oven shall be a horizontal flow circulating air oven with minimum internal dimensions of 460 mm × 460 mm × 460 mm (18 in. × 18 in. × 18 in.). The oven shall be heated and stabilized to a temperature of 177°C, +5°/–0°C (350°F, +10°/–0°F).

6-4.11.3 Specimens shall be three helmets of each different style or model. Specimen helmets shall be securely mounted on a room-temperature nonmetallic headform in the "as worn" position. A liner, ear flaps, or a similar device shall be deployed to protect the suspension, if necessary.

6-4.11.4 A series of points shall be marked 75 mm (3 in.) apart on the outer edge of the peak or brim of the sample helmets, allowing at least three points on a peak and eight of more points on a full brim. The vertical distance from a known horizontal base plane to the mark points on the peak or brim shall be measured and recorded.

6-4.11.5 The sample helmet mounted on the headform shall be placed in the center of the oven. If the sample helmet contains a peak only, the sample helmet shall face into the airflow. The oven door shall not remain open more than 15 seconds. The air circulation shall be shut off while the door is open and turned on when the door is closed.

6-4.11.6 After 5 minutes, +15/-0 seconds, the sample helmet mounted on the headform shall be removed and allowed to cool for a minimum of 2 minutes. The vertical distance from the marked points to the base plane shall be measured, recorded, and compared with the measurements recorded in 6-18.3 to determine pass/fail.

6-5 Total Heat Loss Test.

6-5.1 Application.

6-5.1.1 This test method shall apply to protective garment composites.

6-5.2 Specimens.

6-5.2.1 Total heat loss testing shall be conducted on at least three specimens. Specimens shall consist of all the layers of the protective garment composite arranged in the order and orientation they are worn.

6-5.3 Sample Preparation.

6-5.3.1 Specimens to be tested shall be conditioned for five wash/dry cycles as specified in 6-1.2.

6-5.4 Apparatus.

6-5.4.1 The test apparatus shall consist of a test plate with temperature controller and power-input measuring capability.

6-5.4.2 The test plate shall be surrounded by a guard ring and bottom plate that can be controlled to eliminate lateral and downward heat transfer from the test plate.

6-5.4.3 The test plate and guard ring shall have a wettable surface.

6-5.4.4 The test plate, guard ring, and bottom plate shall be in an environmental chamber that controls the temperature, relative humidity, and airflow over the test plate. These properties shall be continuously measured in the free-flow air stream uninfluenced by the boundary of the test plate.

6-5.4.4.1 Apparatus used to measure temperature shall be accurate to within ±0.25°C (0.1°F).

6-5.4.4.2 Apparatus used to measure relative humidity shall be accurate to within ±4 percent RH.

6-5.5* Procedure.

6-5.5.1 The test plate shall have a temperature of 35°C, ±0.5°C (95°F, ±1°F).

6-5.5.2 The local environmental climate shall be 25°C, ±0.5°C (77°F, ±1°F) and 65 percent RH, ±4 percent RH.

6-5.5.3 The airflow shall be the same for all calibrations and tests.

6-5.5.4 The total thermal resistance (R_{ct}) of the specimen shall be calculated from the following equation:

$$R_{ct} = \frac{(T_s - T_a)A}{H}$$

where:

R_{ct} = total thermal resistance of the specimen and surface air layer (°C m^2/W)
T_s = temperature at the plate surface (°C)
T_a = temperature in the local environment (°C)
A = area of the test plate (m^2)
H = power input (W)

6-5.5.5 Measurement of thermal resistance shall be done when equilibrium is reached.

6-5.5.5.1 Data used to calculate the thermal resistance shall be collected at least every 5 minutes.

6-5.5.5.2 Equilibrium shall be a rate of change of less than 3 percent per hour of the calculated thermal resistance over a period of not less than 30 minutes.

6-5.5.5.3 The standard deviation of calculated thermal resistance shall be less than 1 percent.

6-5.5.6 The average bare plate thermal resistance, including the air layer and any apparatus contribution (R_{cbp}), shall be an average of at least three measurements with nothing mounted on the test plate.

6-5.5.7 The average intrinsic thermal resistance of the sample alone (R_{cf}) shall be determined by subtracting the average bare plate resistance (R_{cbp}) from the average of the total thermal resistance (R_{cf}) of the specimens tested.

6-5.5.8 For thermal resistance measurements, the test apparatus shall be calibrated in accordance with 6-5.5.8.1 through 6-5.5.8.6.

6-5.5.8.1 One layer of 7.5 oz/yd^2 Nomex® duck shall be mounted on the test plate and the total thermal resistance (R_{ct}) measured.

6-5.5.8.2 Two layers of 7.5 oz/yd^2 Nomex duck shall be mounted on the test plate and the total thermal resistance (R_{ct}) measured.

6-5.5.8.3 Three layers of 7.5 oz/yd^2 Nomex duck shall be mounted on the test plate and the total thermal resistance (R_{ct}) measured.

6-5.5.8.4 Four layers of 7.5 oz/yd^2 Nomex duck shall be mounted on the test plate and the total thermal resistance (R_{ct}) measured.

6-5.5.8.5 The test apparatus shall meet the following constraints:

(a) A graph of the total thermal resistance versus the number of layers of 7.5 oz/yd^2 Nomex duck shall be linear for the bare plate value and the one, two, three, and four layers.

(b) The slope of the linear regression shall be 0.0206°C m^2/W, ±10 percent.

(c) No individual data measurement shall be outside the ±10 percent range of the value predicted by the linear regression.

(d) The intrinsic thermal resistance of four layers of 7.5 oz/yd^2 Nomex duck shall be 0.082°C m^2/W, ±10 percent.

6-5.5.8.6 If the test apparatus cannot meet any one of these constraints, no specimens shall be tested until the apparatus is adjusted to meet these constraints.

6-5.5.9 The specimen to be tested shall be mounted on the test plate in the orientation it has in the finished garment, from the skin surface (plate surface) to the outside, and the total thermal resistance (R_{ct}) shall be measured.

6-5.5.10 Water shall be fed to the test plate and guard ring to uniformly wet the test plate and guard ring surface.

6-5.5.11 The test plate and guard ring shall be covered with a liquid barrier that prevents wetting of the test specimen by the water.

6-5.5.12* Apparent total evaporative resistance (AR_{et}) shall be calculated from the following equation:

$$AR_{et} = \frac{\left\{\dfrac{(P_s - P_a)A}{H - [(T_s - T_a)A]}\right\}}{R_{ct}}$$

where:

AR_{et} = apparent total evaporative resistance of the specimen and surface area (kPa m^2/W)

P_s = water vapor pressure at the test plate surface (kPa)

P_a = water vapor pressure in the local environment (kPa)

A = area of the test plate (m^2)

H = power input (W)

T_s = temperature at the test plate surface (°C)

T_a = temperature in the local environment (°C)

R_{ct} = total thermal resistance of the specimen and surface air layer (°C m^2/W)

6-5.5.13 A measurement of the apparent evaporative resistance shall be taken when equilibrium is reached.

6-5.5.13.1 Data to calculate apparent evaporative resistance shall be collected at least every 5 minutes.

6-5.5.13.2 Equilibrium shall be a rate of change of less than 3 percent per hour of calculated apparent evaporative resistance over a period not less than 30 minutes.

6-5.5.13.3 The standard deviation of the calculated apparent evaporative resistance shall be less than 1 percent.

6-5.5.13.4 If data collection cannot be completed within 4 hours after mounting the specimen on the test plate, the specimen shall be removed from the test plate and allowed to dry for at least 24 hours at 20°C, ±5°C (70°F, ±10°F) before retesting. Subsequent data reporting shall state that drying was required. If the retest of the specimen still cannot be completed within 4 hours, then it shall be reported that the specimen cannot be tested by this method.

6-5.5.14 The average bare plate evaporative resistance, including the air layer, the liquid barrier, and any test apparatus contribution, (R_{cbp}), shall be an average of at least three measurements with only the liquid barrier mounted on the plate. The local environmental climate shall be permitted to increase above 25°C (77°F), if necessary, to maintain the test plate temperature at 35°C (95°F).

6-5.5.15* The average apparent intrinsic evaporative resistance of the sample alone (AR_{ef}) shall be the apparent total evaporative resistance (AR_{et}) minus the average bare plate evaporative resistance (R_{cbp}).

6-5.5.16 For evaporative resistance measurements, the test apparatus shall be recalibrated in accordance with 6-5.5.16.1 through 6-5.5.16.7.

6-5.5.16.1 The permeability index of the liquid barrier alone on the wetted test plate shall be greater than 0.7. The permeability index shall be calculated from the following equation:

$$i_m = 0.061\left[\frac{R_{cbp}}{R_{ebp}}\right]$$

where:

i_m = permeability index

R_{cbp} = average bare plate thermal resistance (without liquid barrier) as determined in 6-5.5.6 (°C m^2/W)

R_{ebp} = average bare plate evaporative resistance (with liquid barrier in place) as determined in 6-5.5.14 (kPa m^2/W)

6-5.5.16.2 One layer of 7.5 oz/yd^2 Nomex duck shall be mounted on the test plate and the apparent evaporative resistance (AR_{et}) measured.

6-5.5.16.3 Two layers of 7.5 oz/yd^2 Nomex duck shall be mounted on the test plate and the apparent evaporative resistance (AR_{et}) measured.

6-5.5.16.4 Three layers of 7.5 oz/yd^2 Nomex duck shall be mounted on the test plate and the apparent evaporative resistance (AR_{et}) measured.

6-5.5.16.5 Four layers of 7.5 oz/yd^2 Nomex duck shall be mounted on the test plate and the apparent evaporative resistance (AR_{et}) measured.

6-5.5.16.6 The test apparatus shall meet the following constraints:

(a) A graph of the apparent total evaporative resistance (AR_{et}) versus the number of layers of 7.5 oz/yd^2 Nomex duck shall be linear for the bare plate value and the one, two, three, and four layers.

(b) The slope of the linear regression shall be 0.005 kPa m^2/W, ±10 percent.

(c) No individual data measurement shall be outside the ±10 percent range of the value predicted by the linear regression.

(d) The apparent intrinsic evaporative resistance (AR_{ef}) of four layers of 7.5 oz/yd^2 Nomex duck shall be 0.020 kPa m^2/W, ±10 percent.

6-5.5.16.7 If the test apparatus cannot meet any one of these constraints, no specimens shall be tested until the test apparatus is adjusted to meet these constraints.

6-5.5.17 The specimen to be tested shall be mounted on the wetted test plate with the liquid barrier in place in the orientation it has in the finished garment, from the skin surface (plate surface) to the outside, and the total thermal resistance (AR_{et}) shall be measured.

6-5.6 Report.

6-5.6.1 The average intrinsic thermal resistance (R_{cf}) of the sample shall be reported. The average intrinsic thermal resistance (R_{cf}) of the specimens shall be determined by averaging all values obtained over the equilibrium period, using a minimum of six values. The average intrinsic thermal resistance (R_{cf}) of the sample shall be determined by averaging the values for all specimens. If the results for any of the three individual specimens vary more than 10 percent from the average of all three, then the test shall be repeated on the specimen(s) lying outside the ±10 percent limit. If the retest produces a value(s) within the ±10 percent limit, then the new value(s) shall be used instead. If the retest remains outside the ±10 percent limit, then an additional three specimens shall be tested, and all original and retest results shall be reported along with the average and standard deviation of intrinsic thermal resistance and a statement identifying this sample as having a high variability.

6-5.6.2 The average apparent intrinsic evaporative resistance (AR_{ef}) of the sample shall be reported. The average apparent intrinsic evaporative resistance (AR_{ef}) of the specimens shall be determined by averaging all values obtained over the equilibrium period using a minimum of six values. The average apparent intrinsic evaporative resistance (AR_{ef}) of the sample shall be determined by averaging the values for all specimens. If the results for any of the three individual specimens vary more than 10 percent from the average of all three, then the test shall be repeated on the specimen(s) lying outside the ±10 percent limit. If the retest produces a value(s) within the ±10 percent limit, then the new value(s) shall be used instead. If the retest remains outside the ±10 percent limit, then an additional three specimens shall be tested, and all original and retest results shall be reported along with the average and standard deviation of apparent intrinsic evaporative resistance and a statement identifying this sample as having a high variability.

6-5.6.3* The average total heat loss (Q_t) of the sample shall be determined and reported, subject to the reporting requirements in 6-5.6.1 and 6-5.6.2. The total heat loss of the sample shall be calculated from the following equation:

$$Q_t = \frac{10°C}{R_{cf} + 0.04} + \frac{3.57\ kPa}{AR_{ef} + 0.0035}$$

where:

Q_t = total heat loss (W/m^2)

R_{cf} = average intrinsic thermal resistance of the sample as determined in 6-5.6.1 (°C m^2/W)

AR_{ef} = average apparent intrinsic evaporative resistance of the sample as determined in 6-5.6.2 (kPa m^2/W)

6-5.7 Interpretation.

6-5.7.1 Pass/fail determination shall be based on the average reported total heat loss measurement of all specimens tested.

6-6 Tear Resistance Test.

6-6.1 Application.

6-6.1.1 This test shall apply to garment and face/neck shroud materials. If the garment or face/neck shroud is constructed of several separable layers, then all layers including any supplemental liners shall be individually tested.

6-6.2 Specimens.

6-6.2.1 A minimum of five specimens in each of the warp, machine or coarse, and filling directions, cross-machine or wales directions shall be tested.

6-6.2.2 If the material is nonanisotropic, then ten specimens shall be tested.

6-6.3 Sample Preparation.

6-6.3.1 Specimens shall be conditioned as specified in 6-1.1.

6-6.3.2 Samples for conditioning shall be at least 1 m (1 yd) square of material.

6-6.4 Procedure.

6-6.4.1 Specimens shall be tested in accordance with ASTM D 1424, *Standard Test Method for the Tear Resistance of Woven Fabrics by Falling Pendulum (Elmendorf) Apparatus.*

6-6.5 Report.

6-6.5.1 The tear resistance of each specimen shall be reported to the nearest 0.45 N (0.1 lbf) of force. The tear resistance for each direction shall be calculated.

6-6.6 Interpretation.

6-6.6.1 Pass/fail performance shall be based on the tear resistance in each direction. Failure in any one direction shall constitute failure for the material.

6-7 Cleaning Shrinkage Resistance Test.

6-7.1 Application.

6-7.1.1 This test method shall apply to the protective garment and face/neck shroud textiles.

6-7.1.2 Modifications to this test method for testing woven textile materials shall be as specified in 6-7.7.

6-7.1.3 Modifications to this test method for testing knit and stretch woven materials shall be as specified in 6-7.8.

6-7.2 Specimens.

6-7.2.1 Cleaning shrinkage resistance testing shall be conducted on three specimens of each material, and each separable layer of composite material shall be tested separately.

6-7.3 Sample Preparation.

6-7.3.1 Specimens to be tested shall be conditioned as specified in 6-1.1.

6-7.4 Procedure.

6-7.4.1 Specimens shall be tested using five cycles of Machine Cycle I, Wash Temperature IV, and Drying Procedure Aiii of AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

6-7.4.2 A 1.8 kg, ±0.1 kg (4.0 lb, ±0.2 lb) load shall be used. A laundry bag shall not be used.

6-7.4.3 Specimen marking and measurements shall be conducted in accordance with the procedure specified in AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

6-7.4.4 Knit fabric specimens shall be pulled to original dimensions and shall be allowed to relax for 1 minute prior to measurement.

6-7.5 Report.

6-7.5.1 The percent change in the width and length dimensions of each specimen shall be calculated. Results shall be reported as the average of all three specimens in each dimension.

6-7.6 Interpretation.

6-7.6.1 The average percent change in both dimensions shall be used to determine pass/fail performance. Failure of either dimension shall constitute failure for the entire sample.

6-7.7 Specific Requirements for Testing Woven Textile Materials.

6-7.7.1 Each specimen shall be 380 mm × 380 mm, ±13 mm (15 in. × 15 in., $\pm^1/_2$ in.) and shall be cut from the fabric to be utilized in the construction of the item.

6-7.7.2 Samples for conditioning shall be at least 1 m (1 yd) square of each material.

6-7.7.3 Testing shall be performed as specified in 6-7.2 through 6-7.6.

6-7.8 Specific Requirements for Testing Knit and Stretch Woven Textile Materials.

6-7.8.1 Other than for wristlets, the dimensions of each specimen shall be 380 mm × 380 mm, ±13 mm (15 in. × 15 in., $\pm^1/_2$ in.) and shall be cut from the fabric to be utilized in the construction of the item.

6-7.8.2 The dimensions of wristlet specimens shall be 115 mm × 115 mm, ±13 mm ($4^1/_2 \times 4^1/_2$ in., $\pm^1/_2$ in.) and shall be cut from the wristlet fabric to be utilized in the construction of the clothing item.

6-7.8.3 Samples for conditioning shall include material that is at least 50 mm (2 in.) larger in each of the two required specimen dimensions.

6-7.8.4 Testing shall be performed as specified in 6-7.2 through 6-7.6.

6-8 Seam Breaking Strength Test.

6-8.1 Application.

6-8.1.1 This test shall apply to seams used in protective garments and shrouds.

6-8.2 Specimens.

6-8.2.1 A minimum of five seam specimens representative of the garment shall be tested for each seam type.

6-8.2.2 The five seam specimens shall be straight seams. Seam specimens shall be permitted to be cut from the finished garment or shall be permitted to be prepared by joining two pieces of the garment fabric.

6-8.2.2.1 Where two pieces of woven garment fabric are joined, the woven fabric seam specimen shall be prepared as specified in 8.2.1.2 of ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*, and shall use the same thread, seam type, and stitch type as used in the finished garment.

6-8.2.2.2 Where two pieces of knit or stretch woven garment fabric are joined, the knit fabric seam specimen shall be prepared as specified in 7.2.2 of ASTM D 3940, *Standard Test Method for Bursting Strength (Load) and Elongation of Sewn Seams of Knit or Woven Stretch Textile Fabrics*, using the same thread, seam type, and stitch type as used in the finished garment.

6-8.2.2.3 Specimens of garment seam assemblies constructed from other than woven or knit textiles shall be tested as specified in 6-8.2.2.1.

6-8.2.2.4 Where a piece of woven garment fabric and a knit or stretch woven fabric are joined, the seam specimen shall be prepared as specified in 8.2.1.2 of ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*, and shall use the same thread, seam type, and stitch type as used in the finished garment.

6-8.3 Sample Preparation.

6-8.3.1 Samples for conditioning shall be 1 m (1 yd) square of material.

6-8.4 Procedure

6-8.4.1 All woven seam assemblies shall be tested in accordance with ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics.* The test machine shall be operated at a rate of 305 mm/min (12 in./min).

6-8.4.2 All knit seam assemblies and all stretch woven seam assemblies shall be tested in accordance with ASTM D 3940, *Standard Test Method for Bursting Strength (Load) and Elongation of Seams of Knit and Stretch Woven Textiles.*

6-8.4.3 Combination woven and knit or stretch woven seam assemblies shall be tested in accordance with ASTM D 1683, *Standard Test Method for Failure in Sewn Seams at Woven Fabrics.* The test machine shall be operated at a rate of 305 mm/min (12 in./min).

6-8.5 Report.

6-8.5.1 The seam breaking strength for each seam specimen shall be reported. The average seam breaking strength for each seam type shall also be reported.

6-8.5.2 The type of seams tested shall be reported as to whether the specimens were cut from the finished garment or prepared from fabric samples.

6-8.6 Interpretation.

6-8.6.1 The average seam breaking strength for each seam type shall be used to determine pass/fail performance.

6-9 Thread Heat Resistance Test.

6-9.1 Application.

6-9.1.1 This test shall apply to each type of sewing thread used in the construction of protective garments, gloves, footwear, and face/neck shrouds.

6-9.2 Specimens.

6-9.2.1 Five different specimens shall be tested.

6-9.3 Sample Preparation.

6-9.3.1 Samples shall be conditioned as specified in 6-1.1.

6-9.3.2 Samples for conditioning shall be 150 mm (6 in.) or greater lengths of thread.

6-9.4 Procedure.

6-9.4.1 Specimens shall be tested to a temperature of 260°C (500°F) in accordance with Method 1534, Melting Point of Synthetic Fibers, of FED-STD-191A, *Textile Test Methods*.

6-9.5 Report.

6-9.5.1 The condition of all specimens shall be observed and recorded at 260°C (500°F) to determine pass/fail.

6-9.6 Interpretation.

6-9.6.1 Any specimen exhibiting melting at 260°C (500°F) shall constitute failure of this test for the thread type.

6-10 Electrical Insulation Test.

6-10.1 Equipment.

6-10.1.1 The following equipment shall be provided for Test Procedure A:

(a) A source of 60-Hz alternating current variable from 0 to 2200 volts true RMS

(b) Wiring and terminals for application of voltage to the water in the vessel

(c) A voltmeter to measure the applied voltage to within 2 percent

(d) A millimeter to measure the current leakage to within 2 percent

(e) A vessel, containing tap water, of sufficient size to submerge an inverted helmet to the dielectric test plane

(f) A frame for suspending the test specimen in water

6-10.1.2 The following equipment shall be provided for Test Procedure B:

(a) A source of 60-Hz alternating current variable from 0 to 2200 volts true RMS

(b) Wiring and terminals for application of voltage across the crown of the test specimen

(c) A voltmeter to measure the applied voltage to within 2 percent

(d) A millimeter to measure the applied current to within 2 percent

(e) A vessel, containing tap water, of sufficient size to completely submerge an inverted helmet

(f) A size 7 aluminum headform, commonly know as the "ISEA Standard Headform" shall be used. The headform shall have a mass of 3.6 kg ±0.5 kg (8 lb ±1 lb). The test headform shall be of the nominal dimensions of the headform in Table 6-10.1.2 and Figures 6-10.1.2(a) through (c).

Table 6-10.1.2 Data for Contour Drawing of ISEA Headform (all dimensions in mm)

	Horizontal Plane	Distance from Datum Plane	Vertical Sections												
			0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180°
	0-0	99	0	0	0	0	0	0	0	0	0	0	0	0	0
	1-1	95	22.5	22.5	23	25.5	26.5	28	28.5	31	33	36	39	38.7	40
	2-2	90	39.5	40	40	40.5	40.5	40.5	41.5	43.5	47.5	50	53	53	54.5
	3-3	85	53.5	54	55.7	51.5	50.5	50	51.5	53.5	57	60.5	64	64.5	65.5
	4-4	80	62.5	63	60.9	59	57	57	57.5	60.5	63.5	67.3	70.7	70.7	72.2
	5-5	70	72.5	74	71.5	68.2	65.5	64.5	65.3	68	72	75.7	79.1	80	82
	6-6	60	82	82	79.5	75	71.0	69.4	70.1	73	77.5	81.7	85.1	87.5	87.9
	7-7	50	87.3	87	84.5	79	74	71.5	72	75.7	80.9	85.8	89.4	91	92.3
	8-8	40	90.2	90.5	87.5	81.5	75.5	73.0	73.5	76.9	82.7	88.3	91.3	93.5	95
	9-9	20	94.0	94	90.5	83.5	77.1	73.7	74.2	77.8	84.3	91	95.5	97.6	98.5
Datum Plane	10-10	0	96.5	96.5	93.0	84.6	77.5	73.5	74.2	79	85	92.5	96.5	98.8	99.9
	11-11	20	96.5	96.5	93.0	84.6	77.5	73.5	72	70	78.5	84	90	91	95
	12-12	40	96.5	96.5	93.0	84.6	77.5	73.5	70	63.5	70	75	81	82	84
	13-13	60	96.5	96.5	93.0	84.6	77.5	73.5	68	58	57.5	63	69	69	72
	14-14	80	96.5	96.5	93.0	84.6	77.5	73.5	66	54	48	53	59	60	63
	15-15	100	96.5	96.5	93.0	84.6	77.5	73.5	64	52	48	49	54	56	59
	16-16	115.9	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5
	17-17	128.6	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5

Note: All dimensions ±5 mm.

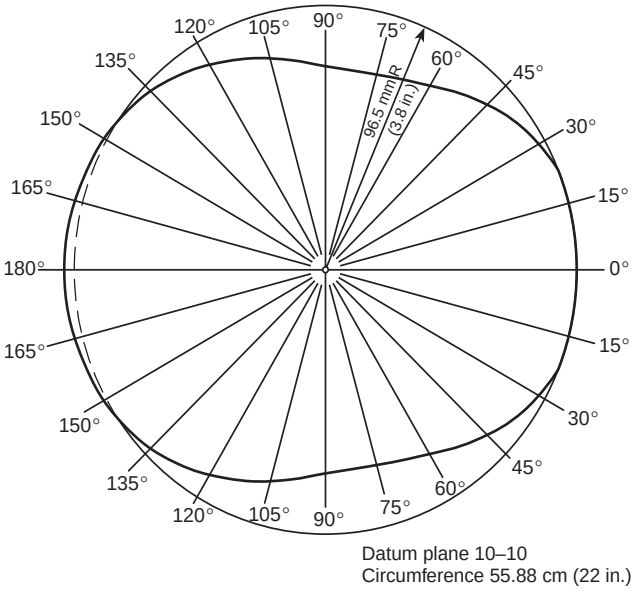


Figure 6-10.1.2(a)

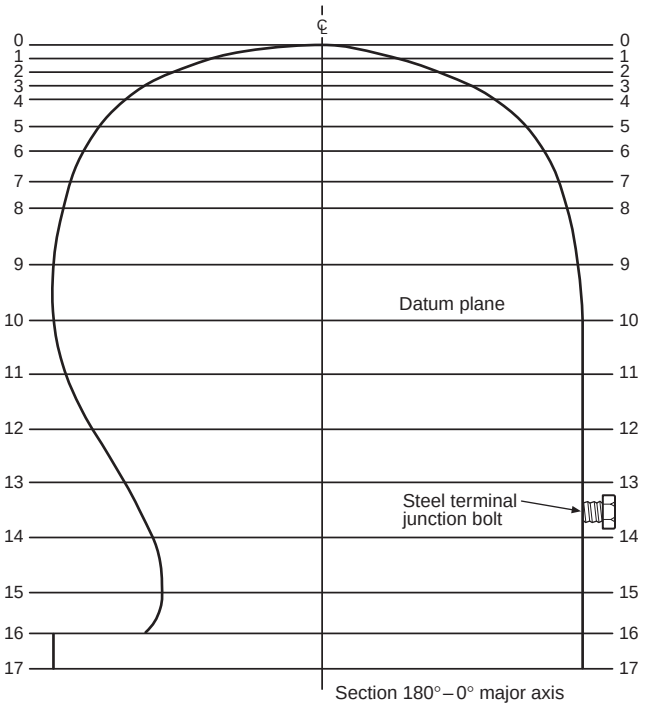


Figure 6-10.1.2(b)

6-10.2 Procedures.

6-10.2.1 Where the sample helmet has a coating over the basic shell material, the exterior surface of the shell shall be abraded with a No. 60 grit garnet paper until the basic shell material is exposed.

6-10.2.2 Sample helmets shall be preconditioned at a temperature of 70°F, ±5°F (21°C, ±3°C) and at a relative humidity of 65 percent, ±5 percent, for at least 24 hours. Sample helmets shall be tested within 5 minutes after removal from preconditioning.

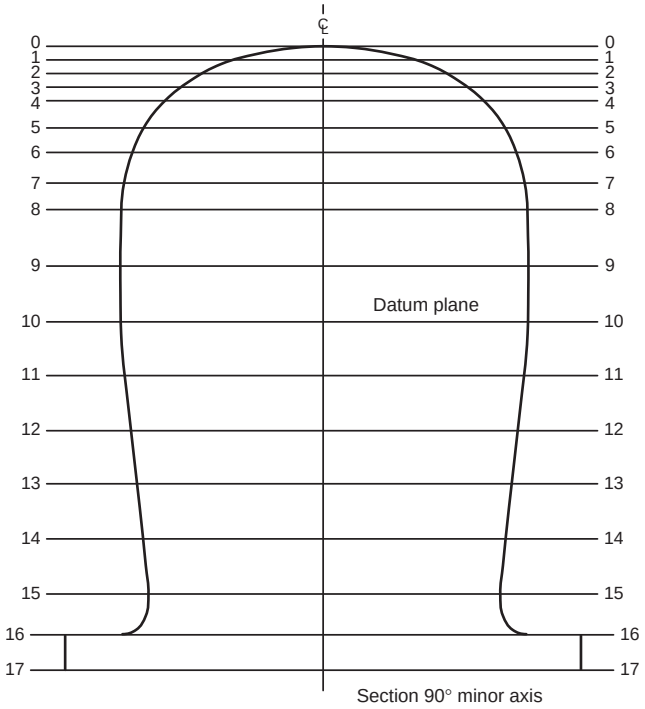


Figure 6-10.1.2(c)

6-10.2.3 Procedure A.

6-10.2.3.1 The inside of the sample helmet, with suspension system and permanent accessories installed, shall be filled with fresh tap water within 13 mm ($^1/_2$ in.) of the juncture of the crown and the peak or brim with the helmet inverted, unless the helmet has holes in the crown for mounting the suspension system, in which case it shall be filled to within 13 mm ($^1/_2$ in.) of these holes. No special provisions shall be made for accessory mounting holes above the plane of the suspension system mounting holes. The sample helmet shall then be submerged in the same type of water as the water on the inside of the helmet.

6-10.2.3.2 The voltmeter and millimeter shall be attached to the circuit. Care shall be taken to keep the unsubmerged portion of the sample helmet dry so that electrical flashover will not occur when voltage is applied.

6-10.2.3.3 A 60-Hz alternating current voltage shall be applied and increased to 2200 volts, ±2 percent for 1 minute.

6-10.2.4 Procedure B.

6-10.2.4.1 The sample helmet and suspension system shall be completely submerged in tap water for a period of 15 minutes, +2/–0 minutes. The helmet shall be removed from the tap water and allowed to drain for no longer than 2 minutes.

6-10.2.4.2 The sample helmet shall be mounted on the modified ISEA aluminum headform, with the chin strap firmly secured to the headform by means of the conductive terminal junction bolt.

6-10.2.4.3 A lead carrying 60-Hz alternating voltage shall be attached to all metal parts on the helmet's exterior, or at least above the brim edge. A second pickup lead shall be attached to the terminal junction bolt. Voltage shall be applied to the external helmet shell lead(s) and increased to 2200 volts, ±2 percent volts. The voltage shall be maintained for 15 seconds.

6-10.3 Report.

6-10.3.1 Any current leakage or evidence of breakdown shall be recorded for each helmet.

6-10.4 Interpretation.

6-10.4.1 One or more helmet specimens failing either of these tests shall constitute failing performance.

6-11 Top Impact Resistance Test (Force).

6-11.1 Application.

6-11.1.1 This test shall apply to complete helmets.

6-11.2 Specimens.

6-11.2.1 Specimens shall be five helmets of each different style or model.

6-11.3 Sample Preparation.

6-11.3.1 Samples for conditioning shall be complete helmets.

6-11.3.2 Specimens shall be conditioned for each environmental condition specified in 6-1.1, 6-1.3, 6-1.4, and 6-1.5 prior to each impact.

6-11.4 Apparatus.

6-11.4.1 A size 7 aluminum headform, commonly known as the "ISEA Standard Headform," shall be used. The headform shall have a mass of 3.6 kg, ±0.5 kg (8 lb, ±1 lb).

6-11.4.2 A steel drop mass of 3.58 kg, ±0.05 kg (7.90 lb, ±0.10 lb) shall be used. The striking face of the drop mass shall be a spherical segment with a radius of 48 mm, ±8 mm ($1^{7}/_{8}$ in., $\pm^{5}/_{16}$ in.) and a chord length of at least 75 mm (3 in.).

6-11.4.3 An electronic force measurement system with the following minimum specifications shall be used:

(a) Range: 4450 N (1000 lbf)
(b) Peak force measurement accuracy: ±2.5 percent
(c) Resolution: 22 N (5 lbf)
(d) Load cell rigidity: 4.4×10^{9} N/m (2.5×10^{7} lbf/in.)
(e) Minimum mechanical resonant frequency of the headform/load cell system: 5000 Hz
(f) Load cell diameter: 75 mm (3 in.)

6-11.4.4 The system frequency response shall comply with SAE J211, *Instrumentation for Impact Test*, Channel Frequency Class 1000, specifications. The minimum mechanical resonant frequency shall be calculated from the following formula:

$$f = \frac{(\sqrt{kg/m})}{2\pi}$$

where:

kg = the load cell rigidity [N/m (lbf/ft)]

m = the mass of the structure on top of the load cell [kg (slugs)]

6-11.4.5 All surfaces in contact with the load cell shall have a surface finish of at least 0.8×10^{-6} m (32×10^{-6} in.) rms. In addition, those surfaces in contact with the load cell shall be flat to within 12.7×10^{-6} m (500×10^{-6} in.).

6-11.4.6 The load cell shall have a backup mass of at least 540 kg (1200 lb). The load cell assembly shall be rigidly mounted between the headform structure and a steel plate at least 305 mm square (1 ft) square and 25 mm (1 in.) thick. The backup mass shall be concrete or a rigid material of equal or greater density at least 610 mm square (2 ft) square.

6-11.4.7 The surface of the steel plate, in the area of the load cell assembly mounting, shall be flat within ±0.15 mm (±0.005 in.) and within 1 degree of level. The steel plate shall be rigidly attached to, and in intimate contact with, the backup mass.

6-11.4.8 The vertical centerline of the drop mass, the headform, and the load cell shall all be colinear within 3 mm ($^{1}/_{8}$ in.). The sensitive axis of the load cell shall be aligned within 1 degree of vertical. The guide or guides shall be vertical and, in the case of a double guide system, parallel to within 6 mm per 3 m ($^{1}/_{4}$ in. per 10 ft) of length.

6-11.4.9* The instrumentation calibration shall be verified at least before and after each test series or at the beginning and end of each day of testing, whichever is the shorter length of time.

6-11.4.10 The test system shall be analyzed dynamically to ensure that any mechanical resonance associated with transducer mountings does not distort the output data.

6-11.4.11 Prior to testing, the instrumentation shall be allowed to warm up until stability is achieved.

6-11.4.12 Throughout calibration, verification, and testing, the ambient temperature shall be 20°C to 28°C (68°F to 82°F), and the relative humidity shall be 30 percent to 70 percent.

6-11.5 Procedure.

6-11.5.1 Where faceshield, goggles, or headlamps are provided with the helmet, the device shall be removed from the helmet for this test.

6-11.5.2 Specimen helmets shall be adjusted to a size sufficient to properly fit on the headform.

6-11.5.3 Each specimen shall be subjected to a different environmental conditioning prior to each impact. The environmental conditionings shall be as specified in 6-1.1, 6-1.3, 6-1.4, and 6-1.5.

6-11.5.4 Specimens shall be positioned on the headform with the horizontal center plane parallel within 5 degrees of the reference plane. The front-to-back centerline of the shell shall be within 13 mm ($^{1}/_{2}$ in.) of the mid-sagittal plane of the headform.

6-11.5.5 Specimens shall be subjected to each impact within the specified time after being removed from conditioning.

6-11.5.6 The impactor shall be dropped from a height that yields an impact velocity within 2 percent of 5.47 m/sec (17.9 ft/sec). A means of verifying the impact velocity to within 2 percent for each impact shall be incorporated.

6-11.5.7 The verification tests shall demonstrate an accuracy of 2.5 percent or better in the measured force.

6-11.6 Report.

6-11.6.1 The results of each system verification shall be made part of the test results for specimens being tested.

6-11.6.2 The peak force and impact velocity shall be recorded for each test.

6-11.7 Interpretation.

6-11.7.1 Pass/fail performance shall be determined for each specimen. One or more helmet specimens failing this test shall constitute failing performance.

6-12 Helmet Physical Penetration Resistance Test.

6-12.1 Application.

6-12.1.1 This test method shall apply to protective helmets.

6-12.2 Specimens.

6-12.2.1 Specimens shall be five helmets of each different style or model.

6-12.3 Sample Preparation.

6-12.3.1 Samples for conditioning shall be complete helmets.

6-12.3.2 Specimens shall be conditioned for each environmental condition specified in 6-1.1, 6-1.3, 6-1.4, and 6-1.5 prior to each physical penetration.

6-12.4 Apparatus.

6-12.4.1 A size 7 aluminum headform, commonly known as the "ISEA Standard Headform," shall be used. The headform shall have a mass of 3.6 kg, ±0.5 kg (8 lb, ±1 lb). Above the test line, it shall have an electrically conductive surface that is electrically connected to the contact indicator.

6-12.4.2 The penetration striker shall have a mass of 1 kg, +0.02/−0.00 kg (2.2 lb, +0.01/−0.00 lb). The point of the striker shall be a cone with an included angle of 60 degrees, $\pm 1/2$ degree, a height of 38 mm ($1\ 1/2$ in.), and a tip radius of 0.5 mm, ±0.1 mm (0.020 in., ±0.004 in.). The hardness of the striking tip shall be Rockwell Scale C-60, minimum. The penetration striker shall be electrically connected to the contact indicator.

6-12.4.3 The contact indicator shall indicate when electrical contact has been made between the penetration striker and the conductive surface of the test headform. The contact indicator shall have a response time of less than 0.5 milliseconds.

6-12.4.4 The test shall be conducted at an ambient temperature of 20°C to 28°C (68°F to 82°F), and the relative humidity shall be 30 percent to 70 percent.

6-12.5 Procedure.

6-12.5.1 The environmentally conditioned helmet shall be placed on the rigidly mounted test headform and secured by the helmet retention system or by other means that will not interfere with the test. Specimen helmets shall be adjusted to a size sufficient to properly fit on the headform. Specimens shall be positioned on the headform with the horizontal center plane parallel within 5 degrees of the reference plane. The front-to-back centerline of the shell shall be within 13 mm (0.5 in.) of the mid-sagittal plane of the headform.

6-12.5.2 The drop height of the penetration striker shall be adjusted so that the velocity at impact is at 7 m/sec, ±0.1 m/sec (23 ft/sec, ±0.5 ft/sec). The plumb bob shall be dropped to strike the sample helmet shell within a circle whose diameter is 75 mm (3 in.) and whose center shall be the geometric center of the shell. The plumb bob shall not fall on any portion of the ridges or make contact with the headform.

6-12.6 Report.

6-12.6.1 The pass/fail result for each helmet shall be reported.

6-12.7 Criteria.

6-12.7.1 One or more helmet specimens failing this test shall constitute failing performance.

6-13 Helmet Flammability Test.

6-13.1 Application.

6-13.1.1 This test method shall apply to protective helmets and antiglare material on helmets, where provided as permitted in 4-2.4.

6-13.1.2 Helmets which are not provided with antiglare material shall be tested to Procedure A only.

6-13.2 Specimens.

6-13.2.1 A minimum of five complete helmets shall be tested for each of the tests in this section.

6-13.3 Sample Preparation.

6-13.3.1 Specimens shall be conditioned as specified in 6-1.1.

6-13.4 Apparatus.

6-13.4.1 A standard Bunsen burner shall be used.

6-13.4.1.1 The Bunsen burner shall be fueled by a bottled methane gas, lab grade or better, of 3.72×10^7 J/m^3, $\pm 1.8 \times 10^6$ J/m^3 (1000 Btu/ft^3, ±50 Btu/ft^3).

6-13.4.1.2 A control valve system with a delivery rate designed to furnish gas to the burner under a pressure of 3.5 kPa, +0.7/−0 kPa ($1/2$ psi, +0.1/−0.0 psi) at the burner shall be utilized.

6-13.4.1.3 The barrel of the Bunsen burner shall be 13 mm, ±3 mm ($1/2$ in., $\pm 1/8$ in.) in diameter. A flame spreader shall not be used.

6-13.4.1.4 The Bunsen burner shall be adjusted to produce a 50-mm (2-in.) blue flame with a 25-mm (1-in.) inner core.

6-13.4.2 Other apparatus equipment shall include a laboratory test stand, fume hood, and stopwatch. The laboratory test stand shall be capable of holding the specimen helmet in both an inverted horizontal position and in the "as worn" position allowing flame contact as specified in 6-13.5.1.2 and 6-13.5.2.1, respectively.

6-13.5 Procedures.

6-13.5.1 Procedure A.

6-13.5.1.1 Each helmet shall be attached to the laboratory test stand so that it is held in an inverted horizontal position. The stand and the helmet shall be placed in a draftfree fume hood.

6-13.5.1.2 Any point with 100 mm (4 in.) of the apex of the helmet crown shall be chosen, and the flame of the Bunsen burner shall be applied so that the tip of the inner cone contacts the helmet surface ±5 mm ($\pm 3/16$ in.). The barrel of the Bunsen burner shall be held at an angle of 45 degrees, ±5 degrees, to the helmet surface. The chosen point shall not be closer than 25 mm (1 in.) from any decals, logos, or retroreflective markings.

6-13.5.2 Procedure B.

6-13.5.2.1 The specimen shall be attached to the laboratory test stand so that it is held in the "as worn" position. The stand and specimen shall be placed in a draftfree fume hood. The flame of the Bunsen burner shall be applied so that the tip of the inner cone is at the helmet surface, ±5.0 mm (±$^3/_{16}$ in.) at any point under the peak or front of the brim, and 13 mm, ±3 mm ($^1/_2$ in., ±$^1/_8$ in.) from the edge of the peak or brim.

6-13.5.3 The flame shall be applied to the test surface for 5 seconds, +1/–0 second. After removal of the flame, any afterflame shall be measured.

6-13.6 Report.

6-13.6.1 Afterflame times shall be reported for each specimen at each flame impingement location. The afterflame times shall be reported to the nearest 0.5 second.

6-13.7 Interpretation.

6-13.7.1 Pass/fail performance shall be based on the longest measured afterflame time for each procedure.

6-14 Glove Heat Resistance Test.

6-14.1 Specimens shall be three gloves of each different style or model.

6-14.2 Specimen gloves, including label, shall be preconditioned as specified in 6-1.1. Specimen gloves shall then be placed in a circulating air oven for not less than 4 hours at 49°C, +2°/±0°C (120°F, +5°/±0°F).

6-14.3 The length of the sample glove shall be measured from the tip of the middle finger to the end of the glove body on the palm side. The width of the specimen glove shall be the width measurement on the palm side 25 mm (1 in.) below the base of the fingers. Where the glove is made with a wristlet of a different material, the wristlet shall be measured separately. These measurements shall constitute the before test measurements.

6-14.4 The test oven shall be a horizontal flow circulating oven with minimum interior dimensions of 610 mm × 610 mm × 610 mm (24 in. × 24 in. × 24 in.). The test oven shall have an airflow rate of minimum 38 m to 76 m (125 linear ft to 250 linear ft) at the standard temperature and pressure of 21°C (70°F) at 1 atmosphere, measured at the center point of the oven. A test thermocouple shall be positioned so that it is level with the horizontal centerline of a mounted glove. The thermocouple shall be equidistant between the vertical centerline of a mounted glove placed in the middle of the oven and the oven wall where the airflow enters the test chamber. The thermocouple shall be an exposed bead, Type J or K No. 30 AWG thermocouple. The test oven shall be heated and the test thermocouple stabilized at 204°C, +6°/–0°C, (400°F, +10°/–0°F) for a minimum of 30 minutes.

6-14.4.1 When testing specimen gloves, the glove opening shall be clamped together and the glove shall be suspended by the clamp in the oven so that the entire glove is not less than 51 mm (2 in.) from any oven surface, or another specimen glove, and the airflow is parallel to the plane of the material.

6-14.4.2 Where gloves have more than a single layer, the specimen shall consist of the innermost surface of the glove composite measuring 102 mm × 102 mm (4 in. × 4 in.). The specimen shall be suspended by metal hooks at the top and centered in the oven so that the entire specimen is not less than 50 mm (2 in.) from any oven surface, or other specimen, and the airflow is parallel to the plane of the material.

6-14.5 The oven door shall not remain open more than 15 seconds. The air circulation shall be shut off while the door is open and turned on when the door is closed. The total recovery time shall not exceed 30 seconds. The thermocouple reading shall remain at 204°C, +6°/–0°C (400°F, +10°/–0°F) for the duration of the test.

6-14.6 The specimen glove or composite specimen, mounted as specified, shall be exposed in the test oven for 5 minutes, +15/–0 seconds. The test exposure time shall begin when the test thermocouple recovers 204°C, +6°/–0°C (400°F, +10°/–0°F).

6-14.7 After the specified exposure, the specimen glove or composite specimen shall be removed and shall be examined for separation, melt, ignition, or drip to determine pass/fail.

6-14.8 The length of the sample glove shall be measured from the tip of the middle finger to the end of the glove body on the palm side. The width of the specimen glove shall be the width measurement on the palm side 25 mm (1 in.) below the base of the fingers. Where the glove is made with a wristlet of a different material, the wristlet shall be measured separately. These measurements shall constitute the after-test measurements. The after-test measurements shall be evaluated with the before-test measurements obtained in 6-14.3 to determine pass/fail.

6-15 Suspension System Retention Test.

6-15.1 Application.

6-15.1.1 This test shall apply to protective helmets.

6-15.2 Specimens.

6-15.2.1 Specimens shall be five helmets of each different style or model.

6-15.3 Sample Preparation.

6-15.3.1 Specimens shall be conditioned as specified in 6-1.1.

6-15.3.2 Samples for conditioning shall be whole helmets.

6-15.4 Apparatus.

6-15.4.1 The suspension system retention test fixtures shall consist of rigid material of sufficient thickness and optional design to facilitate firm attachment to the helmet suspension and the tensile test machine as shown in Figure 6-15.4.1.

6-15.4.2 The force gauge shall be accurate to 1 N (0.25 lb).

6-15.5 Procedure.

6-15.5.1 Specimens shall be positioned and secured so that the helmet's reference plane is horizontal. Each attachment point of the crown strap shall be tested by applying a pull force perpendicular to the reference plane to a maximum load of 22.5 N, +1/–0 N (5 lbf, +0.25/–0 lbf). The force shall be increased from 0 N to 22.5 N at a load rate of 25 mm/min, ±5 mm (1 in./min, ±0.2 in.). The force shall be applied through the centerline at each attachment point.

6-15.5.2 Each adjusting mechanism of the helmet suspension system assembly shall be secured and unsecured, as applicable, for 20 repetitions.

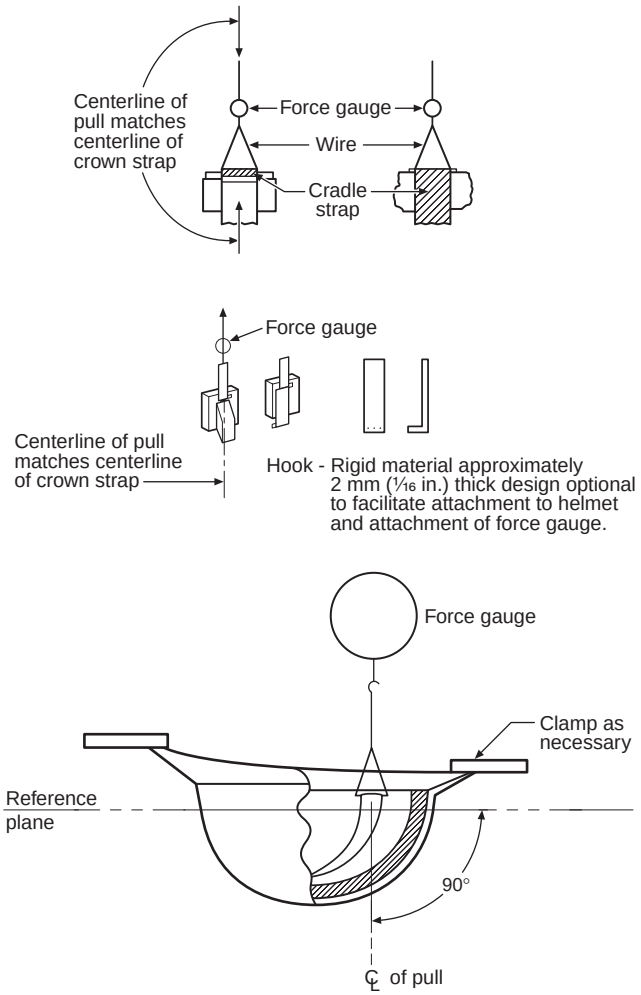


Figure 6-15.4.1 Suspension system retention test setup.

6-15.6 Report.

6-15.6.1 The individual pass/fail results for each attachment point shall be recorded.

6-15.6.2 Each adjusting mechanism of the helmet suspension system shall be observed for proper functioning to determine pass/fail.

6-15.7 Interpretation.

6-15.7.1 One or more helmet specimens failing this test shall constitute failing performance.

6-16 Retroreflectivity Test.

6-16.1 Specimens.

6-16.1.1 A minimum of three trim test specimens shall be tested.

6-16.1.2 Each trim test specimen shall consist of a 305 mm × 305 mm (12 in. × 12-in.) composite made up of multiple strips of the finished trim product. Where retroreflective and nonretroreflective surface areas are combined to form a trim, the complete finished product consisting of the retroreflective and nonretroreflective portions shall be used to form the composite test specimen.

6-16.2 Sample Preparation.

6-16.2.1 Samples for conditioning shall include 305-mm (12-in.) long sections of trim.

6-16.2.2 Specimens shall be conditioned as specified in 6-1.1.

6-16.3 Procedures.

6-16.3.1 Measurement of Coefficient of Retroreflection.

6-16.3.1.1 The coefficient of retroreflection (R_a) shall be determined in accordance with ASTM E 809, *Standard Practice for Measuring Photometric Characteristics of Retroreflectors*, using the following modifications:

(a) Test distance = 15.2 m (50 ft).
(b) Observation angle = 0.2 degrees.
(c) Entrance angle = –4 degrees.
(d) The receiver shall be provided with an entrance aperture of 25 mm (1 in.), ±5 percent, in diameter which is equivalent to 0.1 degree angular aperture.
(e) The exit aperture of the source shall be circular and 25 mm (1 in.), ±5 percent, in diameter which corresponds to 0.1 degree angular aperture.
(f) Retroreflector reference angle = 90 degrees.
(g) Datum mark shall be placed as specified by the trim manufacturer.

6-16.3.1.2 The coefficient of retroreflection (R_a) shall be calculated by the following equation:

$$R_a = \frac{R_I}{A_r}$$

where:

R_I = the coefficient of luminous intensity, measured as specified in 6-16.3.1.1

A_r = only the retroreflective surface area of the trim test specimen's surface area

A_r shall be calculated by subtracting the nonretroreflective surface area from the test specimen's total surface area.

6-16.4 Interpretation.

6-16.4.1 For trim retroreflectivity, pass/fail performance shall be determined using the average coefficient of retroreflection (R_a) reported for each group of specimens for each of the procedures specified in 6-16.4.1.

6-17 Retention System Test.

6-17.1 Application.

6-17.1.1 This test shall apply to protective helmets.

6-17.2 Specimens.

6-17.2.1 Specimens shall be five helmets of each different style or model.

6-17.3 Sample Preparation.

6-17.3.1 Samples for conditioning shall be whole helmets.

6-17.3.2 Specimens shall be conditioned as specified in 6-1.1.

6-17.3.3 Specimen helmets with chin straps shall be conditioned for heat as specified in Section 6-18, Heat Distortion Test, and then shall be allowed to cool to room temperature.

6-17.4 Apparatus.

6-17.4.1 The headform shall be an ISO size J.

6-17.4.2 The mechanical chin structure shall consist of two rollers 13 mm ($^1/_2$ in.) in diameter with centers that are 75 mm (3 in.) apart. The mechanical chin structure shall conform with Figure 6-17.4.2.

6-17.4.3 The mechanical chin structure shall be designed to be used with a calibrated tensile test machine. The calibrated tensile test machine shall be capable of measuring the force applied to the retention system within 2 percent at the specified force.

6-17.4.4 The test shall be conducted at an ambient temperature of 20°C to 28°C (68°F to 82°F), and the relative humidity shall be 30 percent to 70 percent.

6-17.4.5 Prior to testing, the test machine shall be allowed to warm up until stability is achieved.

6-17.5 Procedure.

6-17.5.1 The headform and mechanical chin structure shall be positioned so that the distance between the bottom of the rollers and the top of the headform is 200 mm, ±10 mm (8 in., ±0.4 in.). The chin strap shall be passed around the rollers, and the helmet shall be secured to the headform. The chin strap shall be adjusted and preloaded to 45 N, ±5 N (10 lbf, ±1 lbf). The distance between the top of the helmet and the rollers shall be measured and recorded to the nearest 0.5 mm (0.02 in.).

6-17.5.2 The force applied to the retention system shall be slowly increased to 225 N, ±5 N (50 lbf, ±1 lbf). The force shall be increased smoothly at a rate between 9.0 N/sec to 45 N/sec (2 lbf/sec to 10 lbf/sec).

6-17.5.3 Where using a tensile testing machine, the load rate shall be 25 mm/min (1 in./min) to a limit of 225 N (50 lbf).

6-17.5.4 The distance between the top of the helmet and the rollers shall be measured and recorded again after the force has been maintained at 225 N, ±5N (50 lbf, ±1 lbf) for 60 seconds, +5/−0 seconds. The difference between the second measurement and the first shall be the retention system elongation.

6-17.5.5 In addition, each adjusting mechanism of the helmet chin strap assembly shall be secured and unsecured, as applicable, for 20 repetitions.

6-17.6 Report.

6-17.6.1 The retention system elongation shall be measured for each helmet specimen.

6-17.6.2 Each mechanism shall be observed for proper functioning to determine pass/fail.

6-17.7 Interpretation.

6-17.7.1 One or more helmet specimens failing this test shall constitute failing performance.

6-18 Heat Distortion Test.

6-18.1 The test oven shall be a horizontal flow circulating air oven with minimum internal dimensions of 455 mm × 455 mm × 455 mm (18 in. × 18 in. × 18 in.). The oven shall be heated and stabilized to a temperature of 177°C, +5°/−0°C (350°F, +10°/−0°F).

6-18.2 Specimens shall be three helmets of each different style or model. Specimen helmets shall be securely mounted on a room-temperature nonmetallic headform in the "as worn" position. A liner, ear flaps, or a similar device shall be deployed to protect the suspension, if necessary.

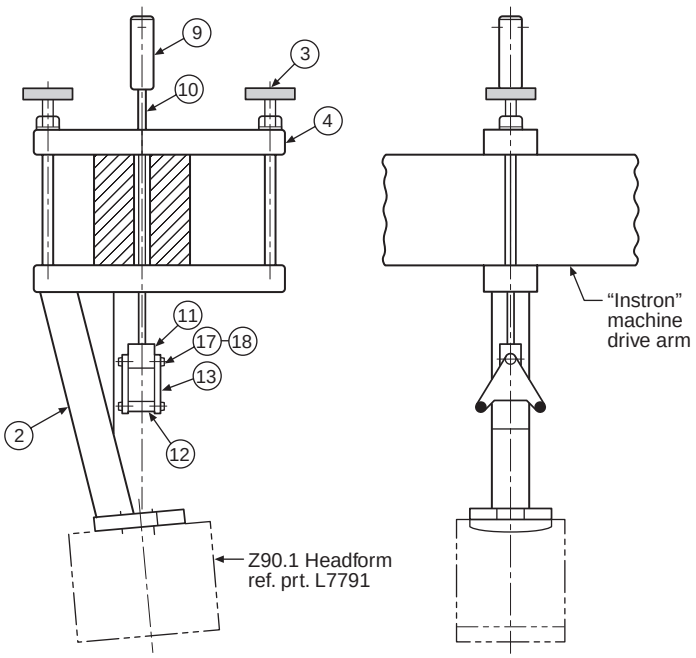


Figure 6-17.4.2 Retention system test setup.

ITEM NO.	PART NO.	SHT. NO.	DESCRIPTION	MAT'L.	VEND. OR STR. SIZE	QTY.
1	L8539	1	Retention Test Fixt. Assy.	—	—	1
2		2	Main Support Assy.	—	—	1
3		2	Knurled Knob Assy.	—	—	2
4		2	Rect. Alum. Bar	6061-T6	1 1/2 x 3 x 14 Lg.	1
5		2	Rect. Alum. Bar	6061-T6	1 1/2 x 3 x 14 Lg.	1
6		2	Alum. Bar	6061-T6	2 x 2 x 7 1/2 Lg.	1
7		2	Alum. Bar	6061-T6	2 x 2 x 12.96 Lg.	1
8		2	Alum. Flat	6061-T6	3/4 x 4 1/2 x 5 Lg.	1
9		2	C.F. Steel Rod	Stl.	1 1/4 Dia. x 4 Lg.	1
10		2	C.F. Steel Rod	Stl.	3/8 Dia. x 22 Lg.	1
11		2	C.F. Steel Flat	Stl.	1 x 1 1/4 x 1 1/2 Lg.	1
12		2	Hollow Steel Tube	Stl.	.500 O.D. .384 I.D. x 1 1/2	2
13		2	C.F. Steel Flat	Stl.	1/4 x 3 1/4 x 3 3/4 Lg.	2
14		2	C.F. Steel Flat	Stl.	39 x 3/4 Thk.	2
15		2	C.F. Steel Rod	Stl.	3/4 ∅ x 10 1/2 Lg.	2
16		2	Hex Nut	Stl.	3/4 - 10 Unc.	2
17		1	Hex Hd. Bolt	Stl.	3/8 - 24 Unf. x 2 1/2 Lg.	3
18		1	Hex Nut	Stl.	3/8 - 24 Unf.	3

Notes:

1. Remove burrs and break sharp edges.
2. All steel parts are to be solvent cleaned and zinc plated 0.0003 to 0.0010 in. thick.
3. Headform is to be bolted in place using a No. 3 socket head cap screws ½–13 UNC × 1½ Lg.

6-18.3 A series of points shall be marked 75 mm (3 in.) apart on the outer edge of the peak or brim of the sample helmets, allowing at least three points on a peak and eight or more points on a full brim. The vertical distance from a known horizontal base plane to the mark points on the peak or brim shall be measured and recorded.

6-18.4 The sample helmet mounted on the headform shall be placed in the center of the oven. If the sample helmet contains a peak only, the sample helmet shall face into the airflow. The oven door shall not remain open more than 15 seconds. The air circulation shall be shut off while the door is open and turned on when the door is closed.

6-18.5 After 5 minutes, +15/−0 seconds, the sample helmet mounted on the headform shall be removed and allowed to cool for a minimum of 2 minutes. The vertical distance from the marked points to the base plane shall be measured, recorded, and compared with the measurements recorded in 6-18.3 to determine pass/fail.

6-19 Goggle and Headlamp Clip Attachment Test.

6-19.1 Application.

6-19.1.1 This test method shall apply to goggle and headlamp clips on helmets.

6-19.2 Specimens.

6-19.2.1 A minimum of three helmets with goggle and headlamp clips shall be tested for each test.

6-19.3 Sample Preparation.

6-19.3.1 Specimens shall be conditioned as specified in 6-1.1.

6-19.3.2 Samples for conditioning shall be complete helmets with goggle and headlamp clips in place.

6-19.4 Apparatus.

6-19.4.1 The test fixture shall consist of a 1.4 kg (3 lb) weight attached to a 1-mm ($^{1}/_{32}$-in.) diameter wire loop.

6-19.5 Procedure.

6-19.5.1 The helmet shall be turned on edge with the clip to be tested facing directly down and supported on the brim except directly beneath the clip as shown in Figure 6-19.5.1.

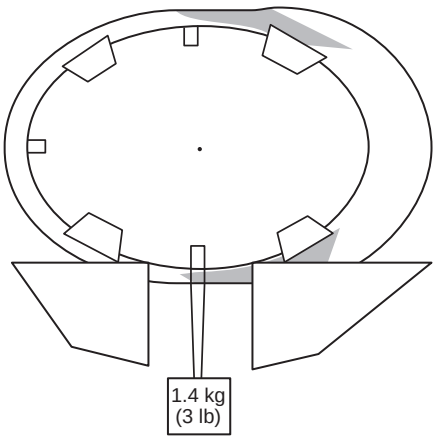


Figure 6-19.5.1 Test setup (side view of top of helmet).

6-19.5.2 The wire shall be looped under the clip and, without allowing any vertical drop, the weight shall be suspended from the clip.

6-19.5.3 After 5 seconds +2/−0 seconds, the clip shall be inspected to determine if it has pulled away from the helmet or deformed more than 6 mm ($^{1}/_{4}$ in.) from its original position, either of which constitutes a failure.

6-19.6 Report.

6-19.6.1 The individual pass/fail results for each specimen and clip shall be recorded.

6-19.7 Criteria.

6-19.7.1 One or more helmet specimens failing this test constitute failing performance.

6-20 Glove Flame Resistance Test.

6-20.1 Specimens.

6-20.1.1 Each specimen to be tested shall be a rectangle at least 50 mm × 150 mm (2 in. × 6 in.). Specimens shall be the composite used in actual glove construction consisting of each single layer, with all layers arranged in proper order. In each test, the specimen's normal outer surface shall be exposed to the flame.

6-20.1.2 Three specimens shall be tested for each material.

6-20.1.3 If a proposed glove construction has stitched-through seams, three additional specimens containing these seams shall be tested. The seam shall be in the direction of the 150-mm (6-in.) dimension.

6-20.2 Sample Preparation.

6-20.2.1 Specimens shall be tested both before and after being subjected to the procedure specified in 6-1.2.

6-20.2.2 All specimens to be tested shall be conditioned as specified in 6-1.1.

6-20.2.3 Samples to be conditioned shall be the composite used in actual glove construction consisting of each single layer, with all layers arranged in proper order and stitched along the edges using the same thread as used in the construction of the glove.

6-20.3 Apparatus.

6-20.3.1 The test apparatus specified in Method 5905.1, "Flame Resistance of Material; High Heat Flux Flame Contact," of FED-STD-191A, *Textile Test Methods*, shall be used.

6-20.3.2 A freestanding flame height indicator shall be used to assist in adjusting the burner flame height. The indicator shall mark a flame height of 75 mm (3 in.) above the top of the burner.

6-20.3.3 A specimen support assembly shall be used that consists of a frame and steel rod of 2 mm ($^{5}/_{64}$ in.) in diameter to support the specimen in an L-shaped position, as shown in Figure 6-20.3.3.

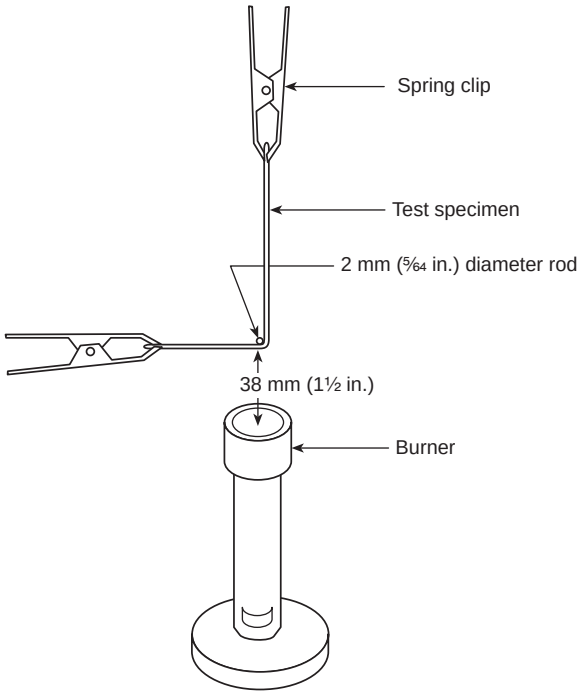


Figure 6-20.3.3 Relationship of test material to burner.

6-20.3.4 The horizontal portion of the specimen shall be not less than 50 mm (2 in.), and the vertical portion shall be not less than 100 mm (4 in.). The specimen shall be held at each end by spring clips under light tension, as shown in Figure 6-20.3.3.

6-20.4 Procedure.

6-20.4.1 A balance shall be used to determine the weight of each specimen to the nearest 0.1 g (0.04 oz) before and after testing.

6-20.4.2 The burner shall be ignited and the test flame shall be adjusted to a height of 75 mm (3 in.) with the gas on/off valve fully open and the air supply completely and permanently off, as it is important that the flame height be closely controlled. The 75-mm (3-in.) height shall be obtained by adjusting the orifice in the bottom of the burner so that the top of the flame is level with the marked flame height indicator.

6-20.4.3 With the specimen mounted in the support assembly, the burner shall be moved so that the middle of the folded corner projects into the flame 38 mm ($1^1/_2$ in.), as shown in Figure 6-20.3.3.

6-20.4.4 The burner flame shall be applied to the specimen for 12 seconds. After 12 seconds, the burner shall be removed.

6-20.4.5 The afterflame time shall be measured as the time, in seconds, to the nearest 0.2 second, that the specimen continues to flame after the burner is removed from the flame.

6-20.4.6 Each layer of the specimen shall be examined for melting or dripping.

6-20.4.7 Each tested sample shall be reconditioned as specified in 6-1.3 and then weighed to the nearest 0.1 g (0.04 oz).

6-20.4.8 The specimen then shall be further examined for char length. The char length shall be determined by measuring the length of the tear through the center of the charred area as specified in 6-20.4.8.1 through 6-20.4.8.4.

6-20.4.8.1 The specimen shall be folded lengthwise and creased, by hand, along a line through the highest peak of the charred area.

6-20.4.8.2 The hook shall be inserted into a hole punched in the specimen that is 6 mm ($^1/_4$ in.) in diameter or less. The hole shall be punched out for the hook at one side of the charred area that is 6 mm ($^1/_4$ in.) from the adjacent outside edge, at the point where the specimen contacted the steel rod, and 6 mm ($^1/_4$ in.) in from the lower end.

6-20.4.8.3 A weight of sufficient size so that the weight and hook together equal the total tearing weight required by Table 6-20.4.8.3 shall be attached to the hook. The total tearing weight for determining char length shall be based on the weight of the composite specimen and shall be determined from Table 6-20.4.8.3.

Table 6-20.4.8.3

Specified Weight per Square Yard of Material Before Any Fire Retardant Treatment or Coating		Total Tearing Weight for Determining Charred Length	
oz/yd²	**g/m²**	**lb**	**kg**
2.0–6.0	68–203	0.25	0.1
over 6.0–15.0	over 203–508	0.5	0.2
over 15.0–23.0	over 508–780	0.75	0.3
over 23.0	over 780	1.0	0.45

6-20.4.8.4 A tearing force shall be applied gently to the specimen by grasping the side of the material at the edge of the char opposite the load and raising the specimen and weight clear of the supporting surface. The end of the tear shall be marked off on the edge and the char length measurement made along the undamaged edge.

6-20.5 Report.

6-20.5.1 The afterflame time and char length shall be reported for each specimen. The average afterflame time and char length shall also be calculated and reported. The afterflame time shall be reported to the nearest 0.2 second and the char length to the nearest 3 mm ($^1/_8$ in.).

6-20.5.2 The percent consumed shall be calculated using the following formula:

$$\text{Percent consumed} = \frac{W - R}{W} \times 100$$

where:

W = original preconditioned weight

R = conditioned weight 24 hours after testing

The percent consumed shall be reported for each specimen to the nearest 0.1 percent. The average percent consumed shall be calculated and reported to the nearest 0.1 percent.

6-20.5.3 Observations of melting or dripping for each specimen shall be reported.

6-20.6 Interpretation.

6-20.6.1 Pass/fail performance shall be based on melting or dripping, the average afterflame time, the average char length, and the percent consumed of the specimen original weight.

6-21 Conductive Heat Resistance Test.

6-21.1 Application.

6-21.1.1 This test method shall apply to glove materials.

6-21.2 Specimens.

6-21.2.1 A total of three specimens shall be tested.

6-21.2.2 Specimens shall be representative of glove body composite construction at the palm of the hand and at the palm side of the fingers.

6-21.2.3 Specimens shall be stitched around the perimeter using the same thread used in glove construction.

6-21.3 Sample Preparation.

6-21.3.1 Specimens shall be conditioned as specified in Section 6-1.2 of this standard.

6-21.4 Procedure.

6-21.4.1 Specimens shall be tested in accordance with ASTM F 1060, *Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact.*

6-21.4.2 Specimens shall be tested using an exposure temperature of 280°C (536°F). The pressure applied during the test shall be 3 kPa (0.5 psi).

6-21.4.3 The time in seconds to pain and to second-degree burn (blister) as predicted by the Stoll Human Tissue Burn Tolerance Criteria as specified in 6-22.5.4 shall be recorded.

6-21.5 Report.

6-21.5.1 The time to pain and time to second-degree burn for each specimen shall be reported. If the time to pain or time to second-degree burn is greater than 30 seconds, then the time to pain or time to second-degree burn shall be reported as >30 seconds.

6-21.6 Interpretation.

6-21.6.1 Pass or fail determinations shall be based on the time to pain and time to second-degree burn of all specimens tested.

6-21.6.2 If an individual result from any test set varies more than ±8 percent from the other individual results of that test series, the results from the test series shall be discarded and another set of specimens shall be tested.

6-22* Thermal Protective Performance (TPP) Test.

6-22.1 Application.

6-22.1.1 This test method shall apply to gloves.

6-22.2 Specimens.

6-22.2.1 Specimens shall consist of the composite used in the actual glove construction, with the layers arranged in proper order. Specimens shall not include seams, where multiple layers are involved. Specimens shall not be stitched to hold individual layers together during testing.

6-22.2.2 Thermal protective performance testing shall be conducted on three specimens. Specimens shall measure 150 mm × 150 mm, ±6 mm (6 in. × 6 in., $\pm^1/_4$ in.) and shall consist of all layers representative of the glove to be tested.

6-22.3 Specimen Preparation.

6-22.3.1 Specimens for conditioning shall include glove material that is a minimum of 180 mm (7 in.) square consisting of the composite used in the actual glove construction, with the layers arranged in proper order and stitched using the same thread used in the construction of the glove.

6-22.3.2 Specimens shall be tested both before preconditioning, and tested after preconditioning as specified in 6-1.2 and then conditioning as specified in 6-1.1.

6-22.4 Apparatus.

6-22.4.1 The test apparatus shall consist of a specimen holder assembly, specimen holder assembly support, thermal flux source, protective shutter, sensor assembly, and recorder. The apparatus shall also have a gas supply, gas rotameter, burners, and sensor.

6-22.4.1.1 The specimen holder assembly shall consist of upper and lower mounting plates. Specimen holder maintaining plates shall be 150 mm × 150 mm, ±2 mm, × 6 mm, ±1 mm (6 in. × 6 in., $\pm^1/_{16}$ in. × $^1/_4$ in., $\pm^1/_{32}$ in.). The lower specimen mounting plate shall have centered a 100 mm × 100 mm, ±2 mm (4 in. × 4 in., $\pm^1/_{16}$ in.) hole. The upper specimen mounting plate shall have centered a 133 mm × 133 mm, ±2 mm ($5^1/_4$ in. × $5^1/_4$ in., $\pm^1/_{16}$ in.) hole. The lower specimen mounting plate shall have a 25 mm, ±2 mm high, × 3 mm, ±1 mm (1 in., $\pm^1/_{16}$ in. high, × $^1/_8$ in., $\pm^1/_{32}$ in.) thick steel post welded to each corner 6 mm, ±2 mm ($^1/_4$ in., $\pm^1/_{16}$ in.) from each side and perpendicular to the plane of the plate or some other method for aligning the specimen shall be provided. 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. Specifications for the specimen holder assembly shall be as shown in Figure 6-22.4.1.1.

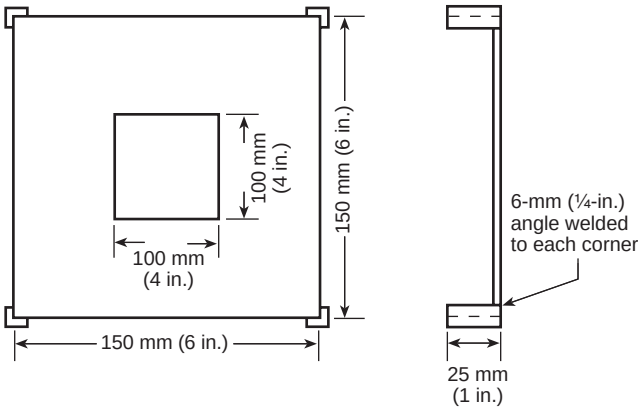


Figure 6-22.4.1.1 Lower specimen mounting plate.

6-22.4.1.2 The 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.

6-22.4.1.3 The 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 T-150 infrared tubes affixed beneath and centered between the burners as shown in Figure 6-22.4.1.3.

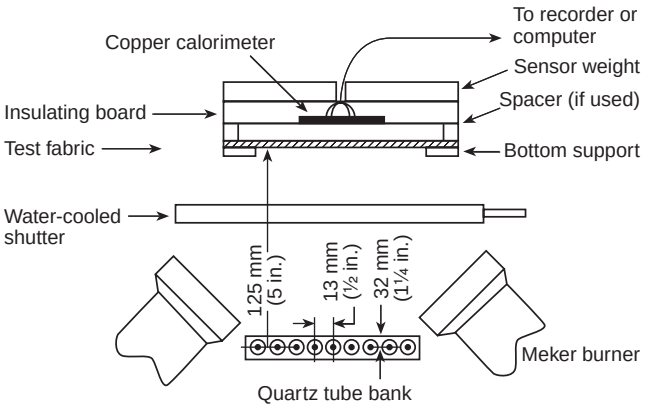


Figure 6-22.4.1.3 Specifications for TPP tester thermal flux source.

6-22.4.1.4 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 of the time periods before and after specimen exposure.

6-22.4.1.5 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, as detailed in Figure 6-22.4.1.10. Sensor assembly shall consist of 133 mm × 133 mm × 13 mm ($5^1/_4$ in. × $5^1/_4$ in. × $^1/_2$ in.) heat-resistant block that fits without binding into the hole of the 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).

6-22.4.1.6 The recorder shall be any strip chart recorder with full-scale deflection of at least 150°C (300°F) or 10 mV and sufficient sensitivity and scale divisions to read exposure time to ±0.1 second; alternatively, an equivalent automated data acquisition system meeting or exceeding the sensitivity and accuracy requirements of the strip chart recorder shall be permitted to be used instead of a strip chart recorder.

6-22.4.1.7 The gas supply shall be propane, methane, or natural gas with appropriate reducer and valving arrangements to control the gas supply pressure at 8 psig, ±0.1 psig and capable of providing flow equivalent to 2 L/min (0.07 ft^3/min) air at standard conditions.

6-22.4.1.8 The gas rotameter shall be any gas rotameter with range to give flow equivalent to 2 L (0.07 ft^3)/min air at standard conditions.

6-22.4.1.9 The burners shall be Meker or Fisher burners with 38 mm, ±2 mm ($1^1/_2$ in., $\pm^3/_{32}$ in.) diameter top and with orifice size of 1.2 mm (0.05 in.).

6-22.4.1.10 The sensor shall be a copper calorimeter mounted in an insulating block. The calorimeter shall conform to the specifications provided in Figure 6-22.4.1.10. The sensor shall be coated with a flat black paint.

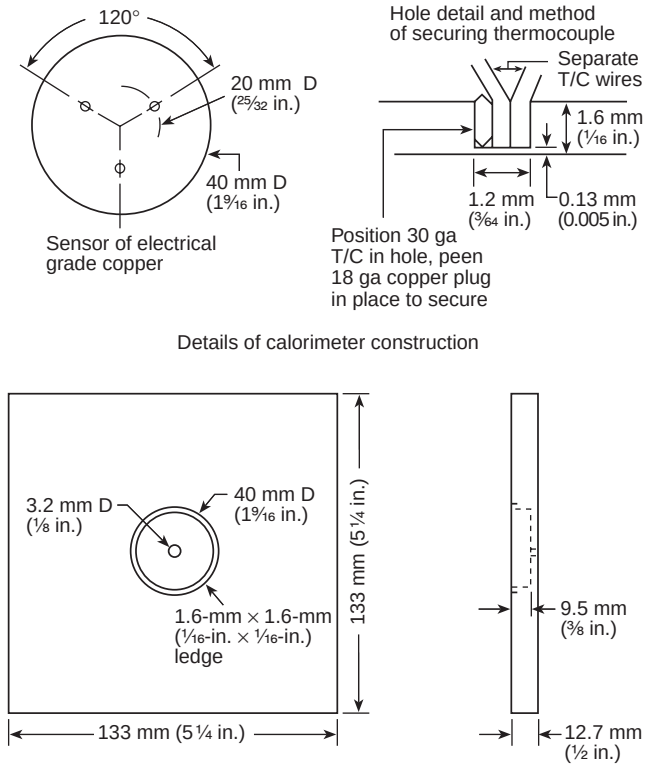


Figure 6-22.4.1.10 Sensor assembly.

6-22.4.2 A radiometer shall be used in the calibration of the test apparatus.

6-22.4.2.1 The radiometer shall be a Gardon-type radiation transducer with a diameter of 25 mm (1 in.). The heat flux operating range shall be from 0 kW/m^2 to 60 kW/m^2 (0 cal/cm^2/sec to 1.4 cal/cm^2/sec or 0 Btu/ft^2/sec to 5 Btu/ft^2/sec). The radiometer shall be water cooled and the cooling water temperature shall be above the ambient dew point temperature.

6-22.5 Procedure.

6-22.5.1 General Procedures.

6-22.5.1.1 All testing and calibration shall be performed in a hood or ventilated area to carry away combustion products, smoke, or fumes. If air currents disturb the flame, the apparatus shall be shielded. Procedures for testing and calibration shall be performed using the same hood and ventilation conditions.

6-22.5.1.2 Care shall be exercised in handling the burner with open flame. Adequate separation shall be maintained between flame and combustible materials. Since the specimen holder and sensor assembly become heated during prolonged

testing, protective gloves shall be used when handling these hot objects. Since some test specimens become hazardous when exposed to direct flame, care shall be used when the specimen ignites or releases combustible gases. If specimens ignite, the gas supply at the cylinder shall be shut off and the flame shall be allowed to burn the gas.

6-22.5.2 Calibration Procedure.

6-22.5.2.1 Specimens shall be exposed to a thermal flux of 83 kW/m^2, ±4 kW/m^2 (2 cal/cm^2/sec, ±0.1 cal/cm^2/sec) as measured with the copper calorimeter. The copper calorimeter shall be the only heat sensor used in setting the total 83 kW/m^2 (2 cal/cm^2/sec) exposure condition. The total heat flux shall be calculated directly and only from the voltage output of the thermocouples, using the measured temperature rise of the testing copper calorimeter, the area and mass of the calorimeter, and the heat capacity of copper to calibrate the heat flux. Other heat sensing devices shall not be used to reference or adjust the total heat flux read by the copper calorimeter.

6-22.5.2.2 The total heat flux and the 50 percent/50 percent, ±5 percent radiant/convective balance of the energy sources shall be set in accordance with the procedures in 6-22.5.2.3 through 6-22.5.2.6. The level of the radiant heat flux shall be determined using a radiometer and the level of the total heat flux shall be determined by using a calibration copper calorimeter designated and used only to set the total exposure level.

6-22.5.2.3 Once an initial setting of 50 kW/m^2, ±4 kW/m^2 (0.3 cal/cm^2/sec, ±0.1 cal/cm^2/sec) has been made to the array of new quartz lamps, the operating voltage shall be recorded and permanently retained for test purposes. During all future calibration procedures, the voltage setting of the quartz lamps shall be compared to the current voltage setting of the new quartz lamps, and if the voltage increase is 5 V or greater from the initial setting, the lamps shall be replaced.

6-22.5.2.4* The two Meker or Fisher burners shall be initially adjusted so that the flames converge upon each other just below the center of the radiometer. The primary color of the flame shall be blue.

6-22.5.2.5 The radiant thermal flux source of nine quartz infrared tubes alone shall be set to an incoming radiant heat flux of 12 kW/m^2, ±4 kW/m^2 (0.3 cal/cm^2/sec, ±0.1 cal/cm^2/sec) using a commercial radiometer meeting the specifications of 6-22.4.2. The radiometer window shall be positioned at the geometric center of the sample holder and at the same plane as a test specimen. The radiometer shall be mounted in a holder of the same overall size, shape, and material as the one used for the copper calorimeter to ensure similar heat and flame patterns across the faces of the radiometer and calorimeters. The radiant quartz tubes shall be turned on and "run" for a minimum of 2 minutes prior to measuring the radiant heat flux.

6-22.5.2.6 The total heat flux shall be set at 83 kW/m^2, ±4 kW/m^2 (2 cal/cm^2/sec, ±0.1 cal/cm^2/sec) using the calibration copper calorimeter, defined in 6-22.4.1.10, by adjusting only the gas supply to the Meker or Fisher burners. Without a mounted specimen, the calibration copper calorimeter shall be placed on top of the specimen holder with the blackened copper calorimeter facing down, and then exposed directly to the flame of the burner. The response of the calorimeter shall be recorded for at least 10 seconds. The lowest temperature point on the curve where the response is linear shall be chosen, and the increase in sensor temperature for 10 seconds of heating shall also be determined. The initial reading from the 10-second reading shall be subtracted to obtain the increase. The response shall be 148°C, ±4°C (267°F, ±7°F) equivalent to 7.86, ±0.20 mV for an iron-contantan thermocouple for an exposure heat flux of 83 kW/m^2, ±2 kW/m^2 (2 cal/cm^2/sec, ±0.05 cal/cm^2/sec).

6-22.5.3 Test Procedure.

6-22.5.3.1 After the total thermal heat flux has been set at 83 kW/m^2, ±4 kW/m^2 (2 cal/cm^2/sec, ±0.1 cal/cm^2/sec) using the calibration procedure in 6-22.5.2.4 through 6-22.5.2.6, the testing copper calorimeter shall be used to measure the total heat flux. Prior to testing, the testing copper calorimeter shall be used to measure the total heat flux by placing the calorimeter face down, and then exposing it directly to the total heat source. The response of the calorimeter shall be recorded for at least 10 seconds. The lowest temperature point on the curve where the response is linear shall be chosen, and the increase in sensor temperature for 10 seconds of heating shall be determined. The initial reading from the 10-second reading shall be subtracted to obtain the increase. The response shall be 148°C, ±4°C (267°F, ±7°F) equivalent to 7.86 mV, ±0.20 mV for an iron-contantan thermocouple for an exposure heat flux of 83 kW/m^2, ±2 kW/m^2 (2 cal/cm^2/sec, ±0.05 cal/cm^2/sec).

6-22.5.3.2 If the measurement from the testing copper calorimeter is within +4/–0 kW/m^2 (+0.1/–0 cal/cm^2/sec) then testing shall be done. If the measurement from the testing copper calorimeter does not agree within +4 kW/m^2 (+0.1 cal/cm^2/sec) of the measurement of the calibration calorimeter, the testing copper calorimeter shall be repaired, reconditioned, or replaced to achieve agreement.

6-22.5.3.3 Specimens shall be mounted by placing the surface of the material to be used as the outside of the garment face-down on the mounting plate. The subsequent layers shall be placed on top in the order used in the garment, with the surface to be worn toward the skin facing up. With the protective shutter engaged, the specimens shall be placed on the specimen holder.

6-22.5.3.4 The testing copper calorimeter shall be placed directly on the specimen in contact with the surface to be worn toward the skin.

6-22.5.3.5 The protective shutter shall be retracted and chart paper movement on the recorder shall be started using a chart speed consistent with the preparation of the overlay described in 6-22.5.4.1. The start time of the exposure shall be indicated. The exposure shall be continued for 30 seconds. The protective shutter shall be engaged (closed), the recorder shall be stopped, the calorimeter shall be removed and cooled, and then the specimen holder and exposed specimen shall be removed.

6-22.5.3.6 After each exposure, the calorimeter shall be cooled to 33°C, ±1°C (91°F, ±2°F) before the next heat flux determination. The sensor shall be cooled after exposure with a jet of air or by contact with a cold surface.

6-22.5.3.7 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 reconditioning. The cooled sensor shall be carefully cleaned with acetone or petroleum solvent, making certain there is no ignition source nearby.

6-22.5.3.8* If copper is showing on the testing copper calorimeter, the surface shall be completely repainted with a thin layer of flat black spray paint. At least one calibration run shall be performed comparing the testing copper calorimeter with the calibration copper calorimeter. If the testing calorimeter is in error by more than +4/–0 kW/m^2 (+0.1/–0 cal/cm^2/sec), all electrical connections and points where thermocouples are secured to the testing calorimeter shall be checked. Two more calibration runs shall be conducted by comparing the testing copper calorimeter with the calibration grade copper calorimeter. The average error shall be calculated. If the average error of the testing calorimeter is more than +4 kW/m^2 (+0.1 cal/cm^2/sec), then the testing calorimeter shall be repaired and recalibrated or the testing calorimeter shall be replaced.

6-22.5.4 Preparation of Human Tissue Burn Tolerance Overlay.

6-22.5.4.1 Tolerance Overlay. The thermal end point shall be determined with a plot of energy versus the time to cause a second-degree burn in human tissue as shown in Table 6-22.5.4.1. The calorimeter equivalent from Table 6-22.5.4.1 that corresponds to the recorder scale shall be plotted on recorder chart paper. ΔT°C, ΔT°F, or ΔmV, columns 6, 7, or 8, shall be plotted on the vertical axis and the corresponding time, column 1, shall be plotted on the horizontal axis. Chart units based on the recorder full-scale deflection and the chart speed for a graph directly comparable to the recorder sensor trace shall be used. If pen deflection is from left to right and paper movement down, the plot shall be from right to left with origin at lower right. If recorder trace differs, the graph shall be adjusted accordingly. An exact transparent duplicate shall be made for the overlay. The overlay shall be compared with the original to ensure change in the overlay size

6-22.5.4.2. Computer Processing of the Data. The information provided in Table 6-22.5.4.1 shall be permitted to be used as the criteria of performance in the software of a computer program. In this case, the sensor response shall be compared with the thermal response, either pain sensation or second-degree burn in human tissue, to determine the thermal end points. The product of the time to a second-degree burn in human tissue and the exposure energy heat flux shall be the TPP rating.

6-22.5.5 Determination of Test Results.

6-22.5.5.1 The time to the second-degree burn shall be graphically determined from the recorder chart of the sensor response and criterion overlay prepared in 6-22.5.4.1. The overlay shall be positioned on the recorder chart, matching the zero of the overlay with the exposure start time resulting from heat transfer. The horizontal axis (time) shall be placed in line with the initial trace of the pen, keeping the overlay square with the recorder chart. The time to the second-degree burn shall be read to the nearest 0.1 second from the overlay chart at the point when the sensor response curve and the tissue tolerance curve cross. If the sensor response curve and the tissue tolerance curves do not cross, >30 shall be recorded as the test result.

6-22.5.5.1.1 If a computer software program is used, the sensor response shall be compared with the data describing the human tissue heat tolerance to determine like values. The time from the start of the exposure to the time when these values are the same shall be taken at the exposure time.

Table 6-22.5.4.1 Human Tissue Tolerance to Second-Degree Burn [a]

Exposure	Heat Flux		Total Heat		Calorimeter[b] Equivalent		
Time (sec)	cal/cm^{2}sec	kW/m^2	cal/cm^2	kW sec/m^2	ΔT°F	ΔT°C	ΔmV
1	1.2	50	1.20	50	16.0	8.9	0.46
2	0.73	31	1.46	61	19.5	10.8	0.57
3	0.55	23	1.65	69	22.0	12.2	0.63
4	0.45	19	1.80	75	24.0	13.3	0.69
5	0.38	16	1.90	80	25.3	14.1	0.72
6	0.34	14	2.04	85	27.2	15.1	0.78
7	0.30	13	2.10	88	28.0	15.5	0.80
8	0.274	11.5	2.19	92	29.2	16.2	0.83
9	0.252	10.6	2.27	95	30.2	16.8	0.86
10	0.233	9.8	2.33	98	31.1	17.3	0.89
11	0.219	9.2	2.41	101	32.1	17.8	0.92
12	0.205	8.6	2.46	103	32.8	18.2	0.94
13	0.194	8.1	2.52	106	33.6	18.7	0.97
14	0.184	7.7	2.58	108	34.3	19.1	0.99
15	0.177	7.4	2.66	111	35.4	19.7	1.02
16	0.168	7.0	2.69	113	35.8	19.8	1.03
17	0.160	6.7	2.72	114	36.3	20.2	1.04
18	0.154	6.4	2.77	116	37.0	20.6	1.06
19	0.148	6.2	2.81	118	37.5	20.8	1.08
20	0.143	6.0	2.86	120	38.1	21.2	1.10
25	0.122	5.1	3.05	128	40.7	22.6	1.17
30	0.107	4.5	3.21	134	42.8	23.8	1.23

[a]Stoll, A.M., and Chianta, M.A., "Method and Rating System for Evaluation of Thermal Protection," *Aerospace Medicine*, vol. 40, 1968, pp. 1232–1238.
[b]Iron-constantan thermocouple.

6-22.5.5.2 The TPP rating shall be calculated as follows as the product of exposure energy heat flux and time to burn:

$$\text{TPP rating} = F \times T$$

where:

F = exposure heat flux (cal/cm^2/sec)

T = time to burn (s)

6-22.6 Report.

6-22.6.1 The individual test TPP rating of each specimen shall be reported. The average TPP rating shall be calculated and reported. If a TPP rating is greater than 60, then the TPP rating shall be reported as >60.

6-22.7 Interpretation.

6-22.7.1 Pass or fail determinations shall be based on the average reported TPP rating of all specimens tested.

6-22.7.2 If an individual result from any test set varies more than ±8 percent from the average result, the results from the test set shall be discarded and another set of specimens shall be tested.

6-23 Cut Resistance Test.

6-23.1 Application.

6-23.1.1 This test method shall apply to protective gloves and footwear uppers.

6-23.2 Specimens.

6-23.2.1 A minimum of three specimens measuring at least 150 mm (6 in.) square shall be tested.

6-23.3 Sample Preparation.

6-23.3.1 Specimens shall be tested after conditioning as specified in 6-1.1.

6-23.4 Apparatus.

6-23.4.1 The static cut test apparatus shall consist of an L-shaped metal frame and pivot arm that lowers a sharp-edged blade onto a sample specimen, as shown in Figure 6-23.4.1.

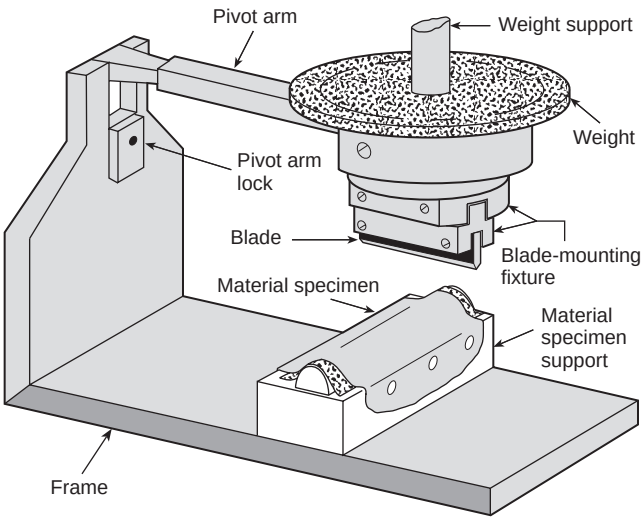


Figure 6-23.4.1 Static cut test apparatus.

6-23.4.2 A locking mechanism shall be mounted upright on the L-frame to engage the pivot arm and secure it in a neutral position above the sample specimen. The locking mechanism shall be used when the blade is being replaced or when the specimen is being moved into or from the testing position.

6-23.4.3 The blade shall be mounted in a blade holder at the outer end of the pivot arm, as shown in Figure 6-23.4.3. The blade shall be mounted so its sharp edge is tangential.

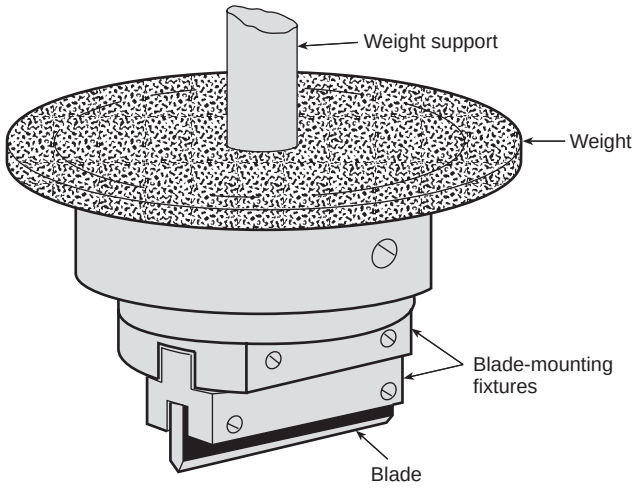


Figure 6-23.4.3 Test blade holder.

6-23.4.4 The pivot arm shall be capable of supporting weights above the blade holder. Incremental weights of 0.91 kg (2 lb) each shall be supplied to allow a maximum force of 9.1 kg (20 lb) to be applied during testing. The pivot arm, blade holder, and blade together shall weigh 0.91 kg (2 lb) and shall contribute to the force applied to the blade.

6-23.4.5 The sharp-edged blade shall be made of tool-hardened steel with an edge having a 60 degree inclined angle and a 0.025-mm (0.001-in.) radius as shown in Figure 6-23.4.5.

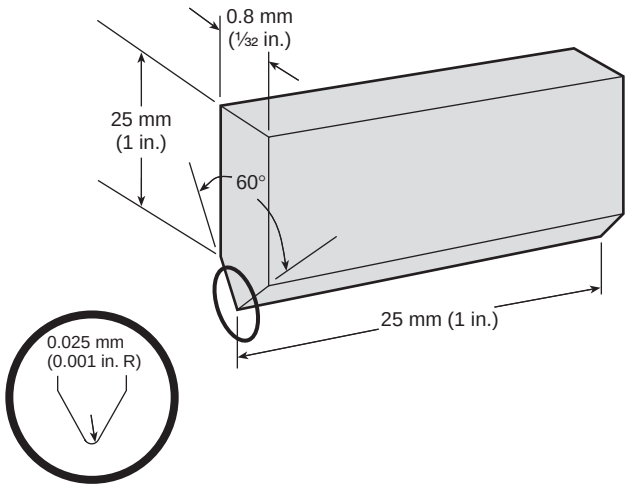


Figure 6-23.4.5 Test blade.

6-23.4.6 The sharpness or geometry of the blade edge shall be closely monitored and controlled to prevent changes in cutting characteristics in order to ensure a consistent baseline for interpreting the cut data.

6-23.4.7 A test blade shall be either replaced or resharpened when the sharpness (geometry) of the blade edge changes.

6-23.4.8 The specimen support assembly shall consist of a soft wood block with dimensions of 50 mm × 50 mm × 100 mm (2 in. × 2 in. × 4 in.) and a 20-mm ($^3/_4$-in.) diameter, half-rounded, soft wood rod mounted to the block as shown in Figure 6-23.4.8.

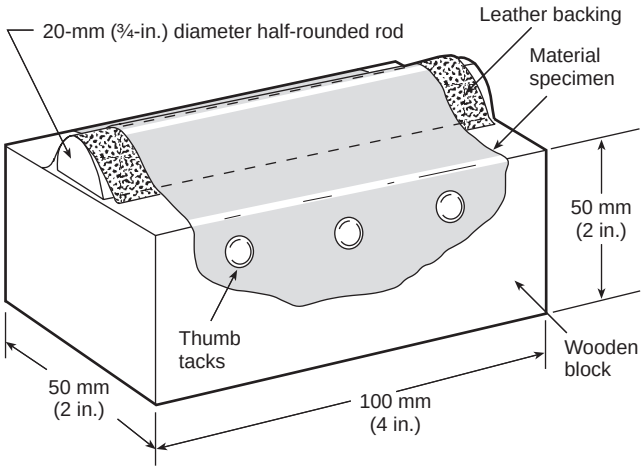


Figure 6-23.4.8 Material specimen support.

6-23.4.9 A 1.5-mm ($^1/_{16}$-in.) thick soft leather strip shall be draped over the rod and block to simulate the cushioning effects of skin and to protect the blade on a cut-through as shown in Figure 6-23.4.8.

6-23.4.10 The sample specimen support shall be designed to be freestanding so that several parallel-cut attempts, spaced not less than 3 mm ($^1/_8$ in.) apart, can be made on each sample specimen.

6-23.5 Procedure.

6-23.5.1 During the test, the sample specimen shall be oriented so that the normal outer surface is the first to be contacted by the edge of the blade.

6-23.5.2 Three sample specimens shall be tested, and two cuts shall be made on each sample specimen.

6-23.5.3 The sample specimen shall be draped over the leather strip covering the rod and block and then tacked, but not stretched, tightly in place as shown in Figure 6-23.4.8. The support assembly shall be positioned on the base of the L-frame, as shown in Figure 6-23.4.1.

6-23.5.4 The pivot arm and blade holder shall be loaded to 8.2 kg, +80/–0 gram (18 lb, +3/–0 oz). A blade shall be inserted into the holder, and the pivot arm shall be lowered to bring the blade edge into contact with the sample specimen surface.

6-23.5.5 The initial specimen-edge contact shall be made 3 mm ($^1/_8$ in.) from the leading end of the blade.

6-23.5.6 The specimen assembly shall be drawn smoothly under the weighted blade at a rate no greater than 508 mm/min (20 in./min) in a direction parallel to the blade edge. The support assembly shall be stopped when the specimen-edge contact is 3 mm ($^1/_8$ in.) from the trailing edge of the blade.

6-23.5.7 The pivot arm shall be lifted to remove the blade edge from the sample specimen, and the locking mechanism shall be engaged to secure the pivot arm.

6-23.5.8 The sample specimen shall be inspected visually to determine whether it was cut through completely at any point by the blade edge. Care shall be taken in inspecting the sample specimen surface for cut. Grooving can occur, but this shall not constitute a cut.

6-23.6 Report.

6-23.6.1 The pass/fail results for each specimen shall be reported.

6-23.6.2 For footwear, if the sample specimen has not been cut, a force of >8.2 kg (>18 lb) shall be reported.

6-23.7 Interpretation.

6-23.7.1 Any one cut failing this test shall constitute failing performance.

6-23.8 Specific Requirements for Testing Gloves.

6-23.8.1 Samples for conditioning shall be whole gloves.

6-23.8.2 Specimens shall consist of each composite of the palm, palm side of the fingers, and back of the glove used in the actual glove construction, with the layers arranged in proper order. Where the specimen composites of the palm, the palm side of the fingers, and the back of the glove are identical, only one representative composite shall be required to be tested.

6-23.9 Specific Requirements for Testing Footwear Uppers.

6-23.9.1 Samples for conditioning shall be whole footwear items.

6-23.9.2 Specimens shall consist of each composite of footwear item used in the actual footwear construction, with the layers arranged in proper order. Specimens shall be taken from the thinnest portion of the footwear upper.

6-24 Puncture Resistance Test.

6-24.1 Application.

6-24.1.1 This test method shall apply to protective gloves and footwear uppers.

6-24.1.2 Modifications to this test method for testing footwear uppers shall be specified in 6-24.7 and 6-24.8.

6-24.1.3 Modifications to this test method for testing footwear uppers shall be as specified in 6-24.8.

6-24.2 Specimens.

6-24.2.1 A minimum of three specimens measuring at least 150 mm (6 in.) square shall be tested.

6-24.3 Specimen Preparation.

6-24.3.1 Specimens shall be tested after conditioning as specified in 6-1.1.

6-24.4 Procedure.

6-24.4.1 All specimens shall be tested in accordance with ASTM F 1342, *Standard Test Method for Resistance of Protective Clothing Materials to Puncture.*

6-24.5 Report.

6-24.5.1 The puncture force in N (lbf) shall be reported for each specimen.

6-24.6 Interpretation.

6-24.6.1 The puncture force of each specimen shall be evaluated to determine pass/fail.

6-24.6.2 Any one puncture failing this test shall constitute failing performance.

6-24.7 Specific Requirements for Testing Gloves.

6-24.7.1 Specimens shall consist of each composite of the palm, palm side of the fingers, and back of the glove used in the actual glove construction, with the layers arranged in proper order. Where the specimen composites of the palm, palm side of the fingers, and back of the glove are identical, only one representative composite shall be required to be tested.

6-24.7.2 Testing shall be performed as specified in 6-24.2 through 6-24.6.

6-24.8 Specific Requirements for Testing Footwear Uppers.

6-24.8.1 Specimens shall consist of each composite of footwear item used in the actual footwear construction, with the layers arranged in proper order. Specimens shall be taken from the thinnest portion of the footwear upper.

6-24.8.2 Testing shall be performed as specified in 6-24.2 through 6-24.6.

6-25 Dexterity Test.

6-25.1 Application.

6-25.1.1 This test shall apply to gloves.

6-25.2 Specimens.

6-25.2.1 A minimum of three gloves pairs shall be used for testing.

6-25.2.2 Each sample glove pair shall be tested as a complete set of gloves in new, as distributed, condition.

6-25.2.3 Glove pair specimens shall not receive special softening treatments prior to tests.

6-25.2.4 Sample glove pairs shall be tested for each material and construction combination.

6-25.3 Sample Preparation.

6-25.3.1 Glove pair specimens shall be preconditioned as specified in 6-1.2.

6-25.3.2 Samples for conditioning shall be whole glove pairs.

6-25.4 Procedure.

6-25.4.1 Dexterity shall be evaluated using the standardized procedure known as the *Bennett Hand-Tool Dexterity Test.*

6-25.4.2 Test subjects shall be selected such that their hand dimensions are a close as possible to those specified in the tables in 4-3.4.2.

6-25.4.3 Each test subject used to perform the test shall practice until the baseline times of that person's last three repetitions varies no more than 6 percent.

6-25.4.4 Each test subject shall be tested with a minimum of three gloves. A minimum of six dexterity tests with gloves shall be conducted, with at least three dexterity tests with small-sized gloves and three dexterity test with large-sized gloves.

6-25.4.5 Dexterity test times with gloves shall be compared with baseline dexterity test times for specific test subjects. The percentage of dexterity test times with gloves to baseline dexterity test times shall be calculated as follows:

$$\text{Percent of bare-handed control} = \frac{\text{Dexterity test (with gloves)}}{\text{Dexterity test baseline}} \times 100$$

6-25.5 Report.

6-25.5.1 The percent of barehand control shall be reported for each glove pair specimen and test subject tested.

6-25.6 Interpretation.

6-25.6.1 One or more glove pair specimens failing this test shall constitute failing performance.

6-26 Grip Test.

6-26.1 Specimens.

6-26.1.1 A minimum of three glove pairs each for size small and size large shall be used for testing.

6-26.1.2 Each sample glove pair shall be tested as a complete set of gloves in new, as distributed, condition.

6-26.1.3 Sample glove pairs shall not receive special softening treatments prior to tests.

6-26.1.4 Sample glove pairs shall be tested for each material and construction combination.

6-26.2 Sample Preparation.

6-26.2.1 Samples for conditioning shall be whole gloves.

6-26.2.2 Specimen glove pairs shall be preconditioned as specified in 6-1.2.

6-26.2.3 Specimen glove pairs shall be tested after being conditioned as specified in 6-1.1.

6-26.3 Apparatus.

6-26.3.1 Grip testing shall be evaluated with the use of a 10 mm ($^3/_8$ in.) diameter, three-strand, prestretched polyester rope attached to a calibrated force measuring device.

6-26.4 Procedure.

6-26.4.1 Test subjects shall be selected so that their hand dimensions are as close as possible to the middle of the range for hand length and hand circumference as specified in the tables provided for size small and size large gloves in 4-3.4.2.

6-26.4.2 Each test subject shall make three successive attempts to lift as much weight using the halyard as possible, using both hands and keeping both feet firmly planted on the ground. The average weight hoisted over the three trials shall be the bare-handed weight lift capability.

6-26.4.3 Conditioned sample gloves shall be tested on a dry rope and then on a wet rope.

6-26.4.4 Each test subject shall test a minimum of three pairs of sample gloves. Test subjects shall attempt one trial with each pair of gloves for a minimum of six grip tests for each set of conditions, with at least three grip tests with size small gloves and three grip tests with size large gloves.

6-26.4.5 Weight-pulling capacity with gloves (WPC_g) shall be compared with bare-handed weight lift capability (WLC_b). The percentage of weight pulling capacity with gloves to bare-handed weight lift capability shall be calculated as follows:

$$\frac{WPC_g}{WLC_b}\,(100) = \text{Percent bare-handed control}$$

6-26.5 Report.

6-26.5.1 The percent of bare-handed control shall be reported for each sample glove pair, condition, and test subject tested.

6-26.6 Interpretation.

6-26.6.1 One or more sample glove pairs failing this test shall constitute failing performance.

6-27 Corrosion Resistance Test.

6-27.1 Specimens shall be five items of each different style or model of hardware from footwear. 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 hours, +30/−0 minutes.

6-27.2 Immediately following the test exposure and prior to examination, specimens shall be rinsed under warm, running tap water and dried with compressed air.

6-27.3 Specimens shall then be examined visually with the unaided eye to determine pass/fail. Specimens shall also be evaluated for hardware functionality.

6-28 Footwear Conductive Heat Resistance Test.

6-28.1 Specimens.

6-28.1.1 A minimum of three complete footwear items shall be tested.

6-28.2 Sample Preparation.

6-28.2.1 Samples for conditioning shall be whole footwear.

6-28.2.2 Specimens shall be preconditioned as specified in 6-1.1.

6-28.3 Apparatus.

6-28.3.1 The apparatus shall consist of an iron plate measuring 25 mm × 150 mm × 460 mm (1 in. × 6 in. × 18 in.) and an oven capable of heating the plate to a temperature of 500°C (932°F), a Type J or Type K thermocouple, and a meter to read the thermocouple temperature.

6-28.4 Procedure.

6-28.4.1 The thermocouple shall be affixed to the insole surface of the specimen next to the foot, directly above the ball of the foot. The thermocouple shall be taped to the surface with electrical tape to hold it onto the insole surface.

6-28.4.2 The plate shall be heated to a temperature of 500°C, ±10°C (932°F, ±18°F) and shall maintain this temperature throughout the test period.

6-28.4.3 The specimen shall be filled with 4.55 kg (10 lb) of 10-mm ($^3/_8$-in.) steel balls. The weight of the steel balls shall be evenly distributed inside the boot. The specimen shall be placed on the plate in the upright position for 30 seconds.

6-28.4.4 The thermocouple temperature shall be recorded at 30 seconds, +2/−0 seconds after the specimen is placed on the heated metal plate.

6-28.5 Report.

6-28.5.1 The temperature at 30 seconds of exposure shall be reported for each specimen. The average temperature at 30 seconds of exposure for all specimens shall also be calculated and reported.

6-28.6 Interpretation.

6-28.6.1 The average temperature at 30 seconds of exposure for all specimens shall be used to determine pass/fail performance.

6-29 Eyelet and Stud Post Attachment Test.

6-29.1 Application.

6-29.1.1 This test method shall apply to protective footwear eyelets and stud posts.

6-29.2 Specimens.

6-29.2.1 Specimens shall total two eyelets and two stud post on three separate footwear items.

6-29.2.2 Specimens shall be removed from the footwear and shall be 25 mm × 50 mm (1 in. × 2 in.).

6-29.3 Sample Preparation.

6-29.3.1 Samples for conditioning shall be whole footwear.

6-29.3.2 The eyelets or stud post specimens shall be conditioned as specified in 6-1.1.

6-29.4 Apparatus.

6-29.4.1 A tensile testing machine shall be used with a traverse rate of 50 mm/min (2 in./min). Clamps measuring 25 mm × 38 mm (1 in. × $1^1/_2$ in.) shall have gripping surfaces that are parallel, flat, and capable of preventing slippage of the specimen during the test.

6-29.5 Procedure.

6-29.5.1 The stud post or eyelet puller shall be inserted or attached to the upper position of the tensile machine. The traverse rate shall be set a 50 mm/min (2 in./min). The test eyelet or stud post shall be attached using the appropriate puller fixture. The eyelet stay shall be clamped, but clamping the metal portion of the eyelets of stud hooks in the lower clamps shall not be permitted. The distance between the clamps and stud hooks or eyelets shall be 2 mm to 3 mm ($^5/_{64}$ in. to $^1/_8$ in.). The test shall then be started.

6-29.6 Report.

6-29.6.1 The force will reach a peak, decline slightly, and then increase to complete failure; however, the value at which the force first declines shall be reported and recorded as the detachment strength, as this is the initial failure point where separation of the material around the eyelet of the stud post occurs. Each detachment strength force shall be calculated and reported.

6-29.7 Interpretation.

6-29.7.1 Each detachment strength force shall be evaluated to determine pass/fail.

6-29.7.2 Any single detachment strength force less than 294 N (66 lbf) shall constitute failing performance.

6-30 Glove Fit Test.

6-30.1 Glove Manufacturing Tolerances.

6-30.1.1 Before beginning the fit evaluation, glove specimens shall be measured to ensure all specimens of the same size are within ±5 mm ($\pm^{3}/_{16}$ in.) of the manufacturer's specified length and width dimensions for the specific size.

6-30.2 Test Subjects.

6-30.2.1 Glove fit evaluation shall be made by at least ten test subjects for initial certification, and by at least five test subjects for recertification, for each of the five glove sizes specified in 4-3.4.2.

6-30.2.2 Test subjects for sizes "XS" and "S" shall be at least 80 percent female for both initial certification and recertification.

6-30.2.3 Test subjects for size "M" shall be 50 percent female and 50 percent male for initial certification, and shall be two female and three male for recertification.

6-30.2.4 Test subjects for sizes "L" and "XL" shall be at least 80 percent male for both initial certification and recertification.

6-30.3 Procedure

6-30.3.1 Each test subject shall be measured by the tester for all twelve hand dimensions as specified in Table 6-30.3.1, *Anthropometric Dimension Descriptions*.

6-30.3.2 All hand measurements shall be taken on the test subject's right hand and shall be recorded to the nearest millimeter. After recording all measurements for a test subject, the subject's "predicted size" glove shall be determined based upon the key sizing values for hand length and hand circumference.

6-30.3.3 Quantitative measurements shall be taken of any offset between the test subject's fingertips and the glove fingertips, and between test subject's finger crotches and the glove crotches.

6-30.3.4 Qualitative statements by the test subject regarding the looseness or tightness in circumference of each glove finger and at the glove palm and wrist areas shall also be recorded by the tester.

6-30.3.5 Each test subject shall be asked to evaluate the fit and comfort of the glove, and this evaluation shall be recorded. In addition, the tester shall provide input regarding the overall fit of each glove size.

6-30.3.6 Depending upon the fit of the initial try-on size, test subjects shall be upsized or downsized according to specific problems encountered. For each test subject, the best-fitting sizes in both the test subject's and tester's opinions shall be recorded. In the event that none of the existing sizes are acceptable, the subject shall be recorded as a "no fit."

6-30.3.7* The test subjects shall don their "predicted size" glove.

6-30.3.8 The tester shall determine from the test subject if the thumb and index finger are at the ends of the thumb and index finger of the glove. The tester shall feel the tips of the thumb and index finger from the outside to verify the test subject's answer. Using an inside caliper, the tester shall measure any glove finger extension beyond the test subject's fingers for all fingers and shall record the quantitative results.

6-30.3.9 The quantitative results shall be recorded by categorizing finger lengths as "short," "satisfactory," or "long." In order to categorize a glove as "satisfactory," no extension shall be permissible between the tip of the glove finger and the tip of the test subject's finger.

6-30.3.10 The quantitative offset values between the four glove finger crotches and the respective four finger crotches shall be recorded.

6-30.3.11 The tester shall determine from the test subject if the glove constricts either the fingers or the hand in terms of circumference. The tester shall feel each finger and the sides of the glove to verify the test subject's answer. Using an inside caliper, the tester shall quantitatively measure any excess circumference. Flat measurements shall be permitted to be doubled to convert into a circumference measurement. The test values and measurements shall be recorded.

6-30.3.12 The qualitative circumferential fit shall be recorded as "tight," "satisfactory," or "loose" based upon estimates of excess circumference between the side of the fingers and side of the glove finger, and the side of the hand and the side of the glove body.

6-30.3.13 Following the steps in 6-30.3.1 through 6-30.3.12 steps, the tester and the test subject shall evaluate the overall fit of the "predicted size" glove.

6-30.3.14 Where disagreement between the tester and the test subject occurs, the tester's assessment shall be definitive. For this assessment, the test subject shall don the next glove size that is larger and smaller than the "predicted glove" size, where such sizes exist, and the tester shall determine which of the two or three glove sizes is the best fitting. The "predicted glove" size shall be recorded as "best fitting," "acceptable," or "unacceptable." The determination of "acceptable" shall apply to the situation where the "best fitting" glove is not the "predicted size" glove but, in the tester's opinion, the subject could still function in the "predicted size" glove.

6-30.4 Results.

6-30.4.1 The pass/fail for the gloves shall be determined by three criteria, and gloves shall pass all three criteria to be rated as "pass" for this fit test.

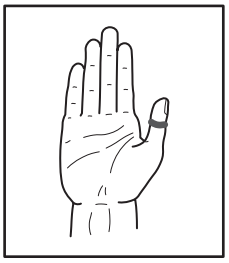
6-30.4.1.1 For overall fit, the relationship between the "predicted size" glove and the ratings of "best fitting," "acceptable," or "unacceptable" shall be evaluated. For both initial certification and recertification, gloves shall be indicated as passing this criteria when at least 80 percent of the test subject's "predicted size" are also their "best fitting" size, and no "predicted sizes" rate as "unacceptable."

6-30.4.1.2 For stand off, all values for extension of the glove finger beyond the test subject's fingers, offset of the glove finger crotches, and excess circumference of glove fingers and glove body shall be examined for all gloves. Determination shall be made if any of the measured glove values are greater than requirements specified in 5-3.9. The gloves shall be indicated as passing this criteria when all values meet those specified requirements.

Table 6-30-3.1 Anthropometric Dimension Measurements

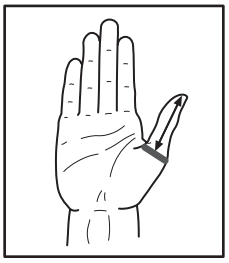
Digit 1 Circumference

The circumference of the thumb shall be measured at the maximum protrusion of the interphalangeal joint. The hand shall rest on a table. The thumb shall be abducted and straight, but shall not be hyperextended.



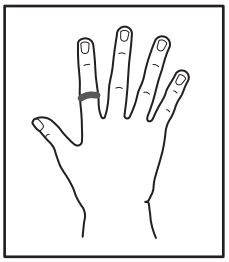
Digit 1 Length

On a data blank, the distance along the axis of the thumb from the midpoint of the tip of the thumb to the level of the first crotch shall be measured.



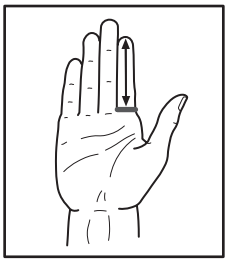
Digit 2 Circumference

The circumference of the index finger shall be measured at the maximum protrusion of the proximal interphalangeal joint. The hand shall rest on a table. The fingers shall be straight and abducted.



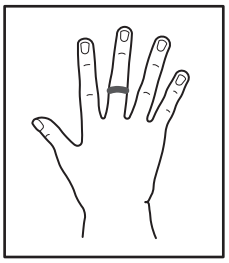
Digit 2 Length

On a data blank, the distance along the axis of the index finger from the midpoint of the tip of the index finger to the level of the second crotch shall be measured.



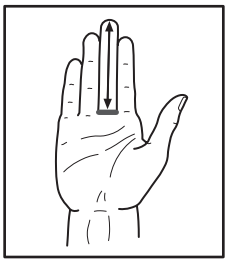
Digit 3 Circumference

The circumference of the middle finger shall be measured at the maximum protrusion of the proximal interphalangeal joint. The hand shall rest on a table. The fingers shall be straight and abducted.



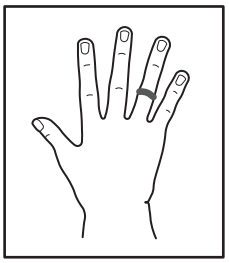
Digit 3 Length

On a data blank, the distance along the axis of the middle finger from the midpoint of the tip of the middle finger to the average level of the second and third crotches shall be measured.



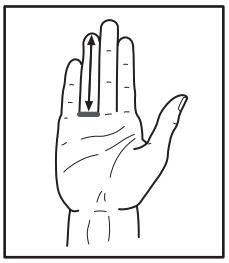
Digit 4 Circumference

The circumference of the ring finger shall be measured at the maximum protrusion of the proximal interphalangeal joint. The hand shall rest on a table. The fingers shall straight and abducted.



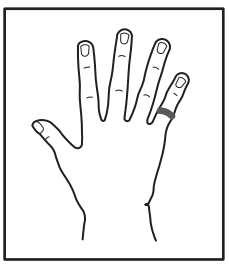
Digit 4 Length

On a data blank, the distance along the axis of the ring finger from the midpoint of the tip of the ring finger to the average level of the third and fourth crotches shall be measured.



Digit 5 Circumference

The circumference of the little finger shall be measured at the maximum protrusion of the proximal interphalangeal joint. The hand shall rest on a table. The fingers shall be straight and abducted.



Digit 5 Length

On a data blank, the distance along the axis of the little finger from the midpoint of the tip of the little finger to the level of the fourth crotch shall be measured.

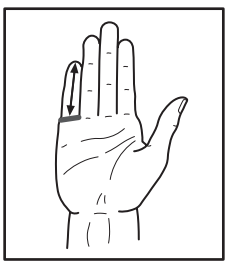
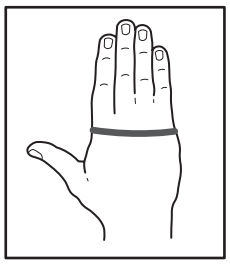
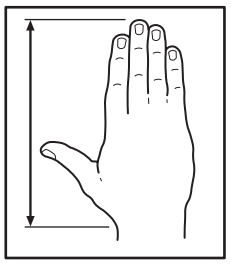


Table 6-30-3.1 Anthropometric Dimension Measurements *(Continued)*

Hand Circumference The circumference of the right hand shall be measured with a tape passing over the landmarks at metacarpale II and metacarpale V. The test subject shall place the palm on a table, the fingers together, and the thumb abducted. The middle finger shall be parallel to the long axis of the forearm. The two distal phalanges of the fingers shall lie on a flat surface 8 mm higher than the table.	
Hand Length The length of the right hand between the stylion landmark on the wrist and the tip of the middle finger shall be measured with a Poech sliding caliper. The subject shall place the palm on a table, the fingers together, and the thumb abducted. The middle finger shall be parallel to the long axis of the forearm. The two distal phalanges of the fingers shall lie on a flat surface 8 mm higher than the table.	

6-30.4.1.3 For manufacturing tolerances, the manufacturer's stated length and width specifications for each size glove and the measured length and width values for each size glove obtained in the evaluation shall be examined and compared. The gloves shall be indicated as passing this criteria when all measured values of all gloves do not exceed the specified value by more than ±5 mm ($\pm^{3}/_{16}$ in.).

6-30.4.1.4 Gloves that do not pass all three criteria shall be rated as a "fail" for the fit test.

6-31 Footwear Abrasion Test.

6-31.1 Specimens.

6-31.1.1 A minimum of three footwear soles with heels shall be tested.

6-31.2 Sample Preparation.

6-31.2.1 Samples for conditioning shall be complete footwear soles with heel.

6-31.2.2 Specimens shall be conditioned as specified in 6-1.1.

6-31.3 Procedure.

6-31.3.1 Abrasion resistance tests of the footwear soles and heels shall be performed in accordance with ASTM D 1630, *Standard Test Method for Rubber Property—Abrasion Resistance (Footwear Abrader*).

6-31.4 Report.

6-31.4.1 The abrasion resistance rating of each specimen shall be reported.

6-31.5 Interpretation.

6-31.5.1 One or more footwear specimens failing this test shall constitute failing performance.

6-32 Label Durability and Legibility Test One.

6-32.1 Application.

6-32.1.1 This test method shall apply to labels on protective garments, gloves boots, and face/neck shrouds.

6-32.1.2 Modifications to this test method for testing garment labels shall be as specified in 6-32.7.

6-32.1.3 Modifications to this test method for testing glove labels shall be as specified in 6-32.8.

6-32.1.4 Modifications to this test method for testing footwear labels shall be as specified in 6-32.9.

6-32.1.5 Modifications to this test method for testing face/neck shroud labels shall be as specified in 6-32.10.

6-32.2 Specimens.

6-32.2.1 A minimum of three of each label type for each item shall be tested in each test. Where labels have areas of "write-in" information, two additional specimens shall be tested that include those areas, with sample information written in.

6-32.3 Sample Preparation.

6-32.3.1 Samples shall be conditioned as specified in 6-1.1.

6-32.4 Procedures.

6-32.4.1 Laundering Durability Test.

6-32.4.1.1 Specimens shall be subjected to ten cycles of laundering and drying using Machine Cycle 1, Wash Temperature V, and Drying Procedure Ai of AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

6-32.4.1.2 A 1.8-kg, ±0.1 kg (4-lb, ±0.2 lb) load shall be used. A laundry bag shall not be used.

6-32.4.1.3 Specimens shall be examined for legibility to the unaided eye by a person with 20/20 vision, or vision corrected to 20/20, at a nominal distance of 300 mm (12 in.) in a well-illuminated area.

6-32.4.2 Abrasion Durability Test.

6-32.4.2.1 Specimens shall be subjected to abrasion in accordance with ASTM D 4966, *Standard Test Method for Abrasion Resistance of Textile Fabrics,* with the following modifications:

(a) The standard abrasive fabric and the felt-backing fabric shall be soaked for 25 hours in distilled water, or agitated in distilled water until they are thoroughly wet.
(b) The standard abrasive fabric shall be rewetted after each set of cycles of applying 20 ml (0.68 oz) of distilled water from a squeeze bottle by squirting on the center of the abrasive composite pad.
(c) Specimen shall be subjected to 200 cycles, 3200 revolutions, of the test apparatus.

6-32.4.2.2 Specimens shall be examined for legibility to the unaided eye by a person with 20/20 vision, or vision corrected to 20/20, at a nominal distance of 300 mm (12 in.) in a well-illuminated area.