NFPA 1971
Standard on Protective Ensemble for Structural Fire Fighting

1997 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 1971

Standard on

Protective Ensemble for Structural Fire Fighting

1997 Edition

This edition of NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*, was prepared by the Technical Committee on Structural 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 Fall Meeting held November 18–20, 1996, in Nashville, TN. It was issued by the Standards Council on January 17, 1997, with an effective date of February 7, 1997, and supersedes all previous editions.

This edition of NFPA 1971 was approved as an American National Standard on February 21, 1997.

Origin and Development of NFPA 1971

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

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

The 1981 edition of NFPA 1971 represented a complete editorial reworking of the 1975 edition to make the document more usable by both the fire service and protective clothing manufacturers. The 1981 edition was acted on at the Annual Meeting in Dallas, Texas on May 19, 1981.

The 1986 edition incorporated a complete revision of the document to include more performance requirements and less specifications. Separate performance and testing chapters were written. The 1986 edition was acted on at the Annual Meeting in Atlanta, Georgia, May 19–22, 1986.

Following the 1986 edition, the Committee was renamed from the Technical Committee on Protective Equipment for Fire Fighters to the Technical Committee on Fire Service Protective Clothing and Equipment.

The 1991 edition incorporated third party certification, labeling, and listing for the protective clothing. A new chapter was added to address interface items, specifically the protective hood and protective wristlets. Appendix material was developed on cleaning of garments and evaluating how materials can affect heat stress. The 1991 edition, the fourth edition, was presented to the NFPA membership at the Annual Meeting in Boston, MA, May 19-23, 1991, and was issued with an effective date of August 16, 1991.

In October 1994, the NFPA Standards Council reorganized the Technical Committee on Fire Service Protective Clothing and Equipment as the Project on Fire and Emergency Services Protective Clothing and Equipment operating with seven technical committees and a technical correlating committee. NFPA 1971 is now the responsibility of the Technical Committee on Structural Fire Fighting Protective Clothing and Equipment.

This 1997 edition of NFPA 1971, the fifth edition, has combined four former standards on structural fire fighting: NFPA 1971, *Standard on Protective Clothing for Structural Fire Fighting*; NFPA 1972, *Standard on Helmets for Structural Fire Fighting*; NFPA 1973, *Standard on Gloves for Structural Fire Fighting*; and NFPA 1974, *Standard on Protective Footwear for Structural Fire Fighting*, into a single document now titled NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*.

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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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These lists represent the membership at the time each 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 front of the book.

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, head, and interface protection for fire fighters or other emergency services responders during incidents involving structural fire fighting operations. These operations include 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. Additionally, this committee shall have primary responsibility for documents on the selection, care, and maintenance of structural fire fighting protective clothing and protective equipment by fire and emergency services organizations and personnel.

Contents

How to Use This Standard

This edition of NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting,* contains all requirements for coats, trousers, helmets, gloves, boots, and the interface components of hoods and wristlets, all elements of the structural fire fighting protective ensemble.

Previous to the 1997 edition of NFPA 1971, the requirements for helmets, gloves, and boots were contained in separate standards (NFPA 1972, NFPA 1973, and NFPA 1974 respectively).

This standard is organized by chapters and sections. Chapters 3, 4, and 5 follow the same format throughout. Chapters 1, 2, 6, and 7 are formatted differently because of the different nature of the material contained in them and how it is used.

Chapter 1, as in other NFPA standards, covers the "administration" of this standard. Chapter 1 contains the scope statements, purpose statements, definitions that are important for a clearer understanding of the contents, and general requirements on "units" (i.e., the measurements used in the standard).

Chapter 2, as in all fire and emergency protective clothing and equipment standards, contains the requirements for third-party certification of the elements of the protective ensemble, the requirements for the certification organization itself, requirements for specific inspection and testing items the certification organization must address, and the requirements for a manufacturer's quality assurance program to be overseen by the certification organization.

Chapters 3, 4, and 5 contain the actual requirements for the elements of the protective ensemble: the garments (includes the coat, the trousers, and the coveralls), the helmet, the gloves, the footwear, the hood interface component, and the wristlet interface component.

These three chapters are formatted in the same manner to be as "user friendly" as a standard will allow. Chapter 3 contains the labeling and user information requirements, divided into sections for each element of the protective ensemble. Chapter 4 contains the design requirements, also divided into sections for each element. And Chapter 5 contains the performance requirements, and it is divided into sections for each element as well.

The first section in each chapter, identified as Sections 3-1, 4-1, or 5-1, always has the requirements for the garments.

The second section in each chapter, identified as Sections 3-2, 4-2, or 5-2, always has the requirements for the helmets.

The third section in each chapter, identified as Sections 3-3, 4-3, or 5-3, always has the requirements for the gloves.

The fourth section in each chapter, identified as Sections 3-4, 4-4, or 5-4, always has the requirements for the footwear.

The fifth section in each chapter, identified as Sections 3-5, 4-5, or 5-5, always has the requirements for the hood interface component.

The sixth section, identified as Sections 4-6 or 5-6 (there is no Section 3-6), always has the requirements for the wristlet interface component.

There is one section seven, identified as 4-7, that contains the design requirements for accessories.

The determination of whether or not a product complies with the requirements in Chapter 3 and 4 is mostly done by inspection as these labels, printed information, and design criteria are best evaluated by examination and inspection.

Chapter 5, however, contains the physical performance that the product or components have to be able to achieve and what the pass/fail criteria is. The determination of compliance is by actual testing. Therefore, Chapter 5 is the all important key to Chapter 6, the test methods.

Every performance requirement in Chapter 5 has a direct reference to the appropriate test method in Chapter 6. So, to find the flame test for gloves, one would go to Section 5-3 (the performance requirements for gloves) in Chapter 5 and find the performance requirement for flame resistance for gloves. In that performance requirement (5-3.6) is a direct reference to Section 6-4, Flame Resistance Test.

To find any test method for a protective element, go to the performance requirements for that element in Chapter 5 and you will find the direct reference to the test method in Chapter 6.

Chapter 6 contains all the test methods. Each test method begins with an "application" statement that specifies which elements or element components the test applies to and if there are any modifications to the test method for a specific element or component, and where the modifications are located. Each test method follows a step-by-step format from application to specimens, sample preparation, apparatus, procedure, report, and interpretation so that each test method is complete.

In order to reduce the possibility of errors in test methods and because so many elements and element components use the same test or a slight variation of the same test, it was important to organize the test methods by the type of test and not by the individual elements.

Chapter 7 contains the mandatory references to other standards or specifications and identifies which specific documents and editions are the mandatory reference.

Following Chapter 7 are the appendices that include nonmandatory, advisory, informational items to assist in the understanding of specific requirements or related issues. An asterisk (*) following a paragraph or section number in the text of Chapters 1 through 7 indicates that there is explanatory material for that paragraph in Appendix A. Wherever (*) follows a section or paragraph number (i.e., 2-1.4*) you will find the associated appendix material in Appendix A with the same paragraph number, prefixed by the letter "A" (i.e., A-2-1.4).

NOTICE

Following the issuance of this 1997 edition of NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*, by the NFPA Standards Council, certain appeals were filed with the NFPA Board of Directors

The appeals request the following:

1. That a new section be added to Chapter 2 requiring that manufacturers and manufacturing facilities be registered in accordance with ISO 9001 or ISO 9002, as applicable, and that this requirement for ISO registration have an effective date of March 1, 1999.

2. That a new paragraph be added to Section 5-1 requiring protective coats and protective trousers to be tested for "Total Heat Loss," and a new test method added to Chapter 6 to measure the heat loss through these garments to determine pass/fail to the performance requirement in Section 5-1.

NFPA will announce the disposition of the appeals when they have been determined. Anyone wishing to receive the dispositions of the appeals should notify in writing the Secretary, Standards Council, NFPA, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

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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, certification requirements, and test methods for protective ensembles that include protective coats, protective trousers, protective coveralls, helmets, gloves, footwear, and interface components designed to provide a minimum level of protection for fire fighters against adverse environmental effects during structural fire fighting operations and certain other emergency operations.

1-1.2 This standard shall apply to the design, manufacturing, and certification of new protective ensembles or new individual elements of the protective ensemble. This standard shall not apply to structural fire fighting protective clothing and equipment manufactured to previous editions of NFPA 1971, *Standard on Protective Clothing for Structural Fire Fighting*; NFPA 1972, *Standard on Helmets for Structural Fire Fighting*; NFPA 1973, *Standard on Gloves for Structural Fire Fighting*; and NFPA 1974, *Standard on Protective Footwear for Structural Fire Fighting*.

1-1.3 This standard shall not apply to specialized protective ensembles for wildland fire fighting operations; for approach, entry, proximity, or other such specialty fire fighting operations; or for hazardous materials emergency operations. This standard shall not apply to protection from radiological agents, protection from all biological agents, or protection from all hazardous chemicals.

1-1.4 Certification of the structural fire fighting protective ensemble, or individual elements of the protective ensemble, to the requirements of this standard shall not preclude certification to additional appropriate standards where the protective ensemble or elements of the protective ensemble meet all applicable requirements of each standard.

1-1.5 The requirements of this standard shall not apply to accessories that might be attached to any element of the structural fire fighting protective ensemble unless specifically addressed herein.

1-1.6 Nothing herein shall 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, and certification of the individual elements comprising the protective ensemble utilized during structural fire fighting operations, and certain other emergency operations where there is a threat of fire or where certain physical hazards are likely to be encountered, such as during non-fire-related rescue operations, emergency medical operations, and victim extrication.

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 structural fire fighting personnel can be exposed.

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

1-3 Definitions.

Accessories. Those items that are attached to a protective ensemble element but designed in such a manner to be removable from the protective ensemble element and that are not necessary to meet the requirements of this standard. Such accessories include, but are not limited to, utility belts, harnesses, back packs, tools, tool packs, radios, radio packs, suspenders, lights, and heat sensing devices.

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

Approved.* Acceptable to the authority having jurisdiction.

Arch. The bottom curve of the foot, from the heel to the ball.

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

Barrier Material. A single-layer fabric or a laminated/coated, multilayer material that is considered as a single-layer fabric that limits transfer from the face of the layer to the other side.

Basic Plane. A helmet term for the plane through the centers of the external ear openings and the lower edges of the eye sockets.

Basic Weight. The weight of the helmet, including all components specified in 4-2.1.

Biological Agents. Biological materials that could be capable of causing a disease or long-term damage to the human body.

Bitragion Coronal Arc.* A helmet term for the arc between the right and left tragion as measured over the top of the head in a plane perpendicular to the mid-sagittal plane.

Bitragion Inion Arc.* A helmet term for the arc between tragion as measured over the inion. For test purposes, the Bitragion Inion Arc is identified as Datum Plane 10 in Figures 6-15.4.1(a) through (c).

Body Fluids. Fluids produced by the body including, but not limited to, blood, semen, mucus, feces, urine, vaginal secretions, breast milk, amniotic fluid, cerebrospinal fluid, synovial fluid, and pericardial fluid.

Brim. A part of the shell of the helmet extending around the entire circumference of the helmet.

Brim Line. A horizontal plane intersecting the point of the front opening of the helmet at the mid-sagittal plane.

Cargo Pockets. Pockets located on the protective garment exterior.

Certification/Certified. A system whereby a certification organization determines that a manufacturer has demonstrated the ability to produce a product that complies with the requirements of this standard, authorizes the manufacturer to use a label on listed products that comply with the requirements of this standard, and establishes a follow-up program conducted by the certification organization as a check on the methods the manufacturer uses to determine compliance with the requirements of this standard.

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

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

Chin Strap. An adjustable strap, fitting under the chin, to help secure the helmet to the head.

Coat. A protective garment; an element of the protective ensemble designed to provide minimum protection to upper torso and arms, excluding the hands and head.

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

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

Component. Any material, part, or subassembly used in the construction of the protective ensemble or any element of the protective ensemble. (*See also Interface Components.*)

Composite. The layer or combination of layers of the protective ensemble or any element of the protective ensemble that provides the required protection.

Coronal Plane. A helmet term for the plane, perpendicular to the basic and mid-sagittal planes, that passes through the centers of the external ear openings.

Coverall. A protective garment; an element of the protective ensemble configured as a single-piece garment and designed to provide minimum protection to the torso, arms, and legs, excluding the head, hands, and feet.

Crown. The portion of the helmet that covers the head above the reference plane.

Crown Straps. A helmet term for the part of the suspension that passes over the head.

Dielectric Test Plane. A plane that runs from the intersection of the test line and mid-sagittal plane in the front of the headform diagonally through the headform to the intersection of the reference plane and mid-sagittal plane in the rear of the headform.

Drip. To run or fall in drops or blobs.

Ear Covers. An integral part of the helmet designed to provide limited protection for the ears. Provides no significant thermal protection.

Elements. The parts or items that comprise the protective ensemble. The protective ensemble elements are coats, trousers, coveralls, helmets, gloves, footwear, and interface components.

Energy Absorbing System. A material, suspension system, or combination thereof incorporated into the design of the helmet to attenuate impact energy.

Ensemble. See definition of "Protective Ensemble."

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 because *direct entry into flames is made.* Usually these operations are exterior operations. Entry fire fighting is not structural fire fighting. (*See also Approach Fire Fighting, Proximity Fire Fighting, and Structural Fire Fighting.*)

Eye/Face Positioning Index. The distance, as specified by the manufacturer, from the top lateral midpoint of the faceshield/goggle components to the basic plane of the Alderson 50 percent adult male headform where the faceshield/goggle component is positioned on the headform.

Faceshield. A helmet component intended to help protect a portion of the wearer's face in addition to the eyes, not intended as primary eye protection.

Faceshield/Goggle. Used in this standard to identify criteria that applies to either a faceshield or goggle component of a helmet.

Flame Resistance. The property of a material whereby the application of a flaming or nonflaming source of ignition and the subsequent removal of the ignition source results in the termination of combustion. Flame resistance can be an inherent property of the material, or it can be imparted by specific treatment.

Fluorescence. A process by which radiant flux of certain wavelengths is absorbed and reradiated nonthermally in other, usually longer, wavelengths.

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

Footwear. An element of the protective ensemble designed to provide minimum protection to the foot, ankle, and lower leg.

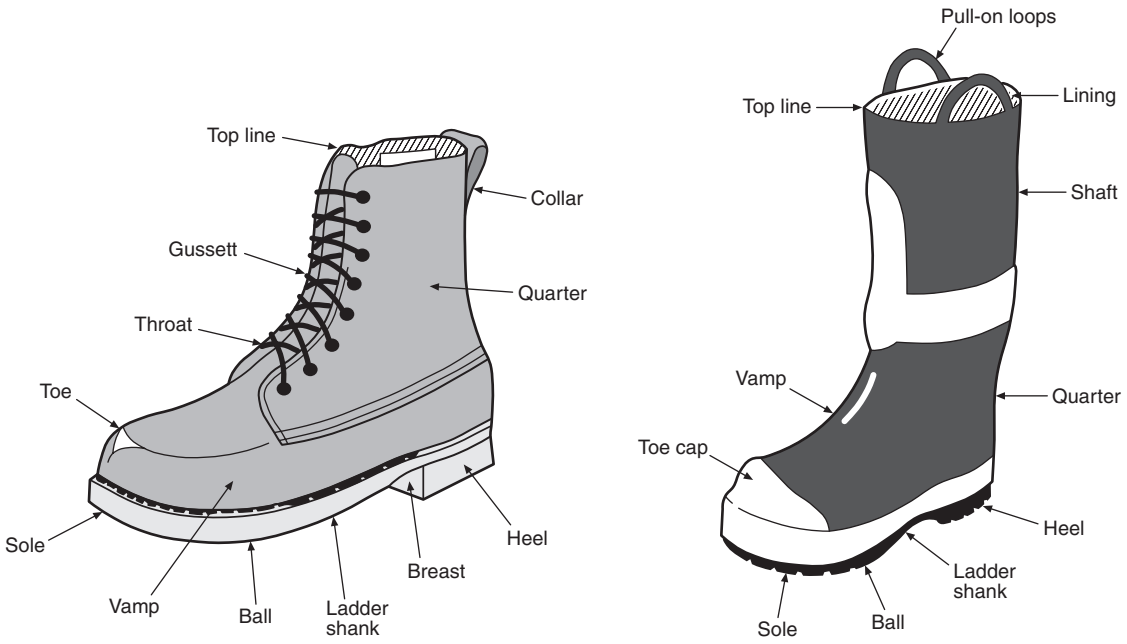


Figure 1-3 Identification of footwear terms.

Functional. The ability of an element or component of an element to continue to be utilized for its intended purpose.

Garment(s). The coat, trouser, or coverall elements of the protective ensemble designed to provide minimum protection to the upper and lower torso, arms, and legs, excluding the head, hands, and feet.

Gauntlet. The circular, flared, or otherwise expanded part of the glove that extends beyond the opening of the glove body. (*See also Glove Wristlet.*)

Glove Body. The part of the glove that extends from the tip of the fingers to 2.54 cm (1 in.) beyond the wrist crease.

Glove Liner. The innermost component of the glove body composite that comes into contact with the wearer's skin.

Gloves. An element of the protective ensemble designed to provide minimum protection to the fingers, thumb, hand, and wrist.

Glove Wristlet. The circular, close-fitting part of the glove, usually made of knitted material, that extends beyond the opening of the glove body. (*See also Gauntlet and Wristlet.*)

Goggles. A helmet component intended to help protect the wearer's eyes and a portion of the wearer's face, not intended as primary eye protection. (*See also Faceshield/Goggle.*)

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

Hazardous Chemicals. Any solid, liquid, gas, or mixture thereof that can potentially cause harm to the human body through respiration, ingestion, skin absorption, injection, or contact.

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

Headband. The portion of the helmet suspension that encircles the head.

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

Helmet. An element of the protective ensemble designed to provide minimum protection to the head.

Helmet Positioning Index. The distance, as specified by the manufacturer, from the lowest point of the brow opening at the lateral midpoint of the helmet to the basic plane of the reference headform when the helmet is firmly positioned on the headform.

Hood. The interface component element of the protective ensemble designed to provide limited protection to the coat/helmet/SCBA facepiece interface area. (*See also Interface Components.*)

Horizontal Center Plane. Any plane passing through the helmet whose intersection with the helmet surface is equidistant from the top of the helmet at all points.

Inherent Flame Resistance. As applied to textiles, flame resistance that is derived from an essential characteristic of the fiber or polymer from which the textile is made.

Insole. The inner part of the protective footwear upon which the foot rests and that conforms to the bottom of the foot.

Interface Area. An area of the body where the protective garments, helmet, gloves, footwear, or SCBA facepiece meet (i.e., the protective coat/helmet/SCBA facepiece area, protective coat/protective trouser area, the protective coat/glove area, and the protective trouser/footwear area).

Interface Components. Elements of the protective ensemble that are designed to provide limited protection to interface areas.

Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization 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. (*See also Product Label.*)

Ladder Shank. Reinforcement to the shank area of footwear designed to provide additional support to the instep when standing on a ladder rung.

Liquid Borne Pathogen. An infectious bacteria or virus carried in human, animal, or clinical body fluids, organs, or tissues.

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. The area of body below the waist including the legs but excluding the ankles and feet.

Major A Seams. See definition of "Seams."

Major B Seams. See definition of "Seams."

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

Melt. A response to heat by a material resulting in evidence of flowing or dripping.

Mid-Sagittal Plane. A helmet term for the plane, perpendicular to the basic and coronal planes, that bisects the head symmetrically.

Minor Seams. See definition of "Seams."

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

Model Weight. The basic weight of the helmet plus accessories for the specific model identified.

Moisture Barrier. The portion of the composite designed to prevent the transfer of liquids.

Nape Device. A device located below the Bitragion Inion Arc used to aid in helmet retention.

Outer Shell. The outermost layer of the composite with the exception of trim, hardware, reinforcing material, and wristlet material.

Product. The compliant protective ensemble or the compliant elements of the protective ensemble.

Product Label. A label or marking affixed to each compliant element of a protective ensemble 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 or be part of the product label. (*See also Labeled.*)

Protective Clothing. See definition of "Protective Ensemble."

Protective Coat. See definition of "Coat."

Protective Coverall. See definition of "Coverall."

Protective Ensemble. Multiple elements of clothing and equipment designed to provide a degree of protection for fire fighters from adverse exposures to the inherent risks of structural fire fighting operations and certain other emergency operations. The elements of the protective ensemble are coats, trousers, coveralls, helmets, gloves, footwear, and interface components.

Protective Footwear. See definition of "Footwear."

Protective Garment. See definition of "Garment."

Protective Glove. See definition of "Gloves."

Protective Helmet. See definition of "Helmet."

Protective Hood. See definition of "Hood."

Protective Trouser. See definition of "Trouser."

Protective Uniform.* A unit of textile apparel configured as a shirt, pant, or coverall and designed to be both the thermal barrier or a portion of the thermal barrier of a garment element of the protective ensemble, and an apparel unit(s) of a station/work uniform.

Protective Wristlet. See definition of "Wristlet."

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

Puncture-Resistant Device. A reinforcement to the bottom of protective footwear located between the sole with heel and the insole that is designed to provide puncture resistance.

Radiological Agents. Radiation associated with X-rays, alpha, beta, and gamma emissions from radioactive isotopes, or other materials in excess of normal background radiation levels.

Reference Plane. A headform term for the plane that is 60 mm ± 1 mm (2.36 in. ± 0.04 in.) above and parallel to the basic plane.

Retention System. The complete assembly by which the helmet is retained in position on the head.

Retroreflection. The reflection of light in which the reflected rays are preferentially returned in the direction close to the opposite of the direction of the incident rays, with this property being maintained over wide variations of the direction of the incident rays.

Retroreflective Markings. A material that reflects and returns a relatively high proportion of light in a direction close to the direction from which it came.

Sample. Protective ensemble elements taken from a manufacturer's current production lot. (*See also Specimen.*)

Seam. Any permanent attachment of two or more materials in a line formed by joining the separate material pieces.

Seam Assembly. The structure obtained when fabrics are joined by means of a seam.

Seams.

Major A Seams. Outermost layer seam assemblies where rupture could reduce the protection of the garment by exposing the inner layers such as the moisture barrier, the thermal barrier, the wearer's station/work uniform, other clothing, or skin.

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

Minor Seams. Seam assemblies that are not classified as Major A or Major B seams.

Separate. A material response evidenced by splitting or delaminating.

Shall. Indicates a mandatory requirement.

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

Shell. The outermost layer of the protective ensemble element composite. (*See also Outer Shell.*)

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

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.

Structural Fire Fighting Coat. See definition of "Coat."

Structural Fire Fighting Coverall. See definition of "Coverall."

Structural Fire Fighting Ensemble. See definition of "Protective Ensemble."

Structural Fire Fighting Footwear. See definition of "Footwear."

Structural Fire Fighting Garment(s). See definition of "Garment."

Structural Fire Fighting Glove. See definition of "Gloves."

Structural Fire Fighting Helmet. See definition of "Helmet."

Structural Fire Fighting Protective Clothing. See definition of "Protective Ensemble."

Structural Fire Fighting Trousers. See definition of "Trousers."

Suspension. A helmet term for the energy attenuating system made up of the headband and crown strap.

Sweatband. A helmet term for that part of a headband, either integral or attached, that comes in contact with the wearer's forehead.

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

Thermal Barrier. The portion of protective ensemble element composites that is designed to provide thermal protection.

Toecap. A reinforcement to the toe area of footwear designed to protect the toes from impact and compression.

Top. A helmet term for the intersection between the midsagittal plane and the Bitragion-Coronal Arc extended to the helmet surface.

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

Trim. Retroreflective and fluorescent material attached to the outermost surface of the protective ensemble element for visibility enhancement. Retroreflective materials enhance nighttime visibility, and fluorescent materials enhance daytime visibility.

Trouser. A protective garment. An element of the protective ensemble that is designed to provide minimum protection to the lower torso and legs, excluding the ankles and feet.

Upper. That part of the protective footwear, as shown in Figure 1-3, including, but not limited to, the toe, vamp, quarter, shaft, collar, and throat; but not including the sole with heel, puncture-resistant device, and insole.

Upper Torso. The area of body above the waist and extending to the shoulder, including the arms and wrists but excluding the hands.

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 vegetation that is not within structures but that is involved in a fire situation.

Winter Liner. A garment term for an optional component layer designed to provide added insulation against cold.

Wristlet. An interface component element of the protective ensemble that is the circular, close-fitting extension of the coat sleeve, usually made of knitted material, designed to provide limited protection to the protective coat/glove interface area. (*See also Gauntlet, Glove Wristlet, and Interface Components.*)

1-4 Units.

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

Chapter 2 Certification

2-1 General.

2-1.1 All individual elements of the protective ensemble that are labeled as being compliant with this standard shall meet or exceed all applicable requirements specified in this standard and shall be certified.

2-1.2 All certification shall be performed by an approved certification organization that meets at least the requirements specified in Section 2-2.

2-1.3 All individual compliant elements of the protective ensemble shall be labeled and listed. All individual compliant elements of the protective ensemble shall also have a product label. The product label shall meet the applicable requirements for the specific element specified in 3-1.1, 3-2.1, 3-3.1, 3-4.1, and 3-5.1.

2-1.4* The certification organization's label, symbol, or identifying mark shall be attached to the product label or shall be part of the product label.

2-2 Certification Organization.

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

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

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

2-2.4* 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 in use to ensure proper control of all testing. Good practice shall be followed regarding the use of laboratory manuals, form data sheets, documented calibration and calibration routines, performance verification, proficiency testing, and staff qualification and training programs.

2-2.5 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 Section 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 the product's continued compliance 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 Sampling levels for testing and inspection 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 to this standard are compliant, unless such sampling levels are specified herein. Information about sampling levels shall be provided to the purchaser upon request.

2-3.1.1 For certification of garments, the required testing and conditioning of the garment, materials, and components shall be specified as shown in Table 2-3.1.1.

2-3.1.2 For certification of helmets, a test series shall consist of 14 helmets. A minimum of three test series shall be required for certification. Each helmet shall be subjected to the environmental conditioning and test or tests specified in Table 2-3.1.2. The order of testing shall be from left to right in Table 2-3.1.2. Where there is more than one environmental condition for a specific test, the order of environmental conditioning for that test shall be from top to bottom in Table 2-3.1.2.

2-3.1.3 For certification of gloves, the required testing and conditioning of the glove, materials, and components shall be specified as shown in Table 2-3.1.3.

2-3.1.4 For certification of footwear, the required testing and conditioning of the footwear, materials, and components shall be specified as shown in Table 2-3.1.4.

2-3.1.5 For certification of interface components, the required testing and conditioning of the hood and wristlet, materials, and components shall be specified as shown in Table 2-3.1.5.

2-3.2 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 for the specific protective ensemble element in 3-1.1, 3-2.1, 3-3.1, 3-4.1, and 3-5.1.

Table 2-3.1.1 Protective Garment Test Matrix

Test Material or Component	Flame Resist.	Heat/ Thermal Resist.	TPP	Thread Melting	Tear Resist	Seam Strength	Clean. Shrink. Resist.	Water Absorb. Resist.	Water Penet. Resist.	Liquid Penet. Resist.	Viral Penet. Resist.	Corros. Resist.	Label Durab.	Retro-reflect. Fluor.	Overall Liquid Penet.	Breaking Strength
	6-2	6-6	6-10	6-11	6-12	6-14	6-25	6-26	6-27	6-28	6-29	6-30	6-42	6-46	6-48	6-50
Clothing															X	
Composite			X													
Outer Shell	X	X			X		X	X								X
Moisture Barr.	X	X			X		X		X	X	X					
Thermal Barr.	X	X			X		X									
Winter Liner	X	X			X		X	X								X
Labels		X											X			
Other Textiles	X	X														
Thread				X												
Seams		X				X										
Hardware												X				
Trim	X	X												X		
Environmental Condition																
Washing/Drying 6-1.2	X		X					X	X	X	X	X				X
Room Temperature 6-1.3	X	X	X		X	X	X	X	X	X	X	X	X	X	X	
Convective Heat 6-1.5									X	X	X		X	X		

Table 2-3.1.2 Protective Helmet Test Matrix

Environmental Condition	Flame 6-2 6-3 6-4 6-5	Heat 6-6	Retention 6-35 6-36	Elec. 6-31 6-32	Shell Retention 6-44	F/GC Luminous Transmittance 6-45	F/GC Impact 6-17	Top Impact 6-15	Label 6-43	Impact Accel. 6-16	Penetration 6-19	Trim 6-46	Ear Covers 6-2	F/GC Scratch Resistance 6-23	Hardware Corrosion 6-30
Room Temperature 6-1.3	1	2	1	4	1	6	3	3	2	5	3	6	3	8	
Wet 6-1.7							4	4	4	6	4				
Radiant 6-1.6								7	7	8	14				
Low Temp. 6-1.4							9	9	9	10	9				
Convective Heat 6-1.5							13	11			12				
Salt Spray 6-30															3, 4, 9

F/GC = Faceshield/goggle component.
Note: Numbers refer to helmet specimen number used for respective test(s).

Table 2-3.1.3 Protective Glove Test Matrix

Test Material or Component	Flame Resist. 6-2 6-4	Heat/ Thermal Resist. 6-6	Conduc. Heat Resist. 6-7	TPP 6-10	Thread Melting 6-11	Burst Strength 6-13	Seam Strength 6-14	Punct. Resist 6-20	Cut Resist. 6-22	Liquid Penet. Resist. 6-28	Viral Penet. Resist. 6-29	Corros. Resist. 6-30	Overall Liquid Integrity 6-33	Liner Retent. 6-37	Dext. 6-38	Grip 6-39	Label Dura. 6-42
Whole Glove		X											X	X	X	X	
Composite	X		X	X				X	X		X						
Gauntlet or Wristlet	X					X			X								
Innermost Layer		X															
Labels																	X
Thread					X												
Seams							X			X	X						
Hardware												X					
Environmental Condition																	
Washing/Drying 6-1.2	X	X	X	X			X			X	X		X		X	X	
Room Temperature 6-1.3	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X
Convective Heat 6-1.5										X	X		X				X
Wet 6-1.8															X	X	
Flexing 6-1.10													X				

Table 2-3.1.4 Protective Footwear Test Matrix

Test Material or Component	Flame Resist. 6-5	Heat Resist. 6-6	Cond. Heat Resist. 6-7 6-8	Rad. Heat Resist. 6-9	Thread Melting 6-11	Impact Comp. Test 6-18	Punc. Resist. 6-20 6-21	Cut Resist. 6-22	Abras. Resist. 6-24	Liquid Penet. Resist. 6-28	Vital Penet. Resist. 6-29	Corr. Resist. 6-30	Elect. Insul. 6-32	Liquid Integr. 6-34	Bend Resist. 6-40	Slip Resist. 6-41	Label Durab. 6-42	Alt. St 6-49
Whole Boot		X											X	X				
Upper			X				X	X										
Sole			X				X		X							X		
Toe						X												
Selected Parts	X			X						X	X							
Labels																	X	
Thread					X													
Hardware												X						
Ladder Shank															X			
Eyelets/Studposts																		X
Environmental Condition																		
Washing/Drying 6-1.2																		
Room Temperature 6-1.3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Convective Heat 6-1.6										X	X							
Wet 6-1.9																		

Table 2-3.1.5 Protective Hood and Wristlet Test Matrix

Test Material or Component	Flame Resistance	Shrinkage Resistance	Heat Resistance	TPP	Thread Melting	Burst Strength	Seam Strength	Cleaning Shrinkage
	6-2	6-6	6-6	6-10	6-11	6-13	6-14	6-25
Hood material or composite	X	X	X	X		X		X
Hood seams							X	
Hood thread					X			
Wristlet material or composite	X	X	X	X		X		X
Wristlet seams							X	
Wristlet thread					X			
Environmental Condition								
Washing/Drying 6-1.2	X	X	X	X				X
Room Temperature 6-1.3	X	X	X	X	X	X	X	X

2-3.3 Inspection by the certification organization shall include a review of any graphic representations used on product labels, as permitted by 3-1.1.5, 3-2.1.5, 3-3.1.5, 3-4.1.5, and 3-5.1.5, to ensure that the symbols are consistent with the worded statements, readily understood, and clearly communicate the intended message.

2-3.4 Inspection by the certification organization shall include a review of the user information required by 3-1.2, 3-2.2, 3-3.2, 3-4.2, and 3-5.2 to ensure that the information has been developed and is available.

2-3.5 Inspection by the certification organization for determining compliance with the design requirements specified in Chapter 4 shall be performed on whole or complete products.

2-3.6 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 element samples or element sample specimens that are representative of materials and components used in the actual construction of protective ensemble element products. The certification organization also shall be permitted to use sample materials cut or taken from a representative product.

2-3.7 Where certification testing includes an element with an accessory or accessories, each accessory shall be certified as complying with Section 4-8.

2-3.8 Any change in the design, construction, or material of a compliant product 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.

2-3.9 The certification organization shall not allow any modifications, pretreatment, conditioning, or other such special processes of the product or any product component 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 product or product components that are the same in every respect to the actual final product or product component. The certification organization shall not allow the substitution, repair, or modification, other than as specifically permitted herein, of any product or any product component during testing.

2-4 Recertification.

2-4.1 All individual elements of the protective ensemble 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 the element'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 element.

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, upon 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 of materials, work in process, and completed articles. Criteria for acceptance and rejection of materials, processes, and final product shall be part of the instructions.

2-5.3 The manufacturer shall maintain records of all pass/fail tests. Pass/fail records shall indicate the disposition of a 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 part of the quality assurance program, maintain a calibration program of all instruments used to ensure proper control of testing. The calibration program shall document 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 nonconforming material, including procedures for the identification, segregation, and disposition of rejected material. All nonconforming materials or products shall be identified to prevent their use, shipment, and intermingling with conforming materials or products.

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

Chapter 3 Labeling and Information

3-1 Protective Garments.

3-1.1 Product Label Requirements.

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

3-1.1.2 Multiple label pieces shall be permitted in order to carry all statements and information required to be on the product label.

3-1.1.3* 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.

3-1.1.4 All worded portions of the required product label shall be printed at least in English.

3-1.1.5 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product label(s). Such graphic representations shall be consistent with the worded statements and shall be readily understood and clearly communicate the intended message.

3-1.1.6 The following statement shall be printed legibly on the product label with all letters shall be at least 2.5 mm (0.10 in.) high.

> "THIS GARMENT MEETS THE GARMENT REQUIREMENTS OF NFPA 1971, STANDARD ON PROTECTIVE ENSEMBLE FOR STRUCTURAL FIRE FIGHTING, 1997 EDITION."

3-1.1.7 The following information shall also be printed legibly on the product label with all letters at least 1.6 mm (0.063 in.) high:

(a) Manufacturer's name, identification, or designation

(b) Manufacturer's address

(c) Country of manufacture

(d) Manufacturer's garment identification number or lot number or serial number

(e) Month and year of manufacture (not coded)

(f) Model name, number, or design

(g) Size

(h) Garment material(s)

(i) Cleaning precautions

3-1.1.8 Supplementary Product Labels.

3-1.1.8.1 Where the garment's outer shell, thermal barrier, or moisture barrier layers can be separated from each other, each separable layer shall have a supplementary product label permanently attached.

3-1.1.8.2 Supplementary product labels shall also meet the requirements of 3-1.1.4 and 3-1.1.5.

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 element.

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

1. Inspection frequency and details

(d) /doff

1. Donning and doffing procedures

2. Sizing and adjustment procedures

3. Interface issues

(e) Use

1. 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, General Requirements of Subpart I, 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. Inspection details

3. Maintenance criteria and methods of repair where applicable

4. Decontamination procedures for both chemical and biological contamination

(g) Retirement and disposal

1. Retirement and disposal criteria and considerations

3-2 Protective Helmets.

3-2.1 Product Label Requirements.

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

3-2.1.2 Multiple label pieces shall be permitted in order to carry all the statements and information required to be on the product label.

3-2.1.3* 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.

3-2.1.4 All worded portions of the required product label shall be printed at least in English.

3-2.1.5 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product label(s). Such graphic representations shall be consistent with the worded statements and shall be readily understood and clearly communicate the intended message.

3-2.1.6 The following statement shall be printed legibly on the product label. All letters shall be at least 2.5 mm (0.10 in.) high.

"THIS HELMET MEETS THE HELMET REQUIREMENTS OF NFPA 1971, STANDARD ON PROTECTIVE ENSEMBLE FOR STRUCTURAL FIRE FIGHTING, 1997 EDITION."

3-2.1.7 The following information shall also be printed legibly on the product label with all letters at least 1.6 mm (0.063 in.) high:

(a) Manufacturer's name, identification, or designation

(b) Manufacturer's address

(c) Country of manufacture

(d) Manufacturer's helmet identification number or lot number or serial number

(e) Month and year of manufacture (not coded)

(f) Model name, number, or design

(g) Helmet size or size range

(h) Cleaning precautions

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 element.

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

1. Inspection frequency and details

(d) Don/doff

1. Donning and doffing procedures

2. Sizing and adjustment procedures

3. Interface issues

(e) Use

1. 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, General Requirements of Subpart I, 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 for both chemical and biological contamination

(g) Retirement and disposal

1. Retirement and disposal criteria and considerations

3-3 Protective Gloves.

3-3.1 Product Label Requirements.

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

3-3.1.2 Multiple label pieces shall be permitted in order to carry all the statements and information required to be on the product label.

3-3.1.3* 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.

3-3.1.4 All worded portions of the required product label shall be printed at least in English.

3-3.1.5 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product labels. Such graphic representations shall be consistent with the worded statements and shall be readily understood and clearly communicate the intended message.

3-3.1.6 The following statement shall be printed legibly on the product label. All letters shall be at least 2.5 mm (0.10 in.) high.

"THIS GLOVE MEETS THE GLOVE REQUIREMENTS OF NFPA 1971, STANDARD ON PROTECTIVE ENSEMBLE FOR STRUCTURAL FIRE FIGHTING, 1997 EDITION."

3-3.1.7 The following information shall also be printed legibly on the product label with all letters at least 1.6 mm (0.063 in.) high:

(a) Manufacturer's name, identification, or designation

(b) Manufacturer's address

(c) Country of manufacture

(d) Manufacturer's glove identification number or lot number or serial number

(e) Month and year of manufacture (not coded)

(f) Model name, number, or design

(g) Glove size or size range

(h) Cleaning precautions

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 element.

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

1. Inspection frequency and details

(d) Don/doff

1. Donning and doffing procedures

2. Sizing and adjustment procedures

3. Interface issues

(e) Use

1. 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, General Requirements of Subpart I, 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 for both chemical and biological contamination

4. Instructions for frequency and method of user testing for water resistance

(g) Retirement and disposal

1. 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 4-3.5.3.

3-4 Protective Footwear.

3-4.1 Product Label Requirements.

3-4.1.1* Each footwear element of the protective ensemble 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 Multiple label pieces shall be permitted in order to carry all the statements and information required to be on the product label.

3-4.1.3* 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.

3-4.1.4 All worded portions of the required product label shall be printed at least in English.

3-4.1.5 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product labels. Such graphic representations shall be consistent with the worded statements and shall be readily understood and clearly communicate the intended message.

3-4.1.6 The following statement shall be printed legibly on the product label. All letters shall be at least 2.5 mm (0.10 in.) high.

"THIS BOOT MEETS THE FOOTWEAR REQUIREMENTS OF NFPA 1971, STANDARD ON PROTECTIVE ENSEMBLE FOR STRUCTURAL FIRE FIGHTING, 1997 EDITION."

3-4.1.7 The following information shall also be printed legibly on the product label with all letters at least 1.6 mm (0.063 in.) high:

(a) Manufacturer's name, identification, or designation

(b) Manufacturer's address

(c) Country of manufacture

(d) Manufacturer's footwear identification number or lot number or serial number

(e) Month and year of manufacture (not coded)

(f) Model name, number, or design

(g) Footwear size and width

(h) Cleaning precautions

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 element.

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 boot 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

1. Inspection frequency and details

(d) Don/doff

1. Donning and doffing procedures

2. Sizing and adjustment procedures

3. Interface issues

(e) Use

1. 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, General Requirements of Subpart I, 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 for both chemical and biological contamination

(g) Retirement and disposal

1. 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 Protective Hood Interface Component.

3-5.1 Product Label Requirements.

3-5.1.1 Each hood interface component of the protective ensemble shall have a product label or labels permanently and conspicuously attached to each hood. At least one product label shall be conspicuously located on or inside each hood when the hood is properly assembled with all components in place.

3-5.1.2 Multiple label pieces shall be permitted in order to carry all the statements and information required to be on the product label.

3-5.1.3* 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.

3-5.1.4 All worded portions of the required product label shall be printed at least in English.

3-5.1.5 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product labels. Such graphic representations shall be consistent with the worded statements and shall be readily understood and clearly communicate the intended message.

3-5.1.6 The following statement shall be printed legibly on the product label. All letters shall be at least 2.5 mm (0.10 in.) high.

"THIS HOOD MEETS THE HOOD INTERFACE REQUIREMENTS OF NFPA 1971, STANDARD ON PROTECTIVE ENSEMBLE FOR STRUCTURAL FIRE FIGHTING, 1997 EDITION."

3-5.1.7 The following information shall also be printed legibly on the product label with all letters at least 1.6 mm (0.063 in.) high:

(a) Manufacturer's name, identification, or designation

(b) Manufacturer's address

(c) Country of manufacture

(d) Manufacturer's hood identification number or lot number or serial number

(e) Month and year of manufacture (not coded)

(f) Model name, number, or design

(g) Size

(h) Garment material(s)

(i) Cleaning precautions

3-5.2 User Information.

3-5.2.1 The hood manufacturer shall provide at least the user information that is specified in 3-5.2.4 with each hood element.

3-5.2.2 The hood manufacturer shall attach the required user information, or packaging containing the user information, to the hood in such a manner that it is not possible to use the hood without being aware of the availability of the information.

3-5.2.3 The required user information, or packaging containing the user information, shall be attached to the hood so that a deliberate action is necessary to remove it. The hood manufacturer shall provide notice that the user information is to be removed ONLY by the end user.

3-5.2.4* The hood manufacturer shall provide at least the following instructions and information with each hood:

(a) Pre-use information

1. Safety considerations

2. Limitations of use

3. Hood marking recommendations and restrictions

4. A statement that most performance properties of the hood 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

1. Inspection frequency and details

(d) Don/doff

1. Donning and doffing procedures

2. Sizing and adjustment procedures

3. Interface issues

(e) Use

1. 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, General Requirements of Subpart I, Personal Protective Equipment

(f) Maintenance and cleaning

1. Cleaning instructions and precautions with a statement advising users not to use hoods that are not thoroughly cleaned and dried

2. Maintenance criteria and methods of repair where applicable

3. Decontamination procedures for both chemical and biological contamination

(g) Retirement and disposal

1. Retirement and disposal criteria and considerations

Chapter 4 Design Requirements

4-1* Protective Garment Design Requirements.

4-1.1 A sample garment 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* Garments shall consist of a composite of an outer shell, moisture barrier, and thermal barrier. This composite shall be permitted to be configured as a single layer or multiple layers.

4-1.2.1 The moisture barrier, or the thermal barrier or a portion of the thermal barrier, of a garment element shall be permitted to be configured as a protective uniform apparel unit or units. Where configured in this manner, the assembled garment element of the protective ensemble shall meet the requirements specified in 2-1.1. The protective uniform apparel unit(s) shall also meet all applicable requirements specified in NFPA 1975, *Standard on Station/Work Uniforms for Fire Fighters.*

4-1.2.2 Where moisture barriers or thermal barriers are configured as permitted in 4-1.2.1, the garment manufacturer shall identify the protective uniform apparel unit(s) that comprise the garment element and that need to be worn together in order for the garment element to be compliant with the requirements of this standard. Each such protective uniform apparel unit and the garment element itself shall have a label that meets the requirements of 3-1.1.8, Supplementary Product Labels. This supplementary product label shall be in addition to any other product label requirements that apply to the protective uniform apparel units or that apply to the garment element.

4-1.3* Garments shall have a means of securing the moisture barrier and thermal barrier to the outer shell.

4-1.4 Moisture barriers and thermal barriers, or materials meeting the performance requirements of these components, shall extend, as a minimum, to the neckline seam of the coat, to the waistline seam of the trouser, and to within 7.62 cm (3.0 in.) of the bottom outer shell hems of protective garments. In coats, the moisture barriers and thermal barriers, or materials meeting the performance requirements of these components, shall also extend to within 2.54 cm (1.0 in.) of the sleeve end of the outer shell and be permitted to retract a maximum of 5.08 cm (2.0 in.) from the sleeve end of the outer shell, and in trousers, shall also extend to within 7.62 cm (3.0 in.) of the bottom outer shell hems and be permitted to retract a maximum of 10.2 cm (4.0 in.) from the bottom outer shell hem. Moisture barriers and thermal barriers, or materials meeting the performance requirements of these components, shall be configured in a manner to provide overlap at all closures.

4-1.5 Protective garments and their closure systems, including the coat front and trouser flies, shall be constructed in a manner that provides continuous moisture and thermal protection. Such closure systems shall be secured with positive locking fasteners including, but not limited to, hooks and dees or zippers. Nonpositive fasteners, such as snaps or hook and pile tape, shall not be used as positive locking fasteners but shall be permitted to be utilized as supplementary garment closure devices.

4-1.6 Snaps shall at least meet the requirements of Fasteners, Snap, Style 2, MS27980E of *Fastener, Snap* MIL-F-10884F. The construction of the snap shall be permitted to vary from the drawings with regard to the attachment means.

4-1.7* Fastener tape shall meet the requirements of MIL-F-21840G, *Fastener Tapes, Hook and Pile, Synthetic*. Class 2 hook and pile fastener tapes shall not be permitted.

4-1.8 Zippers shall meet the requirements of FED-V-F-106F, *Fasteners, Interlocking, Slide*.

4-1.9 Hooks and dees shall be nonferrous. Hooks shall be inward facing and shall have at least three attachment points. Dees shall have at least two attachment points.

4-1.10 All garment hardware finish shall be free of rough spots, burrs, or sharp edges.

4-1.11* Cargo pockets, where provided, shall have a means to drain water and shall have a means of fastening in the closed position.

4-1.12* Garments shall have fluorescent and retroreflective trim permanently attached to the outer shell of garments to meet visibility requirements. Trim shall be not less than 5.08 cm (2.0 in.) wide and shall have both retroreflective and fluorescent surfaces. The retroreflective surface of trim shall be not less than 1.6 cm (0.625 in.) wide. Fluorescent and retroreflective areas of trim shall appear to be continuous for the length of the trim, with gaps between areas of retroreflectivity of not more than 3.18 mm (0.125 in.).

4-1.12.1 Trim used to meet the minimum trim pattern requirements shall have a minimum fluorescent surface of 5.08 cm^2/linear cm (2.0 $in.^2$/linear in.) of trim.

4-1.12.2 Trim used in excess of that required by the minimum trim pattern requirements specified and illustrated in Figures 4-1.14.5 and 4-1.15.3 shall be permitted to not meet the minimum fluorescent surface of 5.08 cm^2/linear cm (2.0 $in.^2$/linear in.) of trim.

4-1.13 Trim used in excess of that required by the minimum trim pattern requirements specified and illustrated in Figures 4-1.14.5 and 4-1.15.3 shall be permitted to be obscured by components including, but not limited to, pockets, storm flaps, and reinforcing patches as long as the minimum trim pattern is not obscured.

4-1.14 Additional Design Requirements for Protective Coats.

4-1.14.1 Coats shall provide protection as specified to the upper torso, neck, arms, and wrists, excluding the hands and head.

4-1.14.2* Each coat sleeve shall have a protective wristlet permanently attached to the coat sleeve in a manner that will not permit a gap in the thermal protection and that meets the requirements specified in Section 4-6 and Section 5-6.

4-1.14.3 Coats shall have a composite collar at least 10.2 cm (4.0 in.) in height at any point and shall have a closure system. The collar and closure system shall consist of an outer shell, moisture barrier, and thermal barrier, or of materials that meet all applicable performance requirements as specified in Section 5-1.

4-1.14.4 Coat hardware shall not penetrate through the outer shell, moisture barrier, and thermal barrier to contact the wearer's body when the coat is worn with the closures fastened, unless the hardware is completely covered by external closure flaps.

4-1.14.5* The trim configuration for the coat shall be in accordance with Figure 4-1.14.5. The minimum trim pattern for the coat shall consist of one circumferential band of trim around the bottom of the coat near the hem. The front of the coat shall also have at least one band of horizontal trim at the chest level. No vertical strips of trim shall be permitted on the front of the coat. The back of the coat shall also have a minimum of either two vertical strips of trim, perpendicular to the bottom band with one strip located on both the left and right side of the back of the coat, or a minimum of one horizontal band of trim at the chest/shoulder blade level. The minimum trim configuration for each sleeve shall be one circumferential band, or a staggered 360-degree visibility pattern meeting or exceeding the surface area of a continuous circumferential band, between the wrist and elbow area.

4-1.15 Additional Design Requirements for Protective Trousers.

4-1.15.1* Trousers shall provide protection as specified to the lower torso and legs, excluding the ankles and feet.

4-1.15.2 Trouser hardware shall not penetrate through the outer shell, moisture barrier, and thermal barrier to come into contact with the wearer's body when the trouser is worn with the closure fastened, unless the hardware is located on or above the waistline or hardware is completely covered by external closure flaps.

4-1.15.3* The trim configuration for the trousers shall be in accordance with Figure 4-1.15.3. The minimum trim pattern for the trousers shall consist of two circumferential bands of trim: one band around each leg between the bottom hem and knee areas.

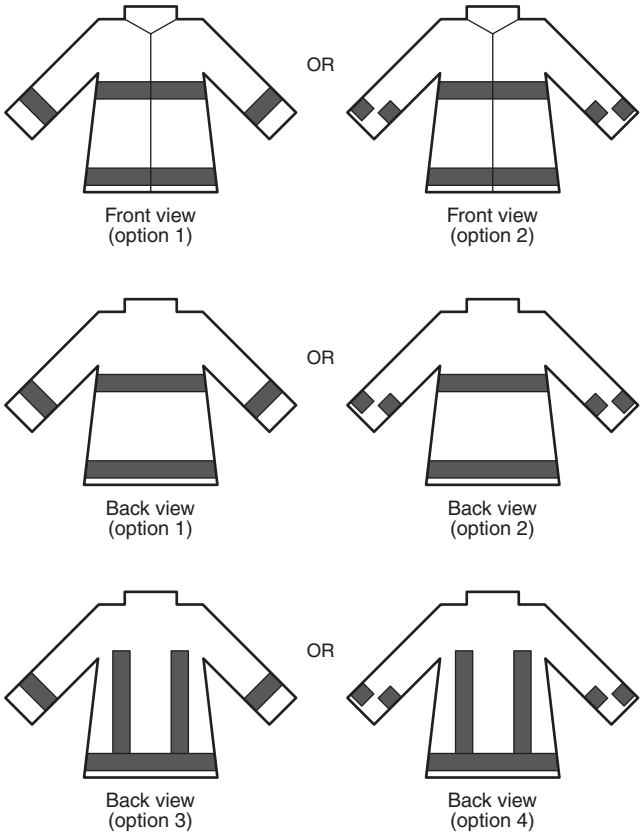


Figure 4-1.14.5 Minimum required coat trim patterns.

4-1.16 Additional Design Requirements for Protective Coveralls.

4-1.16.1 That portion of the coverall that corresponds to the coat shall meet all requirements of 4-1.14.

4-1.16.2 That portion of the coverall that corresponds to the trouser shall meet all requirements of 4-1.15.

4-2 Protective Helmet Design Requirements.

4-2.1 A sample helmet 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 for structural fire fighting shall consist of at least the following assembled components: a shell, an energy absorbing system, a retention system, fluorescent and retroreflective trim, ear covers, and either a faceshield, or goggles, or both.

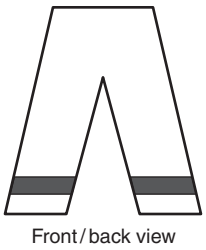


Figure 4-1.15.3 Minimum required trouser trim patterns.

4-2.3 There shall be no openings penetrating the shell other than those provided by the manufacturer for mounting energy absorbing systems, retention systems, and accessories.

4-2.4 The helmet, with the faceshield/goggle components stowed, shall provide peripheral vision clearance of at least105 degrees to each side of the mid-sagittal plane when seated according to its helmet positioning index on the reference headform illustrated in Figure 4-2.4.

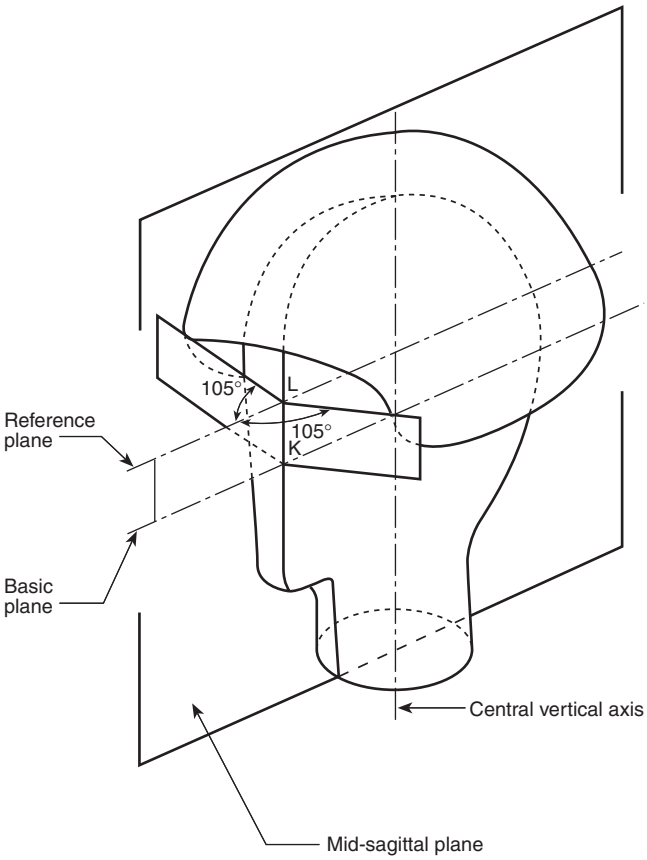


Figure 4-2.4 Helmet peripheral vision.

4-2.5 The retention system shall include a chin strap and a nape device. The chin strap shall have a minimum width of 1.9 cm (0.75 in.).

4-2.6 The helmet shall have fluorescent and retroreflective trim on the shell exterior.

4-2.6.1 A minimum of 26 cm^2 (4 $in.^2$) of the retroreflective area of the trim shall be visible when the helmet, with faceshield/goggle component in the stowed position, is viewed from any angle at or above the reference plane at a distance of 2.44 m (8.0 ft).

4-2.6.2 A minimum of 26 cm^2 (4 $in.^2$) of the fluorescent area of the trim shall be visible when the helmet, with the faceshield/goggle component in the stowed position, is viewed from any angle at or above the reference plane at a distance of 2.44 m (8.0 ft).

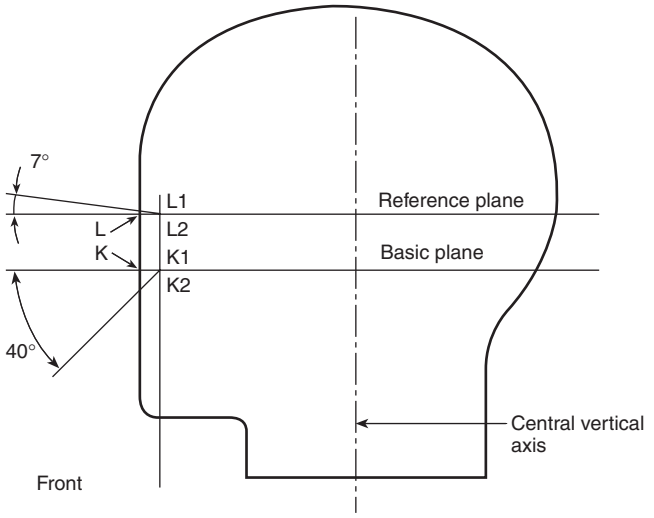
4-2.6.3 The entire surface of the trim shall be permitted to be both fluorescent and retroreflective.

4-2.7 The faceshield/goggle component(s), when deployed in accordance with its helmet and eye/face positioning indexes on an Alderson 50th percentile male headform shall provide the following coverage.

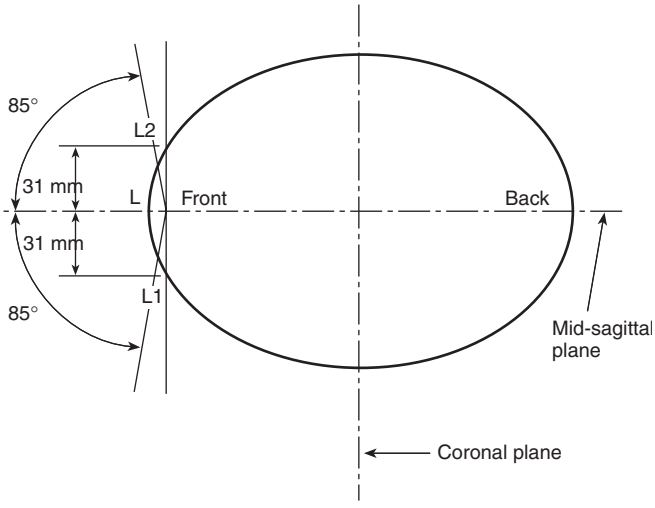
(a) A dihedral angle of at least 85 degrees measured horizontally between L and K on each side of the sagittal plane that passes through point L as shown in Figure 4-2.7.

(b) An upper dihedral angle of at least 7 degrees above the reference plane that is defined by the straight line passing through L1 and L2 as shown in Figure 4-2.7.

(c) A lower dihedral angle of at least 40 degrees under the basic plane that is defined by the straight line passing through K1 and K2 situated on the surface of the headform at 31 mm (1.22 in.) on each side of point K as shown in Figure 4-2.7.



(a) Section of headform in longitudinal vertical plane



(b) Section of headform in reference plane

Figure 4-2.7 Faceshield/goggle component field of view.

4-2.8 The minimum coverage area for ear covers when deployed, the distance from the reference plane downward to the edge of the ear protector, shall be at least:

(a) 125 mm (5 in.) when measured 50 mm (2 in.) forward of the coronal plane

(b) 150 mm (5.9 in.) when measured 25 mm (1 in.) forward of the coronal plane

(c) 160 mm (6.3 in.) when measured at the coronal plane

(d) 160 mm (6.3 in.) when measured at the mid-sagittal plane at the rear of the headform

4-3 Protective Glove Design Requirements.

4-3.1 A sample glove 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 The sample glove shall consist of a composite meeting the performance requirements of Section 5-3. This composite shall be permitted to be configured as a continuous or joined single layer, or as continuous or joined multiple layers.

4-3.3 The sample glove body shall extend circumferentially not less than 2.54 cm (1 in.) beyond the wrist crease where measured from the tip of the finger and shall be close fitting at the opening to restrict the entry of embers and other foreign particles. The location of the wrist crease shall be determined as shown in Figure 4-3.3.

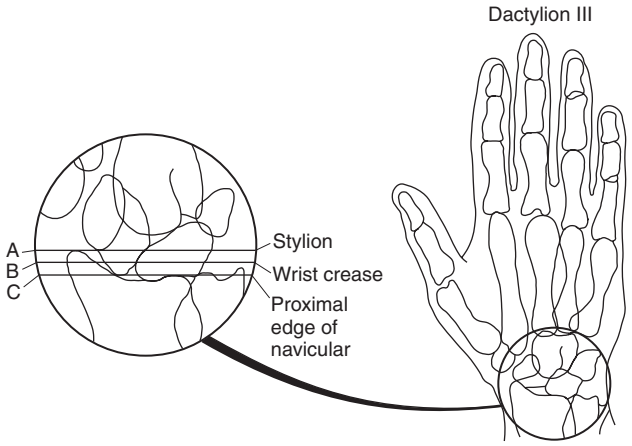


Figure 4-3.3 Anatomical landmarks at base of hand.

4-3.4 Sample gloves shall be permitted to be provided with either a gauntlet or a glove wristlet. Where gloves are provided with a gauntlet or a glove wristlet, the sample glove body and the gauntlet or glove wristlet shall extend circumferentially at least 5.08 cm (2 in.) beyond the wrist crease, taking into consideration the requirement specified in 4-3.3. Where gloves are not provided with a gauntlet or a glove wristlet, the sample glove body shall extend circumferentially at least 5.08 cm (2 in.) beyond the wrist crease, an increase of 2.54 cm (1 in.) to the requirement specified in 4-3.3.

4-3.5 Protective Glove Sizing.

4-3.5.1 Hand dimensions for selection of proper glove size shall consist of measuring the following two dimensions, as shown in Figure 4-3.5.1:

(a) Hand Circumference

(b) Length of the hand

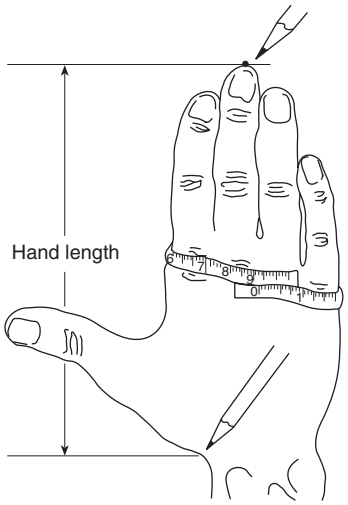


Figure 4-3.5.1 Method of measuring hand dimensions for selection of proper glove.

4-3.5.1.1 Hand circumference shall be measured by placing a measuring tape on a table or other flat surface with the numerals facing downward. The subject shall place the right hand, palm down and fingers together, in the middle of the tape so that the tape can pass straight across the metacarpal knuckles. The circumference shall be measured to the nearest 3.18 mm (0.125 in.), as shown in Figure 4-3.5.1.

4-3.5.1.2 Finger circumference shall be measured at the proximal interphalangeal joint (first knuckle). Finger length shall be measured from the tip of the finger to the base of the finger crease on the palm side.

4-3.5.1.3 Hand length shall be measured by placing the subject's hand, palm down, on a piece of paper with the fingers together and the hand and arm in a straight line. The thumb shall be fully abducted, extended away from the palm as far as possible. The paper shall be marked at the tip of the third, or middle, finger. A pencil mark shall be placed in the notch at the base of the thumb where the thumb joins the wrist. The straight line distance between the two points shall be measured to the nearest 3.18 mm (0.125 in.), as shown in Figure 4-3.5.1.

4-3.5.2* In order to label or otherwise represent a glove as compliant with the requirements of this standard, the manufacturer shall provide gloves in not less than five separate and distinct sizes. The manufacturer shall provide gloves that at least fit the hand dimension ranges specified in 4-3.5.3.

4-3.5.3* The glove size indicated on the label shall be determined by the hand dimensions given in Tables 4-3.5.3(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.

4-4.2 Footwear shall consist of a sole with heel, upper with lining, and insole with a puncture-resistant device, and an impact- and compression-resistant toecap permanently attached.

Table 4-3.5.3(a) Sizing for Small (XS) Glove

			cm	in.
THE RANGE FOR HAND LENGTH:			**16.25 – 17.25**	**(6.40 – 6.79)**
THE RANGE FOR HAND CIRCUMFERENCE:			**16.25 – 20.25**	**(6.40 – 7.97)**
	Mid-Size Value		**Range to Be Accommodated**	
	cm	**(in.)**	**cm**	**(in.)**
Digit 1 Circumference	6.17	(2.43)	5.60 – 6.74	(2.20 – 2.65)
Digit 2 Circumference	6.06	(2.39)	5.50 – 6.63	(2.17 – 2.61)
Digit 3 Circumference	6.08	(2.39)	5.53 – 6.63	(2.18 – 2.61)
Digit 4 Circumference	5.69	(2.24)	5.12 – 6.26	(2.02 – 2.46)
Digit 5 Circumference	5.00	(1.97)	4.48 – 5.52	(1.76 – 2.17)
Digit 1 Length	4.94	(1.94)	4.36 – 5.52	(1.72 – 2.17)
Digit 2 Length	6.44	(2.54)	5.75 – 7.12	(2.26 – 2.80)
Digit 3 Length	7.29	(2.87)	6.71 – 7.87	(2.64 – 3.10)
Digit 4 Length	6.78	(2.67)	6.13 – 7.42	(2.41 – 2.92)
Digit 5 Length	5.09	(2.00)	4.52 – 5.66	(1.78 – 2.23)
Hand Circumference	18.25	(7.19)	16.34 – 20.16	(6.43 – 7.94)
Hand Length	16.75	(6.59)	16.27 – 17.23	(6.41 – 6.78)

Table 4-3.5.3(b) Sizing for Small (S) Glove

			cm	in.
THE RANGE FOR HAND LENGTH:			**17.25 – 18.25**	**(6.79 – 7.19)**
THE RANGE FOR HAND CIRCUMFERENCE:			**17.25 – 21.25**	**(6.79 – 8.37)**
	Mid-Size Value		**Range to Be Accommodated**	
	cm	**(in.)**	**cm**	**(in.)**
Digit 1 Circumference	6.40	(2.52)	5.82 – 6.97	(2.29 – 2.74)
Digit 2 Circumference	6.29	(2.48)	5.73 – 6.85	(2.26 – 2.70)
Digit 3 Circumference	6.31	(2.48)	5.76 – 6.87	(2.27 – 2.70)
Digit 4 Circumference	5.92	(2.33)	5.35 – 6.49	(2.11 – 2.56)
Digit 5 Circumference	5.22	(2.06)	4.70 – 5.74	(1.85 – 2.26)
Digit 1 Length	5.31	(2.09)	4.74 – 5.89	(1.87 – 2.32)
Digit 2 Length	6.89	(2.71)	6.21 – 7.57	(2.44 – 2.98)
Digit 3 Length	7.71	(3.04)	7.13 – 8.30	(2.81 – 3.27)
Digit 4 Length	7.19	(2.83)	6.55 – 7.03	(2.58 – 3.08)
Digit 5 Length	5.44	(2.14)	4.87 – 6.01	(1.92 – 2.37)
Hand Circumference	19.25	(7.58)	17.34 – 21.16	(6.83 – 8.33)
Hand Length	17.75	(6.99)	17.27 – 18.23	(6.80 – 7.18)

4-4.3 Footwear height shall be a minimum of 20.32 cm (8.0 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 be removed prior to measurement.

4-4.4 The footwear heel breast shall not be less than 1.27 cm (0.5 in.) nor more than 2.54 cm (1.0 in.). The heel breasting angle shall not be less than 90 degrees nor more than 135 degrees. The edges shall not be less than, or extend more than, 1.27 cm (0.5 in.) laterally from the upper at any point. The width of the footwear heel shall be equal to or greater than the width of the sole, excluding any calendar roll if present, at the intersection of the heel breast and the sole bottom.

Table 4-3.5.3(c) Sizing for Medium (M) Glove

			cm	in.
THE RANGE FOR HAND LENGTH:			**18.25 – 19.25**	**(7.19 – 7.58)**
THE RANGE FOR HAND CIRCUMFERENCE:			**18.25 – 22.25**	**(7.19 – 8.76)**
	Mid-Size Value		**Range to Be Accommodated**	
	cm	**(in.)**	**cm**	**(in.)**
Digit 1 Circumference	7.01	(2.76)	6.36 – 7.65	(2.50 – 3.01)
Digit 2 Circumference	6.82	(2.69)	6.31 – 7.32	(2.48 – 2.88)
Digit 3 Circumference	6.83	(2.69)	6.26 – 7.40	(2.46 – 2.91)
Digit 4 Circumference	6.34	(2.50)	5.78 – 6.90	(2.28 – 2.72)
Digit 5 Circumference	5.63	(2.22)	5.09 – 6.17	(2.00 – 2.43)
Digit 1 Length	5.63	(2.22)	5.00 – 6.26	(1.97 – 2.46)
Digit 2 Length	7.11	(2.80)	6.50 – 7.72	(2.56 – 3.04)
Digit 3 Length	8.07	(3.18)	7.55 – 8.58	(2.97 – 3.38)
Digit 4 Length	7.61	(3.00)	7.14 – 8.08	(2.81 – 3.18)
Digit 5 Length	5.78	(2.28)	5.16 – 6.41	(2.03 – 2.52)
Hand Circumference	20.25	(7.97)	18.34 – 22.16	(7.22 – 8.72)
Hand Length	18.75	(7.38)	18.27 – 19.23	(7.19 – 7.57)

Table 4-3.5.3(d) Sizing for Large (L) Glove

			cm	in.
THE RANGE FOR HAND LENGTH:			**19.25 – 20.25**	**(7.58 – 7.97)**
THE RANGE FOR HAND CIRCUMFERENCE:			**19.25 – 23.25**	**(7.58 – 9.15)**
	Mid-Size Value		**Range to Be Accommodated**	
	cm	**(in.)**	**cm**	**(in.)**
Digit 1 Circumference	7.26	(2.86)	6.62 – 7.91	(2.61 – 3.11)
Digit 2 Circumference	7.03	(2.77)	6.53 – 7.54	(2.57 – 2.97)
Digit 3 Circumference	7.10	(2.80)	6.53 – 7.66	(2.57 – 3.02)
Digit 4 Circumference	6.60	(2.60)	6.04 – 7.16	(2.38 – 2.82)
Digit 5 Circumference	5.85	(2.30)	5.31 – 6.39	(2.09 – 2.52)
Digit 1 Length	5.87	(2.31)	5.24 – 6.50	(2.06 – 2.56)
Digit 2 Length	7.49	(2.95)	6.88 – 8.10	(2.71 – 3.19)
Digit 3 Length	8.54	(3.36)	8.03 – 9.06	(3.16 – 3.57)
Digit 4 Length	8.03	(3.16)	7.56 – 8.50	(2.98 – 3.35)
Digit 5 Length	6.13	(2.41)	5.51 – 6.75	(2.17 – 2.66)
Hand Circumference	21.25	(8.37)	19.34 – 23.16	(7.61 – 9.12)
Hand Length	19.75	(7.78)	19.27 – 20.23	(7.59 – 7.96)

4-4.5 The puncture-resistant device shall cover the maximum area of the insole.

4-4.6 Metal parts shall not penetrate from the outside into the lining or insole at any point.

4-4.7 No metal parts, including but not limited to nails or screws, shall be present or utilized in the construction or attachment of the sole with heel to the puncture-resistant device, insole, or upper.

Table 4-3.5.3(e) Sizing for Extra-Large (XL) Glove

			cm	in.
THE RANGE FOR HAND LENGTH:			**20.25 – 21.25**	**(7.97 – 8.37)**
THE RANGE FOR HAND CIRCUMFERENCE:			**20.25 – 24.25**	**(7.97 – 9.55)**
	Mid-Size Value		**Range to Be Accommodated**	
	cm	**(in.)**	**cm**	**(in.)**
Digit 1 Circumference	7.52	(2.96)	6.87 – 8.16	(2.70 – 3.21)
Digit 2 Circumference	7.25	(2.85)	6.74 – 7.76	(2.65 – 3.06)
Digit 3 Circumference	7.36	(2.90)	6.79 – 7.93	(2.67 – 3.12)
Digit 4 Circumference	6.86	(2.70)	6.30 – 7.42	(2.48 – 2.92)
Digit 5 Circumference	6.06	(2.39)	5.52 – 6.60	(2.17 – 2.60)
Digit 1 Length	6.11	(2.41)	5.48 – 6.75	(2.16 – 2.66)
Digit 2 Length	7.86	(3.09)	7.26 – 8.47	(2.86 – 3.33)
Digit 3 Length	9.02	(3.55)	8.51 – 9.54	(3.35 – 3.76)
Digit 4 Length	8.44	(3.32)	7.97 – 8.91	(3.14 – 3.51)
Digit 5 Length	6.48	(2.55)	5.85 – 7.10	(2.30 – 2.80)
Hand Circumference	22.25	(8.76)	20.34 – 24.16	(8.01 – 9.51)
Hand Length	20.75	(8.17)	20.27 – 21.23	(7.98 – 8.36)

4-4.8 Protective Footwear Sizing.

4-4.8.1 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

4-4.8.2* 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 Scientific Foot Measuring Device.

4-4.8.3 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 Hood Interface Component Design Requirements.

4-5.1 A sample hood shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 2-3.

4-5.2 The hood shall be designed to cover and provide the limited protection, as specified within this section, to the head, face, and neck areas that do not receive primary protection from the helmet or the SCBA facepiece.

4-5.3 Specimens of hoods shall be measured to determine the areas of coverage. The hood shall be donned properly in the position in which it is intended to be worn on an ISO size J reference headform. In this position, the hood shall provide a minimum coverage on each side measured downward from the reference plane at the coronal plane of 23 cm (9.06 in.), shall provide a minimum coverage in the back measured downward from the reference plane at the rear mid-sagittal plane of 33 cm (13 in.), and shall provide a minimum coverage in the front measured downward from the reference plane

at the front mid-sagittal plane, excluding the face opening, of 29.5 cm (11.60 in.).

4-5.4 The hood shall be designed with a face opening. Other than where the hood face opening is designed to interface with a specific SCBA facepiece or where the hood face opening is designed to be adjustable, the hood face opening shall measure 14.25 cm, +0.0/–2.54 cm (5.6 in., +0.0/–1.0 in.) in any direction when the hood is laid out in a relaxed condition on a flat surface, smoothed out, and with the face opening up.

4-5.4.1 Where the hood face opening is designed to interface with a specific SCBA facepiece, the hood face opening shall overlap the outer edge of the specific SCBA facepiece-to-face seal perimeter by not less than 1.3 cm (0.5 in.).

4-5.4.2 Where the hood face opening is provided with manual adjustment, the hood face opening shall be adjustable to achieve a face opening of 14.25 cm (5.6 in.).

4-6 Protective Wristlets Interface Component Design Requirements.

4-6.1 A sample wristlet 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 The wristlet shall be designed to cover and provide limited protection to the wrist areas.

4-6.3 The wristlet shall be permanently attached to the protective coat sleeve in a manner that will not permit a gap in the thermal protection.

4-7 Partial Eye/Face Protective Interface Component Design Requirements.

4-7.1 The partial eye/face protective device shall provide coverage of at least 90 degrees when measured from each side of the mid-sagittal plane and 50 mm above the basic plane when measured at the intersection of the mid-sagittal and basic planes when positioned in accordance with mean vf-defined eye/face positioning index.

4-8 Accessory Design Requirements.

4-8.1 Any accessories attached to any element of the protective ensemble shall not interfere with the function of the element or with the function of any of the element's component parts.

4-8.2 Any accessories attached to any element of the protective ensemble shall not degrade the designed protection or performance of the element below the requirements of this standard.

Chapter 5 Performance Requirements

5-1 Protective Garment Performance Requirements.

5-1.1 Specimens of garment composite consisting of outer shell, moisture barrier, and thermal barrier shall be tested for thermal insulation as specified in Section 6-10, "Thermal Protective Performance (TPP) Test," and shall have an average thermal protective performance (TPP) of not less than 35.0.

5-1.2 Specimen garment composite shall be tested for overall liquid penetration resistance as specified in Section 6-48, "Liquid Penetration Test," and shall allow no liquid penetration.

5-1.3 Specimens of garment outer shells, moisture barriers, thermal barriers, collar linings, winter liners where provided, trim, lettering, and other materials used in garment construction including, but not limited to, padding, reinforcement, interfacing, binding, hanger loops, emblems, and patches shall be individually tested for resistance to flame as specified in Section 6-2, "Flame Resistance Test One," and shall not have a char length of more than 10.16 cm (4.0 in.) average, shall not have an afterflame of more than 2.0 seconds average, and shall not melt or drip.

5-1.3.1 Labels shall be tested as specified in 5-1.4 only when placed on the exterior of the garment; zippers and seam sealing materials shall be tested as specified in 5-1.4 only if placed on the exterior of the garment or if they directly contact the wearer's body; and elastic and hook and pile fasteners shall be tested as specified in 5-1.4 only if they directly contact the wearer's body.

5-1.3.2 Small specimens such as hanger loops, and emblems (patches) which are not large enough to meet the specimen size requirements in 6-2.2.1, shall be tested for resistance to flame as specified in Section 6-2, Flame Resistance Test One, and shall not be totally consumed, shall not have an afterflame of more than 2.0 seconds average, and shall not melt or drip.

5-1.4 Specimens of garment outer shells, moisture barriers, thermal barriers, winter liners where provided, and collar linings shall be individually tested for resistance to heat as specified in Section 6-6, "Heat and Thermal Shrinkage Resistance Test," and shall not shrink more than 10.0 percent in any direction.

5-1.5 Specimens of garment outer shells, moisture barriers, thermal barriers, collar linings, winter liners where provided, trim, lettering, and other materials used in garment construction — including, but not limited to, padding, reinforcement, labels, interfacing, binding, hanger loops, emblems or patches; but excluding elastic and hook and pile fasteners where these items are placed so that they will not directly contact the wearer's body — shall be individually tested for resistance to heat as specified in Section 6-6, "Heat and Thermal Shrinkage Resistance Test," and shall not melt, separate, or ignite.

5-1.6 Specimens of garment moisture barrier seams shall be individually tested for resistance to heat as specified in Section 6-6, "Heat and Thermal Shrinkage Resistance Test," and shall not drip or ignite.

5-1.7 Specimens of garment outer shells and collar linings shall be individually tested for resistance to heat as specified in Section 6-6, "Heat and Thermal Shrinkage Resistance Test," and shall not char.

5-1.8 Specimens of all garment hardware, excluding hook and pile fasteners, where placed so that they will not directly contact the wearer's body, shall be individually tested for resistance to heat as specified in Section 6-6, "Heat and Thermal Shrinkage Resistance Test," and shall not ignite and shall remain functional.

5-1.9 All sewing thread utilized in the construction of garments shall be made of an inherently flame resistant fiber and shall be tested for resistance to melting as specified in Section 6-11, "Thread Melting Test," and shall not melt below 260°C (500°F).

5-1.10 Specimens of garment outer shells and collar linings shall be individually tested for resistance to tearing as specified in Section 6-12, "Tear Resistance Test," and shall have a tear strength of not less than 10 kg (22 lb).

5-1.11 Specimens of garment moisture barriers, thermal barriers, and winter liners, where provided, shall be tested for resistance to tearing as specified in Section 6-12, "Tear Resistance Test," and shall have a tear strength of not less than 2.27 kg (5 lb). Where configured as individual barrier layers, specimens of garment moisture barriers, thermal barriers, and winter liners, where provided, shall be individually tested. Where one or more of these barriers are configured as a single barrier layer by bonding or laminating individual barriers together so that the individual layers do not retain their individuality and are not separable, they shall be tested as a composite.

5-1.12 Specimens of all garment seam assemblies shall be tested for strength as specified in Section 6-14, "Seam Breaking Strength Test."

5-1.12.1 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 675 N (150 lbf) force for Major A seams, 337.5 N (75 lbf) force for Major B seams, and 180 N (40 lbf) force for Minor seams when tested using the method specified in 6-14.2.2.1.

5-1.12.2 Seam breaking strength shall be considered acceptable when the fabric strength is less than the required seam strength specified in 5-1.12.1 of this section, providing the fabric fails without failure of the seam below the applicable forces specified in 5-1.12.1.

5-1.12.3 Specimens of all knit or stretch woven garment seam assemblies shall demonstrate a sewn seam strength equal to or greater than 180 N (40 lbf) force when tested using the method specified in 6-14.2.2.2.

5-1.12.4 All combination woven and knit or stretch knit seam specimens shall meet the requirements specified in 5-1.12.1.

5-1.13 Specimens of garment moisture barriers shall be tested for resistance to water penetration as specified in Section 6-27, "Water Penetration Resistance Test," and shall have a minimum water penetration resistance of 1.76 kg/cm^2 (25 psi) when tested as specified in 6-27.4.1 and 0.07 kg/cm^2 (1 psi) when tested as specified in 6-27.4.2.

5-1.14* Specimens of protective garment materials shall be tested for resistance to liquids penetration as specified in Section 6-28 "Liquid Penetration Resistance Test," and shall show no penetration of the test liquids for at least 1 hr.

5-1.15 Specimens of garment moisture barrier seams shall be tested for resistance to water penetration as specified in Section 6-27, "Water Penetration Resistance Test," and shall have a minimum water penetration resistance of not less than 0.07 kg/cm^2 (1 psi) when tested as specified in 6-27.4.2.

5-1.16 Specimens of garment moisture barriers and moisture barrier seams shall be tested for resistance to liquid or blood borne pathogens as specified in Section 6-29, "Viral Penetration Resistance Test," and shall allow no penetration of the Phi-X-174 bacteriophage for at least 1 hour.

5-1.17 Specimens of garment outer shells, moisture barriers, thermal barriers, winter liners where provided, and collar linings shall be individually tested for resistance to shrinkage as specified in Section 6-25, "Cleaning Shrinkage Resistance Test," and shall not shrink more than 5 percent in any direction.

5-1.18 Specimens of garment outer shells and collar linings shall be individually tested for resistance to water absorption as specified in Section 6-26, "Water Absorption Resistance Test," and shall not have more than 30 percent water absorption.

5-1.19 Specimens of garment outer shells and collar lining shall be individually tested for strength after washing as specified in Section 6-50, "Breaking Strength Test," and shall have a breaking strength of not less than 63.6 kg (140 lb).

5-1.20 Specimens of all garment metal hardware and specimens of all garment hardware that include metal parts shall be individually tested for resistance to corrosion as specified in Section 6-30, "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 and shall remain functional. Ferrous metals shall show no corrosion of the base metal and shall remain functional.

5-1.21 Specimens of labels shall be tested for durability and legibility as specified in Section 6-42, "Label Durability and Legibility Test One," and shall remain in place and shall be legible.

5-1.22 Specimens of garment trim shall be tested for retroreflectivity and fluorescence as specified in Section 6-46, "Retroreflectivity and Fluorescence Test," and shall have a Coefficient of Retroreflection (R_a) of not less than 100 cd/lux/m^2 (cd/fc/ft^2) and shall be designated as fluorescent.

5-2 Protective Helmets Performance Requirements.

5-2.1 Specimen helmets shall be tested for resistance to impact as specified in Section 6-15, "Top Impact Resistance Test (Force)," and shall have no sample transmit a force of more than 3780 N (850 lbf).

5-2.2 Specimen helmets shall be tested for resistance to impact as specified in Section 6-16, "Impact Resistance Test (Acceleration)," and shall have no sample exceed the maximum acceleration specified in Table 5-2.2. Any acceleration duration above 200 Gn shall not exceed 3 milliseconds; acceleration duration above 150 Gn shall not exceed 6 milliseconds.

Table 5-2.2

Impact Location	Maximum Acceleration*	(m • sec/sec)	(m • sec/sec)
Top	150 × Gn	(1471.5)	(4830)
Front	300 × Gn	(2943.0)	(9660)
Sides	300 × Gn	(2943.0)	(9660)
Back	300 × Gn	(2943.0)	(9660)

*Gn denotes gravitational acceleration, which is defined as 9.81 m per second per second (32.2 ft per second per second).

5-2.3 Specimen helmets shall be tested for resistance to penetration as specified in Section 6-19, "Physical Penetration Resistance Test," and shall exhibit no electrical or physical contact between the penetration test striker and the headform.

5-2.4 Specimen helmets shall be tested for resistance to heat as specified in Section 6-6, "Heat and Thermal Shrinkage Resistance Test," and shall:

(a) Have no parts of the complete helmet assembly that do not contact the headform before this test come in contact with the headform as a result of this test

(b) Have no shell distortion in the back extend more than 4.0 cm (1.6 in.) below the original position of the helmet

(c) Have no distortion of the front and sides of the shell extend more than 3.0 cm (1.2 in.) below the original position of the helmet

(d) Have no separation, melting, or dripping of the retention system, energy absorption system, or ear covers

(e) Have a chin strap closure device remain functional

(f) Have no ignition of any part of the helmet assembly

(g) Have no ignition or melting of the product labels

(h) Have no part of the faceshield/goggle component that was not below the brim line prior to the test be below the brim line after the test

(i) Have no part of the faceshield/goggle component drip

5-2.5 Specimen helmets shall be tested for resistance to flame as specified in Section 6-3, "Flame Resistance Test Two," Procedures A and C, and shall not show any visible afterflame or glow 5.0 seconds after removal from the test flame in each test.

5-2.6 Specimen helmets shall be tested for resistance to electricity as specified in 6-31.5.1 Procedure A and 6-31.5.2 Procedure B and shall not have leakage current exceeding 3.0 mA in each test.

5-2.7 Specimen helmets shall be tested for retention ability as specified in Section 6-35, "Retention System Test," without any break occurring and without any resulting slip or stretch of more than 2.03 cm (0.8 in.).

5-2.8 Specimen helmet suspension systems shall be tested for retention ability as specified in Section 6-36, "Suspension System Retention Test," and shall not separate from the helmet shell.

5-2.9 Specimen helmets shall be tested for shell retention ability as specified in Section 6-44, "Shell Retention Test," and shall not have the helmet shell separate from the helmet suspension and retention systems.

5-2.10 Specimens of all materials utilized in the construction of helmet ear covers shall be individually tested for resistance to flame as specified in Section 6-2, "Flame Resistance Test One," and shall not have a char length greater than 10.2 cm (4.0 in.), shall not show any visible afterflame 2.0 seconds after removal from the test flame, and shall not melt or drip.

5-2.11 Specimens of all materials utilized in the construction of helmet ear covers shall be individually tested for resistance to heat as specified in Section 6-6, "Heat and Thermal Shrinkage Resistance Test," and shall not shrink more than 10 percent in any direction, and shall not melt, separate, or ignite.

5-2.12 All sewing thread utilized in the construction of the helmet ear covers shall be made of an inherently flame resistant fiber and shall be tested for melting resistance as specified in Section 6-11, "Thread Melting Test," and shall not melt below 260°C (500°F).

5-2.13 Specimens of all helmet metal hardware and specimens of all helmet hardware that include metal parts shall be individually tested for resistance to corrosion as specified in Section 6-30, "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 and shall remain functional. Ferrous metals shall show no corrosion of the base metal and shall remain functional.

5-2.14 Specimens of labels shall be tested for durability and legibility as specified in Section 6-43, "Label Durability and Legibility Test Two," and shall remain in place and shall be legible.

5-2.15 Specimens of helmet trim shall be tested for retroreflectivity and fluorescence as specified in Section 6-46, "Retroreflectivity and Fluorescence Test," and shall have a Coefficient of Retroreflection (*Ra*) of not less than 100 cd/lux/m^2 (cd/fc/ft^2) and shall be designated as fluorescent.

5-2.16 Specimens of faceshield/goggle components shall be tested for resistance to impact as specified in Section 6-17, "Faceshield/Goggle Component Lens Impact Resistance Test," Test One and Two, and shall have no contact with an eye of the headform; nor shall any parts of fragments be ejected from the component that could contact the eye of the headform.

5-2.17 Specimens of faceshield/goggle components shall be tested for flame resistance as specified in Section 6-3 "Flame Resistance Test Two," Procedure B; and shall not show any visible afterflame 5 seconds after removal of the test flame.

5-2.18 Specimens of all fabrics utilized in construction of faeshield/goggle components shall be tested for flame resistance as specified in Section 6-6.10 "Specific Requirements for Testing Other Garment, Clothing, Trim, and Label Materials," and shall not have a char length of more than 102 mm (4 in.) average, and shall not have an afterflame of more than 5 seconds average after removal of the test flame.

5-2.19 Specimens of faceshield/goggle component lenses shall be tested for resistance to scratching as specified in Section 6-23 "Faceshield/Goggle Component Lens Scratch Resistance Test," and shall not exhibit a delta haze of greater than 25 percent.

5-2.20 Specimens of faceshield/goggle component lenses shall be tested for transmittance of light as specified in Section 6-45 "Luminous (Visible) Transmittance Test." Clear lenses shall transmit not less than 85 percent of the incident visible radiation. Colored lenses shall transmit not less than 43 percent of the incident visible radiation.

5-3 Protective Glove Performance Requirements.

5-3.1 Specimens of the glove body composite shall be tested for thermal insulation as specified in Section 6-10, "Thermal Protective Performance (TPP) Test," and shall have an average thermal protective performance rating (TPP) not less than 35.0.

5-3.2 Where gauntlets or glove wristlets are provided, specimens of the glove gauntlet or glove wristlet composite shall be tested for thermal insulation as specified in Section 6-10, "Thermal Protective Performance (TPP) Test," and shall have an average TPP rating of not less than 20.0.

5-3.3 Specimen gloves shall be tested for resistance to heat as specified in Section 6-6, "Heat and Thermal Shrinkage Resistance Test," and shall not melt, separate, or ignite, shall not shrink more than 5 percent in length or width, shall be donnable, and shall be flexible.

5-3.4 Specimens of the innermost separable layer of the glove body composite that is designed to come into contact with the wearer's skin shall be individually tested for resistance to heat as specified in Section 6-6, "Heat and Thermal Shrinkage Resistance Test," and shall not melt, separate, or ignite.

5-3.5 Specimens of the glove body composite shall be tested for thermal insulation as specified in Section 6-7, "Conductive Heat Resistance Test One," and shall have a second-degree burn time of not less than 10.0 seconds and shall have a pain time of not less than 6.0 seconds.

5-3.6 Specimens of the glove body composite shall be tested for resistance to flame as specified in Section 6-4, "Flame Resistance Test Three," and shall not have a char length of more than 10.2 cm (4 in.) average and shall not have an afterflame of more than 2.0 seconds average after removal of the test flame. The composite shall not melt or drip, and the consumed materials shall not exceed 5 percent of the sample specimen's original weight.

5-3.7 Where gauntlets or glove wristlets are provided, specimens of the glove gauntlet or glove wristlet composite shall be tested for resistance to flame as specified in Section 6-2, "Flame Resistance Test One," and shall not have a char length of more than 10.2 cm (4 in.) average, shall not have an afterflame of more than 2.0 seconds average after removal of the test flame, and shall not melt or drip.

5-3.8 All sewing thread utilized in the construction of gloves shall be made of an inherently flame resistant fiber and shall be tested for melting resistance as specified in Section 6-11, "Thread Melting Test," and shall not melt below 260°C (500°F).

5-3.9* Specimens of the glove body composite and seams shall be tested for resistance to liquid or blood borne pathogens as specified in Section 6-29, "Viral Penetration Resistance Test," and shall allow no penetration of the Phi-X-174 bacteriophage for at least 1 hour.

5-3.10* Specimen glove body composite and seams shall be tested for resistance to liquid penetration as specified in Section 6-28, "Liquid Penetration Resistance Test" and shall allow no penetration of test liquids for at least 1 hour.

5-3.11 Specimens of the glove body composite shall be tested for resistance to cut as specified in Section 6-22, "Cut Resistance Test," and shall not cut completely through the composite under an average applied load of 8.2 kg (18 lb).

5-3.12 Specimens of the glove gauntlet or glove wristlet composite, if different from the glove body composite, shall be tested for resistance to cut as specified in Section 6-22, "Cut Resistance Test," and shall not cut completely through the composite under an average applied load of 8.2 kg (18 lb).

5-3.13 Specimens of the glove body composite shall be tested for resistance to puncture as specified in Section 6-20, "Puncture Resistance Test One," and shall not be punctured under an average applied force of 6 kg (13.2 lb).

5-3.14* Specimen gloves shall be tested for dexterity as specified in Section 6-38, "Dexterity Test," and shall have the dexterity time not exceed 140 percent of bare-hand control time.

5-3.15 Specimens of knit glove wristlet material(s) shall be tested for material strength as specified in Section 6-13, "Burst Strength Test," and shall have a burst strength of not less than 23 kg (50.6 lb).

5-3.16 Specimens of knit glove wristlet seams shall be tested for seam strength as specified in Section 6-14, "Seam Breaking Strength Test," and shall have a burst strength of not less than 18.5 kg (40.7 lb).

5-3.17 Specimen gloves shall be tested for grip as specified in Section 6-39, "Grip Test," and shall have a weight-pulling capacity not less than 80 percent of the bare-hand control value.

5-3.18* Specimen gloves shall be tested for resistance to leakage as specified in Section 6-33, "Overall Liquid Integrity Test One," and shall show no leakage.

5-3.19* Specimen gloves shall be tested for ease of donning as specified in Section 6-37, "Liner Retention Test," and shall have the final donning time not exceed the baseline donning time plus 20 seconds.

5-3.20 Specimens of all glove metal hardware and specimens of all glove hardware that include metal parts shall be individually tested for resistance to corrosion as specified in Section 6-30, "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 and shall remain functional. Ferrous metals shall show no corrosion of the base metal and shall remain functional.

5-3.21 Specimens of labels shall be tested for durability and legibility as specified in Section 6-42, "Label Durability and Legibility Test One," and shall remain in place and shall be legible.

5-4 Protective Footwear Performance Requirements.

5-4.1 Specimen footwear shall be tested for resistance to heat as specified in Section 6-6, "Heat and Thermal Shrinkage Resistance Test," and shall not have any part of the footwear melt, separate, or ignite; and shall have all components remain functional.

5-4.2 Specimen footwear shall be tested for thermal insulation as specified in Section 6-9, "Radiant Heat Resistance Test," and the temperature of the upper lining surface in contact with the skin shall not exceed 44°C (111°F).

5-4.3 Specimen footwear shall be tested for thermal insulation as specified in Section 6-7, "Conductive Heat Resistance Test One," and the temperature of the upper lining surface in contact with skin shall have a second-degree burn time of not less than 10.0 seconds and shall have a pain time of not less than 6.0 seconds.

5-4.4 Specimen footwear shall be tested for thermal insulation as specified in Section 6-8, "Conductive Heat Resistance Test Two," and the temperature of the insole surface in contact with the foot shall not exceed 44°C (111°F).

5-4.5 Specimen footwear, with components in place, shall be tested for resistance to flame as specified in Section 6-5, "Flame Resistance Test Four," and shall not have an afterflame

of more than 2.0 seconds, shall not melt or drip, and shall not exhibit any burn-through.

5-4.6 All sewing thread utilized in the construction of footwear shall be made of an inherently flame resistant fiber and shall be tested for melting resistance as specified in Section 6-11, "Thread Melting Test," and shall not melt below 260°C (500°F).

5-4.7 Specimen footwear shall be tested for resistance to water as specified in Section 6-34, "Overall Liquid Integrity Test Two," and shall show no water penetration.

5-4.8 Specimens of the footwear upper material composite, upper seams, vamp seams, and sole seams shall be tested for resistance to liquids penetration as specified in Section 6-28, "Liquid Penetration Resistance Test," and shall allow no penetration of the test liquids for at least 1 hour.

5-4.9 Specimens of the footwear upper material composite, upper seams, vamp seams, and sole seams shall be tested for resistance to liquid or blood borne pathogens as specified in Section 6-29, "Viral Penetration Resistance Test," and shall allow no penetration of the Phi-X-174 bacteriophage for at least 1 hour.

5-4.10 Specimen footwear shall be tested for resistance to puncture as specified in Section 6-20, "Puncture Resistance Test One," and shall not puncture the footwear upper under an average applied force of 6 kg (13.2 lb).

5-4.11 Specimen footwear shall be tested for resistance to puncture as specified in Section 6-21, "Puncture Resistance Test Two," and shall not allow puncture through the sole area and the heel area at a force load of less than 1211.6 N (272 lbf).

5-4.12 Specimen footwear shall be tested for resistance to cut as specified in Section 6-22, "Cut Resistance Test," and shall not allow any cut through the footwear upper composite at any point under an average applied load of 8.2 kg (18 lb).

5-4.13* Specimen footwear shall be tested for resistance to slipping as specified in Section 6-41, "Slip Resistance Test." The soles shall have a static coefficient of 0.75 or greater in a dry condition, and they shall have a static coefficient of 0.50 or greater in a wet condition.

5-4.14 Specimen footwear shall be tested for resistance to abrasion as specified in Section 6-24, "Abrasion Resistance Test," and the sole with heel shall have an abrasion index of not less than 100.

5-4.15* Specimen footwear shall be tested for resistance to electricity as specified in Section 6-32, "Electrical Insulation Test Two," and shall have no leakage in excess of 5.0 mA.

5-4.16 Specimens of footwear toes shall be tested for resistance to impact and compression as specified in Section 6-18, "Impact and Compression Tests," and shall have an impact requirement of 101.7 J (75 ft-lb), and shall have a compression requirement of 11,121 N (2500 lbf) with a minimum clearance of at least 1.27 cm (0.5 in.).

5-4.17 Specimens of footwear ladder shanks shall be tested for resistance to bending as specified in Section 6-40, "Ladder Shank Bend Resistance Test," and shall not deflect more than 6.35 mm (0.25 in.).

5-4.18 Specimens of footwear stud posts and eyelets shall be tested for attachment strength as specified in Section 6-49, "Eyelet and Stud Post Attachment Test," and shall have a minimum detachment strength of 30 kgf (66 lbf).

5-4.19 Specimens of all footwear metal hardware and specimens of all footwear hardware that include metal parts including, but not limited to, toecap, ladder shank, puncture-resistant device, and components shall be individually tested for resistance to corrosion as specified in Section 6-30, "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 metal. All components shall remain functional.

5-4.20 Specimens of labels shall be tested for durability and legibility as specified in Section 6-42, "Label Durability and Legibility Test One," and shall remain in place and shall be legible to the unaided eye.

5-5 Protective Hood Interface Component Performance Requirements.

5-5.1 Specimens of hood face openings, that are not manually adjustable or that are not designed for interface with a specific SCBA facepiece, shall be tested for shape retention as specified in Section 6-47, "Hood Opening Size Retention Test," and shall retain at least 80 percent of the original face opening size but shall not exceed 14.25 cm (5.6 in.).

5-5.1.1 Where hood face openings are designed to interface with a specific SCBA facepiece, specimens of such hood face openings shall be tested for shape retention as specified in Section 6-47, "Hood Opening Size Retention Test," and shall overlap the outer edge of the specific SCBA facepiece-to-face seal perimeter by not less than 1.3 cm (0.5 in.).

5-5.1.2 Where hood face openings are designed to be manually adjustable, specimens of such hood face openings shall meet the design requirement specified in 4-5.4.2.

5-5.2 Specimen hoods shall be tested for thermal insulation as specified in Section 6-10, "Thermal Protective Performance (TPP) Test," and shall have a thermal protective performance (TPP) of not less than 20.0.

5-5.3 Specimens of hood material(s), including labels but excluding hook and pile fasteners and elastic when not placed in direct contact with the body, shall be individually tested for resistance to flame as specified in Section 6-2, "Flame Resistance Test One," and shall not have a char length of more than 10.2 cm (4 in.) average, shall not have an afterflame of more than 2.0 seconds average, and shall not melt or drip. Labels not meeting the specimen size requirements for the procedure specified in 6-2.1 shall be sewn to a support fabric of the required size.

5-5.4 Specimens of hood material(s), including labels but excluding hook and pile fasteners and elastic when these items are placed where they will not directly contact the wearer's body, shall be individually tested for resistance to heat as specified in Section 6-6, "Heat and Thermal Shrinkage Resistance Test," and shall not shrink more than 10 percent in any direction.

5-5.5 Specimens of hood material(s), including labels but excluding hook and pile fasteners and elastic when these items are placed where they will not directly contact the wearer's body, shall be individually tested for resistance to

heat as specified in Section 6-6, "Heat and Thermal Shrinkage Resistance Test," and shall not melt, separate, or ignite.

5-5.6 Specimens of hood material(s), including labels but excluding hook and pile fasteners and elastic when these items are placed where they will not directly contact the wearer's body, shall be individually tested for resistance to shrinkage as specified in Section 6-25, "Cleaning Shrinkage Resistance Test," and shall not shrink more than 5 percent in any direction.

5-5.7 All sewing thread utilized in the construction of hoods shall be made of an inherently flame resistant fiber and shall be tested for melting resistance as specified in Section 6-11, "Thread Melting Test," and shall not melt below 260°C (500°F).

5-5.8 Specimens of knit hood material(s) shall be tested for material strength as specified in Section 6-13, "Burst Strength Test," and shall have a burst strength of not less than 23 kg (50.6 lb).

5-5.9 Specimens of knit hood seams shall be tested for seam strength as specified in Section 6-14, "Seam Breaking Strength Test," and shall have a burst strength of not less than 18.5 kg (40.7 lb).

5-5.10 Specimens of labels shall be tested for durability and legibility as specified in Section 6-42, "Label Durability and Legibility Test One," and shall remain attached to the hood and shall be legible to the unaided eye.

5-6 Protective Wristlet Interface Component Performance Requirements.

5-6.1 Specimen wristlets shall be tested for thermal insulation as specified in Section 6-10, "Thermal Protective Performance (TPP) Test," and shall have a thermal protective performance (TPP) of not less than 20.0.

5-6.2 Specimens of wristlet material(s) shall be individually tested for resistance to flame as specified in Section 6-2, "Flame Resistance Test One," and shall not have a char length of more than 10.2 cm (4 in.) average, shall not have an afterflame of more than 2.0 seconds average, and shall not melt or drip.

5-6.3 Specimens of wristlet material(s) shall be individually tested for resistance to heat as specified in Section 6-6, "Heat and Thermal Shrinkage Resistance Test," and shall not shrink more than 10 percent in any direction.

5-6.4 Specimens of wristlet material(s) shall be individually tested for resistance to heat as specified in Section 6-6, "Heat and Thermal Shrinkage Resistance Test," and shall not melt, separate, or ignite.

5-6.5 Specimens of wristlet material(s) shall be individually tested for resistance to shrinkage as specified in Section 6-25, "Cleaning Shrinkage Resistance Test," and shall not shrink more than 5 percent in any direction.

5-6.6 All sewing thread utilized in the construction of wristlets shall be made of an inherently flame resistant fiber and shall be tested for melting resistance as specified in Section 6-11, "Thread Melting Test," and shall not melt below 260°C (500°F).

5-6.7 Specimens of knit wristlet material(s) shall be tested for material strength as specified in Section 6-13, "Burst Strength Test," and shall have a burst strength of not less than 23 kg (50.6 lb).

5-6.8 Specimens of knit wristlet seams shall be tested for seam strength as specified in Section 6-14, "Seam Breaking Strength Test," and shall have a burst strength of not less than 18.5 kg (40.7 lb).

Chapter 6 Test Methods

6-1 Sample Preparation Procedures.

6-1.1 Application.

6-1.1.1 The sample preparation procedures contained in this section shall apply to each test method in this chapter, as specifically referenced in the sample preparation section of each test method.

6-1.1.2 Only the specific sample preparation procedure or procedures referenced in the sample preparation section of each test method shall be applied to that test method.

6-1.2 Washing and Drying Procedure for Garments, Gloves, Hoods, and Wristlets.

6-1.2.1 Specimens shall be subjected to five cycles of washing and drying in accordance with the procedure specified in Machine Cycle 1, Wash Temperature V, and Drying Procedure Ai, of ANSI/AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*. A laundry bag shall not be used.

6-1.3 Room Temperature Conditioning Procedure for Garments, Trim, Helmets, Gloves, Footwear, and Faceshield/Goggle Components.

6-1.3.1 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 Section 4 of Federal Test Method Standard 191A, *Textile Test Methods*, or for at least 24 hours, whichever is shorter. Specimens shall be tested within 5 minutes after removal from conditioning.

6-1.3.2 Helmet and faceshield/goggle component specimens shall be conditioned at a temperature of 21°C, ±3°C (70°F, ±5°F) and a relative humidity of 25 percent to 50 percent. Specimens shall be tested within 5 minutes after removal from conditioning.

6-1.4 Low Temperature Environmental Conditioning Procedure for Helmets.

6-1.4.1 Sample specimens shall be conditioned by exposing them to a temperature of –32°C, ±1°C (–25°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.

6-1.5 Convective Heat Conditioning Procedure for Helmets, Gloves, Footwear, Moisture Barriers, Moisture Barrier Seams, Labels, and Trim.

6-1.5.1 Samples shall be conditioned by exposing them to the procedures specified in 6-6.4 and in 6-6.5.2 through 6-6.5.5, with the following modifications:

(a) The oven preheat specified in 6-6.4.3 shall be stabilized at 141°C, +6°/–0°C [285°F, +10°/–0°F] for helmets and trim.

(b) The oven preheat specified in 6-6.4.3 shall be stabilized at 177°C, +6°/–0°C [350°F, +10°/–0°F] for gloves only.

(c) The specimen exposure time specified in 6-6.5.4 shall begin when the test thermocouple reading shall remain at 141°C, +6°/–0°C [285°F, +10°/–0°F] for the duration of the test.

(d) The specimen removal and pass/fail inspection specified in 6-6.5.5and 6-6.5.6shall be disregarded.

(e) After 10 minutes, +15/–0 seconds, the specimen shall be removed and subjected to the required testing.

(f) For helmet specimens, the required testing shall be performed within 15 seconds, ±5 seconds, or the specimen shall be discarded and a new specimen shall be conditioned and tested as specified in this section.

(g) For gloves and trim specimens, the required testing shall be performed within 24 hours, ±1 hour.

6-1.6 Radiant and Convective Heat Environmental Conditioning Procedure for Helmets.

6-1.6.1 Sample helmets shall be conditioned by exposing the area to be impacted/penetrated to a radiant heat source. The top, sides, front, and back test areas to be impacted/penetrated shall be as specified in Figure 6-1.6.1.

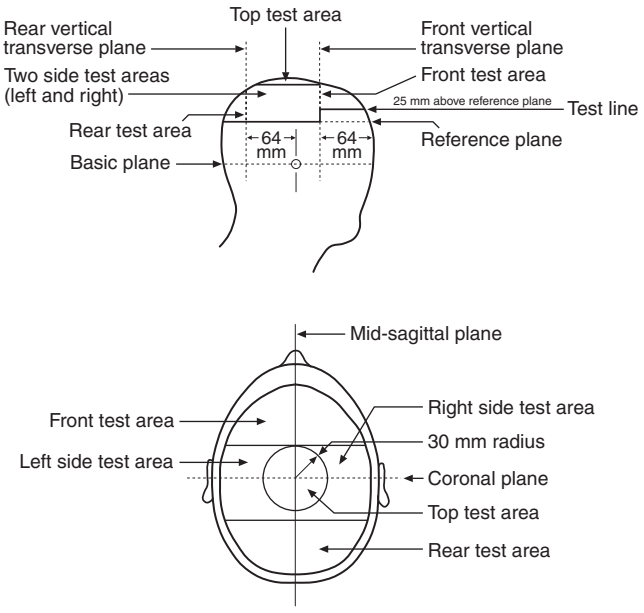


Figure 6-1.6.1 Helmet test areas and landmarks.

6-1.6.2 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.

6-1.6.3 The radiometer shall have a spectral response flat within ±3 percent over a range of at least 1.0 mm to 10.1 mm (0.00004 in. to 0.0004 in.) and an overall accuracy of at least ±5 percent of the reading.

6-1.6.4 The radiant panel shall have an effective radiating surface at least 15.24 cm, ±0.64 cm (6.0 in., ±0.25 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).

6-1.6.5 The radiant heat transducer shown in Figure 6-1.6.5 shall be constructed from sheet copper, ASTM B 152, *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 5.08 cm, ±0.4 mm (2.00 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 6-1.6.5. 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.

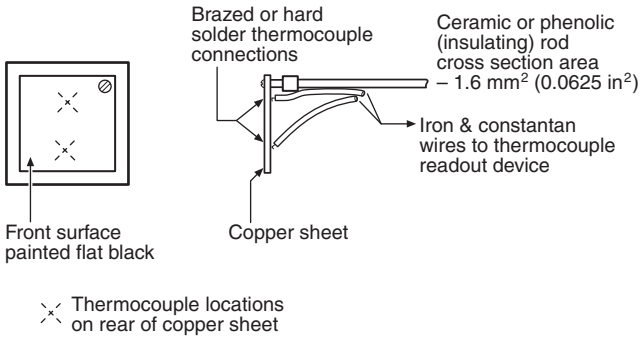


Figure 6-1.6.5 Radiant heat transducer.

6-1.6.6 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.

6-1.6.7 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 7.5-cm (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.

6-1.6.8* 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 260°C (500°F) shall be recorded. That time shall be 2.50

minutes, ±15.0 seconds. A closed insulated chamber shall be required to achieve this exposure time.

6-1.6.9 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 6-1.6.6. The helmet shall be subjected to the exposure conditions specified in 6-1.6.1 for the time recorded in 6-1.6.8. The exposure time shall be not less than the time recorded in 6-1.6.8, nor more than 5 seconds longer than that time.

6-1.7 Wet Conditioning Procedure for Helmets and Faceshield/Goggle Component.

6-1.7.1 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.

6-1.8* Wet Conditioning Procedure for Gloves.

6-1.8.1 Specimens shall be conditioned by complete immersion in water at a temperature of 21°C, ±3°C (70°F, ±5°F) for 2 minutes. Specimens shall be removed from water, hung in a vertical position for 5 minutes, and laid horizontal with AATCC textile blotting paper both under and over the specimen under a weight of 0.0020 kg/cm^2, ±0.0002 kg/cm^2 (0.50 psi, ±0.05 psi) for a period of 20 minutes in accordance with paragraph 7.2 of AATCC 70, *Test Method for Water Repellency: Tumble Jar Dynamic Absorption Test.*

6-1.9 Wet Conditioning Procedure for Footwear.

6-1.9.1 Where indicated, samples shall be preconditioned by immersion in tap water of 21°C (70.0°F) for 1 hour, ±5 minutes. Samples shall be drained upside down for 5 minutes. Testing shall be done 5 minutes, ±3 seconds after draining.

6-1.10* Flexing Procedure for Gloves.

6-1.10.1 Glove specimens shall be selected to fit the individual test subject. The test subject shall don the glove specimen. Glove specimens shall be flexed by making a tight fist ten times during a 30-second period.

6-2 Flame Resistance Test One.

6-2.1 Application.

6-2.1.1 This test method shall apply to protective garment textiles, hoods, wristlets, helmet ear covers, and trim materials and partial eye/face protective interface components.

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

6-2.1.3 Modifications to this test method for testing knit textile materials shall be as specified in 6-2.9.

6-2.1.4 Modifications to this test method for testing nonwoven textile materials shall be as specified in 6-2.10.

6-2.1.5 Modifications to this test method for testing trim materials shall be as specified in 6-2.11.

6-2.1.6 Modifications to this test method for testing hood label materials shall be as specified in 6-2.12.

6-2.1.7 Modification to this test method for testing lettering that is transfer film shall be as specified in 6-2.13.

6-2.1.8 Modifications to this test method for testing small specimens not meeting the specimen size requirements in 6-2.2.1 shall be tested as specified in 6-2.14.

6-2.2 Specimens.

6-2.2.1 Specimens shall consist of a 7.6-cm × 30.5-cm (3-in. × 12-in.) rectangle with the long dimension parallel to either the warp or filling; the wale or coarse; or the machine or cross machine direction of the material. Each separable layer of multilayer material systems or composites shall be individually tested.

6-2.3 Sample Preparation.

6-2.3.1 Specimens shall be tested both before and after being subjected to the procedure specified in 6-1.2.

6-2.3.2 All specimens to be tested shall be conditioned as specified in 6-1.3.

6-2.4 Apparatus.

6-2.4.1 The test apparatus specified in Method 5903.1, "Flame Resistance of Cloth; Vertical," of Federal Test Method Standard 191A, *Textile Test Methods*, shall be used.

6-2.5 Procedure.

6-2.5.1 Flame resistance testing shall be performed in accordance with Method 5903.1, "Flame Resistance of Cloth; Vertical," of Federal Test Method Standard 191A, *Textile Test Methods.*

6-2.5.2 Each specimen shall be examined for evidence of melting or dripping.

6-2.6 Report.

6-2.6.1 Afterflame time and char length shall be reported for each specimen. The average afterflame time and char length for each material in each direction tested shall be calculated and reported. The afterflame time shall be reported to the nearest 0.2 second and the char length to the nearest 3.2 mm (0.125 in.).

6-2.6.2 Observations of melting or dripping for each specimen shall be reported.

6-2.7 Interpretation.

6-2.7.1 Pass/fail performance shall be based on any observed melting or dripping, the average afterflame time, and the average char length.

6-2.7.2 Failure in either direction shall constitute failure of the material.

6-2.8 Specific Requirements for Testing Woven Textile Materials.

6-2.8.1 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.

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

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

6-2.9 Specific Requirements for Testing Knit Textile Materials.

6-2.9.1 Five specimens from each of the wale and course directions shall be tested.

6-2.9.2 Samples for conditioning shall include material that is a minimum of 7.6 cm × 30.5 cm (3 in. × 12 in.).

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

6-2.10 Specific Requirements for Testing Nonwoven Textile Materials.

6-2.10.1 Five specimens from each of the machine and cross machine directions shall be tested.

6-2.10.2 Samples for conditioning shall be at least 1 m (1 yd) square of each material.

6-2.10.3 Testing shall be performed as specified in 6-2.2 through 6-2.7.

6-2.11 Specific Requirements for Testing Trim Materials.

6-2.11.1 Five trim specimens for flammability testing shall be at least 5.08 cm (2 in.) wide and no more than 7.6 cm (3 in.) wide. Where 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 so that it is exposed directly to the burner flame.

6-2.11.2 Samples for conditioning shall include material sewn onto a 1-m (1-yd) square of ballast material no closer than 5.08 cm (2 in.) apart in parallel strips. The ballast material shall be as specified in ANSI/AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.* Specimens shall be removed from the ballast material prior to testing.

6-2.11.3 Testing shall be performed in only one direction.

6-2.11.4 Testing shall be performed as specified in 6-2.2 through 6-2.7.

6-2.12 Specific Requirements for Testing Hood Label Materials.

6-2.12.1 Five specimens of hood labels attached to the hood material shall be tested. The hood label specimen shall be cut from conditioned samples so that the edge of the hood label is at the bottom of the specimen.

6-2.12.2 Samples for conditioning shall be whole hoods, including the label as normally attached.

6-2.12.3 Testing shall be performed as specified in 6-2.2 through 6-2.7.

6-2.13 Specific Requirements for Testing Lettering that is Transfer Film.

6-2.13.1 Lettering that is transfer film shall be applied to outer shell material meeting the requirements of this standard for testing as specified in 6-2.13.2.

6-2.13.2 Lettering specimens for flammability testing shall be at least 5.08 cm (2 in.) wide and no more than 7.6 cm (3 in.) in width. Samples shall be selected where lettering is most dense.

6-2.13.3 Samples for conditioning shall include material sewn onto a 1-m (1-yd) square of ballast material no closer than 5.08 cm (2 in.) apart in parallel strips. The ballast material shall be as specified in ANSI/AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.* Specimens shall be removed from the ballast material prior to testing.

6-2.14 Specific Requirements for Testing Small Specimens.

6-2.14.1 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.

6-2.14.2 Samples for conditioning shall be at least 1 m (1 yd) square of the textile layer on which the small specimens are attached.

6-2.14.3 Testing shall be performed as specified in 6-2.2 through 6-2.7. Char length shall not be measured.

6-3 Flame Resistance Test Two.

6-3.1 Application.

6-3.1.1 This test method shall apply to protective helmets and partial eye/face protective interface components.

6-3.2 Specimens.

6-3.2.1 Specimens shall be selected as specified in 2-3.9.

6-3.3 Sample Preparation.

6-3.3.1 No sample conditioning shall be performed.

6-3.4 Apparatus.

6-3.4.1 A standard Bunsen burner shall be used.

6-3.4.2 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).

6-3.4.3 A control valve system with a delivery rate designed to furnish gas to the burner under a pressure of 0.0020 kg/cm^2, +0.0004/–0.0 kg/cm^2 (0.5 psi, +0.1/–0.0 psi) at the burner shall be utilized.

6-3.4.4 The barrel of the Bunsen burner shall be 12 mm, ±3 mm (0.5 in., ±0.125 in.) in diameter. A flame spreader shall not be used.

6-3.5 Procedure A.

6-3.5.1 Sample helmets shall be seated on the reference headform specified in Figure 6-16.4.1 according to the helmet's positioning index, as specified in the manufacturer's instructions for the specific helmet. The test setup shall be as shown in Figure 6-3.5.1.

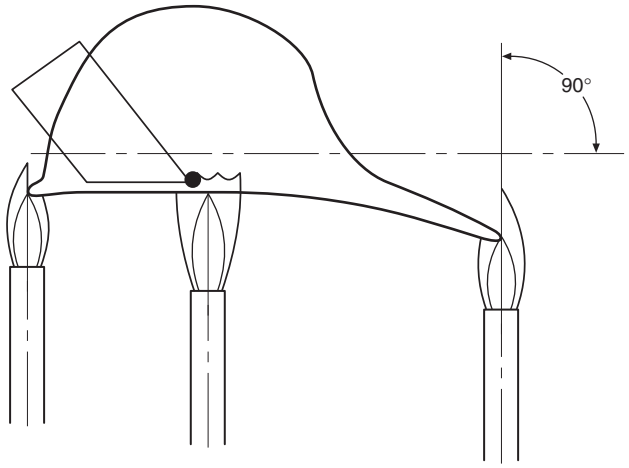


Figure 6-3.5.1 Test Procedure A.

6-3.5.2 The tip of the inner cone of a Bunsen burner flame of 2.54 cm to 3.8 cm (1.0 in. to 1.5 in.) in length shall be placed at the outer edge of the helmet shell at the front, sides, and rear. Where a helmet hanger is provided, the test flame shall be applied off the edge of the helmet hanger at the shell edge.

6-3.5.3 After 15 seconds, +1/–0 seconds, the flame shall be removed and the duration of the afterflame and afterglow shall be measured.

6-3.6 Procedure B.

6-3.6.1 Specimens of faceshield/goggle components shall be attached to an appropriate test fixture so that the lower edge of the specimen is exposed. The test setup shall be as shown in Figure 6-3.6.1.

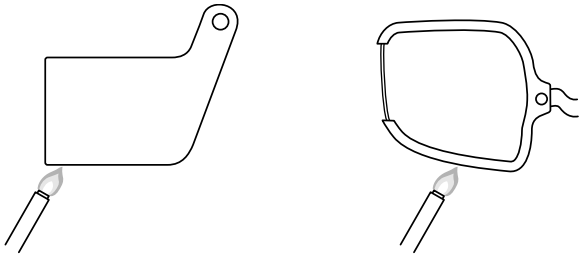


Figure 6-3.6.1 Test Procedure B.

6-3.6.2 The tip of the inner cone of a Bunsen burner flame 2.54 to 3.8 cm (1.0 to 1.5 in.) in length shall be placed on the outer edge of the specimen at the lowest exposed edge of the specimen. The burner shall be held to the test point of the specimen at an angle of 45 degrees, ±10 degrees.

6-3.6.3 After 15 seconds, +1/–0 seconds, the flame shall be removed and the duration of afterflame and afterglow shall be measured.

6-3.7 Procedure C.

6-3.7.1 Sample helmets shall be seated on the reference headform according to the helmet's positioning index, as specified in the manufacturer's instructions for the specific helmet. The helmet shall be positioned under the radiant heat source specified in 6-1.6.4, with the basic plane of the headform parallel to the radiant heat source as shown in Figure 6-3.7.1.

6-3.7.2 Sample helmets shall be positioned so that the area to be tested receives a radiant flux of 1.0 W/cm^2, ±0.1 W/cm^2. After 60 seconds, +5/–0 seconds exposure to the radiant flux and without removing the radiant heat source, the tip of the inner cone of a Bunsen burner flame 2.54 cm to 3.8 cm (1.0 in. to 1.5 in.) in length shall be placed against the helmet test area so that the flame creates an angle of 45 degrees, ±10 degrees with the plane tangent to the test area at the point of contact.

6-3.7.3 After 15 seconds, +1/–0 seconds, the flame shall be removed, and the duration of afterflame and afterglow shall be measured.

6-3.8 Report.

6-3.8.1 Afterflame and afterglow times shall be reported for each specimen at each flame impingement location. The afterflame and afterglow times shall be reported to the nearest 0.2 second.

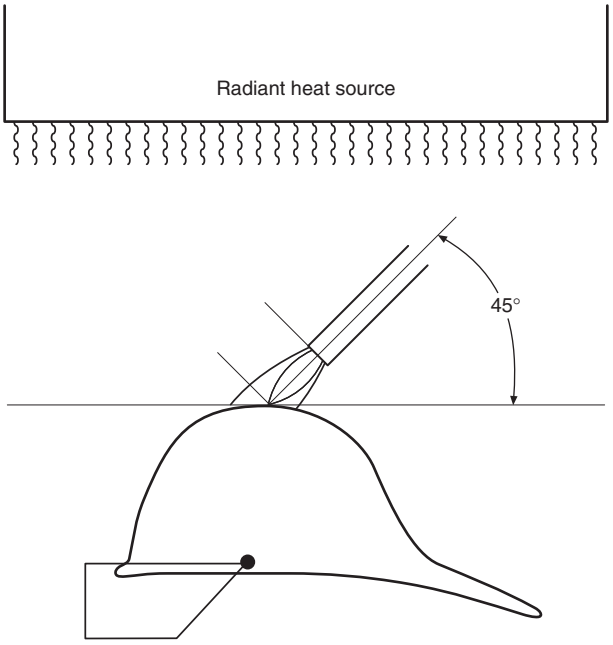


Figure 6-3.7.1 Test Procedure C.

6-3.9 Interpretation.

6-3.9.1 Pass/fail performance shall be based on the longest measured afterflame and afterglow times.

6-4 Flame Resistance Test Three.

6-4.1 Application.

6-4.1.1 This test method shall apply to protective gloves.

6-4.2 Specimens.

6-4.2.1 Each specimen to be tested shall be a rectangle at least 5.08 × 15.24 cm/(2 × 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.

6-4.2.2 Three specimens shall be tested for each material.

6-4.2.3 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 15.24-cm (6-in.) dimension.

6-4.3 Sample Preparation.

6-4.3.1 Specimens shall be tested both before and after being subjected to the procedure specified in 6-1.2.

6-4.3.2 All specimens to be tested shall be conditioned as specified in 6-1.3.

6-4.3.3 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.

6-4.4 Apparatus.

6-4.4.1 The test apparatus specified in Method 5905.1, "Flame Resistance of Material; High Heat Flux Flame Contact," of Federal Test Method Standard 191A, *Textile Test Methods*, shall be used.

6-4.4.2 A freestanding flame height indicator shall be used to assist in adjusting the burner flame height. The indicator shall mark a flame height of 7.6 cm (3 in.) above the top of the burner.

6-4.4.3 A specimen support assembly shall be used that consists of a frame and steel rod of 2 mm (0.0625 in.) in diameter to support the specimen in an L-shaped position, as shown in Figure 6-4.4.3.

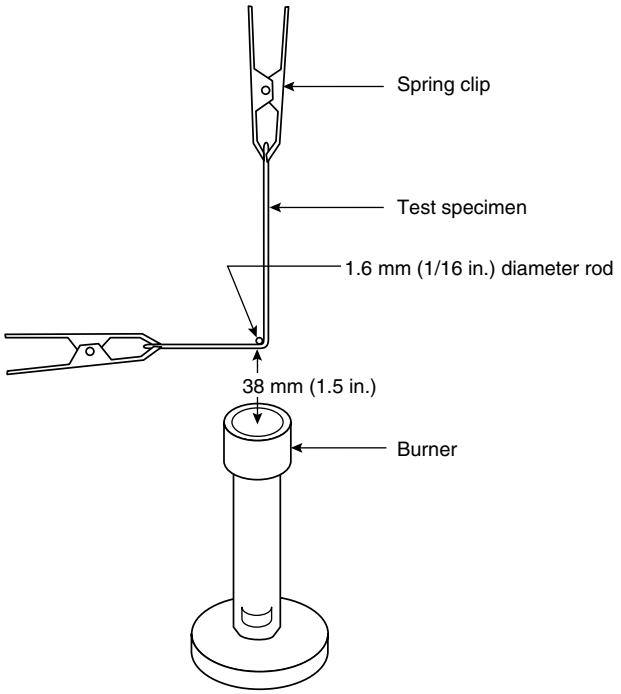


Figure 6-4.4.3 Relationship of test material to burner.

6-4.4.4 The horizontal portion of the specimen shall be not less than 5.08 cm (2 in.), and the vertical portion shall be not less than 10.16 cm (4 in.). The specimen shall be held at each end by spring clips under light tension, as shown in Figure 6-4.4.3.

6-4.5 Procedure.

6-4.5.1 A balance shall be used to determine the weight of each specimen to the nearest 0.1 gm (0.04 oz) before and after testing.

6-4.5.2 The burner shall be ignited and the test flame shall be adjusted to a height of 7.6 cm (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 7.6-cm (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.

6-4.5.3 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 3.8 cm (1.5 in.), as shown in Figure 6-4.4.3.

6-4.5.4 The burner flame shall be applied to the specimen for 12 seconds. After 12 seconds, the burner shall be removed.

6-4.5.5 The afterflame time shall be measured as the time, in seconds, to the nearest 0.2 seconds, that the specimen continues to flame after the burner is removed from the flame.

6-4.5.6 Each layer of the specimen shall be examined for melting or dripping.

6-4.5.7 Each tested sample shall be reconditioned as specified in 6-1.3 and then weighed to the nearest 0.1 g (0.04 oz).

6-4.5.8 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 6-4.5.8.1 through 6-4.5.8.4.

6-4.5.8.1 The specimen shall be folded lengthwise and creased, by hand, along a line through the highest peak of the charred area.

6-4.5.8.2 The hook shall be inserted into a hole punched in the specimen that is 6.4 mm (0.25 in.) in diameter or less. The hole shall be punched out for the hook at one side of the charred area that is 6.4 mm (0.25 in.) from the adjacent outside edge, at the point where the specimen contacted the steel rod, and 6.4 mm (0.25 in.) in from the lower end.

6-4.5.8.3 A weight of sufficient size so that the weight and hook together equal the total tearing weight required by Table 6-4.5.8.3 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 6-4.5.8.3.

Table 6-4.5.8.3

Specified Weight per Square Yard of Material Before Any Fire Retardant Treatment or Coating		Total Tearing Weight for Determining CharredLength	
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

6-4.5.8.4 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.

6-4.6 Report.

6-4.6.1 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 seconds and the char length to the nearest 2.54 mm (0.10 in.).

6-4.6.2 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.

6-4.6.3 Observations of melting or dripping for each specimen shall be reported.

6-4.7 Interpretation.

6-4.7.1 Pass/fail performance shall be based on melting or dripping, the average afterflame time, and the average char length.

6-5 Flame Resistance Test Four.

6-5.1 Application.

6-5.1.1 This test method shall apply to protective footwear.

6-5.2 Specimens.

6-5.2.1 Three complete footwear items shall be tested.

6-5.3 Sample Preparation.

6-5.3.1 Samples for conditioning shall be whole boots.

6-5.3.2 Specimens shall be conditioned as specified in 6-1.3.

6-5.4 Apparatus.

6-5.4.1 The test apparatus specified in Method 5905.1, "Flame Resistance of Material; High Heat Flux Flame Contact," of Federal Test Method Standard 191A, *Textile Test Methods*, shall be used.

6-5.4.2 A freestanding flame height indicator shall be used to assist in adjusting the burner flame height. The indicator shall mark a flame height of 7.6 cm (3 in.) above the top of the burner.

6-5.4.3 A specimen support assembly shall be used to support the footwear specimen above the burner flame.

6-5.5 Procedure.

6-5.5.1 The burner shall be ignited and the test flame shall be adjusted to a height of 7.6 cm (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 7.6-cm (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.

6-5.5.2 With the specimen mounted in the support assembly, the burner shall be moved so that the flame contacts the specimen at a distance of 3.8 cm (1.5 in.) at the angles in the areas shown in Figure 6-5.5.2.

6-5.5.3 The burner flame shall be applied to the specimen for 12 seconds. After 12 seconds, the burner shall be removed.

6-5.5.4 The afterflame time shall be measured as the time, in seconds, to the nearest 0.2 seconds, that the specimen continues to flame after the burner is removed from the flame.

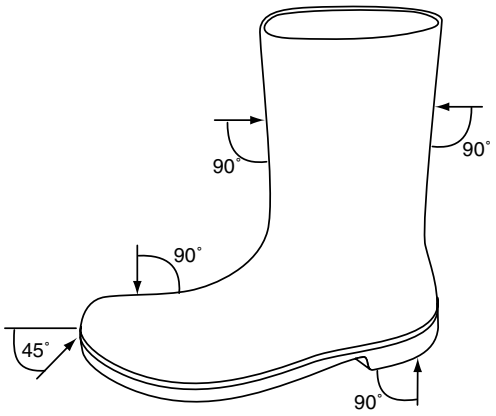


Figure 6-5.5.2 Test areas.

6-5.5.5 Following the flame exposure, the specimen shall be removed and examined for burn-through. Each layer of the specimen shall be examined for melting or dripping.

6-5.6 Report.

6-5.6.1 The afterflame time shall be reported for each specimen. The average afterflame time shall be calculated and reported. The afterflame time shall be reported to the nearest 0.2 seconds.

6-5.6.2 Observations of burn through, melting, or dripping for each specimen shall be reported.

6-5.7 Interpretation.

6-5.7.1 Pass/fail performance shall be based on any observed burn-through, melting or dripping, and the average afterflame time.

6-6 Heat and Thermal Shrinkage Resistance Test.

6-6.1 Application.

6-6.1.1 This test method shall apply to protective garment textiles and hardware; moisture barrier seams; hood, wristlet, helmet ear cover materials, innermost glove liner, trim, and label materials; protective helmets, protective gloves, and protective footwear.

6-6.1.2 Modifications to this test method for testing garment outer shell, moisture barrier, thermal barrier, winter liner, hood, helmet ear cover, and innermost glove liner materials shall be as specified in 6-6.8.

6-6.1.3 Modifications to this test method for testing garment moisture barrier seams shall be as specified in 6-6.9.

6-6.1.4 Modifications to this test method for testing other garment, trim, and label materials shall be as specified in 6-6.10.

6-6.1.5 Modifications to this test method for testing hardware shall be as specified in 6-6.11.

6-6.1.6 Modifications to this test method for testing helmets shall be as specified in 6-6.12.

6-6.1.7 Modifications to this test method for testing gloves shall be as specified in 6-6.13.

6-6.1.8 Modifications to this test method for testing footwear shall be as specified in 6-6.14.

6-6.2 Specimens.

6-6.2.1 Only heat resistance testing shall be conducted on a minimum of three specimens for each moisture barrier seam, hardware item, glove liner material, trim material, label material, other protective garment materials, helmets, and footwear not specified in 6-6.2.2.

6-6.2.2 Both heat and thermal shrinkage resistance testing shall be conducted on a minimum of three specimens for each garment outer shell, moisture barrier, thermal liner, and winter liner; and on whole gloves. Each separable layer of multilayer material systems or composites shall be tested as an individual layer.

6-6.3 Sample Preparation.

6-6.3.1 All specimens to be tested shall be conditioned as specified in 6-1.3.

6-6.4 Apparatus.

6-6.4.1 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 5.08 cm (2 in.) from any interior oven surface or other test specimens.

6-6.4.2 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.

6-6.4.3 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.

6-6.5 Procedure.

6-6.5.1 Specimen marking and measurements shall be conducted in accordance with the procedure specified in ANSI/AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

6-6.5.2 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 5.08 cm (2 in.) from any oven surface or other specimen, and air is parallel to the plane of the material.

6-6.5.3 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.

6-6.5.4 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).

6-6.5.5 Immediately after the specified exposure, the specimen shall be removed and examined for evidence of ignition, melting, dripping, or separation.

6-6.5.6 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.

6-6.6 Report.

6-6.6.1 Observations of ignition, melting, dripping, or separation shall be reported for each specimen.

6-6.6.2 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.

6-6.7 Interpretation.

6-6.7.1 Any evidence of ignition, melting, dripping, or separation on any specimen shall constitute failing performance.

6-6.7.2 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.

6-6.8 Specific Requirements for Testing Garment Outer Shell, Moisture Barrier, Thermal Liner, Winter Liner Materials; Hood, Helmet Ear Cover, and Glove Liner Materials.

6-6.8.1 Samples for conditioning shall be at least 1 m (1 yd) square of each material.

6-6.8.2 Each specimen shall be 38.1 cm × 38.1 cm, ±13 mm (15 in. × 15 in., ±0.5 in.) and shall be cut from the fabric to be utilized in the construction of the clothing item.

6-6.8.3 Specimens shall be tested both before and after being subjected to the procedure specified in 6-1.2.

6-6.8.4 Testing shall be performed as specified in 6-6.2 through 6-6.7.

6-6.8.5 For protective garment outer shell and collar lining materials, any evidence of charring on any specimen of outer shell fabric shall also constitute failing performance in addition to 6-6.7.1.

6-6.9 Specific Requirements for Testing Moisture Barrier Seams.

6-6.9.1 Samples for conditioning shall be a minimum of 1 linear m (1 linear yd) with a minimum of 15.24 cm (6 in.) of material on either side of the seam.

6-6.9.2 Moisture barrier seam specimens shall consist of two 7.62-cm × 15.24-cm (3-in. × 6-in.) pieces of moisture barrier fabric utilized in the garment and sewn together with the same thread, stitch type, and seam type as used in the moisture barrier, with seam-sealing material applied.

6-6.9.3 Specimens shall be tested both before and after being subjected to the procedure specified in 6-1.2.

6-6.9.4 For moisture barrier seam seal materials, observations shall be limited to seam material ignition and dripping.

6-6.9.5 Testing shall be performed as specified in 6-6.2 through 6-6.7. Thermal shrinkage shall not be measured.

6-6.10 Specific Requirements for Testing Other Garment, Clothing, Trim, and Label Materials.

6-6.10.1 Samples for conditioning shall include material sewn onto a 1-m (1-yd) square of ballast material no closer than 5.08

cm (2 in.) apart in parallel strips. The ballast material shall be as specified in ANSI/AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*. Specimens shall be removed from the ballast material prior to testing.

6-6.10.2 Specimen length shall be 15.24 cm (6 in.), other than for textiles utilized in the clothing item in lengths less than 15.24 cm (6 in.), where length shall be the same as utilized in the clothing item. Specimen width shall be 15.24 cm (6 in.), other than for textiles utilized in the clothing item in widths less than 15.24 cm (6 in.), where widths shall be the same as utilized in the clothing item.

6-6.10.3 Specimens shall be tested both before and after being subjected to the procedure specified in 6-1.2.

6-6.10.4 Testing shall be performed as specified in 6-6.2 through 6-6.7. Thermal shrinkage shall not be measured.

6-6.11 Specific Requirements for Testing Hardware.

6-6.11.1 A minimum of three complete hardware items shall be tested.

6-6.11.2 Observations of hardware condition following heat exposure shall be limited to ignition.

6-6.11.3 Hardware shall be evaluated for functionality within 10 minutes following removal from the oven.

6-6.11.4 Testing shall be performed as specified in 6-6.2 through 6-6.7. Thermal shrinkage shall not be measured.

6-6.12 Specific Testing Requirements for Helmets.

6-6.12.1 Samples for conditioning shall include complete helmets.

6-6.12.2 Specimens shall be selected as specified in 2-3.1.1.

6-6.12.3 Sample helmets with ear covers deployed and faceshield/goggle component(s) in the stowed position shall be mounted in accordance with the helmet positioning index on a nonconductive headform conforming to the dimensions in Figure 6-6.12.3. The headform with helmet attached shall be placed in the center of the test oven with the centerline of the front of the helmet facing the airflow.

6-6.12.4 The minimum interior dimensions of the test oven shall be 61 cm × 61 cm × 61 cm (24 in. × 24 in. × 24 in.).

6-6.12.5 The test thermocouple shall be positioned so that it is level with the horizontal centerline of a mounted test helmet. The thermocouple shall be equidistant between the vertical centerline of a mounted test helmet placed in the middle of the oven and the oven wall where the airflow enters the test chamber.

6-6.12.6 Following removal from the oven, the helmet shall be allowed to cool at room temperature for not less than 2 minutes. The shell distortion shall then be measured at the front, back, and sides at eight points radially separated by 45 degrees relative to their original position. The helmet shall be examined to ascertain any effects of the heat exposure.

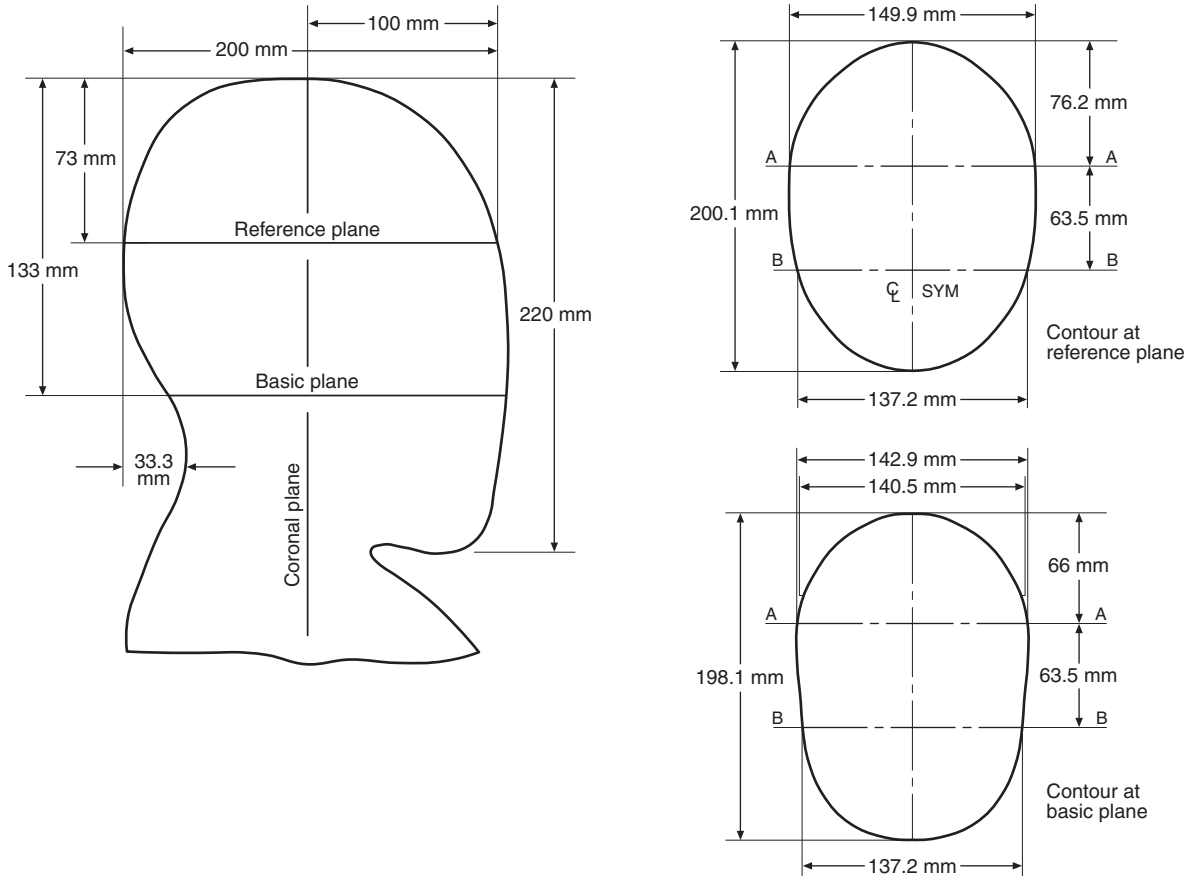


Figure 6-6.12.3 Nonconductive test headform.

6-6.12.7 Testing shall be performed as specified in 6-6.2 through 6-6.7. Thermal shrinkage shall not be measured.

6-6.13 Specific Requirements for Testing Gloves.

6-6.13.1 Samples for conditioning shall be whole gloves.

6-6.13.2 Conditioning shall be performed as specified in 6-1.2.

6-6.13.3 Specimens shall include complete gloves with labels.

6-6.13.4 The minimum interior dimensions of the test oven shall be 61 cm × 61 cm × 61 cm (24 in. × 24 in. × 24 in.).

6-6.13.5 The glove body shall be filled with dry vermiculite, the opening of the glove shall be clamped together, and the specimen shall be suspended by the clamp in the oven so that the entire glove is not less than 5.08 cm (2 in.) from any oven surface or other specimen and airflow is parallel to the plane of the material.

6-6.13.6 The glove specimen dimensions also shall be measured to determine pass/fail. The length measurement of the glove specimen shall be from the tip of the middle finger to the end of the glove body on the palm side. The width measurement of the glove specimen shall be the width measurement on the palm side 2.54 cm (1 in.) below the base of the fingers.

6-6.13.7 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.

6-6.13.8 Specimens shall be donned and flexed as specified in 6-1.10 before and after the heat exposure.

6-6.13.9 Testing shall be performed as specified in 6-6.2 through 6-6.7.

6-6.14 Specific Testing Requirements for Footwear.

6-6.14.1 Samples for conditioning shall be whole boots.

6-6.14.2 The footwear specimen for testing shall be size 9.

6-6.14.3 Footwear specimens shall include sole, heel, and upper. Footwear specimens shall be filled with dry vermiculite. Any closures shall be fastened.

6-6.14.4 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.

6-6.14.5 The minimum interior dimensions of the test oven shall be 61 cm × 61 cm × 61 cm (24 in. × 24 in. × 24 in.).

6-6.14.6 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.

6-6.14.7 Following removal from the oven, the specimen shall be allowed to cool at room temperature for not less than 5 minutes, +15/–0 seconds.

6-6.14.8 Testing shall be performed as specified in 6-6.2 through 6-6.7. Thermal shrinkage shall not be measured.

6-6.14.9 Each tested specimen shall be reconditioned as specified in 6-1.2 and then re-examined inside and outside for separation and functionality.

6-7 Conductive Heat Resistance Test One.

6-7.1 Application.

6-7.1.1 This test method shall apply to protective gloves and footwear upper material.

6-7.1.2 Modifications for this test method for testing gloves shall be as specified in 6-7.7.

6-7.1.3 Modifications for this test method for testing footwear shall be as specified in 6-7.8.

6-7.2 Specimens.

6-7.2.1 A total of three specimens shall be tested.

6-7.3 Sample Preparation.

6-7.3.1 Specimens shall be conditioned as specified in 6-1.3.

6-7.3.2 Samples for conditioning shall be whole gloves and boots.

6-7.4 Procedure.

6-7.4.1 Sample 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.

6-7.4.2 Sample specimens shall be tested using an exposure temperature of 280°C (536°F). The pressure applied during the test shall be 0.0020 kg/cm^2, ±0.0002 kg/cm^2 (0.5 psi, ±0.05 psi).

6-7.4.3 The time in seconds to pain and to second-degree burn and blister, as predicted by the Stoll Human Tissue Burn Tolerance Criteria, shall be recorded.

6-7.5 Report.

6-7.5.1 The time to pain and time to second-degree burn for each specimen shall be reported. The average time to pain and time to second-degree burn shall be calculated and reported. If the time to pain or time to second-degree burn is greater than 30 seconds, the time to pain or time to second-degree burn shall be reported as "> 30 sec."

6-7.6 Interpretation.

6-7.6.1 Pass or fail determinations shall be based on the average time to pain and time to second-degree burn of all specimens tested.

6-7.6.2 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.

6-7.7 Specific Requirement for Testing Gloves.

6-7.7.1 Specimens shall be representative of glove body composite construction at the palm of the hand and at the palm side of the fingers.

6-7.7.2 Specimens shall be stitched around the perimeter using the same thread used in glove construction.

6-7.7.3 Glove specimens shall be tested before and after being subjected to the procedure specified in 6-1.2.

6-7.7.4 Specimens shall also be tested after wet conditioning as specified in 6-1.8.

6-7.7.5 Testing shall be performed as specified in 6-7.2 through 6-7.6.

6-7.8 Specific Requirements for Testing Footwear Upper Materials.

6-7.8.1 Footwear specimens shall include the thinnest portions of the footwear upper.

6-7.8.2 Testing shall be performed as specified in 6-7.2 through 6-7.6.

6-8 Conductive Heat Resistance Test Two.

6-8.1 Application.

6-8.1.1 This test method shall apply to the protective footwear sole.

6-8.2 Specimens.

6-8.2.1 A minimum of three complete footwear items shall be tested.

6-8.3 Sample Preparation.

6-8.3.1 Samples for conditioning shall be whole footwear.

6-8.3.2 Specimens shall be preconditioned as specified in 6-1.3.

6-8.4 Apparatus.

6-8.4.1 The apparatus shall consist of an iron plate measuring 2.54 cm × 15.24 cm × 46 cm (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.

6-8.5 Procedure.

6-8.5.1 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.

6-8.5.2 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.

6-8.5.3 The specimen shall be filled with 4.55 kg (10 lb) of 5 mm (0.375 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.

6-8.5.4 The thermocouple temperature shall be recorded at 30.0 seconds, +2/–0 seconds after the specimen is placed on the heated metal plate.

6-8.6 Report.

6-8.6.1 The temperature at 30 seconds of exposure shall be reported for each specimen. The average temperature at30 seconds of exposure for all specimens shall also be calculated and reported.

6-8.7 Interpretation.

6-8.7.1 The average temperature at 30 seconds of exposure for all specimens shall be used to determine pass/fail performance.

6-9 Radiant Heat Resistance Test.

6-9.1 Application.

6-9.1.1 This test method shall apply to protective footwear.

6-9.2 Specimens.

6-9.2.1 A minimum of three complete footwear items shall be tested.

6-9.3 Sample Preparation.

6-9.3.1 Samples for conditioning shall be complete footwear.

6-9.3.2 Specimens shall be conditioned in accordance with 6-1.3 and 6-1.9.

6-9.4 Apparatus.

6-9.4.1 The apparatus shall consist of the following:

(a) A radiometer with a spectral response flat to within ±3.0 percent of not less than 1.10 to 10.0 mm (0.04 to 0.4 in.) with an accuracy of ±5.0 percent

(b) A radiant panel with an effective radiating surface of not less than 15.24 cm × 15.24 cm (6 in. × 6 in.) and an emittance approximating that of a blackbody of 1000°K, ±200°K (1340°F, ±360°F)

(c) A thermocouple with meter

(d) A test chamber that prevents interference from air movement

6-9.5 Procedure.

6-9.5.1 Tests shall be done on the toe, vamp, quarter, gusset if present, and shaft. If different types or thicknesses of materials are utilized for other areas of the upper, these areas shall also be tested.

6-9.5.2 The radiant panel shall be placed in front of the radiometer, parallel to the plane tangent to the radiometer. The radiant panel shall be adjusted to obtain a stable, uniform irradiance of 1.0 W/cm^2, +0.01/–0.0 W/cm^2 over a minimum 7.6-cm (3-in.) diameter circle located on the above plane and centered at the center of the test area. Calibration shall be achieved when the irradiance changes by less than 10 percent during a 3–minute period.

6-9.5.3 The thermocouple shall be affixed to the inside surface of the lining next to the foot, in the center of the test area. The radiometer shall be replaced with the protective footwear with the test area oriented parallel to the plane tangent to the heat source, at the same distance from the heat source. The area shall be exposed for 1 minute, +5/–0 seconds.

6-9.5.4 The thermocouple temperature shall be recorded at 1 minute, +5/–0 seconds of exposure.

6-9.6 Report.

6-9.6.1 The temperature at 1 minute of exposure shall be reported for each specimen. The average temperature at 1 minute of exposure for all specimens shall also be calculated and reported.

6-9.7 Interpretation.

6-9.7.1 The average temperature at 1 minute of exposure for all specimens tested shall be used to determine pass/fail performance.

6-10* Thermal Protective Performance (TPP) Test.

6-10.1 Application.

6-10.1.1 This test method shall apply to multilayer protective garment composites, hoods, wristlets, and gloves, including single layer knit hood which are worn in contact with the skin.

6-10.1.2 Modifications to this test method for testing garment composites shall be as specified in 6-10.8.

6-10.1.3 Modifications to this test method for testing hoods shall be as specified in 6-10.9.

6-10.1.4 Modifications to this test method for testing wristlets shall be as specified in 6-10.10.

6-10.1.5 Modifications to this test method for testing gloves shall be as specified in 6-10.11.

6-10.2 Specimens.

6-10.2.1 Thermal protective performance testing shall be conducted on three specimens. Specimens shall measure 152.4 mm × 152.4 mm, ±6.4 mm (6 in. × 6 in., ±1/4 in.) and shall consist of all layers representative of the clothing item to be tested.

6-10.3 Sample Preparation.

6-10.3.1 Specimens shall be tested before preconditioning and tested after preconditioning as specified in 6-1.2 and then conditioning as specified in 6-1.3.

6-10.4 Apparatus.

6-10.4.1 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.

6-10.4.1.1 The specimen holder assembly shall consist of upper and lower mounting plates. Specimen holder maintaining plates shall be 152.4 mm × 152.4 mm, ±1.6 mm, × 6.4 mm, ± 0.8 mm (6 in. × 6 in., ± 0.063 in. × 0.25 in., ± 0.313 in.). The lower specimen mounting plate shall have centered a 101.6 mm × 101.6 mm, ± 1.6 mm (4 in. × 4 in., ± 0.063 in.) hole. The upper specimen mounting plate shall have centered a 133.4 mm × 133.4 mm, ± 1.6 mm (5.25 in. × 5.25 in., ±0.063 in.) hole. The lower specimen mounting plate shall have a 25.4 mm, ±1.6 mm high, × 3.2 mm, ± 0.8 mm (1.0 in., ±0.063 in. high, × 0.13 in., ±0.0315 in.) thick steel post welded to each corner 6.4 mm, ±1.6 mm (0.25 in., ±0.063 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 6-10.4.1.1.

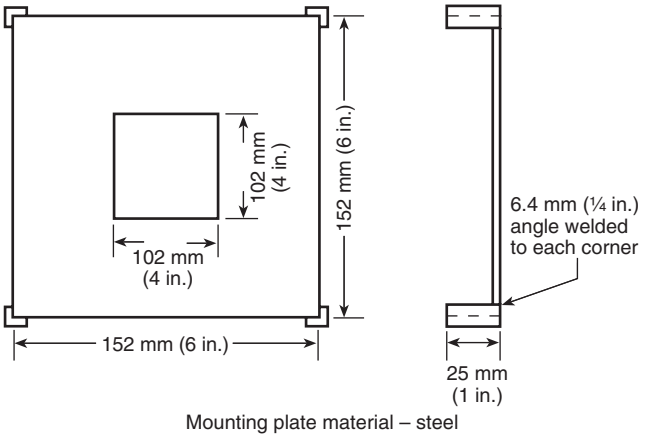


Figure 6-10.4.1.1 Lower specimen mounting plate.

6-10.4.1.2 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.

6-10.4.1.3 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 6-10.4.1.3.

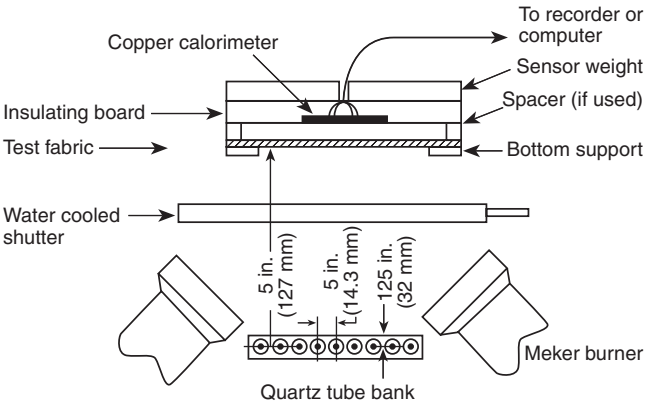


Figure 6-10.4.1.3 Specifications for TPP tester thermal flux source.

6-10.4.1.4 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.

6-10.4.1.5 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 6-10.4.1.10. Sensor assembly shall consist of 133.4 mm × 133.4 mm × 12.7 mm (5.25 in. × 5.25 in. × 0.5 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).

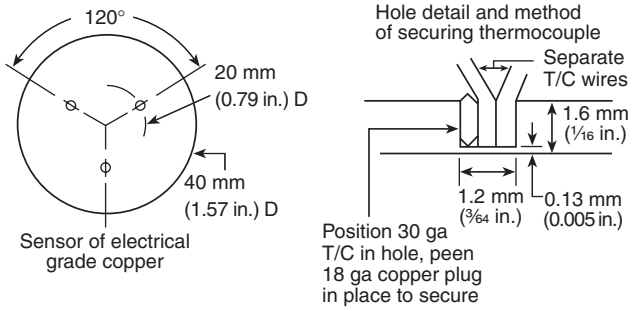
6-10.4.1.6 The recorder shall be any strip chart recorder with full scale deflection of at least 150°C (300°F) or 10 mV and sufficient sensitivity and scale divisions to read exposure time to ±0.1 second; alternatively, an equivalent automated data acquisition system meeting or exceeding the sensitivity and accuracy requirements of the strip chart recorder shall be permitted to be used instead of a strip chart recorder.

6-10.4.1.7 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.

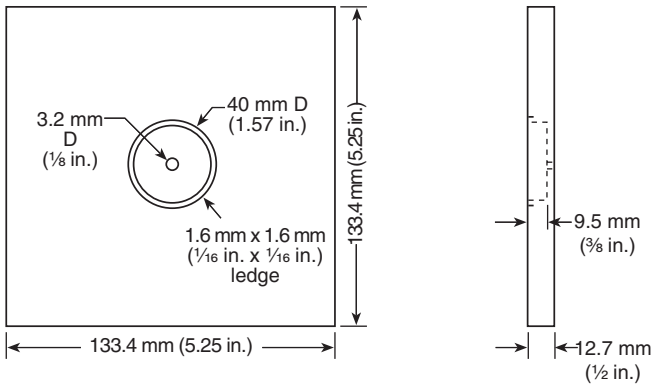
6-10.4.1.8 The gas rotameter shall be any gas rotameter with range to give flow equivalent to 2 L (0.07 ft^3)/min air at standard conditions.

6-10.4.1.9 The burners shall be Meker or Fisher burners with 38 mm, ±2 mm (1.5 in., ±0.1 in.) diameter top and with orifice size of 1.2 mm (0.05 in.).

6-10.4.1.10 The sensor shall be a copper calorimeter mounted in an insulating block. The calorimeter shall conform to the specifications provided in Figure 6-10.4.1.10. The sensor shall be coated with a flat black paint.



Details of calorimeter construction



Sensor support of soft insulation board

Connect 4 T/C in parallel, silver solder connections. Bring common lead out of center hole of support. Secure sensor into support with three or four sewing pins cut to 9.5 mm (3/8 in.) long.

Note: Calorimeters should be painted with flat black paint.

Figure 6-10.4.1.10 Sensor assembly.

6-10.4.2 A radiometer shall be used in the calibration of the test apparatus.

6-10.4.2.1 The radiometer shall be a Gardon type radiation transducer with a diameter of 25.4 mm (1 in.). The heat flux operating range shall be from 0 kW/m^2 to 60 kW/m^2 (0 cal/cm^{2}s to 1.4 cal/cm^{2}s or 0 BTU/ft^2/s to 5 BTU/ft^2/s). The radiometer shall be water cooled and the cooling water temperature shall be above the ambient dew point temperature.

6-10.5 Procedure.

6-10.5.1 General Procedures.

6-10.5.1.1 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.

6-10.5.1.2 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.

6-10.5.2 Calibration Procedure.

6-10.5.2.1 Specimens shall be exposed to a thermal flux of 83 kW/m^2, + 4 kW/m^2 (2.0 cal/cm^{2}s, +0.1 cal/cm^{2}s) 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}s) 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.

6-10.5.2.2 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 6-10.5.2.3 through 6-10.5.2.6. 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.

6-10.5.2.3 Once an initial setting of 50 kW/m^2, ±4 kW/m^2 (0.3 cal/cm^{2}s, ±0.1 cal/cm^{2}s) 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.

6-10.5.2.4* 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 color of the flame shall primarily be blue.

6-10.5.2.5 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}s, ±0.1 cal/cm^{2}s) using a commercial radiometer meeting the specifications of 6-10.4.2. 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.

6-10.5.2.6 The total heat flux shall be set at 83 kW/m^2, ±4 kW/m^2 (2.0 cal/cm^{2}s, ±0.1 cal/cm^{2}s) using the calibration copper calorimeter, defined in 6-10.4.1.10, 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, ± 3.7°C (267°F, ± 6.7°F) equivalent to 7.86, ± 0.20 mV for an iron — constantan thermocouple for an exposure heat flux of 83 kW/m^2, ±2 kW/m^2 (2.0 cal/cm^{2}s, ±0.05 cal/cm^{2}s).

6-10.5.3 Test Procedure.

6-10.5.3.1 After the total thermal heat flux has been set at 83 kW/m^2, ± 4 kW/m^2 (2.0 cal/cm^{2}s, ± 0.1 cal/cm^{2}s) using the calibration procedure in 6-10.5.2.4 through 6-10.5.2.6, 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, ± 3.7°C (267°F, ± 6.7°F) equivalent to 7.86 mV, ± 0.20 mV for an iron — constantan thermocouple for an exposure heat flux of 83 kW/m^2, ± 2 kW/m^2 (2.0 cal/cm^{2}s, ± 0.05 cal/cm^{2}s).

6-10.5.3.2 If the measurement from the testing copper calorimeter is within +4/–0 kW/m^2 (+0.1/–0 cal/cm^{2}s) 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}s) of the measurement of the calibration calorimeter, the testing copper calorimeter shall be repaired, reconditioned, or replaced to achieve agreement.

6-10.5.3.3 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.

6-10.5.3.4 The testing copper calorimeter shall be placed directly on the specimen in contact with the surface to be worn toward the skin.

6-10.5.3.5 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 6-10.5.4.1. 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.

6-10.5.3.6 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.

6-10.5.3.7 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.

6-10.5.3.7.1* 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}s), 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}s), then the testing calorimeter shall be repaired and recalibrated or the testing calorimeter shall be replaced.

6-10.5.4 Preparation of Human Tissue Burn Tolerance Overlay.

6-10.5.4.1 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 6-10.5.4.1.

Table 6-10.5.4.1 Human Tissue[a] Tolerance to Second-Degree Burn

Exposure	Heat Flux		Total Heat		Calorimeter[b] Equivalent		
Time (s)	cal/cm^{2}s	kW/m^2	cal/cm^2	kW s/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.

The calorimeter equivalent from Table 6-10.5.4.1 that corresponds to the recorder scale shall be plotted on recorder chart paper. ΔT°C, ΔT°F, 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.

6-10.5.4.2 Computer Processing of the Data. The information provided in Table 6-10.5.4.1 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.

6-10.5.5 Determination of Test Results.

6-10.5.5.1 The time to the second degree burn shall be graphically determined from the recorder chart of the sensor response and criterion overlay prepared in 6-10.5.4.1. 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.

6-10.5.5.1.1 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.

6-10.5.5.2 The TPP rating shall be calculated 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}s)
T = time to burn(s)

6-10.6 Report.

6-10.6.1 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."

6-10.7 Interpretation.

6-10.7.1 Pass or fail determinations shall be based on the average reported TPP rating of all specimens tested.

6-10.7.2 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.

6-10.8 Specific Requirements for Testing Garments.

6-10.8.1 Specimens shall consist of outer shell, moisture barrier, and thermal barrier. Winter liners shall not be included in the test composite. Collar lining fabric shall be permitted to be included in the protective garment collar fabric composite specimen. Specimens shall not include seams. Specimens shall not be stitched to hold individual layers together during testing.

6-10.8.2 Samples for conditioning shall be at least 1 m square (1 yd square) of each material.

6-10.8.3 Testing shall be performed as described in 6-10.2 through 6-10.7.

6-10.9 Specific Requirements for Testing Protective Hoods.

6-10.9.1 Specimens shall consist of materials from the portion of the protective hood that covers the neck and facial area. Specimens shall not include seams. Specimens shall not be stitched to hold individual layers together during testing.

6-10.9.2 Samples for conditioning shall include hood material that is a minimum of 178 mm (7 in.) square.

6-10.9.3 Testing shall be performed as described in 6-10.2 through 6-10.7.

6-10.10 Specific Requirements for Testing Protective Wristlets.

6-10.10.1 Specimens shall consist of materials from the portion of the protective wristlet that covers the wrist area. Specimens shall not include seams. Specimens shall not be stitched to hold individual layers together during testing.

6-10.10.2 Samples for conditioning shall include wristlet material that is a minimum of 178 mm (7 in.) square.

6-10.10.3 Testing shall be performed as described in 6-10.2 through 6-10.7.

6-10.11 Specific Requirements for Testing Protective Glove Body Composites and Gauntlets.

6-10.11.1 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.

6-10.11.2 Samples for conditioning shall include glove material that is a minimum of 178 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.

6-10.11.3 Testing shall be performed as described in 6-10.2 through 6-10.7.

6-11 Thread Melting Test.

6-11.1 Application.

6-11.1.1 This test shall apply to sewing thread used in the construction of protective garments, hoods, wristlets, footwear, helmets, and helmet ear covers.

6-11.2 Specimens.

6-11.2.1 Five different specimens shall be tested.

6-11.3 Sample Preparation.

6-11.3.1 Specimens shall be conditioned as specified in 6-1.3.

6-11.4 Procedure.

6-11.4.1 Specimens shall be tested in accordance with Test Method 1534, *Melting of Synthetic Fiber* of Federal Test Method Standard 191A, *Textile Test Methods*, at a test temperature of 260°C (500°F).

6-11.5 Report.

6-11.5.1 The condition of specimens shall be observed at 260°C (500°F).

6-11.6 Interpretation.

6-11.6.1 Any specimen exhibiting melting at 260°C (500°F) shall constitute failure of this test.

6-12 Tear Resistance Test.

6-12.1 Application.

6-12.1.1 This test shall apply to woven materials used in protective garments, hoods, and wristlets.

6-12.2 Specimens.

6-12.2.1 Five specimens in each of the warp and filling directions shall be tested from each sample unit. Specimens shall be 7.62-cm × 15.24-cm (3-in. × 6-in.) rectangles. The long dimension shall be parallel to the warp for warp tests and parallel to the filling for filling tests. No two specimens for warp tests shall contain the same warp yarns, nor shall any two specimens for filling tests contain the same filling yarns. The specimen shall be taken no closer to the salvage than one-tenth of the width of the clothing.

6-12.2.2 An isosceles trapezoid having an altitude of 7.62 cm (3 in.) and bases of 2.54 cm (1 in.) and 10.16 cm (4 in.) in length, respectively, shall be marked on each specimen with the aid of a template. A cut 9.5 mm (0.375 in.) in length shall then be made in the center of a line perpendicular to the 2.54-cm (1-in.) edge.

6-12.3 Sample Preparation.

6-12.3.1 Specimens shall be conditioned as specified in 6-1.3.

6-12.3.2 Samples for conditioning shall be 1 m (1 yd) square of material.

6-12.4 Apparatus.

6-12.4.1 Apparatus shall consist of a straining mechanism, two clamps for holding specimens, and load and elongation recording mechanisms, wherein the specimen is held between two clamps and strained by a uniform movement of the pulling clamp. The test machine shall be operated at a rate of 30.48 cm/min (12 in./min).

6-12.4.2 The straining mechanism shall be of such capacity that the maximum load necessary to break the specimen shall be not greater than 85 percent or less than 15 percent of the manufacturer's rated capacity.

6-12.4.3 The clamps shall have two jaws on each clamp. The design of the clamps shall be such that one gripping surface or jaw shall be permitted to be an integral part of the rigid frame of the clamp or shall be fastened to allow a slight vertical movement, while the other gripping surface or jaw shall be completely movable. The dimensions of the immovable jaw of each clamp parallel to the application of the load shall measure 2.54 cm (1 in.), and the dimension of the jaw perpendicular to this direction shall measure 7.62 cm (3 in.) or more. The face of the movable jaw of each clamp shall measure 2.54 cm × 7.62 cm (1 in. × 3 in.). Each jaw face shall have a flat, smooth gripping surface. All edges that might cause a cutting action shall be rounded to a radius of not more than 0.4 mm (0.016 in.). In cases where a cloth tends to slip while being tested, the jaws shall be faced with rubber or other material to prevent slippage. The distance between the jaws shall be 2.54 cm (1 in.) at the start of the test.

6-12.4.4 The recorder shall consist of a calibrated dial, scale, or chart used to indicate applied load and elongation. Error shall not exceed 2 percent for loads up to and including 22.7 kg (50 lb) and 1 percent for loads over 22.7 kg (50 lb) at any reading within its loading range. All machine attachments for determining maximum loads shall be disengaged during the test.

6-12.5 Procedure.

6-12.5.1 The specimen shall be clamped along the nonparallel sides of the trapezoids so that these sides lie along the lower edge of the upper clamp and the upper edge of the lower clamp, with the cut halfway between the clamps. The short trapezoid base shall be held taut, and the long trapezoid base shall lie in the folds.

6-12.5.2 The strain mechanism shall be started, and the force necessary to tear the cloth shall be observed by means of the recording device.

6-12.5.3 If a specimen slips between the jaws, breaks in or at the edges of the jaws, or if for any reason attributable to faulty technique an individual measurement falls markedly below the average test results for the sample unit, such result shall be discarded and another specimen shall be tested.

6-12.6 Report.

6-12.6.1 The tear strength of an individual specimen shall be the average of the five highest peak loads of resistance registered. The tear strength of each specimen shall be reported to the nearest 45.4 g (0.1 lb). An average tear strength shall be calculated for warp and filling directions.

6-12.7 Interpretation.

6-12.7.1 Pass/fail performance shall be based on the average tear strength in the warp and filling directions. Failure in any one direction constitutes failure for the material.

6-13 Burst Strength Test.

6-13.1 Application.

6-13.1.1 This test shall apply to knit materials used in protective garments, hoods, and wristlets.

6-13.2 Specimens.

6-13.2.1 A total of ten specimens shall be tested.

6-13.3 Sample Preparation.

6-13.3.1 Specimens shall be conditioned as specified in 6-1.3.

6-13.3.2 Samples for conditioning shall be 1 m (1 yd) square of material.

6-13.4 Procedure.

6-13.4.1 Specimens shall be tested as specified in ASTM D 3787, Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics—Ball Burst Testing Method.

6-13.5 Report.

6-13.5.1 The burst strength of each specimen shall be reported. The average burst strength of all specimens shall be calculated and reported.

6-13.6 Interpretation.

6-13.6.1 The average burst strength shall be used to determine pass/fail performance.

6-14 Seam Breaking Strength Test.

6-14.1 Application.

6-14.1.1 This test shall apply to seams used in protective garments and hoods.

6-14.2 Specimens.

6-14.2.1 A minimum of five seam specimens representative of the garment shall be tested for each seam type.

6-14.2.2 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.

6-14.2.2.1 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.

6-14.2.2.2 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 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.

6-14.2.2.3 Specimens of garment seam assemblies constructed from other than woven or knit textiles shall be tested as specified in 6-14.2.2.1.

6-14.2.2.4 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.

6-14.3 Sample Preparation.

6-14.3.1 Samples for conditioning shall be 1 m (1 yd) square of material.

6-14.4 Procedure.

6-14.4.1 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 304.8 mm/min (12 in./min).

6-14.4.2 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*.

6-14.4.3 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 304.8 mm/min (12 in./min).

6-14.5 Report.

6-14.5.1 The seam breaking strength for each seam specimen shall be reported. The average seam breaking strength for each seam type shall also be reported.

6-14.5.2 The type of seams tested shall be reported as to whether the specimens were cut from the finished garment or prepared from fabric samples.

6-14.6 Interpretation.

6-14.6.1 The average seam breaking strength for each seam type shall be used to determine pass/fail performance.

6-15 Top Impact Resistance Test (Force).

6-15.1 Application.

6-15.1.1 This test shall apply to complete helmets.

6-15.2 Specimens.

6-15.2.1 Specimens shall be selected as specified in 2-3.9.

6-15.3 Sample Preparation.

6-15.3.1 Samples for conditioning shall be complete helmets.

6-15.3.2 Specimens shall be conditioned for each environmental condition specified in 6-1.3, 6-1.4, 6-1.5, 6-1.6, and 6-1.7 prior to each impact.

6-15.4 Apparatus.

6-15.4.1 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 (8.0 lb, ±1.0 lb). The test headform shall be of the nominal dimensions of the headform in Table 6-15.4.1 and Figures 6-15.4.1(a) through (c).

6-15.4.2 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 4.8 cm, ±8 mm (1.9 in., ±0.3 in.) and a chord length of at least 7.6 cm (3.0 in.).

6-15.4.3 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	4.4×109 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	7.6 cm (3.0 in.)

6-15.4.4 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:

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

where:

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

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

Table 6-15.4.1 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.

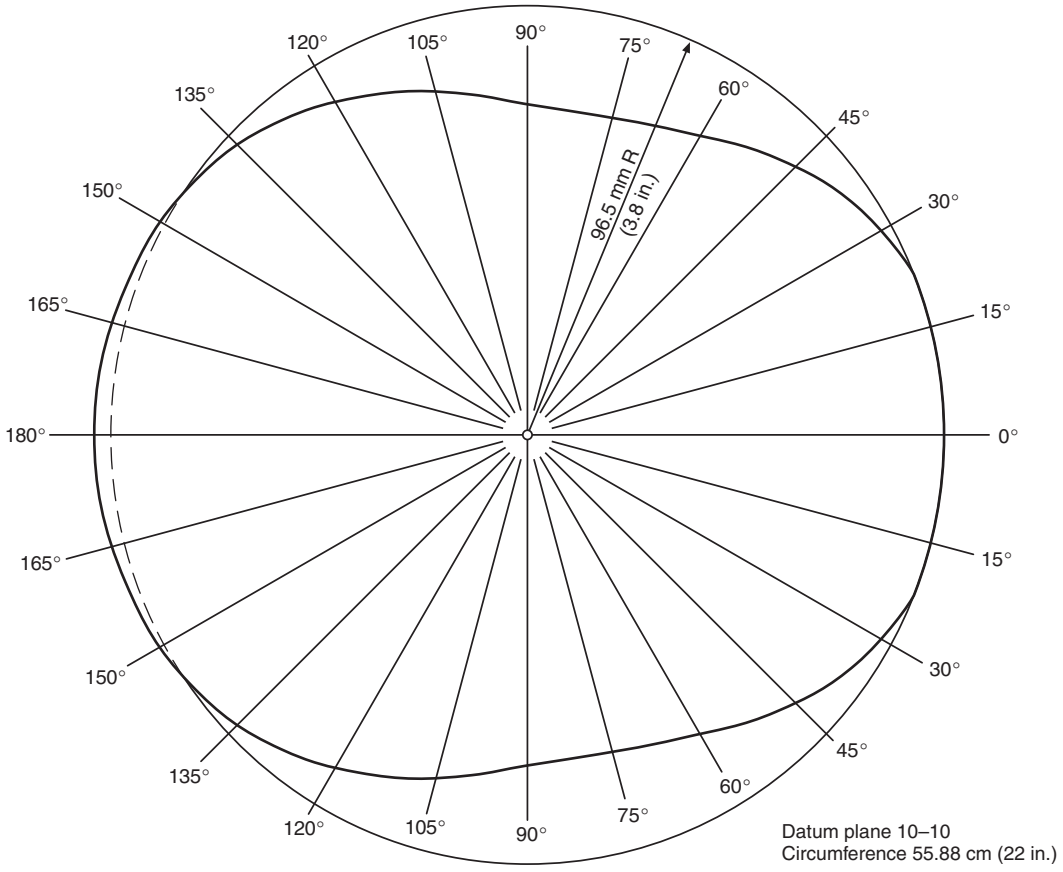


Figure 6-15.4.1(a) ISEA size 7 headform, top.

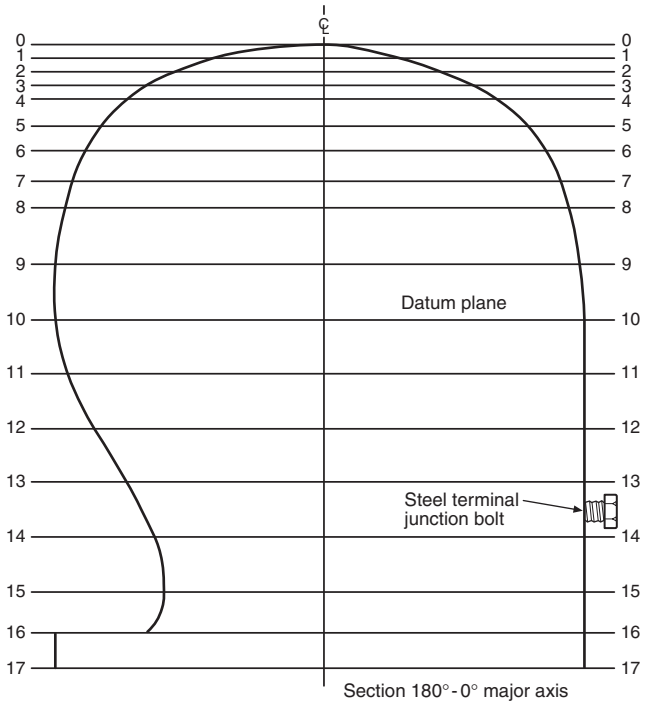


Figure 6-15.4.1(b) ISEA size 7 headform, side with modification for steel terminal junction bolt.

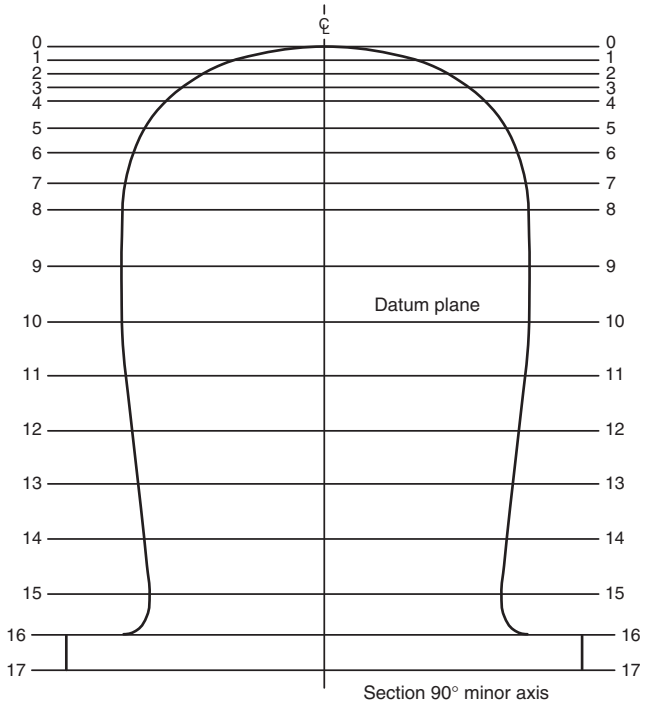


Figure 6-15.4.1(c) ISEA size 7 headform, front.

6-15.4.5 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.).

6-15.4.6 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 30 cm (1 ft) square and 2.54 cm (1 in.) thick. The backup mass shall be concrete or a rigid material of equal or greater density at least 61 cm (2 ft) square.

6-15.4.7 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.

6-15.4.8 The vertical centerline of the drop mass, the headform, and the load cell shall all be colinear within 3 mm (0.125 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 6.4 mm per 3 m (0.25 in. per 10 ft) of length.

6-15.4.9* 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.

6-15.4.10 The test system shall be analyzed dynamically to ensure that any mechanical resonance associated with transducer mountings do not distort the output data.

6-15.4.11 Prior to testing, the instrumentation shall be allowed to warm up until stability is achieved.

6-15.4.12 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.

6-15.5 Procedure.

6-15.5.1 Where faceshield/goggle component(s) are provided, the device shall be removed from the helmet for this 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 midsagittal plane of the headform. Specimens shall be subjected to the environmental conditions specified in 6-1.3, 6-1.4, 6-1.5, 6-1.6, and 6-1.7, prior to each impact and within the specified time after being removed from conditioning.

6-15.5.2 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.

6-15.5.3 The verification tests shall demonstrate an accuracy of 2.5 percent or better in the measured force.

6-15.6 Report.

6-15.6.1 The results of each system verification shall be made part of the test results for specimens being tested.

6-15.6.2 The peak force and impact velocity shall be recorded for each test.

6-15.7 Interpretation.

6-15.7.1 Pass/fail performance shall be determined for each specimen. One or more helmet specimens failing this test shall constitute failing performance.

6-16 Impact Resistance Test (Acceleration).

6-16.1 Application.

6-16.1.1 This test shall be applied to complete helmets.

6-16.2 Specimens.

6-16.2.1 Specimens shall be selected as specified in 2-3.9.

6-16.3 Sample Preparation.

6-16.3.1 Specimens shall be conditioned for each environmental condition specified in 6-1.3, 6-1.4, 6-1.6, and 6-1.7 prior to each impact.

6-16.3.2 Samples for conditioning shall be complete helmets.

6-16.4 Apparatus.

6-16.4.1 The headform shall be an ISO Size J conforming to the manual dimensions in Figure 6-16.4.1. The ISO Size J test headform shall exhibit no resonant frequencies below 3000 Hz, and it shall be made of any low-resonance alloy, such as magnesium K-1A.

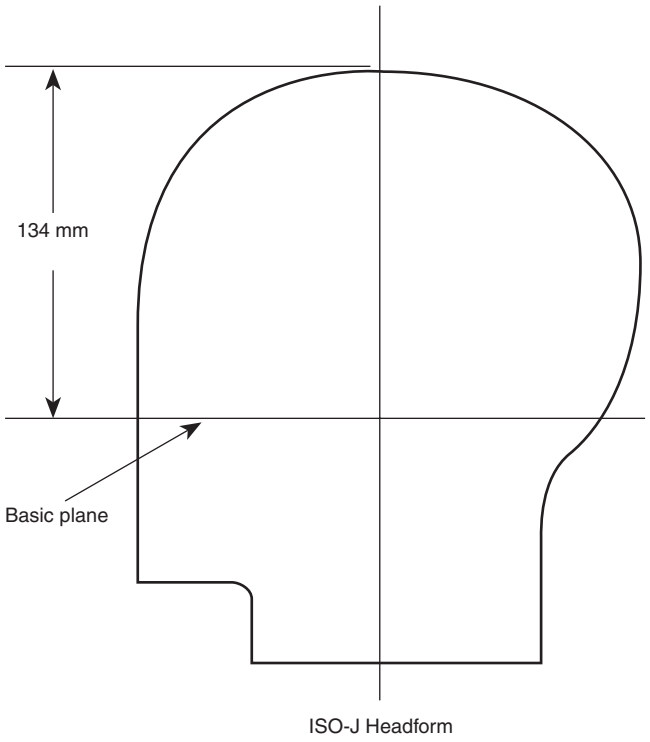


Figure 6-16.4.1 ISO Size J headform (all dimensions in mm).

6-16.4.2 There shall be a drop assembly consisting of the test headform, the accelerometer, and the moving portion of the headform guidance assembly. The drop assembly shall have a total mass of 5.17 kg, ±0.18 kg (11.4 lb, ±0.4 lb).

6-16.4.3 The guidance assembly shall comprise not more than 20 percent of the total mass of the drop assembly.

6-16.4.4 The center of mass of the drop assembly shall lie within a cone of 10 degrees included angle about the vertical, with the apex at the point of impact.

6-16.4.5 A steel test anvil shall be used and shall have a smooth, flat striking surface 12.7 cm, ±15 mm (5.0 in., ±0.6 in.) in diameter. The anvil shall be mounted securely on a steel plate at least 30.5 cm (1 ft) square and 2.54 cm (1 in.) thick. The steel plate shall be rigidly attached to and in intimate contact with a backup mass of at least 540 kg (1200 lb). The backup mass shall be of concrete or a rigid material of equal or greater density at least 61 cm (2 ft) square.

6-16.4.6 An electronic acceleration measurement system with the following minimum specifications shall be used:

(a) Range	500 Gn
(b) Peak acceleration measurement	±2.5 percent accuracy
(c) Resonant frequency	5000 Hz
(d) Accelerometer shock limit	2000 Gn
(e) Resolution	5 Gn

6-16.4.7 The system frequency response shall comply with SAE J211, *Instrumentation for Impact Test*, Channel Frequency Class 1000, specifications. The time duration of acceleration levels shall be measured to within ±0.2 millisecond.

6-16.4.8 A reference anvil shall be substituted for the test anvil to verify the calibration of the acceleration measurement system. The reference anvil shall be constructed of any material that will yield reproducible test results during a period of at least 4 months.

6-16.4.9* For calibration, the center of the reference anvil shall be aligned within 3.2 mm (0.125 in.) of the impact point on the headform. The sensitive axis of the accelerometer shall be aligned within 1 degree of vertical and shall be colinear within 3.2 mm (0.125 in.), with the center of the reference anvil and the impact point on the headform. The guide or guides shall be vertical and, in the case of a double guide system, parallel, to within 64 mm per 3 m (0.25 in. per 10 ft) of length.

6-16.4.10 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.

6-16.4.11 The test system shall be analyzed dynamically to ensure that any mechanical resonance does not distort the output data.

6-16.4.12 Prior to testing, the instrumentation shall be allowed to warm up until stability is achieved.

6-16.4.13 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.

6-16.5 Procedure.

6-16.5.1 A conditioned specimen with faceshield/goggle component(s) removed shall be positioned on the headform with the horizontal center plane of the helmet parallel within 5 degrees of the reference plane of the headform and shall be secured to the drop assembly by its retention system so as to maintain this position during the test. No part of the helmet shell shall be cut away to accommodate the test system, and no part of the test system shall contact the helmet shell either as mounted or during an impact test.

6-16.5.2 The drop assembly with a helmet attached shall be dropped from a height that yields an impact velocity within 2 percent of 6.0 m/s (19.7 ft/s). A means of verifying the impact velocity within 2 percent for each impact shall be incorporated in the test system. The acceleration time duration values, peak acceleration, and impact velocity shall be recorded for each test. Each helmet shall be environmentally conditioned prior to each impact in each of the five impact areas specified in Figure 6-1.6.1. Test series number 1 shall require helmet specimens 5, 6, 8, and 10 to be impacted at the front, rear, side impact areas at a distance of 68 mm + 13.5 mm, -0 mm (2.5 in, + 0.5 in., -0.0 in.) when measured from the test line to the center of the impact anvil.

6-16.5.3 The impact areas shall be as specified in Figure 6-1.6.1. The top, front, rear, and side areas of the helmet shall be tested.

6-16.5.4 The top impact area shall consist of a 30 mm (1.2 in.) radius measured from a point located on the headform at the junction of the coronal plane and mid-sagittal plane.

6-16.5.5 The front impact test area shall consist of an area defined as extending forward on the headform from the front vertical transverse plane to the test line.

6-16.5.6 The rear impact test area shall consist of an area defined as extending backward on the headform from the rear vertical transverse plane extending down to the test line.

6-16.5.7 The side test areas shall consist of the areas between the top test area and test line extending from the rear vertical transverse plane and the front vertical transverse plane.

6-16.5.8 Each conditioned specimen in a series shall be impacted one on the top, rear, front, and side test areas of the helmets as defined in Figure 6-1.6.1. At least one impact shall occur in each test area.

6-16.5.9 The center of the test anvil shall be no lower than 68 mm (2.5 in.) above the test line.

6-16.5.10 The verification tests shall demonstrate an accuracy of 20 percent or better in the measured acceleration.

6-16.6 Report.

6-16.6.1 The results of each system verification shall be made part of the test results for the specimens being tested.

6-16.6.2 The maximum acceleration, duration of acceleration above 200 Gn, and duration of acceleration above 150 Gn shall be recorded for each test.

6-16.7 Interpretation.

6-16.7.1 Pass/fail performance shall be determined for each specimen. One or more helmet specimens failing this test shall constitute failing performance.

6-17 Faceshield/Goggle Component Lens Impact Resistance Test.

6-17.1 Application.

6-17.1.1 This test shall apply to complete helmets.

6-17.2 Specimens.

6-17.2.1 Where the manufacturer produces helmets with faceshield components, a minimum of four complete faceshield components shall be tested.

6-17.2.2 Where the manufacturer produces helmets with goggle components, a minimum of four complete goggle components shall be tested.

6-17.2.3 Where the manufacturer produces helmets with both faceshield and goggle components attached to a single helmet a minimum of four faceshield and four goggle components shall be tested.

6-17.3 Sample Preparation.

6-17.3.1 Samples shall be preconditioned for each of the environmental conditions specified in 6-1.3, 6-1.4, and 6-1.7.

6-17.3.2 Samples for conditioning shall be as defined in 6-17.2.

6-17.4 Test One, High Mass Impact.

6-17.4.1 Apparatus.

6-17.4.1.1 An Alderson 50-percentile male headform shall be used to hold the protective device. It shall be rigidly mounted in the horizontal position, face up, on a base that has a mass of 30 kg (66 lb) or greater. The static stiffness of the headform shall be such that, when a vertical downward force of 20 kg (44 lb) is applied to the forehead of the headform, the back of the headform shall not deflect more than 2 mm (0.079 in.). (*See Figure 6-17.4.1.1.*)

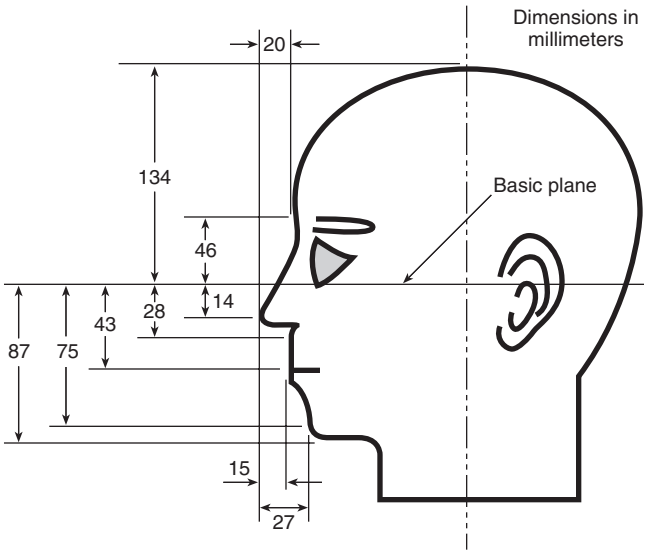


Figure 6-17.4.1.1 Alderson headform.

6-17.4.1.2 The missile shall have a 30-degree conical tip with a 1-mm (0.039-in.) radius, shall weigh 500 g (17.6 oz), and shall have a diameter of 25.4 mm (1 in.). The missile shall be held in position over the headform, tip down, at the designated test height. The missile shall have a heat-treated steel tip.

6-17.4.1.3* The missile shall be dropped through a loose-fitting guide tube having a smooth internal diameter.

6-17.4.2 Procedure.

6-17.4.2.1 Only one faceshield component or goggle component shall be tested at a time.

6-17.4.2.2 The complete helmet shall be placed on the headform in accordance with the helmet positioning index. The alignment shall be such that, with the faceshield/goggle component deployed, when the missile is dropped, it points in line with one of the eyes of the headform.

6-17.4.2.3 The missile shall be dropped from a height of 130 cm (51.2 in.). Four samples shall be tested.

6-17.4.3 Report.

6-17.4.3.1 The pass/fail result for each device shall be reported.

6-17.5 Test Two, High Velocity Impact.

6-17.5.1 Apparatus.

6-17.5.1.1* The test apparatus shall consist of a device capable of propelling a steel ball reproducible at the velocity designated at 250 fps, the device shall show a sample standard deviation of not greater than 2 percent of 250 fps based on a test series of 30 shots. The velocity of the steel ball shall be determined at a distance not greater than 25 cm (9.8 in.) from point of impact. The projectiles used in this test shall be 6.35 mm ($^1/_4$ in.) diameter steel balls weighing approximately 1.06 g (0.04 oz). These balls are damaged during impact and shall be changed frequently to avoid impacts at unexpected locations and large variations in velocity.

6-17.5.1.2 An Alderson 50th percentile male headform shall be used for mounting the helmet with faceshield/goggle component. The headform shall be capable of being rotated on a vertical axis through each corneal vertex in 15-degree increments, from a first position 15 degrees to the nasal side of straight-ahead-viewing out to 90 degrees temporally (it is assumed that the headform is vertical such that the two eyes lie in a horizontal reference plane). The headform shall be capable of being raised 10 mm (0.394 in.) and lowered 10 mm (0.394 in.) with respect to the horizontal plane to carry out testing at the 90 degrees angular position.

6-17.5.2 Procedure.

6-17.5.2.1 Only one faceshield component or goggle component shall be tested at a time.

6-17.5.2.2 The helmet with faceshield/goggle component deploy shall be mounted to the Alderson 50th percentile male headform in accordance with the eye/face positioning index.

6-17.5.2.3 The headform shall be adjusted so that the path of the projectile passes through the center of the right eye. It is then rotated to the first test position, which shall be 15 degrees to the nasal side. The faceshield/goggle component shall be impacted at the test velocity. A new faceshield/goggle component shall be placed on the head form and impacted at 0 degrees. A new faceshield/goggle component shall be placed on the headform and impacted at 45 degrees. A new faceshield/goggle component shall be placed on the headform and impacted at 90 degrees. The impacts at the 45-degree and 90-degree positions shall be at either 10 mm (0.394 in.) above or 10 mm (0.394 in.) below the plane of the eyes.

6-17.5.2.4 The headform shall be adjusted so that the path of the projectile passes throughout the center of the left eye. It is then rotated to the first test position, which shall be 15 degrees to the nasal side. The faceshield/goggle component shall be impacted at the test velocity. A new faceshield/goggle component shall be placed on the headform and impacted at 0 degrees. A new faceshield/goggle component shall be placed on the headform and impacted 45 degrees. A new faceshield/goggle component shall be placed on the headform and impacted at 90 degrees. The impacts at the 45-degree and 90-degree positions shall be at either 10 mm (0.394 in.) above or 10 mm (0.394 in.) below the plane of the eyes.

6-17.5.2.5 Eight specimens shall be tested.

6-17.6 Report.

6-17.6.1 The pass/fail result for each helmet shall be reported.

6-17.7 Interpretation.

6-17.7.1 One or more helmet specimens failing this test shall constitute failing performance.

6-18 Impact and Compression Tests.

6-18.1 Application.

6-18.1.1 This test method shall apply to the toe section of protective footwear.

6-18.2 Specimens.

6-18.2.1 A minimum of three footwear items shall be tested for both impact and compression.

6-18.3 Sample Preparation.

6-18.3.1 Samples for conditioning shall be complete footwear toe sections.

6-18.3.2 Specimens shall be conditioned as specified in 6-1.3.

6-18.4 Procedure.

6-18.4.1 Footwear specimens shall be tested in accordance with Section 1.4 of ANSI Z41, *Standard for Personal Protection—Protective Footwear.*

6-18.5 Report.

6-18.5.1 The impact and compression forces for each specimen shall be reported. The clearance after impact and the compression forces shall be recorded.

6-18.6 Interpretation.

6-18.6.1 One or more footwear specimens failing this test shall constitute failing performance.

6-19 Physical Penetration Resistance Test.

6-19.1 Application.

6-19.1.1 This test method shall apply to protective helmets.

6-19.2 Specimens.

6-19.2.1 Specimens shall be selected as specified in 2-3.9.

6-19.3 Sample Preparation.

6-19.3.1 Samples for conditioning shall be complete helmets.

6-19.3.2 Specimens shall be conditioned for each environmental condition specified in 6-1.3, 6-1.4, 6-1.5, 6-1.6, and 6-1.7 prior to each physical penetration.

6-19.4 Apparatus.

6-19.4.1 The ISO Size J headform shall conform to the nominal dimensions in Figure 6-16.4.1. Above the test line, it shall have an electrically conductive surface that is electrically connected to the contact indicator.

6-19.4.2 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, +0.5 degree, a height of 3.8 cm (1.5 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.

6-19.4.3 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.

6-19.4.4 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.

6-19.5 Procedure.

6-19.5.1 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. The helmet shall be positioned so that the penetration striker shall impact perpendicular to the helmet anywhere above the test line. The impact site shall be at least 7.6 cm (3.0 in.) from the center of a previous penetration or impact site.

6-19.5.2 The drop height of the penetration striker shall be adjusted so that the velocity at impact is at 7 m/s, ±0.1 m/s (23 ft/s, ±0.5 ft/s). A total of two penetration tests for each of the four environmental conditions specified in 6-1.3, 6-1.4, 6-1.5, 6-1.6, and 6-1.7 shall be conducted in such a manner that at least one penetration test shall be performed in each of the test areas defined in Figure 6-1.6.1. The helmet shall be environmentally conditioned prior to each penetration test. A minimum of two penetration test blows shall be applied at different test areas on each helmet.

6-19.6 Report.

6-19.6.1 The pass/fail result for each helmet shall be reported.

6-19.7 Criteria.

6-19.7.1 One or more helmet specimens failing this test shall constitute failing performance.

6-20 Puncture Resistance Test One.

6-20.1 Application.

6-20.1.1 This test method shall apply to protective gloves and footwear uppers.

6-20.2 Specimens.

6-20.2.1 A minimum of three specimens measuring at least 15.24 cm (6 in.) square shall be tested.

6-20.3 Sample Preparation.

6-20.3.1 Samples for conditioning shall be complete gloves or footwear upper sections.

6-20.3.2 Specimens shall be tested after conditioning as specified in 6-1.3.

6-20.4 Procedure.

6-20.4.1 Specimens shall be tested in accordance with ASTM F 1342, *Standard Test Method for Protective Clothing Material Resistance to Puncture.*

6-20.5 Report.

6-20.5.1 The puncture force in kg force (lb force) shall be reported for each specimen. The average puncture force in kg force (lb force) shall be reported for all specimens tested.

6-20.6 Interpretation.

6-20.6.1 The average puncture force shall be used to determine pass/fail performance.

6-20.7 Specific Requirements for Testing Gloves.

6-20.7.1 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.

6-20.7.2 Glove specimens shall also be tested after wet condition as specified in 6-1.8.

6-20.7.3 Testing shall be performed as specified in 6-20.2 through 6-20.6.

6-20.8 Specific Requirements for Testing Footwear Uppers.

6-20.8.1 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.

6-20.8.2 Testing shall be performed as specified in 6-20.2 through 6-20.6.

6-21 Puncture Resistance Test Two.

6-21.1 Application.

6-21.1.1 This test method shall apply to protective footwear soles.

6-21.2 Specimens.

6-21.2.1 A minimum of three footwear soles shall be tested.

6-21.3 Sample Preparation.

6-21.3.1 Samples for conditioning shall be footwear sole sections.

6-21.3.2 Specimens shall be conditioned as specified in 6-1.3.

6-21.4 Procedure.

6-21.4.1 Puncture resistance tests shall be performed in accordance with ANSI Z41, *Standard for Personal Protection—Protective Footwear.*

6-21.5 Report.

6-21.5.1 The force necessary to puncture the sole reinforcement device of each specimen shall be reported.

6-21.6 Interpretation.

6-21.6.1 One or more footwear specimens failing this test shall constitute failing performance.

6-22 Cut Resistance Test.

6-22.1 Application.

6-22.1.1 This test method shall apply to protective gloves and footwear uppers.

6-22.2 Specimens.

6-22.2.1 A minimum of three specimens measuring at least 15.2 cm (6 in.) square shall be tested.

6-22.3 Sample Preparation.

6-22.3.1 Specimens shall be tested after conditioning as specified in 6-1.3.

6-22.4 Apparatus.

6-22.4.1 The static cut test apparatus shall consist of an L-shaped metal frame and pivoted arm that lowers a sharp-edged blade onto a sample specimen, as shown in Figure 6-22.4.1.

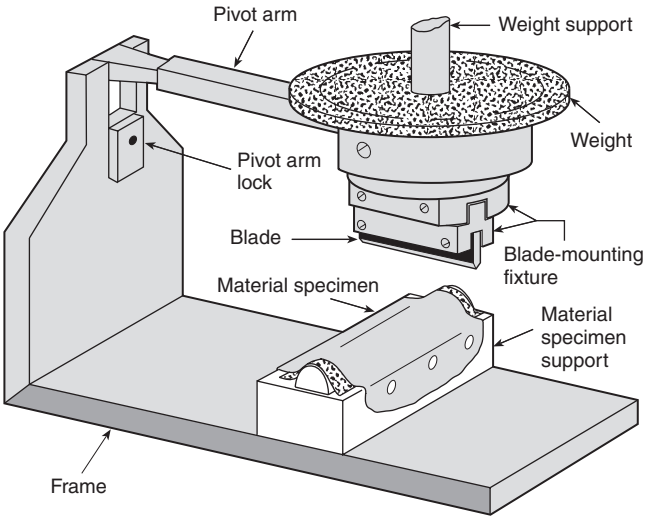


Figure 6-22.4.1 Static cut test apparatus.

6-22.4.2 A locking mechanism shall be mounted upright on the L-frame to engage the pivoted 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.

6-22.4.3 The blade shall be mounted in a blade holder at the outer end of the pivoted arm, as shown in Figure 6-22.4.3. The blade shall be mounted so its sharp edge is tangential.

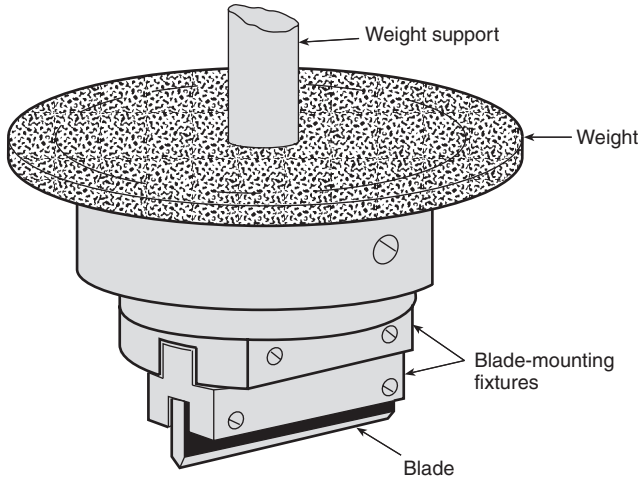


Figure 6-22.4.3 Test blade holder.

6-22.4.4 The pivoted 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 pivoted arm, blade holder, and blade together shall weigh 0.91 kg (2 lb) and shall contribute to the force applied to the blade.

6-22.4.5 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 6-22.4.5.

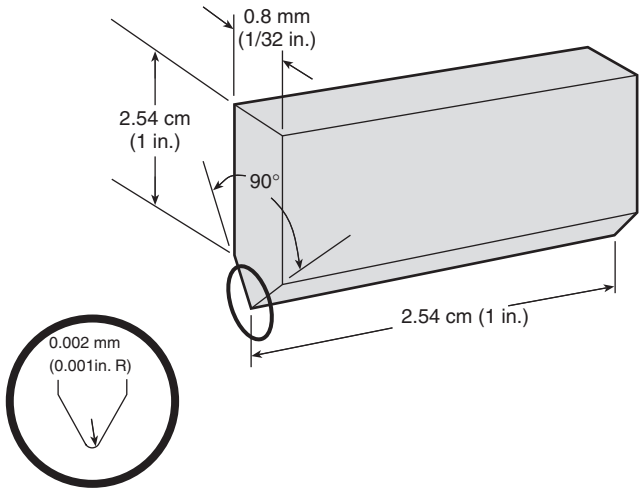


Figure 6-22.4.5 Test blade.

6-22.4.6 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.

6-22.4.7 A test blade shall be either replaced or resharpened when the sharpness (geometry) of the blade edge changes.

6-22.4.8 The specimen support assembly shall consist of a soft wood block with dimensions of 5.1 cm × 5.1 cm × 10.2 cm (2 in. × 2 in. × 4 in.) and a 1.9-cm (0.75-in.) diameter, half-rounded, soft wood rod mounted to the block as shown in Figure 6-22.4.8.

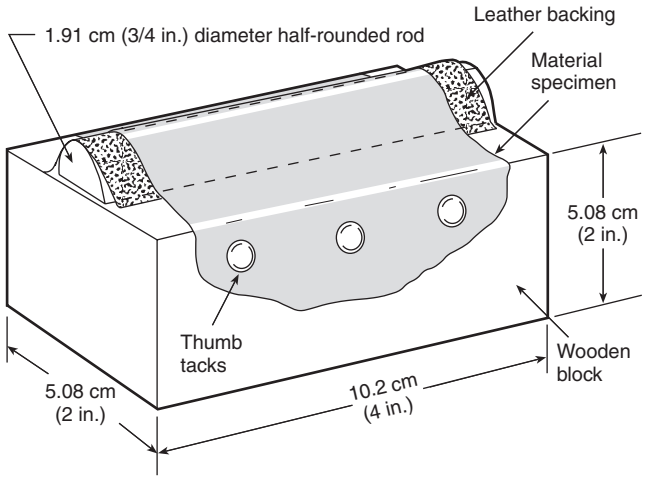


Figure 6-22.4.8 Material specimen support.

6-22.4.9 A 1.3-mm (0.05-in.) thick soft leather strip shall be draped over the rod and block to simulate the cushioning effects of hand skin and to protect the blade on a cut-through as shown in Figure 6-22.4.8.

6-22.4.10 The sample specimen support shall be designed to be freestanding so that several parallel-cut attempts, spaced not less than 3.18 mm (0.125 in.) apart, can be made on each sample specimen.

6-22.5 Procedure.

6-22.5.1 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.

6-22.5.2 Three sample specimens shall be tested, and two cuts shall be made on each sample specimen.

6-22.5.3 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 6-22.4.8. The support assembly shall be positioned on the base of the L-frame, as shown in Figure 6-22.4.1.

6-22.5.4 The pivoted arm and blade holder shall be initially loaded with weights to the maximum force of 9.1 kg (20 lb). A blade shall be inserted into the holder, and the pivoted arm shall be lowered to bring the blade edge into contact with the sample specimen surface.

6-22.5.5 The initial specimen-edge contact shall be made 3.0 mm ($^1/_8$ in.) from the leading end of the blade.

6-22.5.6 The specimen assembly shall be drawn smoothly under the weighted blade at a rate no greater than 51 cm/min (20 in./min) in a direction parallel to the blade edge. The support assembly shall be stopped when the specimen-edge contact is 0.3 cm (0.125 in.) from the trailing edge of the blade.

6-22.5.7 The pivoted 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.

6-22.5.8 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.

6-22.5.9 If the sample specimen surface has been cut, the weight shall be reduced by 0.91 kg (2 lb) and the test procedure shall be repeated.

6-22.5.10 In repeating the test procedure, the sample specimen shall be repositioned so that the blade edge is 3.18 mm (0.125 in.) to the side of the previous cut attempt.

6-22.5.11 The weights shall be reduced in 0.91-kg (2-lb) increments, and the test procedure shall be repeated until the point of no-cut is reached or the minimum weight of 0.91 kg (2 lb) is reached.

6-22.5.12 If all available test sites on the sample specimen have been used, testing shall continue on an identical, fresh sample.

6-22.5.13 The test procedure shall be repeated for the remaining sample specimens, starting with a weight 2 kg (4 lb) heavier than the first noted for cut, until two cuts have been made on a single sample specimen.

6-22.6 Report.

6-22.6.1 The cut force in kg force (lb force) shall be reported to the nearest 1.0 kg (2 lb) for each sample specimen. The average cut force in kg force (lb force) shall be reported for all specimens tested.

6-22.6.2 If the sample specimen has not been cut, a force of > 9.1 kg (> 20 lb) shall be reported.

6-22.7 Interpretation.

6-22.7.1 The average cut force shall be used to determine pass/fail performance.

6-22.8 Specific Requirements for Testing Gloves.

6-22.8.1 Samples for conditioning shall be whole gloves.

6-22.8.2 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.

6-22.8.3 Glove specimens shall also be tested after wet conditioning as specified in 6-1.8.

6-22.9 Specific Requirements for Testing Footwear Uppers.

6-22.9.1 Samples for conditioning shall be whole footwear items.

6-22.9.2 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.

6-23 Faceshield/Goggle Component Lens Scratch Resistance Test.

6-23.1 Application.

6-23.1.1 This test method shall apply to faceshield/goggle component lenses.

6-23.2 Specimens.

6-23.2.1 A minimum of four faceshield/goggle component lenses shall be selected.

6-23.3 Sample Preparation.

6-23.3.1 Specimens shall be conditioned as specified in 6-1.3.

6-23.3.2 Samples for conditioning shall be faceshield/goggle component lenses.

6-23.3.3 Seven samples shall be chosen from a minimum of four lenses. Four samples shall be taken from the left viewing area, and three samples shall be taken from the right viewing area. One of the four samples taken from the left viewing area shall be the setup sample.

6-23.3.4 The left viewing area test samples shall include all of the following criteria:

(a) The sample shall be a square measuring 51 mm × 51 mm (2 in. × 2 in.)

(b) Two edges of the square section shall be parallel within ±2 degrees of the axis of the cylinder or cone in the center of the sample.

(c) The sample shall be taken from the left side of the faceshield/goggle component lens and shall, as a minimum, contain that portion of the lens that is directly in front of the pupil of the left eye as defined by positioning a complete faceshield/goggle component in accordance with the eye/face positioning index on an Alderson 50 percentile male headform.

6-23.3.5 The right viewing area test samples shall include all of the following criteria:

(a) The sample shall be a square measuring 51 mm × 51 mm (2 in. × 2 in.).

(b) Two edges of the square section shall be parallel within ±2 degrees of the axis of the cylinder or cone in the center of the sample.

(c) The sample shall be taken from the right side of the faceshield/goggle component lens and shall, as a minimum, contain that portion of the lens that is directly in front of the pupil of the right eye as defined by positioning a complete faceshield/goggle component in accordance with the eye/face positioning index on an Alderson 50 percentile male headform.

6-23.3.6 Each of the samples shall be cleaned in the following manner:

(a) The sample shall be rinsed with clean tap water.

(b) The sample shall be washed with a solution of nonionic/low phosphate detergent and water using a clean, soft, gauze pad.

(c) The sample shall be rinsed with clean water.

(d) The sample shall be blown dry with filtered compressed air or nitrogen.

6-23.4 Apparatus.

6-23.4.1 The faceshield/goggle component lens scratch test apparatus shall be constructed in accordance with Figure 6-23.4.1.

6-23.4.2 The sample holder shall be configured with a flat surface under the lens or with an inner radius support.

6-23.4.3 The pad holder shall consist of a cylinder 9.5 mm (0.38 in.) high and 25.4 mm (1 in.) in diameter with a radius of curvature equal to the radius of curvature of the outside of the lens in the viewing area ±0.25 diopter. This cylinder shall be rigidly affixed to the stroking arm by a No. 10-32 UNF threaded rod.

6-23.4.4 The pad shall be a Blue Streak M306M wool felt polishing pad 23.8 mm (0.94 in.) in diameter.

6-23.4.5 The abrasive disc shall be made from 3M Part No. 7415, Wood Finishing Pad. A disc 23.8 mm (0.94 in.) in diameter shall be cut from the abrasive sheet.

6-23.5 Procedure.

6-23.5.1 The haze of the sample shall be measured using a haze meter in accordance with ASTM D 1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*, and shall be recorded as follows:

(a) The haze shall be measured in the center of the sample ±1.6 mm (0.063 in.).

(b) The sample shall be repositioned to achieve the maximum haze value within the area specified in 6-23.5.1(a).

(c) The haze meter shall have a specified aperture of 22.3 mm (0.88 in.).

(d) The haze meter shall have a visual display showing 0.1 percent resolution.

(e) The haze meter shall be calibrated before and after each day's use following the procedures outlined in ASTM D 1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*.

6-23.5.2 The setup sample shall be placed cover side up in the test apparatus sample holder.

6-23.5.3 The pad holder, pad, and abrasive disc shall be installed on the stroking arm. The stroking arm shall be leveled to ±3 degrees by adjusting the threaded pin. The pin shall be secured to prevent rotation of the pad holder. The axis of curvature of the pad holder shall be coincident with the axis of curvature of the lens.

6-23.5.4 The stroking arm shall be counterbalanced with the pad holder, pad, and abrasive disc in place.

6-23.5.5 The setup sample shall be replaced with one of the six samples to be tested.

6-23.5.6 A test weight of 1 kg, ±8 g (2.2 lb, ±0.2 oz) shall be installed on the pin above the test sample.

6-23.5.7 The test shall be run for 200 cycles, ±1 cycle. One cycle shall consist of a complete revolution of the eccentric wheel.

6-23.5.8 The length of stroke shall be 14.3 mm (0.56 in.), producing a pattern 38.1 mm (1.5 in.) long. The frequency of the stroke shall be 60 cycles/min, ±1 cycle/min. The center of the stroke shall be within 1.6 mm (±0.063 in.) of the center of the sample.

6-23.5.9 The sample shall be removed and cleaned following the procedure specified in 6-23.3.6. The abrasive disc shall be discarded.

6-23.5.10 The testing steps specified in 6-23.5 shall be repeated five additional times with a new sample and abrasive disc.

6-23.6 Report.

6-23.6.1 After each of the six samples have been tested and cleaned, the haze of the sample shall be measured following the procedure specified in 6-23.5.1.

6-23.6.2 The delta haze shall be calculated by subtracting the initial haze measurement from the final haze measurement.

6-23.7 Interpretation.

6-23.7.1 The six delta haze values shall be averaged. The resultant value shall be compared to the value specified in 5-2.19 to determine pass/fail.

6-24 Abrasion Resistance Test.

6-24.1 Application.

6-24.1.1 This test method shall apply to protective footwear soles and heels.

6-24.2 Specimens.

6-24.2.1 A minimum of three footwear soles with heels shall be tested.

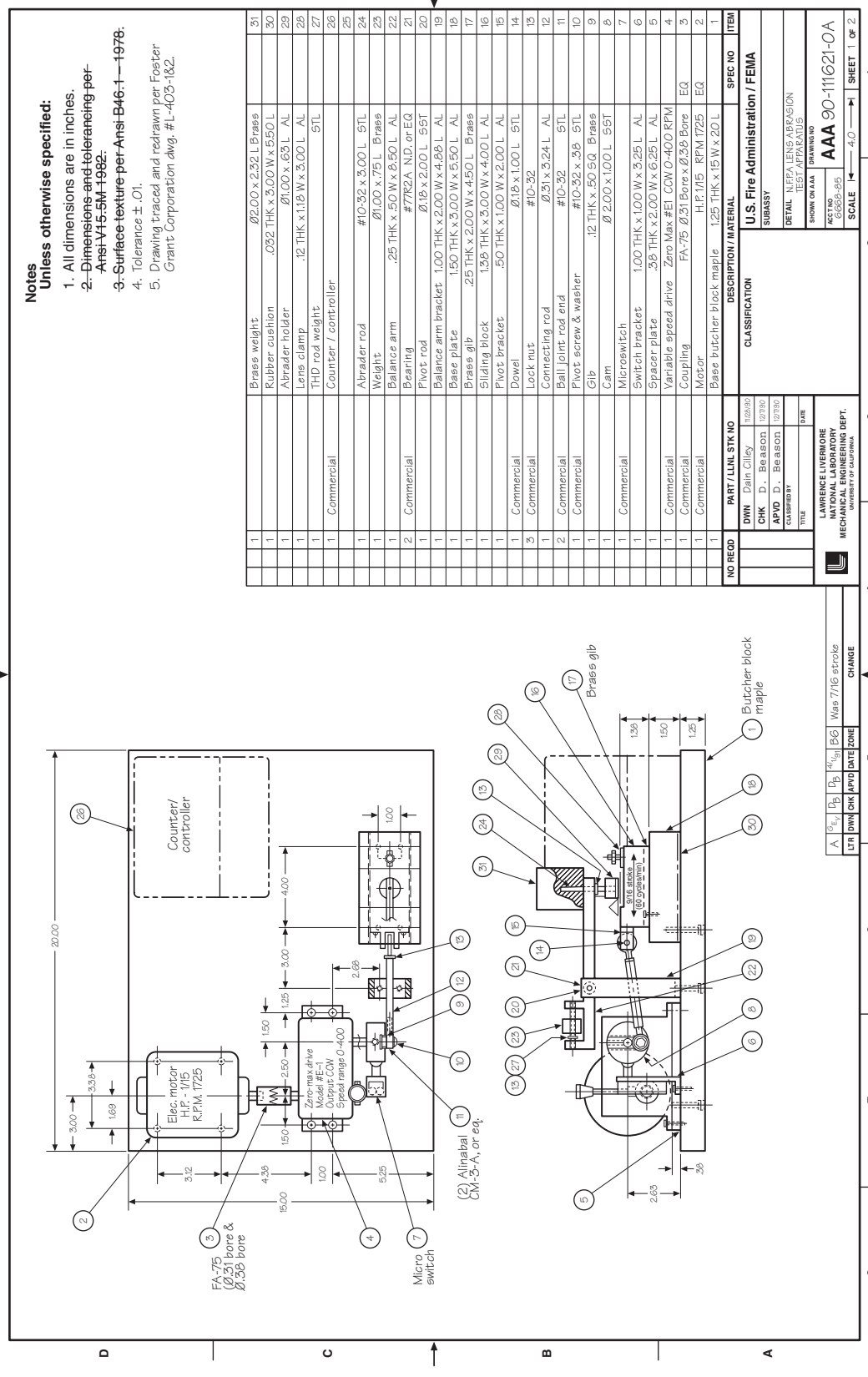


Figure 6-23.4.1 Faceshield/goggle component lens test apparatus.

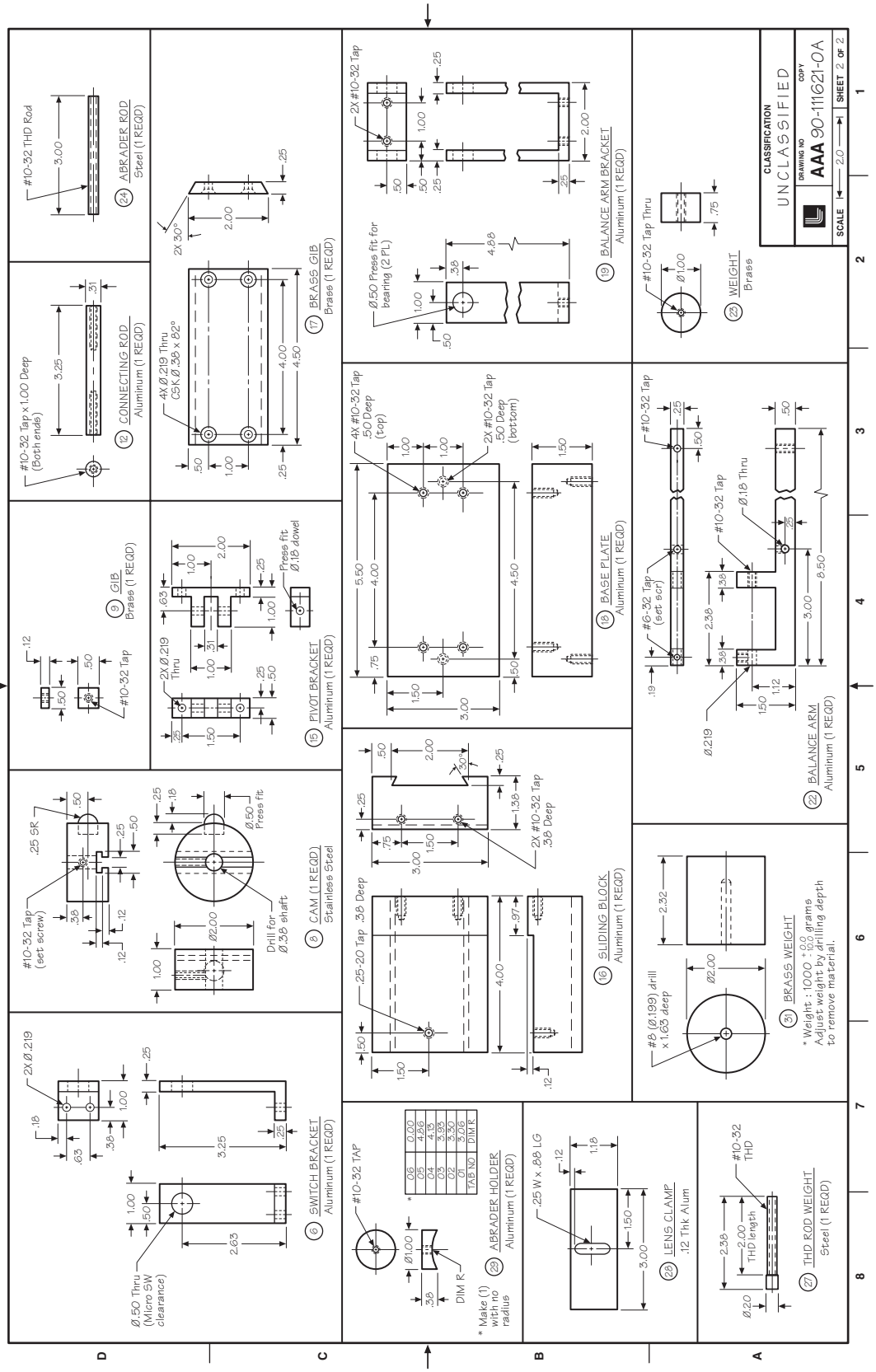


Figure 6-23.4.1 Faceshield/goggle component lens test apparatus (con't).

6-24.3 Sample Preparation.

6-24.3.1 Samples for conditioning shall be complete footwear soles with heel.

6-24.3.2 Specimens shall be conditioned as specified in 6-1.3.

6-24.4 Procedure.

6-24.4.1 Puncture resistance tests shall be performed in accordance with ASTM D 1630, *Standard Test Method for Rubber Property—Abrasion Resistance (Footwear Abrader)*.

6-24.5 Report.

6-24.5.1 The abrasion resistance rating of each specimen shall be reported.

6-24.6 Interpretation.

6-24.6.1 One or more footwear specimens failing this test shall constitute failing performance.

6-25 Cleaning Shrinkage Resistance Test.

6-25.1 Application.

6-25.1.1 This test method shall apply to the protective garment outer shell, moisture barrier, thermal barrier, and winter liner; and the hood and wristlet.

6-25.1.2 Modifications to this test method for testing woven textile materials shall be as specified in 6-25.7.

6-25.1.3 Modifications to this test method for testing knit and stretch woven materials shall be as specified in 6-25.8.

6-25.2 Specimens.

6-25.2.1 Cleaning shrinkage resistance testing shall be conducted on three specimens of each material, and each separable layer of a composite material shall be tested separately.

6-25.3 Sample Preparation.

6-25.3.1 Specimens to be tested shall be conditioned as specified in 6-1.3.

6-25.4 Procedure.

6-25.4.1 Specimens shall be tested using five cycles of Machine Cycle 1, Wash Temperature V, and Drying Procedure Ai of ANSI/AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

6-25.4.2 A 1.8-kg, ±0.1 kg (4.0-lb, ±0.2 lb) load shall be used. A laundry bag shall not be used.

6-25.4.3 Specimen marking and measurements shall be conducted in accordance with the procedure specified in ANSI/AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

6-25.4.4 Knit fabric specimens shall be pulled to original dimensions and shall be allowed to relax for 1 minute prior to measurement.

6-25.5 Report.

6-25.5.1 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.

6-25.6 Interpretation.

6-25.6.1 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.

6-25.7 Specific Requirements for Testing Woven Textile Materials.

6-25.7.1 Each specimen shall be 38.1 cm × 38.1 cm, ±1.3 cm (15 in. × 15 in., ±0.5 in.) and shall be cut from the fabric to be utilized in the construction of the clothing item.

6-25.7.2 Samples for conditioning shall be at least 1 m (1 yd) square of each material.

6-25.7.3 Testing shall be performed as specified in 6-25.2 through 6-25.6.

6-25.8 Specific Requirements for Testing Knit and Stretch Woven Textile Materials.

6-25.8.1 Other than for wristlets, the dimensions of each specimen shall be 38.1 cm × 38.1 cm, ±1.3 cm (15 in. × 15 in., ±0.5 in.) and shall be cut from the fabric to be utilized in the construction of the clothing item.

6-25.8.2 The dimensions of wristlet specimens shall be 11.5 mm × 11.5 mm, ±13 mm (4.5 in. × 4.5 in., ±0.5 in.) and shall be cut from the wristlet fabric to be utilized in the construction of the clothing item.

6-25.8.3 Samples for conditioning shall include material that is at least 5.08 cm (2 in.) larger in each of the two required specimen dimensions.

6-25.8.4 Testing shall be performed as specified in 6-25.2 through 6-25.6.

6-26 Water Absorption Resistance Test.

6-26.1 Application.

6-26.1.1 This test method shall apply to the protective garment outer shell and collar lining materials.

6-26.2 Specimens.

6-26.2.1 Three specimens of outer shell material and collar lining material measuring at least 20.3 cm × 20.3 cm (8 in. × 8 in.) shall be tested separately for water absorption.

6-26.3 Sample Preparation.

6-26.3.1 Samples for conditioning shall be at least 1 m (1 yd) square of each material.

6-26.3.2 Specimens shall be tested after being subjected to the procedure specified in 6-1.2.

6-26.4 Procedure.

6-26.4.1 Specimens shall be tested in accordance with Method 5504, "Water Resistance of Coated Cloth; Spray Absorption Method," of Federal Test Method Standard 191A, *Textile Test Methods*. The normal outer surface shall be exposed to the water spray.

6-26.4.2 For collar lining materials, the exposure surface shall be the surface of the fabric that is next to the skin when the collar is closed in the raised position.

6-26.5 Report.

6-26.5.1 The percent water absorbed for each specimen shall be reported. The average percent water absorption shall be calculated and reported.

6-26.6 Interpretation.

6-26.6.1 The average percent water absorption shall be used for determining pass/fail performance.

6-27 Water Penetration Test.

6-27.1 Application.

6-27.1.1 This test method shall apply to moisture barrier materials and moisture barrier seams.

6-27.1.2 Modifications to this test method for testing moisture barrier materials shall be as specified in 6-27.7.

6-27.1.3 Modifications to this test method for testing moisture barrier seams shall be as specified in 6-27.8.

6-27.2 Specimens.

6-27.2.1 A minimum of five specimens of moisture barrier material shall be tested.

6-27.2.2 Seam specimens shall be cut so that the seam divides the specimen into two equal halves.

6-27.3 Sample Preparation.

6-27.3.1 Specimens shall be tested both before and after being subjected to the procedure specified in 6-1.2.

6-27.3.2 Specimens to be tested shall be conditioned as specified in 6-1.3.

6-27.3.3 Specimens to be tested shall then be conditioned as specified in 6-1.5.

6-27.4 Procedures.

6-27.4.1 Procedure A.

6-27.4.1.1 Specimens shall be tested at 1.76 kg/cm^2 (25 psi) in accordance with Method 5512, "Water Resistance of Coated Cloth; High Range, Hydrostatic Pressure Method," of Federal Test Method Standard 191A, *Textile Test Methods*.

6-27.4.2 Procedure B.

6-27.4.2.1 Specimens shall be tested at 0.07 kg/cm^2 (1 psi) for 5 minutes in accordance with Method 5516, "Water Resistance of Cloth; Water Permeability; Hydrostatic Pressure Method," of Federal Test Method Standard 191A, *Textile Test Methods*.

6-27.5 Report.

6-27.5.1 The pass/fail results for each specimen shall be reported.

6-27.6 Interpretation.

6-27.6.1 The appearance of any water shall constitute failure.

6-27.6.2 One or more test failures of any specimen against any liquid shall constitute failure of the material.

6-27.7 Specific Requirements for Testing Moisture Barrier Materials.

6-27.7.1 Samples for conditioning shall be at least 1 m (1 yd) square.

6-27.7.2 Samples for conditioning as specified in 6-1.5 shall be 15 cm (6 in.) squares cut from sample subjected to the procedures specified in 6-1.2.

6-27.7.3 Specimens shall be tested as specified in 6-27.4.1, Procedure A, and 6-27.4.2, Procedure B.

6-27.8 Specific Requirements for Testing Moisture Barrier Seams.

6-27.8.1 Samples for conditioning shall be at least 15.2 cm × 1 m (6 in. × 1 yd), with the seam bisecting the sample in the longitudinal direction.

6-27.8.2 Samples for conditioning as specified in 6-1.5 shall be 15-cm (6-in.) squares cut from sample subjected to the procedures specified in 6-1.2.

6-27.8.3 Specimens shall be tested as specified in 6-27.4.2, "Procedure B."

6-28 Liquid Penetration Resistance Test.

6-28.1 Application.

6-28.1.1 This test shall apply to protective garment materials, protective gloves, and footwear.

6-28.1.2 Modifications to this test method for testing protective garment materials shall be as specified in 6-28.7.1, 6-28.7.2, and 6-28.7.3.

6-28.1.3 Modifications to this test method for testing protective gloves shall be as specified in 6-28.8.

6-28.1.4 Modifications to this test method for testing protective footwear shall be as specified in 6-28.9.

6-28.2 Specimens.

6-28.2.1 A minimum of three specimens shall be tested. Specimens shall consist of three 7.6-cm (3-in.) squares for each material type.

6-28.3 Sample Preparation.

6-28.3.1 Specimens shall be tested after being subjected to the procedure specified in 6-1.2.

6-28.3.2 Specimens to be tested shall be conditioned as specified in 6-1.3.

6-28.3.3 Specimens to be tested shall then be conditioned as specified in 6-1.5.

6-28.4 Procedure.

6-28.4.1 Liquid penetration resistance testing shall be conducted in accordance with ASTM F 903, *Standard Test Method for Resistance of Protective Clothing Materials to Penetration by Liquids*, using exposure Procedure C.

6-28.4.2 Each of the following liquids shall be tested separately against each sample specimen:

(a) Aqueous film-forming foam (AFFF), 3 percent concentrate

(b) Battery acid (37 percent w/w sulfuric acid)

(c) Fire-resistant hydraulic fluid, phosphate ester base

(d) Surrogate gasoline fuel C as defined in ASTM D 471, a 50/50 percent by volume of Toluene and Iso-octane

(e) Swimming pool chlorinating chemical containing at least 65 percent free chlorine (saturated solution)

6-28.4.3 The normal outer surface of the material shall be exposed to the liquid as oriented in the clothing item.

6-28.5 Report.

6-28.5.1 The pass/fail result for each specimen shall be reported.

6-28.6 Interpretation.

6-28.6.1 One or more test failures of any specimen against any liquid shall constitute failure of the material.

6-28.7 Specific Requirements for Testing Moisture Barrier Materials.

6-28.7.1 Samples for conditioning shall be at least 1 m (1 yd) square.

6-28.7.2 Specimens shall consist of a composite of layers that act as a barrier. All layers must be arranged in proper order.

6-28.7.3 Testing shall be performed as specified in 6-28.2 through 6-28.6.

6-28.8 Specific Requirements for Testing Glove Materials.

6-28.8.1 Three specimens each shall be taken from the sample gloves at the palm, back, and seam areas.

6-28.8.2 Samples for conditioning shall be whole gloves.

6-28.8.3 Testing shall be performed as specified in 6-28.2 through 6-28.6.

6-28.9 Specific Requirements for Testing Footwear Materials.

6-28.9.1 Samples for conditioning shall be whole footwear.

6-28.9.2 Three specimens each shall be taken from the upper and any upper seam areas.

6-28.9.3 Testing shall be performed as described in 6-28.2 through 6-28.6.

6-29 Viral Penetration Resistance Test.

6-29.1 Application.

6-29.1.1 This test shall apply to protective garment moisture barriers, and moisture barrier seams, protective gloves, and protective footwear.

6-29.1.2 Modifications to this test method for testing moisture barriers shall be as specified in 6-29.7.

6-29.1.3 Modifications to this test method for testing moisture barrier seams shall be as specified in 6-29.8.

6-29.1.4 Modifications to this test method for testing gloves shall be as specified in 6-29.9.

6-29.1.5 Modifications to this test method for testing footwear shall be as specified in 6-29.10.

6-29.2 Specimens.

6-29.2.1 A minimum of three specimens shall be tested. Specimens shall consist of three 7.6-cm (3-in.) squares for each material type.

6-29.3 Sample Preparation.

6-29.3.1 Specimens other than footwear shall be tested after being subjected to the procedure specified in 6-1.2.

6-29.3.2 All specimens to be tested shall be conditioned as specified in 6-1.3.

6-29.3.3 All specimens to be tested shall then be conditioned as specified in 6-1.5.

6-29.4 Procedure.

6-29.4.1 Liquid penetration resistance testing shall be conducted in accordance with ASTM F 1671, *Standard Test Method for Resistance of Materials Used in Protective Clothing To Penetration by Blood-Borne Pathogens Using Phi-X-174 Bacteriophage as a Test System.*

6-29.5 Report.

6-29.5.1 The pass/fail result for each specimen shall be reported.

6-29.6 Interpretation.

6-29.6.1 A failure of any specimen against any chemical constitutes failure of the material.

6-29.7 Specific Requirements for Testing Moisture Barrier Materials.

6-29.7.1 Specimens shall consist of the moisture barrier or that material intended to act as the moisture barrier.

6-29.7.2 Samples for conditioning shall be at least 1 m (1 yd) square.

6-29.7.3 Samples for conditioning as specified in 6-1.5 shall be 15 cm (6 in.) squares cut from samples subjected to the procedures in 6-1.2.

6-29.7.4 Testing shall be as described in 6-29.2 through 6-29.6.

6-29.8 Specific Requirements for Testing Moisture Barrier Seams.

6-29.8.1 Samples for conditioning shall be at least 15.2 cm × 1 m (6 in. × 1 yd) with the seam bisecting the sample in a longitudinal direction.

6-29.8.2 Samples for conditioning as specified in 6-1.5 shall be 15 cm (6 in.) squares cut from samples subjected to the procedures in 6-1.2.

6-29.8.3 Testing shall be as described in 6-29.2 through 6-29.6.

6-29.9 Specific Requirements for Testing Glove Materials.

6-29.9.1 Three specimens each shall be taken from sample gloves at the palm, back, and seam areas.

6-29.9.2 Samples for conditioning shall be whole gloves.

6-29.9.3 Testing shall be as described in 6-29.2 through 6-29.6.

6-29.10 Specific Requirements for Testing Footwear Materials.

6-29.10.1 Three specimens each shall be taken from the upper and any upper seam areas.

6-29.10.2 Samples for conditioning shall be whole footwear.

6-29.10.3 Testing shall be as described in 6-29.2 through 6-29.6.

6-30 Corrosion Resistance Test.

6-30.1 Application.

6-30.1.1 This test method shall apply to hardware items on protective garments, helmets, gloves, footwear, and partial eye/face protective devices.

6-30.1.2 Modifications to this test method for testing garment and glove hardware shall be as specified in 6-30.7.

6-30.1.3 Modifications to this test method for testing helmet and partial eye/face protective devices shall be as specified in 6-30.8.

6-30.1.4 Modifications to this test method for testing footwear shall be as specified in 6-30.9.

6-30.2 Specimens.

6-30.2.1 A total of three specimens of each hardware type shall be tested.

6-30.3 Sample Preparation.

6-30.3.1 Specimens shall not be conditioned.

6-30.4 Procedure.

6-30.4.1 Specimens shall be tested in accordance with ASTM B 117, *Standard Method of Salt Spray (Fog) Testing*. Hardware items shall be exposed to a 5 percent, ±1 percent saline solution for a period of 20 hours.

6-30.4.2 Immediately following the storage specified in 6-30.4.1 and prior to examination, specimens shall be rinsed under warm, running tap water and dried with compressed air.

6-30.4.3 Specimens shall then be examined visually with the unaided eye to determine the presence of corrosion.

6-30.4.4 The functionality of each specimen shall be evaluated.

6-30.5 Report.

6-30.5.1 The presence of corrosion and the functionality for each specimen shall be reported.

6-30.6 Interpretation.

6-30.6.1 One or more hardware specimens failing this test shall constitute failing performance for the hardware type.

6-30.7 Specific Requirements for Testing Garment and Glove Hardware.

6-30.7.1 Samples for conditioning shall be whole hardware items.

6-30.7.2 A total of three specimens of each hardware type shall be tested.

6-30.8 Specific Requirements for Testing Helmets and Partial Eye/Face Protective Devices.

6-30.8.1 Samples for conditioning shall be whole helmets and partial eye/face protective devices.

6-30.8.2 A total of three different helmets or partial eye/face protective devices shall be tested.

6-30.9 Specific Requirements for Testing Footwear.

6-30.9.1 Samples for conditioning shall be whole hardware items.

6-30.9.2 A total of three specimens of each hardware type shall be tested.

6-30.9.3 Functionality of the hardware shall not be evaluated.

6-31 Electrical Insulation Test One.

6-31.1 Application.

6-31.1.1 This test method shall apply to protective helmets.

6-31.2 Specimens.

6-31.2.1 Specimens shall be selected as specified in 2-3.9.

6-31.3 Sample Preparation.

6-31.3.1 Specimens shall be conditioned as specified in 6-1.3.

6-31.3.2 Samples for conditioning shall be complete helmets.

6-31.4 Apparatus.

6-31.4.1 The following equipment shall be provided for 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 leakage current 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

6-31.4.2 The following equipment shall be provided for 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 within 2 percent

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

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

(f) An aluminum ISEA size 7 headform modified in accordance with Table 6-15.4.1 and Figures 6-15.4.1(a) through (c)

6-31.5 Procedures.

6-31.5.1 Procedure A.

6-31.5.1.1 Where helmets have a vertical adjustment to the suspension system, the vertical adjustment shall be set to raise the helmet to the highest position, with maximum crown clearance between the headform and the inside of the helmet crown, prior to establishing the helmet positioning index. The helmet shall be placed on the headform specified in Figure 6-6.12.3 and positioned according to the helmet positioning index for this test. After proper positioning in accordance with the helmet positioning index, the dielectric test plane specified in Figure 6-31.5.1.2 shall be determined.

6-31.5.1.2 The helmet shall be inverted and positioned in accordance with the inverted helmet positioning index while maintaining all vertical adjustments set at their highest position. The inverted helmet shall be filled with tap water equal to the dielectric test plane as shown in Figure 6-31.5.1.2. The helmet shall then be submerged in tap water to the same level as the water on the inside of the helmet.

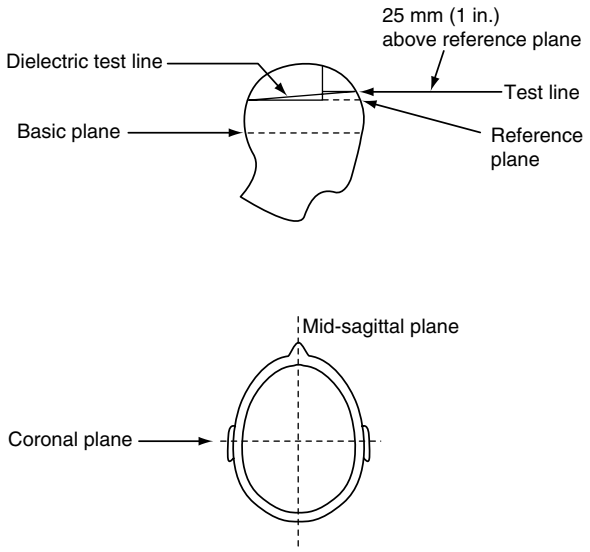


Figure 6-31.5.1.2 Test setup.

6-31.5.1.3 A 60-Hz alternating current voltage shall be applied to the water in the vessel and increased to 2200 volts. The voltage shall be maintained at 2200 volts, ±2 percent for 1 minute.

6-31.5.2 Procedure B.

6-31.5.2.1 The sample helmet and retention 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 not longer than 2 minutes.

6-31.5.2.2 The sample helmet shall then be mounted on the modified ISEA aluminum size 7 headform, with the chinstrap firmly secured to the headform by means of the conductive terminal junction bolt.

6-31.5.2.3 A lead carrying 60-Hz alternating voltage shall be attached to all metal parts on the helmet's exterior, at or above the brim edge. A second pickup lead shall be attached to the terminal junction bolt. Voltage shall be applied to the externalhelmet shell lead and increased to 2200 volts, ± 2 percent volts. The voltage shall be maintained for 15 seconds.

6-31.6 Report.

6-31.6.1 Any current leakage or evidence of breakdown shall be recorded for each helmet.

6-31.7 Interpretation.

6-31.7.1 One or more helmet specimens failing this test shall constitute failing performance.

6-32 Electrical Insulation Test Two.

6-32.1 Application.

6-32.1.1 This test shall apply to protective footwear.

6-32.2 Specimens.

6-32.2.1 A minimum of three footwear items shall be tested.

6-32.3 Sample Preparation.

6-32.3.1 Samples for conditioning shall be whole footwear.

6-32.3.2 Specimens shall be conditioned as specified in 6-1.3.

6-32.4 Procedure.

6-32.4.1 Sample footwear shall be tested to 14,000 V (rms) in accordance with Section 5.1.1 of ASTM F 1116, *Standard Test Method for Determining Dielectric Strength of Overshoe Footwear*. The electrode inside the boot shall be conductive metal shot.

6-32.5 Report.

6-32.5.1 Any current leakage or evidence of breakdown shall be recorded for each footwear item.

6-32.6 Interpretation.

6-32.6.1 One or more footwear specimens failing this test shall constitute failing performance.

6-33 Overall Liquid Integrity Test One.

6-33.1 Application.

6-33.1.1 This test shall apply to protective gloves.

6-33.2 Specimens.

6-33.2.1 A minimum of three glove pairs each for size small and large shall be used for testing.

6-33.3 Sample Preparation.

6-33.3.1 Samples for conditioning shall be whole gloves.

6-33.3.2 Specimens shall be tested after being subjected to the procedure specified in 6-1.2.

6-33.3.3 Specimens shall be tested after being subjected to the procedure specified in 6-1.5.

6-33.3.4 Specimens to be tested shall be conditioned as specified in 6-1.3.

6-33.4 Apparatus.

6-33.4.1* A water markable glove shall cover all areas of the tester's hand. The water markable glove shall be constructed of a fabric that is marked easily by water to determine leakage.

6-33.4.2 Water used for integrity testing shall be treated with a nonfoaming surfactant to lower its surface tension to less than 34 dynes/cm, ±5 dynes/cm.

6-33.5 Procedure.

6-33.5.1 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 4-3.5.3.

6-33.5.2 The test subject shall don the glove specimen over the water markable glove.

6-33.5.3 The test subject shall immerse the glove specimen to within 2.54 cm (1.0 in.) of the top of the body of the glove specimen for 5 minutes in 20°C, ±3°C (68°F, ±5°F) water treated with a surfactant to lower its surface tension to 34 dynes/cm, ±5 dynes/cm. The test subject shall flex the glove specimen in a fist-clenching motion every 10 seconds.

6-33.5.4 The glove specimen shall be removed from the test subject's hand and the inner glove shall be inspected for water marks.

6-33.6 Report.

6-33.6.1 The appearance of any water mark on the inner glove after testing any of the three gloves shall be reported.

6-33.7 Interpretation.

6-33.7.1 The appearance of any water mark on the inner glove after testing any glove shall be considered leakage and shall constitute failing performance.

6-34 Overall Liquid Integrity Test Two.

6-34.1 Application.

6-34.1.1 This test shall apply to protective footwear.

6-34.2 Specimens.

6-34.2.1 A minimum of three footwear items shall be tested.

6-34.3 Sample Preparation.

6-34.3.1 Samples for conditioning shall be whole footwear.

6-34.3.2 Specimens shall be conditioned as specified in 6-1.3.

6-34.4 Procedure.

6-34.4.1 Protective footwear shall be tested in accordance with Appendix B of Footwear Industries of America Standard 1209, *Whole Shoe Flex*. The level of the water shall be no less than 2.54 cm (1 in.) from the lowest point of the throat.

6-34.4.2 The test shall consist of 100,000 flexes.

6-34.4.3 After flexing, the footwear specimen shall be placed in a container that allows its immersion in tap water, treated with a dye and surfactant that achieves a surface tension of 34 dynes/cm, ±5 dynes/cm, to a height not less than 2.54 cm (1.0 in.) from the lowest point of the throat. The paper toweling required in FIA 1209 shall be placed inside the footwear specimen such that the paper toweling intimately contacts all areas inside the footwear specimen to a height not less than 2.54 cm (1.0 in.) from the lowest point of the throat.

6-34.4.4 After 2.0 hr, ±10 min, the paper toweling shall be removed and examined for evidence of liquid leakage.

6-34.5 Report.

6-34.5.1 The appearance of any liquid on the removed paper toweling shall be reported as failure for the tested specimen.

6-34.6 Interpretation.

6-34.6.1 One or more footwear specimens failing this test shall constitute failing performance.

6-35 Retention System Test.

6-35.1 Application.

6-35.1.1 This test shall apply to protective helmets.

6-35.2 Specimens.

6-35.2.1 Specimens shall be selected as specified in 2-3.9.

6-35.3 Sample Preparation.

6-35.3.1 Samples for conditioning shall be whole helmets.

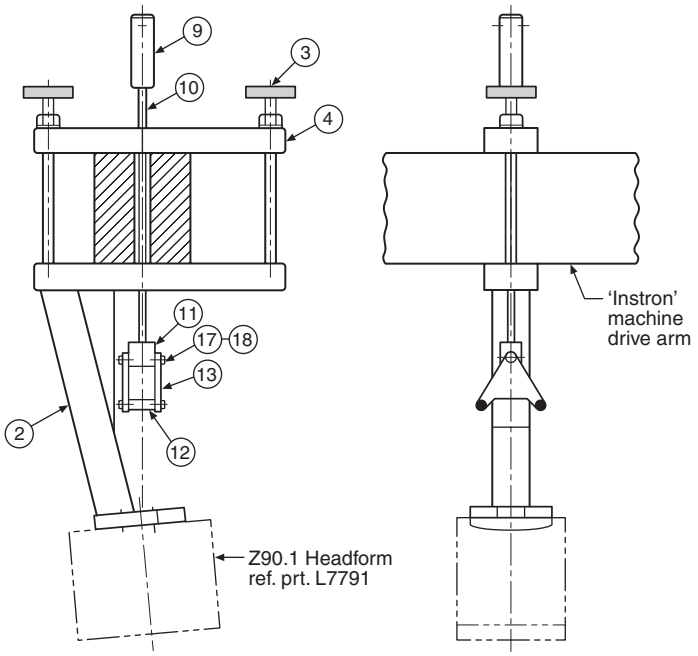
6-35.3.2 Specimens shall be conditioned as specified in 6-1.3.

6-35.4 Apparatus.

6-35.4.1 A size 7 1/2 headform shall be used and shall be of the nominal dimensions specified in Figure 6-16.4.1.

6-35.4.2 The mechanical chin structure shall consist of two rollers 1.27 cm (0.5 in.) in diameter with centers that are 7.6 cm (3.0 in.) apart. The mechanical chin structure shall conform with Figure 6-35.4.2.

6-35.4.3 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.



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–3–socket head cap screws 1/2–13 UNC x 1 1/2 Lg.

Figure 6-35.4.2 Retention system test setup.

6-35.4.4 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.

6-35.4.5 Prior to testing, the test machine shall be allowed to warm up until stability is achieved.

6-35.5 Procedure.

6-35.5.1 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 21.0 cm, ±1.0 cm (8.3 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.).

6-35.5.2 The force applied to the retention system shall be slowly increased to 445 N, ±5 N (100 lbf, ±1 lbf). The force shall be increased smoothly from 45 N to 445 N (10 lbf to 100 lbf) at between 9.0 N/sec to 45 N/sec (2.0 lbf/sec to 10 lbf/sec).

6-35.5.3 Where using a tensile testing machine, the load rate shall be 25 mm/min (1 in./min) to a limit of 445 N (100 lbf).

6-35.5.4 The distance between the top of the helmet and the rollers shall be measured and recorded again after the force has been maintained at 445 N (100 lbf) for 60 seconds, +15/–0 seconds. The difference between the second measurement and the first shall be the retention system elongation.

6-35.6 Report.

6-35.6.1 The retention system elongation shall be measured for each helmet specimen.

6-35.7 Interpretation.

6-35.7.1 One or more helmet specimens failing this test shall constitute failing performance.

6-36 Suspension System Retention Test.

6-36.1 Application.

6-36.1.1 This test shall apply to protective helmets.

6-36.2 Specimens.

6-36.2.1 Specimens shall be selected as specified in 2-3.9.

6-36.3 Sample Preparation.

6-36.3.1 Specimens shall be conditioned as specified in 6-1.3.

6-36.3.2 Samples for conditioning shall be whole helmets.

6-36.4 Apparatus.

6-36.4.1 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 6-36.4.1.

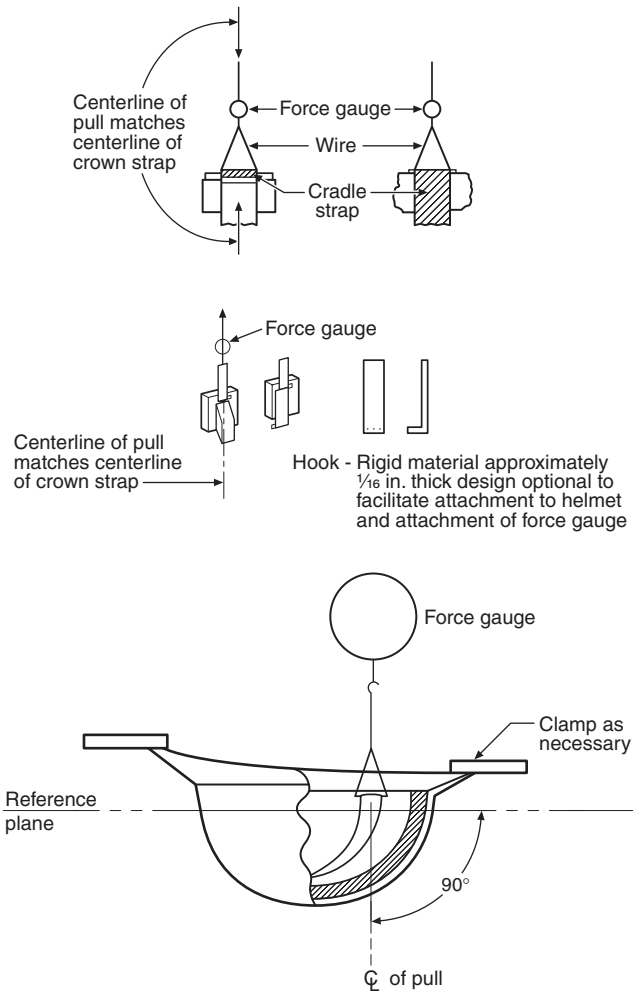


Figure 6-36.4.1 Suspension system test setup.

6-36.5 Procedure.

6-36.5.1 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 45 N, ±5 N (10 lbf, ±1 lbf). The force shall be increased from 0 N to 45 N, ±5 N (0 lbf to 10 lbf, ±1 lbf) at a load rate of 25.4 mm/min, ±5 mm (1 in./min, ±0.2 in.). The force shall be applied through the centerline at each attachment point.

6-36.6 Report.

6-36.6.1 The individual pass/fail results for each attachment point shall be recorded.

6-36.7 Interpretation.

6-36.7.1 One or more helmet specimens failing this test shall constitute failing performance.

6-37 Liner Retention Test.

6-37.1 Application.

6-37.1.1 This test shall apply to protective gloves.

6-37.2 Specimens.

6-37.2.1 A minimum of three glove pairs each for size small and size large shall be used for testing.

6-37.3 Sample Preparation.

6-37.3.1 Samples for conditioning shall be whole gloves.

6-37.3.2 Specimens to be tested shall be conditioned as specified in 6-1.2.

6-37.4 Procedure.

6-37.4.1 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 4-3.5.3.

6-37.4.2 The time to don one glove of the glove pair specimen shall be determined by measuring the time it takes for the test subject to don the single glove on three consecutive trials without altering the sample glove linings between donnings.

6-37.4.3 Each donning trial shall start with the glove lying in front of the test subject and shall end when the test subject's fingers are seated in the sample glove.

6-37.4.4 The baseline donning time shall be the average of the first three donning times as determined in 6-37.4.2. The baseline donning time shall not exceed 10 seconds. The doffing time between donnings shall not exceed 10 seconds.

6-37.4.5 Glove pair specimens shall then be conditioned as specified in 6-1.8.

6-37.4.6 The final donning time shall be the average of the times for the first three donnings after conditioning as specified in 6-37.4.5.

6-37.5 Report.

6-37.5.1 The final donning time and the baseline donning time shall be reported to the nearest 0.1 second for each trial. The average final and baseline donning times shall be calculated and reported.

6-37.6 Interpretation.

6-37.6.1 Pass/fail determinations shall be made using the average final and baseline donning times.

6-38 Dexterity Test.

6-38.1 Application.

6-38.1.1 This test shall apply to protective gloves.

6-38.2 Specimens.

6-38.2.1 A minimum of three glove pairs each for each glove size shall be used for testing.

6-38.2.2 Each sample glove pair shall be tested as a complete set of gloves in new, as distributed, condition.

6-38.2.3 Sample glove pairs shall not receive special softening treatments prior to tests.

6-38.2.4 Sample glove pairs shall be tested for each material and construction combination.

6-38.3 Sample Preparation.

6-38.3.1 Samples for conditioning shall be whole glove pairs.

6-38.3.2 Specimens shall be preconditioned as specified in 6-1.3.

6-38.3.3 Specimens shall be tested after being conditioned for wet conditions as specified in 6-1.8.

6-38.4 Procedure.

6-38.4.1 Dexterity shall be evaluated using Manual 8018-111, *Bennett Hand-Tool Dexterity Test.*

6-38.4.2 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, for all required glove sizes in 4-3.5.3.

6-38.4.3 Each test subject used to perform the test shall practice until the baseline times of that test subject's last three repetitions varies no more than 6 percent.

6-38.4.4 Each test subject shall test a minimum of three pairs of sample gloves for the respective size as required in 4-3.5.3.

6-38.4.5 Dexterity test times using gloves (DTT_g)shall be compared with baseline dexterity test times (DTT_b) for specific test subjects. The percentage of dexterity test times with gloves to baseline dexterity test times shall be calculated as follows:

$$\frac{DTT_g}{DTT_b}\ (100) = \%\ \text{bare-handed control}$$

6-38.5 Report.

6-38.5.1 The percent of bare-handed control shall be reported for each sample glove pair and test subject tested.

6-38.6 Interpretation.

6-38.6.1 One or more sample glove pairs failing this test shall constitute failing performance.

6-39 Grip Test.

6-39.1 Application.

6-39.1.1 This test method shall apply to protective gloves.

6-39.2 Specimens.

6-39.2.1 A minimum of three glove pairs each for size small and size large shall be used for testing.

6-39.2.2 Each sample glove pair shall be tested as a complete set of gloves in new, as distributed, condition.

6-39.2.3 Sample glove pairs shall not receive special softening treatments prior to tests.

6-39.2.4 Sample glove pairs shall be tested for each material and construction combination.

6-39.3 Sample Preparation.

6-39.3.1 Samples for conditioning shall be whole gloves.

6-39.3.2 Specimen glove pairs shall be preconditioned as specified in 6-1.2.

6-39.3.3 Specimen glove pairs shall be tested after being conditioned for dry conditions as specified in 6-1.3.

6-39.3.4 Specimen glove pairs shall be tested after being conditioned for wet conditions as specified in 6-1.8.

6-39.4 Apparatus.

6-39.4.1 Grip testing shall be evaluated with the use of a 9.5-cm (0.375-in.) diameter, three-strand, prestretched polyester rope attached to a calibrated force measuring device.

6-39.5 Procedure.

6-39.5.1 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 4-3.5.3.

6-39.5.2 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.

6-39.5.3 Dry-conditioned sample gloves shall be tested on a dry rope and then on a wet rope.

6-39.5.4 Wet-conditioned sample gloves shall be tested on a dry rope and then on a wet rope.

6-39.5.5 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.

6-39.5.6 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:

$$\frac{WPC_g}{WPC_g}\ (100) = \%\ \text{bare-handed control}$$

6-39.6 Report.

6-39.6.1 The percent of bare-handed control shall be reported for each sample glove pair, condition, and test subject tested.

6-39.7 Interpretation.

6-39.7.1 One or more sample glove pairs failing this test shall constitute failing performance.

6-40 Ladder Shank Bend Resistance Test.

6-40.1 Application.

6-40.1.1 This test shall apply to protective footwear.

6-40.2 Specimens.

6-40.2.1 A minimum of three footwear ladder shanks shall be tested.

6-40.3 Sample Preparation.

6-40.3.1 Samples for conditioning shall be whole footwear.

6-40.3.2 Ladder shanks shall be conditioned as specified in 6-1.3.

6-40.4 Apparatus.

6-40.4.1 The apparatus shall consist of a tensile testing machine, such as an Instron or equivalent, that challenges a specimen with a simulated ladder rung. A 32.5-mm diameter × 50.8-mm long (1.25-in. diameter × 2.0-in. long) noncompressible probe shall be mounted on the movable arm. The specimen support assembly shall consist of two 50.8 mm × 25.4 mm × 25.4 mm (2.0 in. × 1.0 in. × 1.0 in.) noncompressible blocks placed 50.8 mm (2.0 in.) apart as shown in Figure 6-40.4.1.

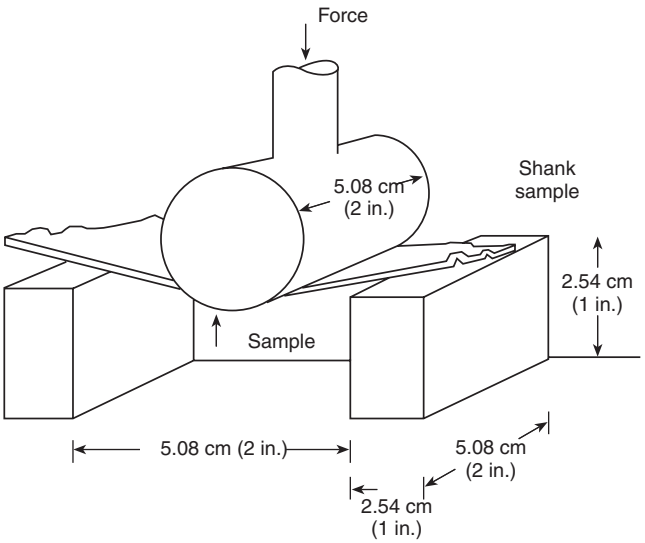


Figure 6-40.4.1 Shank bend test setup.

6-40.5 Procedure.

6-40.5.1 The ladder shank shall be placed on mounting blocks as it would be oriented toward the ladder, when the shank is affixed into the protective footwear, and subjected to force on its center with the test probe operated at 51 mm/min (2 in./min).

6-40.6 Report.

6-40.6.1 Deflection at 182 kg (400 lb) shall be reported to the nearest 1 mm (0.05 in.). The average deflection shall be calculated and reported to the nearest 1 mm (0.05 in.).

6-40.7 Interpretation.

6-40.7.1 Pass/fail performance shall be determined using the average deflection for all specimens tested.

6-41 Slip Resistance Test.

6-41.1 Application.

6-41.1.1 This test method shall apply to the footwear sole and heel section.

6-41.2 Specimens.

6-41.2.1 A minimum of three complete footwear items shall be tested.

6-41.3 Sample Preparation.

6-41.3.1 Samples for conditioning shall be the whole footwear items.

6-41.3.2 Specimens shall be conditioned as specified in 6-1.3.

6-41.4 Procedure.

6-41.4.1 Slip resistance shall be performed in accordance with ASTM F 489, *Standard Test Method for Static Coefficient of Friction of Shoe Sole and Heel Materials as Measured by the James Machine,* in both a dry and a wet condition.

6-41.5 Report.

6-41.5.1 The static coefficient of friction of each specimen under both dry and wet conditions shall be reported. The

average static coefficient of friction of each specimen under both dry and wet conditions shall be calculated and reported.

6-41.6 Interpretation.

6-41.6.1 One or more footwear specimens failing this test shall constitute failing performance.

6-42 Label Durability and Legibility Test One.

6-42.1 Application.

6-42.1.1 This test method shall apply to labels on protective garments, hoods, gloves, and boots.

6-42.1.2 Modifications to this test method for testing garment labels shall be as specified in 6-42.7.

6-42.1.3 Modifications to this test method for testing hood labels shall be as specified in 6-42.8.

6-42.1.4 Modifications to this test method for testing glove labels shall be as specified in 6-42.9.

6-42.1.5 Modifications to this test method for testing footwear labels shall be as specified in 6-42.10.

6-42.2 Specimens.

6-42.2.1 A minimum of three of each type of label for each element shall be tested in each test. If labels have areas of "write-in" information, two additional specimens shall be tested that include those areas, with sample information written in.

6-42.3 Sample Preparation.

6-42.3.1 Specimens shall be conditioned as specified in 6-1.3.

6-42.4 Procedures.

6-42.4.1 Laundering Durability Test.

6-42.4.1.1 Specimens shall be subjected to ten cycles of laundering and drying using Machine Cycle 1, Wash Temperature V, and Drying Procedure Ai of ANSI/AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*.

6-42.4.1.2 A 1.8-kg, ±0.1 kg (4.0-lb, ±0.2 lb) load shall be used. A laundry bag shall not be used.

6-42.4.1.3 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 30.5 cm (12 in.) in a well-illuminated area.

6-42.4.2 Abrasion Durability Test.

6-42.4.2.1 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 24 hours or agitated in distilled water so that they are thoroughly wet.

(b) The standard abrasive fabric shall be rewetted after each set of cycles by applying 20 ml (0.68 oz) of distilled water from a squeeze bottle by squirting on the center of the abrasive composite pad.

(c) Specimens shall be subjected to 200 cycles, 3200 revolutions, of the test apparatus.

6-42.4.2.2 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 30.5 cm (12 in.) in a well-illuminated area.

6-42.4.3 Heat Durability Test.

6-42.4.3.1 Specimens shall be subjected to convective heat as specified in 6-1.5.

6-42.4.3.2 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 30.5 cm (12 in.) in a well-illuminated area.

6-42.5 Report.

6-42.5.1 The legibility for each specimen shall be reported as acceptable or unacceptable.

6-42.6 Interpretation.

6-42.6.1 One or more label specimens failing this test shall constitute failing performance.

6-42.7 Specific Requirements for Testing Garment Labels.

6-42.7.1 For testing label legibility after laundering, specimens shall include individual labels sewn onto a 1-m (1-yd) square ballast material no closer than 51 mm (2 in.) apart in parallel strips. The ballast material shall be as specified in ANSI/AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*.

6-42.7.2 For testing label legibility after abrasion, specimens shall be individual labels.

6-42.7.3 For testing label legibility after convective heat exposure, specimens shall include individual labels sewn onto a separate 38-cm, ±1.3 mm (15-in., ±0.5 in.) square of material that meets the outer shell requirements of this standard.

6-42.7.4 Sample conditioning shall be the same conditioning as specified for the respective tests.

6-42.7.5 Specimens shall be tested separately for legibility after laundering, abrasion, and heat durability tests as specified in 6-42.4.1, 6-42.4.2, and 6-42.4.3, respectively.

6-42.8 Specific Requirements for Testing Hood Labels.

6-42.8.1 For testing label legibility after laundering, specimens shall include complete hoods with labels attached.

6-42.8.2 For testing label legibility after abrasion, specimens shall be individual labels.

6-42.8.3 For testing label legibility after convective heat exposure, specimens shall include individual labels sewn onto a separate 38-cm, ±1.3 mm (15-in., ±0.5 in.) square of hood material that meets the hood material requirements of this standard.

6-42.8.4 Sample conditioning shall be the same conditioning as specified for the respective tests.

6-42.8.5 Specimens shall be tested separately for legibility after laundering, abrasion, and heat durability tests as specified in 6-42.4.1, 6-42.4.2, and 6-42.4.3, respectively.

6-42.9 Specific Requirements for Testing Glove Labels.

6-42.9.1 For testing label legibility after laundering and convective heat exposure, specimens shall include complete gloves with labels attached.

6-42.9.2 For testing label legibility after abrasion, specimens shall be individual labels.