This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: F1790/F1790M – 15 (Reapproved 2021)

Standard Test Method for Measuring Cut Resistance of Materials Used in Protective Clothing with CPP Test Equipment[1]

This standard is issued under the fixed designation F1790/F1790M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

Cut resistance is an important property for protective clothing and equipment, and several standard testing devices have been adopted across different industries to measure this property. A common practice in cut resistance testing is to subject a material specimen to a transversely moving blade under an applied load and measure the distance of blade travel required to cut through the specimen. This test method calculates the load required to cut through different specimens at 25.4 mm [1 in.] blade travel. This calculated load, defined as the calculated cutting load, can be used to compare the cut resistance of materials.

The original F1790–97 test method defined a commercially available apparatus known as the Cut Protection Performance Tester (CPP). In an attempt to harmonize F1790/F1790M with ISO 13997 (another international testing standard for measuring cut resistance) and improve the test method, the scope of the test method was changed in F1790–05 to allow the use of other cut testing equipment, specifically the Tomodynamometer (TDM-100) and a modification to the CPP arm called the Modified CPP (mCPP). The revision addressed issues related to measurement of high frictional coefficient materials like elastomers, specimen mounting, calculated cutting load determination, and other procedures to harmonize with ISO 13997:1999. After further round-robin evaluation by the subcommittee, it was demonstrated that the revisions to the test method result in a bias between the original F1790–97 test method and the revised F1790–05 test method when using the CPP. F1790–05 was not widely adopted in North America because of this bias and large amount of data and experience accumulated with F1790–97. F1790–97 continues to be the test method predominately practiced when using the CPP device. To reduce confusion for end-users of F1790/F1790M and to allow for differences between testing devices, the subcommittee has decided to limit the scope of F1790/F1790M to include only the CPP device and created a separate test method for use of the TDM-100 (Test Method F2992/F2992M).

1. Scope

1.1 This test method covers the measurement of the cut resistance of a material when mounted on a mandrel and subjected to a cutting edge under a specified load using the Cut Protection Performance (CPP) Tester.

1.1.1 This procedure is not valid for high-porosity materials which allow cutting edge contact with the mounting surface prior to cutting.

1.1.2 Test apparatus may have limitations in testing materials with a thickness greater than 3 mm or having a high frictional coefficient such as elastomers.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

[1] This test method is under the jurisdiction of ASTM Committee F23 on Personal Protective Clothing and Equipment and is the direct responsibility of Subcommittee F23.20 on Physical.

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1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D123 Terminology Relating to Textiles

D1000 Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications

D1776/D1776M Practice for Conditioning and Testing Textiles

F1494 Terminology Relating to Protective Clothing

F2992/F2992M Test Method for Measuring Cut Resistance of Materials Used in Protective Clothing with Tomodynamometer (TDM-100) Test Equipment

2.2 *ISO Standards:*[3]

ISO 13997 Protective Clothing—Mechanical Properties—Determination of Resistance to Cutting by Sharp Objects

3. Terminology

3.1 *Definitions:*

3.1.1 *cut resistance, n*—in blade cut testing, the property that hinders cut-through when a material or a combination of materials is exposed to a sharp-edged device.

3.1.2 *cut-through, n*—in blade cut resistance tests, the penetration of the cutting edge entirely through material, as indicated by electrical contact of the cutting edge and the conductive strip or substrate.

3.1.2.1 *Discussion*—For this test, penetration of the cutting edge entirely through the material includes the specimen and mounting tape.

3.1.3 *cut-through distance, n*—in cut resistance testing, the distance of required travel by the cutting edge to cut through the specimen.

3.1.3.1 *Discussion*—For this test, distance of required travel by the cutting edge to cut through the specimen includes the specimen and mounting tape.

3.1.4 *cutting edge, n*—in cut resistance tests, a sharp-edged device used to initiate cut-through of a planar structure.

3.1.5 *no cut, n*—in cut resistance testing, a trial for which the load used is insufficient to cause a cut-through in the maximum allowable blade travel of the apparatus.

3.1.5.1 *Discussion*—For this test method, the maximum allowable blade travel is 50.8 mm [2.0 in.].

3.1.6 *protective clothing, n*—an item of clothing that is specifically designed and constructed for the intended purpose of isolating all or part of the body from a potential hazard; or, isolating the external environment from contamination by the wearer of the clothing.

3.1.6.1 *Discussion*—In this test method, the potential hazard is cutting.

3.1.7 *calculated cutting load, n*—in cut resistance testing, the load required to cause a cutting edge to produce a cut-through when it traverses the reference distance across the material being tested.

3.1.7.1 *Discussion*—The calculated cutting load is determined by performing a series of tests at three or more loads as described in Section 11. A material with a higher calculated cutting load is considered to be more cut resistant.

3.1.8 *reference distance, n*—in cut resistance testing, a standardized distance for a blade to travel across a material to produce a cut-through.

3.1.8.1 *Discussion*—For this test method, the reference distance is 25.4 mm [1.0 in.].

3.2 *Additional Terminology*—Terms relevant to textiles are defined in Terminology D123. Terms relevant to protective clothing are defined in Terminology F1494.

4. Summary of Test Method

4.1 A cutting edge under a specified load is moved one time across a specimen mounted on a mandrel.

4.2 The cut-through distance from initial contact to cut-through is determined, for each load.

4.2.1 A series of tests, at a minimum of three different loads, must be performed to establish a range of cut distance at these different loads.

4.3 The test method uses data from multiple loads to determine the calculated cutting load for the material.

5. Significance and Use

5.1 This test method assesses the cut resistance of a material when exposed to a cutting edge under specified loads. Data obtained from this test method can be used to compare the cut resistance of different materials.

5.2 This test method only addresses that range of cutting hazards that are related to a cutting action by a smooth, sharp edge across the surface of the material. It is not representative of any other cutting hazard to which the material may be subjected such as serrated edges, saw blades, or motorized cutting tools. Nor is it representative of puncture, tear, or other modes of fabric failure.

6. Apparatus

6.1 *Test Principle*—The principle of the cut test is to measure the distance traveled by a cutting edge as it is maintained under a load during the test. The cut test apparatus consists of the following primary components (see Fig. 1): (A) a motor-driven balance arm to hold the cutting edge and to which the load is applied; (B) a cutting edge; and (C) a fixed supporting mandrel on which the specimen is to be mounted. The apparatus should propel the cutting edge across the specimen until sufficient work is applied to cause the specimen to cut through.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, http://www.iso.org.

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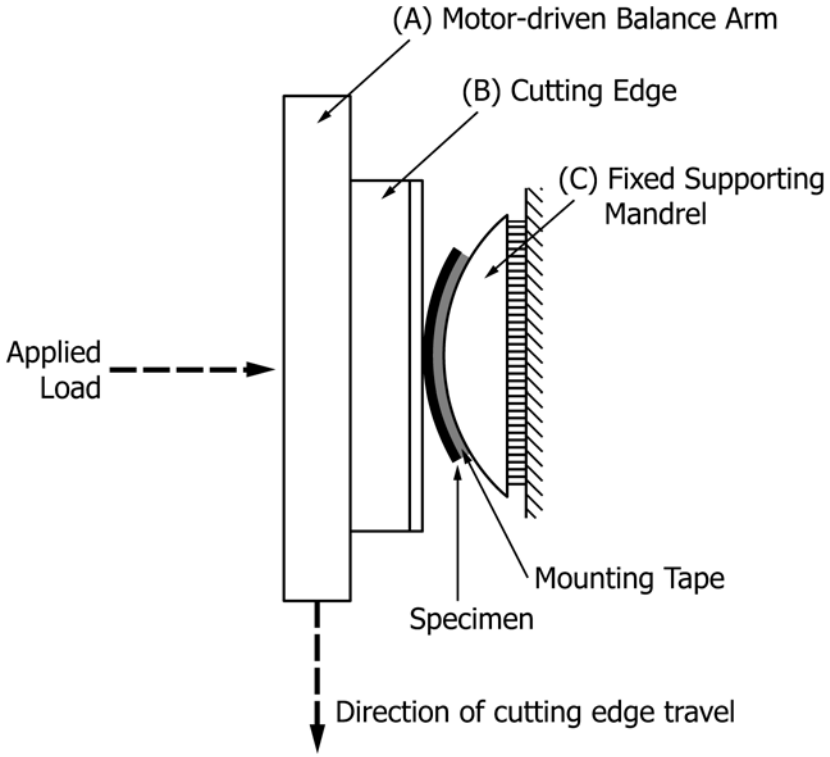


FIG. 1 Schematic of Cut Test Principle

6.2 *CPP Test Apparatus*[4]—The CPP test apparatus (see Fig. 2) consists of a motor-driven balance arm (A) that holds the cutting edge (B) in contact with the specimen mounted on a fixed supporting mandrel (C). The balance arm is connected to the motor using a drive wheel (D) and a connection arm assembly (E). The distance between the center of the drive wheel and attachment point of the connection arm assembly is 25.4 mm [1.0 in.], resulting in a maximum linear displacement of 50.8 mm [2.0 in.] for the balance arm and cutting edge. Cutting edge displacement is measured by a distance meter (F) attached to the motor-driven balance arm assembly that is capable of measuring to 0.1 mm [0.004 in.]. Weights are placed on a pivoting lever arm (G) to generate the load needed to penetrate the moving edge into the specimen and produce a cut-through. The location of the weight on the lever arm will determine the resulting load. Weights placed on the location (G1) closest to the arm pivot will result in a load equal to the applied weight. Weights placed on the location furthest (G2) from the pivot will result in a load twice that of the applied weight. The lever arm counterweight adjustment (H) is used to balance the arm prior to adding weight to the lever arm.

6.2.1 *Cutting Action*—The motor and drive wheel must be set to rotate at 5.0 ± 0.25 rpm. The distance from the center point of the motor and drive wheel to the pivot point of the connection arm is 25.4 mm [1.0 in.].

NOTE 1—Since the cutting edge is propelled by a rotating drive wheel, the resulting vertical speed is not constant during the test. The speed ranges from 0 mm/s at the start of the test, then reaching a maximum of 14 mm/s during the test, and then decreases back to 0 mm/s by the end of the test.

6.2.2 *Cut-Through Detection*—Cut-through is detected by an electrical contact between the cutting edge and the supporting mandrel.

6.2.3 *Mandrel*—The top surface of the mandrel is a rounded form which has an arc of at least 32 mm [1.25 in.] in a circle having a radius of 38 mm [1.5 in.]. The surface of the mandrel shall be conductive and made of metal.

6.3 *Cutting Edge*—Single-edged razor blades[5] shall be used as the cutting edge. The blades shall be made of stainless steel with a hardness greater than 45 HRC. Blades shall be 1.0 ± 0.5 mm [0.039 ± 0.020 in.] thick and ground to a bevel width of 2.5 ± 0.2 mm [0.098 ± 0.008 in.] along a straightedge, resulting in a primary bevel angle of 22° ± 2°. The blade should also contain a honed secondary bevel at the cutting edge with an inclined angle of 36° ± 2°. Blades shall have a cutting edge length greater than 65 mm [2.56 in.] and shall have a width greater than 18 mm [0.71 in.].

[4] The sole source of supply of the CPP Tester known to the committee at this time is Red Clay, Inc., 2388 Brackenville Rd., Hockessin, DE 19707, E-mail: redclay43@verizon.net. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[5] Blade 88-0121 Type GRU-GRU textile blade is available from Energizer Personal Care, LLC (formerly American Safety Razor Company), One Razor Blade Lane, Verona, VA 24482 has proven satisfactory for this test method. It is the sole source of supply of blades known to the committee at this time. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

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