



Standard Test Method for Measuring Cut Resistance of Materials Used in Protective Clothing with Tomodynamometer (TDM-100) Test Equipment¹

This standard is issued under the fixed designation F2992/F2992M; 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.

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 Tomodynamometer (TDM-100).

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 20 mm.

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 non-conformance 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 and health practices and determine the applicability of regulatory limitations prior to use.*

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 Practice for Conditioning and Testing Textiles](#)

[F1494 Terminology Relating to Protective Clothing](#)

[F1790 Test Method for Measuring Cut Resistance of Mate-](#)

[rials Used in Protective Clothing with CPP 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.

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

3.1.4 *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 65 mm [2.6 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.

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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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), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

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 20 mm [0.8 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 is repeated using 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) blade holder and straight line mechanism (B) a cutting edge, a Specimen (C) with conductive strip (D) and double side Mounting Tape (E) mounted to a (F) mandrel. The apparatus should propel the cutting edge across the specimen until sufficient work is applied to cause the specimen to cut through.

6.2 *TDM-100 Test Apparatus*⁴—The TDM-100 is capable of measuring the entire range of cut resistant materials through a horizontal constant speed of blade movement. The maximum linear displacement of the blade is 70 mm [2.75 in.] for the cutting edge. A constant perpendicular force is applied to the specimen throughout blade movement. The TDM-100 test apparatus (see Fig. 2) consists of a Motor and gearhead (1) with Slide system (2) and Blade support/clamp mechanism (3) and Blade (4) in contact with the specimen mounted on a cantilevered Mandrel and holder (5). The Beam (6) is connected to the mandrel. Cutting edge displacement is measured by a Distance meter (7) capable of measuring to 0.1 mm [0.004 in.]. Weights are placed on the Platen (8). These weights generate the load needed to penetrate the moving edge into the specimen and produce a cut through. The resulting load applied to the specimen against the blade equals twice the total weight placed on the platen. The calibration weights (9) are used to balance the beam with sample prior to adding weight to the lever arm. Movement of the Mandrel and holder mechanism is facilitated by use of the Loading /unloading handle (10). Leveling adjustment is facilitated by the Level mechanism (11). The apparatus should be capable of loads ranging from 10 g to 15 kg [0.35 oz to 33 lb].

6.2.1 *Cutting Speed*—The apparatus shall propel the cutting edge across the specimen at a constant speed of 2.5 ± 0.5 mm/s [0.10 in./s].

6.2.2 *Cut Through Distance*—Cut through is detected by an electrical contact between the cutting edge and conductive strip.

⁴ The sole source of supply of the TDM-100 Tomodynamometer is RGI Industrial Products, Inc., 755 Pierre Caisse, St-Jean-sur Richelieu, Quebec, Canada 8C6 7Y5, E-mail: lapointe.louis@rgicanada.com. 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.

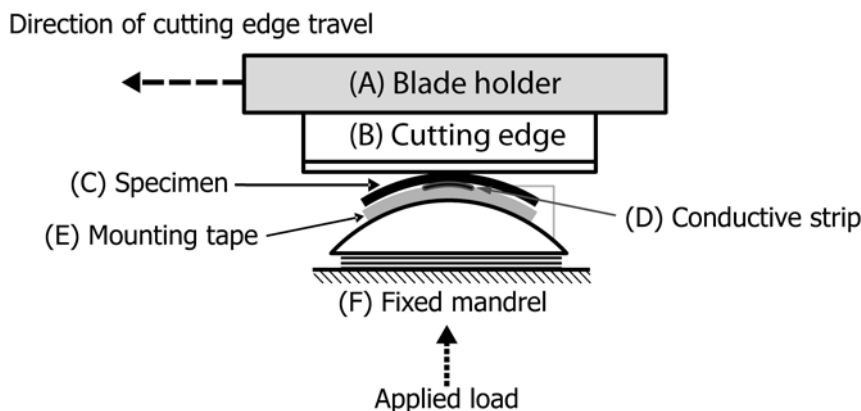


FIG. 1 Schematic of Cut Test Principle

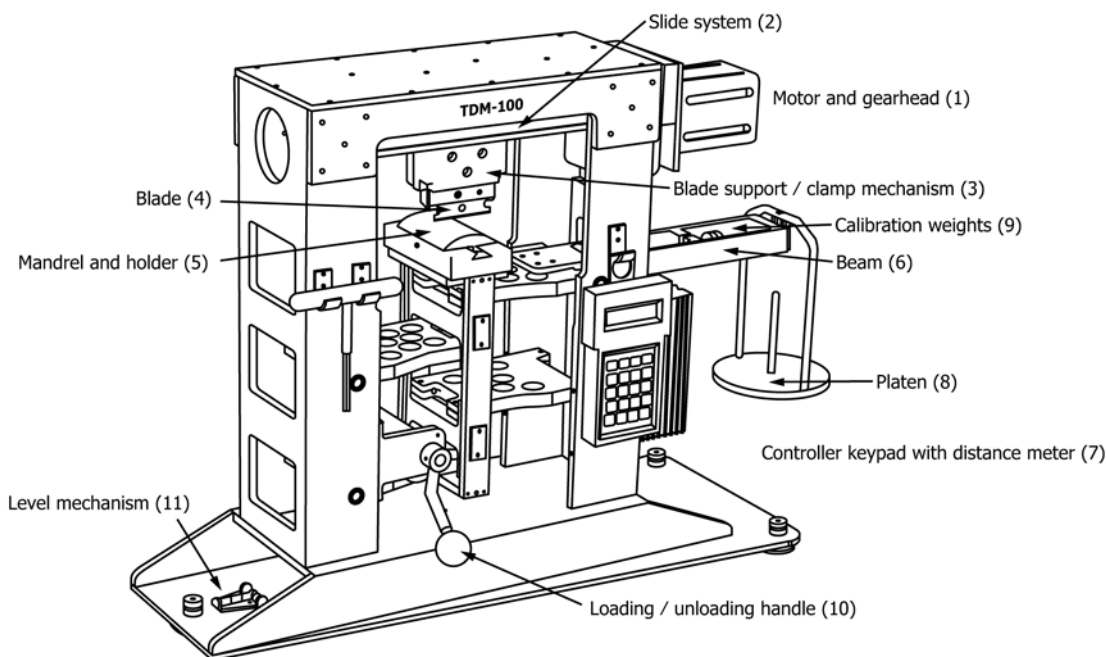


FIG. 2 Schematic of the TDM-100 Tester (Front View)

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 blades⁵ 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 straight edge resulting in a primary bevel angle of $22^\circ \pm 2^\circ$. The blade should also contain a honed secondary bevel at the cutting edge with an inclined angle of $36^\circ \pm 2^\circ$. 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.].

6.4 *Conductive Strip*—A 6-mm [0.26-in.] wide copper or aluminum conductive strip with adhesive backing will be used that is no thicker than 0.3 mm [0.01 in.]. The conductive strip will be centered down the length of the mandrel between the sample and mounting tape. For samples that contain electrically conductive materials, elimination of the conductive metal strip is permitted.

6.5 *Mounting Tape*—Double-sided tape⁶ shall be used to secure the test specimen to the apparatus. The tape should have a cloth carrier and rubber-based adhesive on both sides with a total thickness of 0.38 ± 0.25 mm, weight of 473 ± 33 g/m²,

and a minimum tensile strength of 90 N/cm (see Test Methods D1000 for details on test methods for adhesive tape).

7. Hazards

7.1 The cut test equipment can pose a potential hazard to the technician if proper safety precautions are not followed. The cut test apparatus is to be used only by authorized personnel that have been properly trained.

7.2 Store used blades in a sealed container.

7.3 Remove blades from the apparatus at the end of each test or when the apparatus is not in use.

7.4 Keep hands out of cutting area when a blade is installed in the apparatus and when the apparatus is operating.

7.5 Turn off machine before making instrument adjustments to avoid the chance of a low-voltage shock.

8. Sampling and Test Specimens

8.1 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of shipping units directed in an applicable material specification.

8.2 *Laboratory Sample*—As a laboratory sample for acceptance testing, take at random from each shipping unit in the lot sample, the number of packages or pieces directed in an applicable material specification or other agreement between purchaser and the supplier.

8.3 *Protective Clothing Sample*—A sample of actual Protective Clothing Article.

8.4 Test Specimens:

8.4.1 Take test specimens at random from each sample.

8.4.1.1 When performing up to fifteen cut tests per specimen, as when determining the

⁵ Blade 88-0121 Type GRU-GRU textile blade 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 the apparatus 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.

⁶ Polyken® 108Fr Double-Coated Cloth Tape manufactured by Berry Plastics Corporation or equivalent has proven satisfactory for this test method.