



Standard Test Method for Measurement of Cut Resistance to Chainsaw of Foot Protective Devices¹

This standard is issued under the fixed designation F1458; 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 measures cut resistance of foot protective devices that are designed to protect the foot when operating a chainsaw.

1.2 This test method may be used to test for compliance to minimum performance requirements in established safety standards.

1.2.1 By agreement between the purchaser and the supplier, or as required by established safety standards, this test method can be used to determine any one or both of the following: (1) chain speed 50 (CS50), (2) success/failure (jamming/chain stop) at specified chain speed.

1.3 This test method may be used to determine levels of protection for areas of coverage as stipulated in established safety standards.

1.4 The values stated in SI units are to be regarded as standard.

NOTE 1—The values stated in each system may not be exact equivalents; therefore, each system must be used independently of the other, without combining values in any way.

1.5 *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

[F1414 Test Method for Measurement of Cut Resistance to Chainsaw in Lower Body \(Legs\) Protective Clothing](#)

[F1494 Terminology Relating to Protective Clothing](#)

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.

2.2 *AATCC Test Methods:*³

[AATCC 96 Dimensional Changes in Laundering of Woven and Knitted Fabrics, Except Wool \(1988\)](#)

[AATCC 158 Dimensional Changes on Drycleaning in Perchloroethylene: Machine Method](#)

2.3 *Military Standards:*⁴

[MIL-STD-105 Sampling Procedure and Tables for Inspection by Attributes](#)

[MIL-C-12369 Cloth, Ballistic, Nylon](#)

2.4 *Federal Standard:*⁵

[FS 5100-86 Type II, Cloth, Duck, Nylon, Polyurethane Coated](#)

3. Terminology

3.1 *Definitions:*

3.1.1 *centerline, n*—in foot protective devices, a line that extends from the toe of the footwear horizontally along the sole to the heel vertically to the top of the footwear, and diagonally to the point of intersection at the toe.

3.1.2 *chainsaw, n*—a portable power-operated tool that has cutters linked in a chain used for cutting wood.

3.1.3 *chain speed, n*—the speed of synchronized movement of linked cutters around a bar and sprocket.

3.1.4 *chain speed 50 (CS50), n*—for chainsaw protection, the mean speed at which cut through occurs.

3.1.4.1 *Discussion*—This value establishes the relationship between the probability of cutting through the chainsaw leg protective clothing (or foot protective device) and the speed of the saw chain. For lower chain speeds, the probability of cut through approaches zero, while for higher chain speeds, the probability of cut through approaches one.

3.1.5 *chain stop, n*—for chainsaw cut resistance, the resulting action when a material clogs (jams) the drive sprocket or slows the speed sufficiently to prevent advancement of the saw chain.

³ Available from American Association of Textile Chemists and Colorists (AATCC), P.O. Box 12215, Research Triangle Park, NC 27709-2215, <http://www.aatcc.org>.

⁴ Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, <http://quicksearch.dla.mil>.

⁵ Available from U.S. Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001, <http://www.gpo.gov>.

3.1.6 *cut resistance, n*—the ability of a material, while in contact with the linked cutters, to resist cut through of the cutters of a moving saw chain, independent of either jamming or chain stop.

3.1.7 *foot, n*—the terminal part of the vertebrate leg, including the ankle, upon which an individual stands.

3.1.8 *foot protective device, n—for chainsaw cut resistance*, an article of personal equipment which covers the foot and ankle for the purpose of providing limited protection from injury due to contact with a moving saw chain.

3.1.9 *footwear, n*—a boot or shoe of any construction.

3.1.10 *gaiter, n—for chainsaw cut resistance*, a foot protective device permanently attached to the outside of the footwear.

3.1.11 *jamming, n—for chainsaw cut resistance*, the clogging action manifested by a protective garment or device that can produce a chain stop.

3.1.12 *saw chain, n*—a closed loop of cutters linked together for use in a portable power-operated tool.

3.1.13 *toe area cut zone, n—in the testing of foot protective devices*, that area excluding the sole that extends from the frontmost part of the footwear to a vertical plane 15 ± 0.25 mm behind the toe box; or in the absence of a toe box, the area that extends to a vertical plane 65 ± 6.25 mm from the front of the footwear.

3.1.14 *toe box, n—in testing of foot protective devices*, a component inserted into the toe area of footwear.

3.1.15 *upper, n*—that area of the footwear above the sole.

3.1.16 *upper cut zone, n—in the testing of foot protective devices*, the area starting at the top of the area of protection on the footwear and extending downward to include the entire upper, but excluding the toe area cut zone.

3.2 For definitions of other protective clothing terms used in this test method, refer to Terminology F1494.

4. Summary of Test Method

4.1 Test specimens are securely mounted on a test apparatus.

4.2 A chain saw, of specific characteristic and operating at a designated speed, is brought into contact with the test specimen at specified locations.

4.2.1 The cutting action of the saw chain will achieve one of three results (1) complete cut through, (2) no cut through while saw chain continues to run, or (3) complete chain stop.

4.3 Data collection of cut resistance and CS50 is measured electronically by means of wires placed on the top and the bottom of the test specimen to measure cut through time, and an electronic means to measure chain speed just prior to contact with test specimen and after contact is initiated.

5. Significance and Use

5.1 The purpose of this test method is to provide a measurable criterion of performance defining the level of cut resistance to the cutting action of a saw chain provided by foot protective devices.

5.2 The protection, which can be demonstrated by the foot protective devices, tested in accordance with this test method, is achieved by (1) the material resisting cutting when put in contact with the moving saw chain; (2) a part of the material being drawn into the saw chain and drive mechanism to block the saw chain movement; (3) the materials resisting cutting and absorbing rotational energy so that saw chain speed can be slowed down sufficiently to stop the movement of the saw chain; or (4) any combination of these.

5.3 In case of a dispute arising from differences in reported test results, when using this test method for acceptance testing of commercial shipments, the purchaser and the supplier should perform comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens from the same lot of components to be evaluated. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing. If a bias is found, either its cause must be determined and corrected, or the purchaser and the supplier must agree to interpret future test results in light of the known bias.

6. Apparatus

6.1 *Specimen Holder for Calibration*, in accordance with Test Method F1414.

6.2 *Mounting Bracket for Footwear and Footwear with Protective Devices*:

6.2.1 The mounting bracket must enable the footwear to be moved so that test cuts can be made at stipulated positions (see Figs. 1-4).

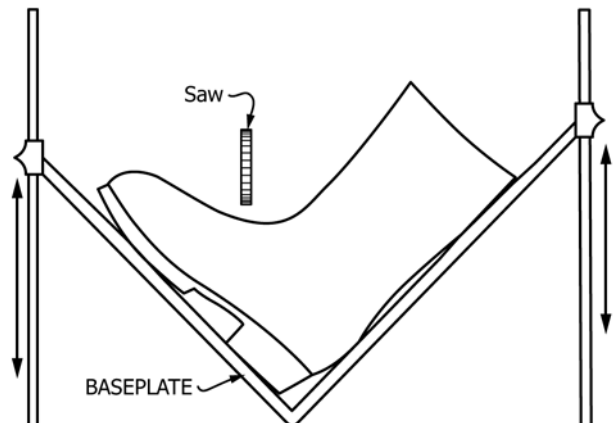


FIG. 1 Upper Cut Test Position

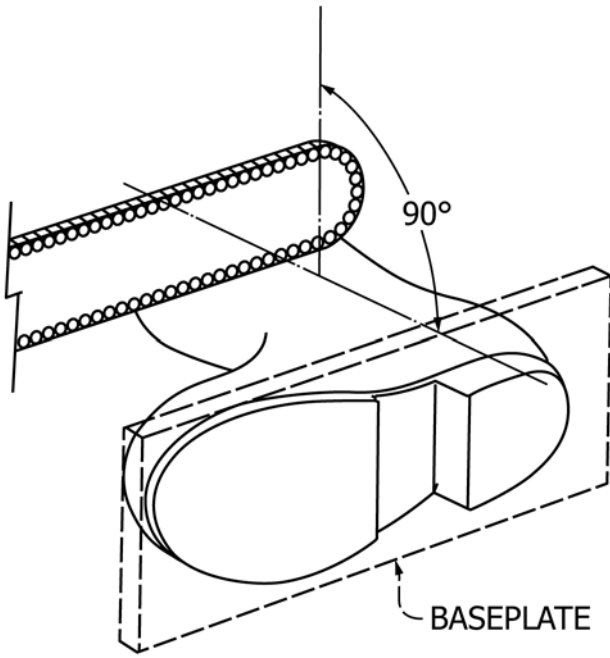


FIG. 2 Upper Test Cut Position

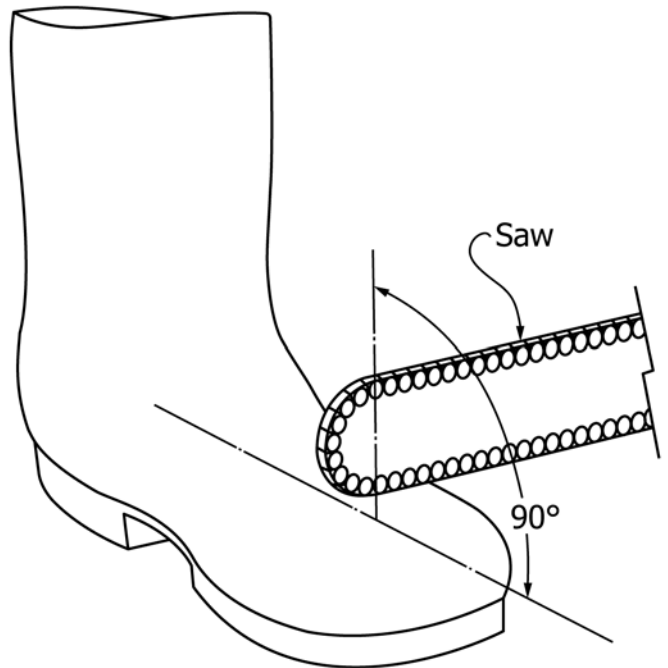


FIG. 4 Toe Cut Test Position

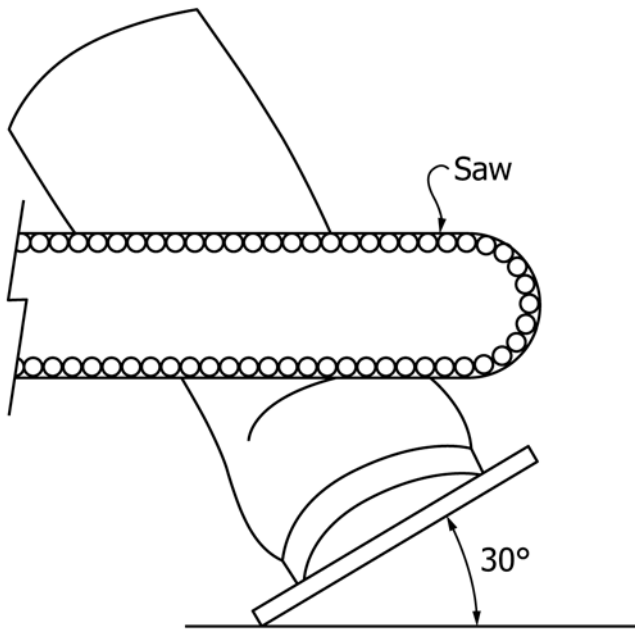


FIG. 3 Toe Cut Test Position

6.2.2 The mounting bracket shall enable footwear to be secured for testing in a manner that neither enhances nor inhibits the cut resistance of the foot protective device.

NOTE 2—Securing or mounting mechanisms should enable footwear, if necessary, to be used for multiple evaluations of protective devices.

6.3 Footwear Form for Mounting Removable Foot Protective Device:^{6,7}

⁶ The sole source of supply of the footwear form known to the committee at this time is Satra, Satra House, Rockingham Road, Kettering, Northants, NN16 9JH, England.

6.3.1 The footwear form used for mounting a removable foot protective device shall be similar to that shown in Fig. 5.

6.3.2 The method of securing the foot protective device to the form shall be the same as that method used to secure the device to footwear.

6.3.3 The form shall then be secured for testing to the aforementioned mounting bracket in a manner that neither enhances nor inhibits the cut resistance of the foot protective device.

6.4 Chainsaw and Related Equipment—The chainsaw and related equipment is in accordance with Test Method F1414.

6.5 Chainsaw Support Bracket—The chainsaw support bracket is in accordance with Test Method F1414.

6.6 Interfaced Data Acquisition System—The interfaced data acquisition system is in accordance with Test Method F1414.

6.7 Filling Material:^{8,7}

6.7.1 The filling material used to provide shape and mass to the footwear shall be pellets made of a high-density polyethylene similar to that used for injection molding.

6.7.1.1 This includes footwear with chainsaw cut protection which is an integral part of the footwear, as well as the footwear that is worn on the inside of a removable foot protective device.

6.7.2 The filling material shall be held in place by covering with a weight of 2 kg ± 20 g.

⁷ 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.

⁸ The sole source of supply of the Style No. LM-6007-00 polyethylene pellets known to the committee at this time is Quantum Chemical Corp., 11500 N. Lake Drive, Cincinnati, OH 45249.

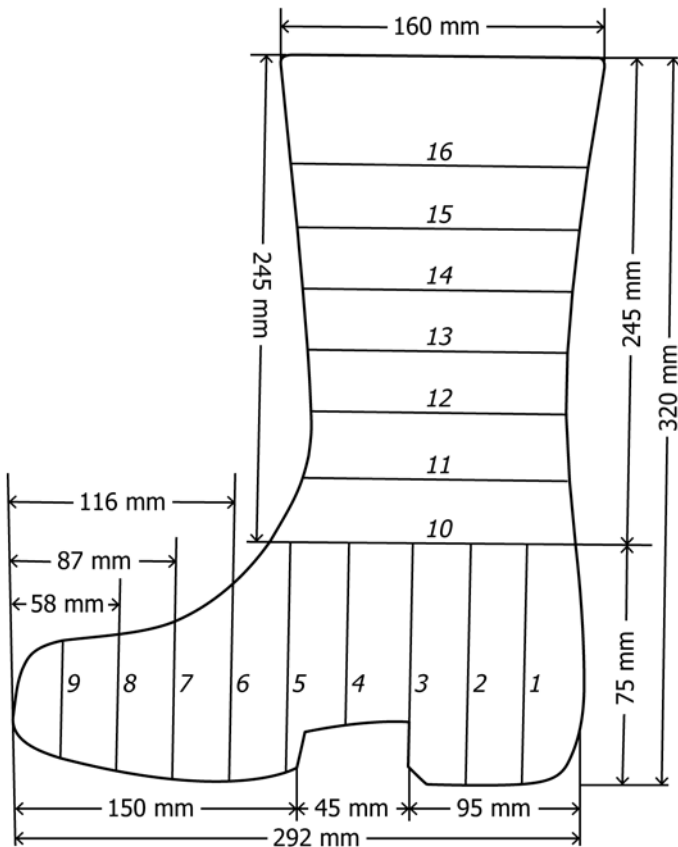


FIG. 5 Footwear Form for Gaiter/Liner

NOTE 3—The weight can be a bag containing leadshot, sand, steel pellets, or some other material to achieve the desired mass.

7. Hazards

NOTE 4—**Warning:** The chainsaw equipment used in the procedure of this test method can pose a potential danger to the technician if specific safety precautions are not followed.

7.1 As a minimum safety precaution, it is suggested that the spark plug wire be disengaged until the engine needs to be started.

7.2 As a further safety precaution, it is suggested that the spark plug wire be grounded by circuitry after cutting the lower wire of the data collection system. If the saw chain stops before the wire is cut, or if the saw chain slides over the specimen, a timer should limit the test and stop the engine by grounding the electric circuitry of the chainsaw.

7.3 The technician performing these tests should use hearing protection to avoid potential loss of hearing.

7.4 The technician performing these tests should use eye protection to avoid potential eye injury.

7.5 The chainsaw engine should be vented to prevent potential danger posed by carbon monoxide.

8. Sampling

8.1 *Lot Sample*—The number of units that constitute a production lot and the number of samples required to be evaluated from that lot will be determined by agreement between the client and the facility using this test method. This

determination must also consider how many units constitute a meaningful measurement of consistent quality that will result in achievement of similar values.

8.2 Number of Specimens:

8.2.1 A pair is considered as two test specimens, one left-foot protective device and one right-foot protective device.

8.2.2 If this test method is used to determine CS50 a minimum of six specimens (3 pairs) at each test cut position will be needed.

8.2.3 If this test method is used to determine “pass/fail” at a specific saw chain speed of an established safety standard, a minimum of six specimens (3 pairs) at each test cut position must pass.

8.2.4 If this test method is used to determine cut through time at a specified speed, a minimum of six specimens (3 pairs) at each test cut position will be needed.

9. Calibration

9.1 The calibration procedures described in Test Method F1414 shall be utilized for this test method.

10. Conditioning

10.1 Footwear:

10.1.1 Place the footwear in a room with an ambient condition of 70 ± 10°F (21 ± 6°C) and a relative humidity of 50 ± 15 %.

10.1.2 Footwear shall be conditioned in this manner for at least 24 h.

10.2 Foot Protective Devices Permanently Attached:

10.2.1 *Textile Materials*—Condition textile foot protective devices that are permanently attached to the footwear in the same manner as footwear.

10.2.2 *Non-Textile Materials*—Condition non-textile foot protective devices that are permanently attached to the footwear in the same manner as footwear.

10.3 Foot Protective Devices Not Permanently Attached:

10.3.1 *Textile Materials*—Condition textile foot protective devices that are not permanently attached to the footwear in the same manner as footwear.

10.3.2 *Non-Textile Materials*—Condition non-textile foot protective devices that are not permanently attached to the footwear in the same manner as footwear.

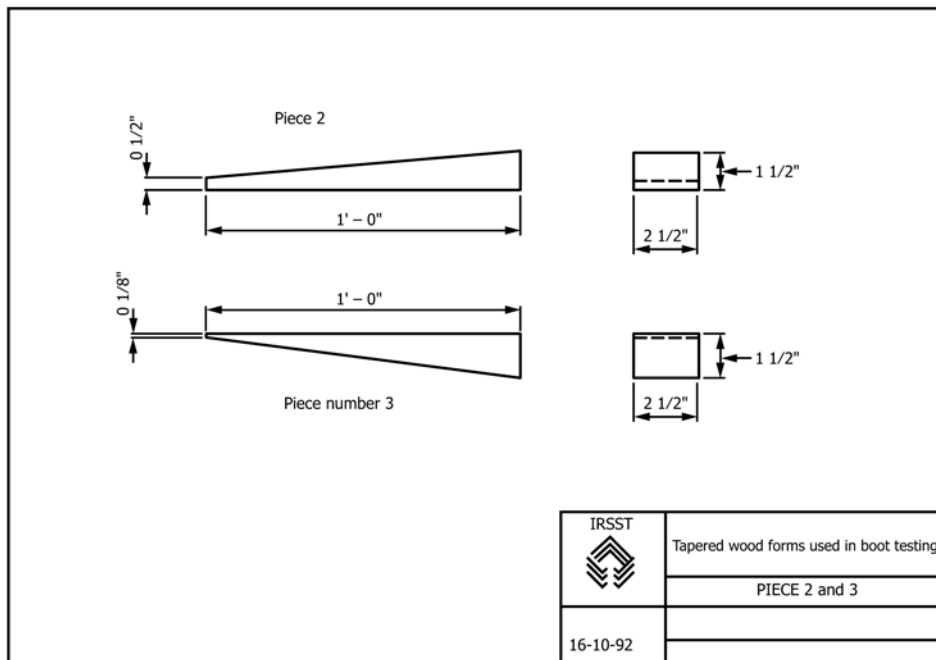
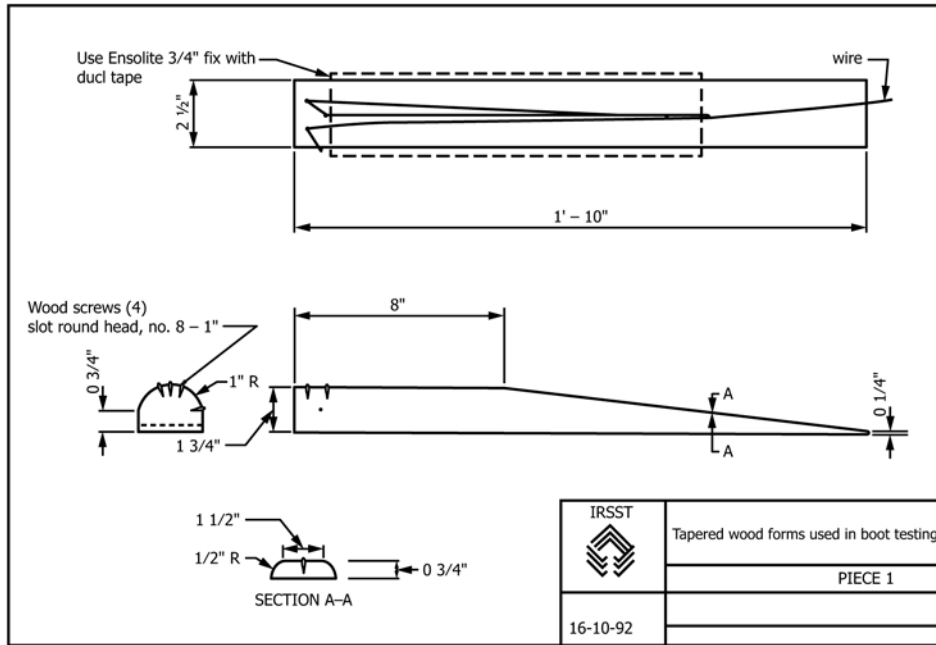
11. Procedure

11.1 Preparation and Mounting of Specimen:

11.1.1 Footwear with Integral Chainsaw Protection or Gaiter:

11.1.1.1 To test the toe area cut zone of footwear with integral chainsaw protection or gaiter, fill the footwear with filling material to a level above the ankle area of the footwear. The weight in accordance with Section 6 shall be used to secure this material in place.

11.1.1.2 To test the upper cut zone of footwear, with integral chainsaw protection or gaiter, at all angles between 0 to 90°, fill the footwear with a material that provides shape and mass; or depending upon the angle of cut, mount the footwear onto a tapered form in accordance with Fig. 6 and Fig. 7.



NOTE 1—Reproduced with permission of the Quebec Occupational Health and Safety Research Institute.

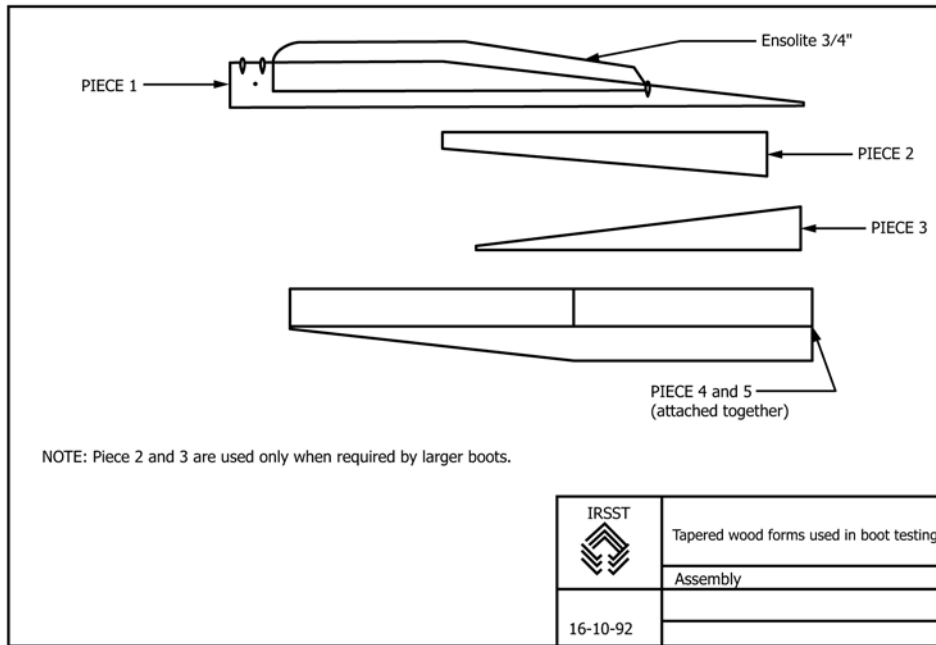
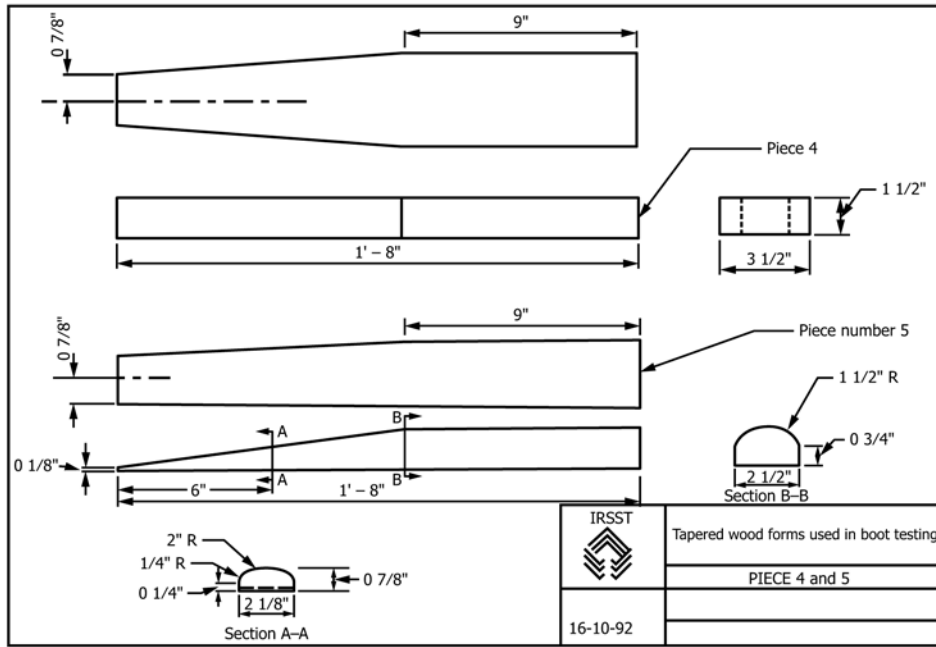
FIG. 6 Tapered Wood Forms Used in Boot Testing

11.1.1.3 Secure the footwear to the mounting bracket of the test apparatus.

11.1.1.4 Position the bottom timing wire from the interfaced data acquisition system perpendicular to the horizontal axis of the guide bar at the point of contact and snug to the inside of the footwear. Position the top wire of the interfaced data acquisition system perpendicular to the horizontal axis of the guide bar at the point of contact and snug to the outside of the footwear.

11.1.1.5 For footwear with a gaiter, position the bottom timing wire from the interfaced data acquisition system perpendicular to the horizontal axis of the guide bar at the point of contact and secure it to be snug to the bottom side of the gaiter. Position the top wire of the interfaced data acquisition system perpendicular to the horizontal axis of the guide bar at the point of contact and snug to the outside of the footwear.

11.1.2 *Removable Foot Protective Device:*



NOTE 1—Reproduced with permission of the Quebec Occupational Health and Safety Research Institute.

FIG. 7 Tapered Wood Forms Used in Boot Testing

11.1.2.1 To test the toe area cut zone of removable foot protective device, fill the footwear with filling material to a level above the ankle area of the footwear. The filling material will be secured in place as described in Section 6.

11.1.2.2 To test the upper cut zone of removable foot protective devices, at all angles between 0° to 90°, fill the footwear with a material that provides shape and mass; or depending upon the angle of cut, use a tapered form as described in Fig. 6 and Fig. 7.

11.1.2.3 Secure the removable foot protective device with the footwear to the mounting bracket of the test apparatus.

11.1.2.4 For removable foot protective device, position the bottom timing wire from the interfaced data acquisition system perpendicular to the horizontal axis of the guide bar at the point of contact and secure it to be snug to the bottom side of the foot protective device. Position the top wire of the interfaced data acquisition system perpendicular to the horizontal axis of the

guide bar at the point of contact and snug to the outside of the foot protective device.

11.2 *Test Cuts:*

11.2.1 Test footwear, with integral chainsaw protection, or gaiters, or removable foot protective devices in the same locations.

11.3 *Test Cut Placements:*

11.3.1 *Upper Cut Zone*—See Fig. 8.

11.3.1.1 The upper cut zone has two test cut locations.

11.3.1.2 Make the first test on the centerline at a point between the front terminus of the upper cut zone (at the back of the toe area cut zone) and 50 mm from the top of the protected area. Position the footwear at an angle such that the tangent of the centerline at the cut point is perpendicular to the plane of the guide bar. The plane of the guide bar shall be perpendicular to the plane of the centerline of the footwear.

11.3.1.3 Make the second at a point 50 to 75 mm from the vertical top terminus of the upper cut zone along either the left or right quarter of the footwear. Position the footwear so that the plane of the guide bar is parallel to the plane of the base plate (see Fig. 1 and Fig. 2).

11.3.2 *Toe Area Cut Zone*—See Fig. 3, Fig. 4, Fig. 9, and Fig. 10.

11.3.2.1 Make at least one test in the toe area cut zone.

11.3.2.2 Make the test at a point approximately 12 ± 2 mm behind the edge of the toe box (see Fig. 4 and Fig. 10).

11.3.2.3 When a toe box other than steel is used, make a second test at a point 25 to 40 mm from the front of the footwear (see Fig. 10).

11.3.2.4 For removable foot protective devices, make a test at a point 25 to 40 mm from the front of the footwear.

11.3.2.5 This test can be made on either the left side or right side of the toe area cut zone of the footwear (see Fig. 4 and Fig. 10).

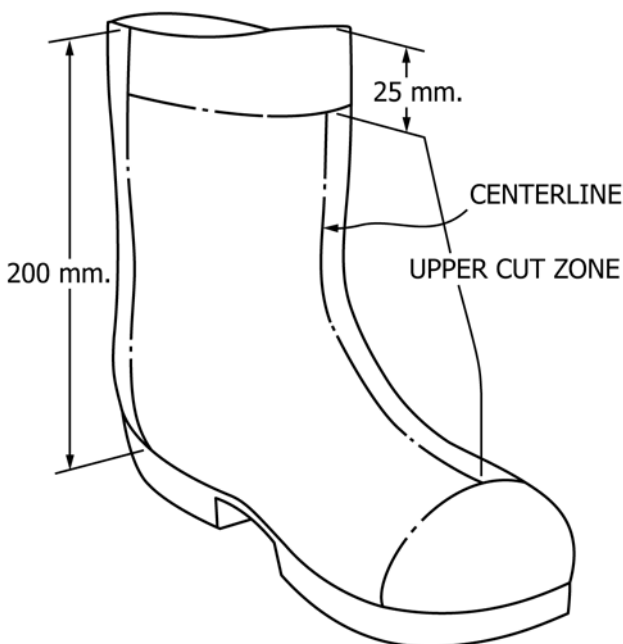


FIG. 8 Centerline/Upper Cut Zone

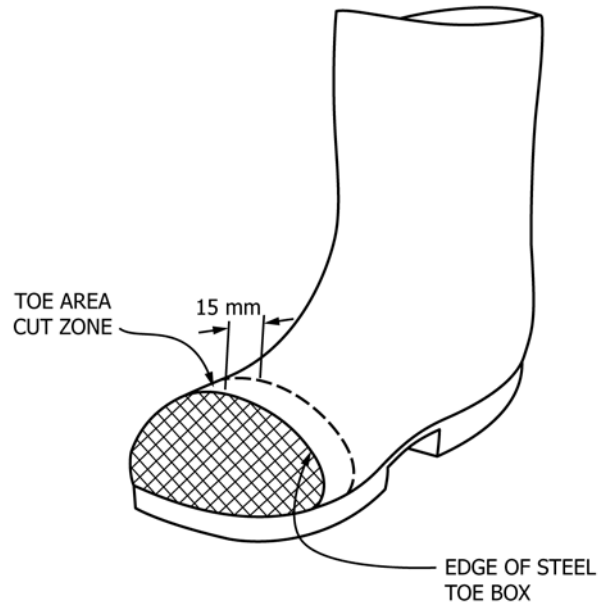


FIG. 9 Toe Area Cut Zone

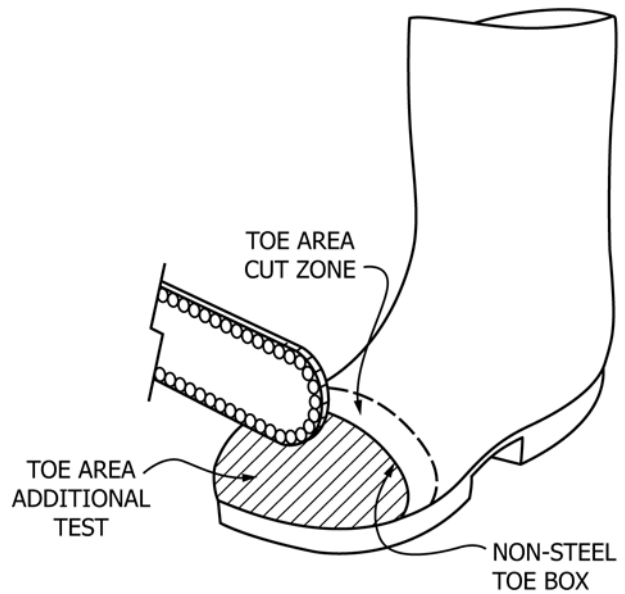


FIG. 10 Toe Area Cut Zone

11.3.2.6 Position the footwear so that the centerline of the guide bar is at an angle of 0 to 30° to the plane of the baseplate when the footwear is mounted on the test bracket (see Fig. 3).

11.3.2.7 The plane of the guide bar is vertical and perpendicular to the centerline of the footwear.

11.4 *Data Collection Circuitry:*

11.4.1 Attach each end of both the bottom and upper wire to a terminal of data collection circuitry.

11.4.2 Verify the continuity of all circuits prior to starting chainsaw procedures. This includes both the upper and bottom timing wires.

11.5 *Chainsaw Preparation:*

11.5.1 Clean and visually check chainsaw after every test cutting. Check any abnormality.

11.5.2 Refuel and oil at least once after every ten test cuts.

NOTE 5—Refueling avoids significant variations in mass.

11.5.3 Start chainsaw and idle for approximately 2 min. Adjust chainsaw speed to the specific speed for the trial in progress.

11.6 *Test Protocol:*

11.6.1 Before the test, turn on the recording circuitry so that a record can be made of chain speed and CS50.

11.6.2 Release the chainsaw to make contact with the test specimen so that the saw chain cuts the top wire and starts the timer.

11.6.3 Terminate the test when there is a cut through, chain stop, or no cut through after 1.5 s.

11.7 *Chain Speed 50 (CS50):*

11.7.1 The chain speed 50 (CS50) can be determined as follows:

11.7.1.1 Start the engine of the chainsaw and set the initial saw chain speed for a specific CS50 value.

11.7.1.2 Trigger the saw release mechanism.

11.7.1.3 Note the results either of cut through, chain stop, or no cut through.

11.7.2 Repeat the test on a new specimen using a lower saw chain speed if the results with the first specimen resulted in a cut through; or a higher saw chain speed, if a chain stop was the result of the first test.

11.7.2.1 Note the results and continue to test in this manner as recommended in Test Method **F1414**.

11.7.2.2 Intermediate saw chain speeds may be used for more accurate results. This would require a larger number of specimens.

11.7.2.3 The CS50 is achieved when all of the six tested specimens pass a specified speed and all the specimens fall within 1 m/s (200 fpm) of the lowest failed specimen at each test location.

12. Interpretation

12.1 Specimens will be cut through at speeds higher than their CS50.

12.1.1 The cutting of the underwire stops the timer.

12.1.2 Jamming can stop the rotation of the saw chain before a cut through.

12.1.2.1 In certain tests, the chainsaw engine may continue to run despite the saw chain being stopped. In these tests, the structure of the foot protective device may have slowed the engine sufficiently for the centrifugal clutch to stop driving the saw chain.

12.2 When this test method is used to determine pass/fail at a specified saw chain speed, all specimens must pass at, or above, the specified saw chain speed.

12.2.1 Failure of a single specimen below a specified saw chain speed results in failure of the specimen lot.

13. Report

13.1 Report the following information:

13.1.1 Location of the test cuts on the footwear or foot protective device.

13.1.2 Quantity and description of the specimens.

13.1.3 Table showing the specimen number, chain speed, and test result.

13.1.4 Table showing the calibration and description of saw chain.

13.1.5 Any value obtained for CS50, cut through, pass/fail, or combination thereof.

14. Precision and Bias

14.1 *Precision*—A set of thirty nine specimens were tested in accordance with Test Method F1458 using a running saw moving at a minimum initial speed of 15.25 m/s (3000 fpm). A boot strap (resampling) approach was used to estimate mean and standard deviation of chain speed 50 (CS50) under the following conditions: (1) chain speeds followed the test guidelines shown in Table 1 Test Method **F1414**; (2) at least six specimens, three pass and three fail were included; and (3) CS50 was estimated as the average of the three fastest pass values and the three slowest fail values. Five hundred boot strap CS50 estimates are summarized in the table:

Property	Average	s_r	Repeatability
CS50	16.8 m/s (3275 fpm)	89.3	247.5

s_r is the intra-laboratory standard deviation. Test method repeatability is defined as the maximum difference that can reasonably be expected between two test results obtained on the same material when test results are obtained in the same laboratory. Test method reproducibility could not be determined from these data.⁹

14.2 *Bias*—The procedures in this test method for measuring the cut resistance of foot protective devices to chain saws have no bias because the value of this evaluation can be defined only in terms of a test method.

15. Keywords

15.1 chainsaw; cut resistance; foot protective devices; footwear; gaiters; liners

⁹ Mandel, John and Lashof, Theodore W., The Nature of Repeatability and Reproducibility, *Jour. Quality Technology*, 19(1), 1987.

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