



# Standard Test Methods for Evaluating Design and Performance Characteristics of Motorized Treadmills<sup>1</sup>

This standard is issued under the fixed designation F2106; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## INTRODUCTION

The goal of these test methods is to provide reliable and repeatable methods for the evaluation of motorized treadmills. Users of the equipment must recognize that conformance to a standard will not necessarily prevent injuries. Like other physical activities, exercise involving a treadmill involves a risk of injury, particularly if the equipment is not maintained or used properly.

## 1. Scope

1.1 These test methods specify procedures and equipment used for testing and evaluating a motorized treadmill for compliance to Specification F2115. Both design and operational parameters will be evaluated. Where possible and applicable, accepted test methods from other recognized bodies will be used and referenced. In case of a conflict between this document and Specification F2115, Specification F2115 takes precedence.

1.2 *Requirements*—A motorized treadmill is to be tested for all of the following parameters:

- 1.2.1 Stability,
- 1.2.2 Exterior design,
- 1.2.3 Endurance,
- 1.2.4 Static loading,
- 1.2.5 Overheating,
- 1.2.6 Adjustable incline system function,
- 1.2.7 User interface parameters,
- 1.2.8 Motorized drive system operation,
- 1.2.9 Warning label compliance, and
- 1.2.10 Documentation.

## 2. Referenced Documents

- 2.1 *ASTM Standards*:<sup>2</sup>

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee F08 on Sports Equipment and Facilities and is the direct responsibility of Subcommittee F08.30 on Fitness Products.

Current edition approved Feb. 1, 2010. Published May 2010. Originally approved in 2001. Last previous edition approved in 2003 as F2106 – 03. DOI: 10.1520/F2106-03R10.

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

F1749 Specification for Fitness Equipment and Fitness Facility Safety Signage and Labels

F2115 Specification for Motorized Treadmills

2.2 *UL Standards*:<sup>3</sup>

UL 1439 Test for Sharpness of Edges on Equipment

UL 1647 Motor Operated Massage and Exercise Machines

2.3 *European Standard*:<sup>4</sup>

EN 957-1 Stationary Training Equipment—Part 1: General Safety Requirements and Test Methods

2.4 *ISO Standards*:<sup>5</sup>

ISO 4649 Rubber—Determination of Abrasion Resistance Using a Rotating Cylindrical Drum Device

ISO 5904 Gymnastic Equipment—Landing Mats and Surfaces for Floor Exercises—Determination of Resistance to Slipping

## 3. Terminology

3.1 *Definitions*—For definitions applicable to this standard see Specification F2115.

## 4. Significance and Use

4.1 The purpose of these test methods is to provide reliable and repeatable test methods for the evaluation of motorized treadmills assembled and maintained according to the manufacturer's specifications. Use of these test methods in conjunction with Specification F2115 is intended to insure appropriate performance and reliability of a motorized treadmill and reduce the risk of serious injury from design deficiencies.

<sup>3</sup> Available from Underwriters Laboratories (UL), Corporate Progress, 333 Pfingsten Rd., Northbrook, IL 60062.

<sup>4</sup> Available from CEN Management Centre, 36 rue de Strasse, B-1050, Brussels, Belgium.

<sup>5</sup> Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland.

## 5. Certification

5.1 These test methods permit self-certification. It is recommended that each manufacturer employ an independent laboratory to evaluate and validate that their designs and test procedures conform and comply with these test methods and Specification **F2115**.

## 6. Units of Measure

6.1 The values stated in SI units are to be regarded as the standard. The values in parenthesis are for information only.

## 7. Sample Preparation

7.1 Assemble and adjust the treadmill on a horizontal surface according to the manufacturer's instructions. On treadmills that are fully assembled, verify according to the manufacturer's instructions that the moving surface has been adjusted to the proper tension and alignment. Unless otherwise stated, the treadmill must pass the following tests without adjustment from this initial condition. Apply power to the treadmill and verify that the unit functions properly. If the unit is equipped with an adjustable incline system, operate it through its full range.

7.2 The individual test methods will describe any variations or modifications that are required to the test sample.

## 8. Report

8.1 *Record of Tests*—Maintain complete test records and test summary reports for all testing, whether performed by the manufacturer or an independent laboratory. The records can be stored on paper, electronically, and/or on photographs. A copy of the test summary must be kept by the laboratory that performed the test for a minimum of five years from the date of the test and by the manufacturer for a minimum of five years past the end of production of the model tested. The summary shall include the signature of the technician(s) performing the tests and a management representative of the laboratory performing the test. The test summary shall include the following information:

8.1.1 Manufacturer's name and location,

8.1.2 Information provided by the manufacturer to accurately identify the configuration of, and specific unit provided to, the testing agency,

8.1.3 Dates over which the tests were conducted, and

8.1.4 Name and location of the testing laboratory, if different from the manufacturer.

8.1.5 Summary and results of each test performed including method and apparatus used. This shall include what the desired requirement was and whether the test sample met that parameter or failed. If the test requires a specific number of cycles to be met, then the report must include the number of cycles actually conducted. If the treadmill fails to meet a parameter, then that failure must be noted in clear and accurate terms to enable a reader of the report to understand at a later date what transpired.

## 9. Test Methods and Procedures

9.1 *Stability*—The treadmill shall be tested by a series of load applications in the orientation that is most obviously unstable.

9.1.1 *Apparatus and Set Up*—Place treadmill on a non-skid  $10^\circ$  surface in the orientation that is least stable. A method of applying a steady state force equal to  $1.0 \times$  maximum user weight in the vertical direction must be provided. Possible methods of providing force include, but are not limited to, pneumatic cylinder(s) or dead weights.

9.1.2 *Calibration*—Using an angle measuring instrument accurate to within  $0.1^\circ$ , verify the nonskid surface is  $10^\circ \pm 0.5^\circ$ . Calibrate the load measurement apparatus to confirm accuracy to within  $\pm 20$  N (4.5 lb.) over entire user weight range.

9.1.3 *Procedure*—Test the treadmill as follows:

9.1.3.1 Using the aforementioned load apparatus, apply a vertical load equal to  $1.0 \times$  maximum specified user weight  $\pm 5\%$  in a non-impact manner at the point on the foot rail which creates the most instability. Verify that the treadmill does not tip over.

9.1.3.2 Repeat 9.1.3.1 with the treadmill oriented in any other directions of potential instability.

9.1.3.3 For folding treadmills, the treadmill shall, after completing 9.1.3.1 and 9.1.3.2 be folded to its storage position per manufacturer's instructions and placed on the  $10^\circ$  inclined surface in all orientations that could cause instability. No additional load is to be applied.

9.1.4 *Pass/Fail Criteria*—In none of the above test conditions shall the treadmill tip over.

9.1.5 *Precision and Bias*—No information is presented about either the precision or bias of test 9.1 for measuring stability since the test result is non-quantitative.

9.2 *Exterior Design*:

9.2.1 *Sharp Edges*—The purpose of this test is to verify that there are no edges in the accessible area that would constitute a risk of injury. Where there is uncertainty, a sharp-edge tester as specified by **UL 1439** is to be employed.

9.2.1.1 *Apparatus and Set Up*—Elevate the treadmill incline to the least favorable position for applying a sharp-edge tester as specified in **UL 1439**.

9.2.1.2 *Calibration*—Calibrate sharp-edge tester per **UL 1439**.

9.2.1.3 *Procedure*—Examine the accessible area by visual and tactile means to ensure all parts are burr-free, rounded, or otherwise insufficiently sharp to constitute a risk of injury. Wherever there may be uncertainty as to the sharpness of an edge, use the edge tester as follows. Cover the tester head with sensing tape as specified in **UL 1439**. Application force should be 6.5 N (1.5 lb). Move the head along the test edge for a distance of 51 mm (2 in.) and back without tiffing the tester off the edge. If the available edge for testing is less than 51 mm (2 in.), repeat the stroke without lifting the tester. Total travel time should range from 2 to 5 s. Examine the tape upon completion of each edge analysis. If any of the sensing tapes break, record the violation and reapply the sensing tapes accordingly.

9.2.1.4 *Pass/Fail Criteria*—If both outer layer sensing tapes have been cut, the edge is unacceptable.

9.2.1.5 *Precision and Bias*—No information is presented about either the precision or bias of test 9.2.1 for evaluating sharp edges since the test result is non-quantitative.

9.2.2 *Corners*—This test is a visual inspection of the unit to insure that all corners in the accessible area are radiused or chamfered.

9.2.2.1 *Apparatus and Set Up*—The test is to be conducted with the treadmill at all inclines and positions possible in normal use and storage.

9.2.2.2 *Calibration*—No calibration required. Visual inspection only.

9.2.2.3 *Procedure*—Inspect all corners to verify that the corners have been radiused or chamfered.

9.2.2.4 *Pass/Fail Criteria*—All corners in the accessible area shall be radiused or chamfered.

9.2.2.5 *Precision and Bias*—No information is presented about either the precision or bias of test 9.2.2 for evaluating comers since the test result is non-quantitative.

9.2.3 *Tube Ends*—This test is a visual inspection of the unit to insure that all tube ends in the accessible area are closed off.

9.2.3.1 *Apparatus and Set Up*—Elevate the treadmill to the incline(s) that will expose all tube ends to the accessible area.

9.2.3.2 *Calibration*—No calibration required. Visual inspection only.

9.2.3.3 *Procedure*—Inspect all tube ends in the accessible area to verify that they are closed off by other components, caps, plugs, or covers.

9.2.3.4 *Pass/Fail Criteria*—All tube ends in the accessible area shall be closed off.

9.2.3.5 No information is presented about either the precision or bias of test 9.2.3 for evaluating tube end closure since the test result is non-quantitative.

9.2.4 Rotating parts in the accessible area and rear roller area. The purpose of this test is to evaluate the risk of injury due to a moving mechanical part. Methodology entails insertion of an articulate probe that simulates an accepted case finger into all questionable areas.

9.2.4.1 *Apparatus and Set Up*—This test requires a probe as specified in Fig. 2, “Test Finger,” of EN 957–1. Verify that all guards are properly positioned and secured and the moving surface is centered per instructions in the owner’s manual. Apply power to the treadmill so that its incline can be elevated and the moving surface can be run.

9.2.4.2 *Calibration*—Verify the articulate probe conforms to the dimensions of Fig. 2, “Test Finger,” of EN 957–1.

9.2.4.3 *Procedure*—With no power applied, insert probe at any pull-in nip points or areas accessible to any mechanical hazards on the treadmill. Points of insertion include, but shall not be limited to the rear roller guards, foot rail to moving surface interface, motor compartment/moving surface gap and any openings in the motor compartment or shroud. For all insertions, the probe is to be rotated and bent in all possible configurations and application force shall not exceed 4.4 N (1 lb). Elevate the treadmill to its maximum incline position. Under the assumption there shouldn’t be any hazard, run the moving surface at minimum speed and verify the finger will not get trapped anywhere. If any other incline positions reveal a potential pull in or nip points, the test shall be repeated at that incline position.

9.2.4.4 *Pass/Fail Criteria*—The probe shall not become entrapped in any mechanical hazard. Entrapment is defined to have occurred if the force to pull out the probe is greater than 4.4 N (1 lb).

9.2.4.5 *Precision and Bias*—No information is presented about either the precision or bias of test 9.2.4 for evaluating hazards of rotating parts since the test result is non-quantitative.

9.2.5 *Guarding from Electrical Hazards*—The purpose of this test is to verify that all electrical elements are adequately guarded to prevent electric shock from uninsulated live parts and film-coated wire. Methodology entails insertion of an articulate probe that simulates a worst case finger into all questionable areas.

9.2.5.1 *Apparatus and Set Up*—This test requires an articulate probe as specified in UL 1647. Verify that all guards are properly positioned and secured and the moving surface is centered per instructions in the owner’s manual. Treadmill to be tested in all incline positions and all normal usage positions that may present a hazard.

9.2.5.2 *Calibration*—Verify articulate probes conform to the dimensions of UL 1647.

9.2.5.3 *Procedure*—With no power applied, insert probe at any points where contact with electrical elements is possible. Points of insertion include, but shall not be limited to the motor compartment/moving surface gap and any openings in the motor compartment or shroud. For all insertions, the probe is to be rotated and bent in all possible configurations and application force shall not exceed 4.4 N (1 lb). Elevate the treadmill to all other incline positions that may present a hazard and repeat the insertion test. The components not involved in the insertion area may now be removed to clearly see whether the probe can contact any electrical hazard.

9.2.5.4 *Pass/Fail Criteria*—The probe shall not contact any electrical hazard.

9.2.5.5 *Precision and Bias*—No information is presented about either the precision or bias of test 9.2.5 for evaluating accessibility of electrical components since the test result is nonquantitative.

9.2.6 *Foot Rails*—The purpose of this test is to evaluate the slip resistance of the foot rails of the treadmill and to verify that they meet specified dimensional requirements.

9.2.6.1 *Apparatus and Set Up*—The treadmill shall be placed adjacent to a test device consisting of a roughened (using 60 to 63 grain size abrasive paper) rubber surfaced block made with standard rubber as defined in clause B.2 of Annex B of ISO 4649, which will apply a vertical force of 30 N (6.6 lb), pulled by a rope affixed to a tensile testing apparatus (equivalent to test set up shown in ISO 5904) or other appropriate means. Temperature of the test apparatus and test specimen shall be  $20^{\circ} \pm 3^{\circ}\text{C}$  ( $68^{\circ} \pm 6^{\circ}\text{F}$ ). Provide a means of spraying a light mist of water onto the foot rails.

9.2.6.2 *Calibration*—Verify that the test equipment is properly calibrated and accurate to within  $\pm 0.5\text{ N}$  ( $\pm 0.1\text{ lb.}$ ) and that the measuring equipment is calibrated and accurate to within  $\pm 1\text{ mm}$  (.040 in).

9.2.6.3 *Procedure*—Place the friction block attached to the test apparatus on the foot rail. Slowly apply force to the friction



block until it begins to move. Record maximum force applied to the friction block. Repeat this procedure two (2) more times. Apply a light mist of water to the foot rail and repeat test. Measure the length, width and placement of the foot rails with respect to the moving surface and the distance between the foot rails.

**9.2.6.4 Pass/Fail Criteria**—Divide the average maximum force applied to the friction block by the weight of the friction block for both the dry and wet conditions. This result is the static coefficient of friction. The coefficient of friction for the foot rails shall exceed 0.5 for both wet and dry conditions. The foot rail dimensions shall conform to dimensional requirements of Sections 4.3.7.2 and 4.3.7.3 of Specification **F2115**.

**9.2.6.5 Precision and Bias**—No information is presented about either the precision or bias of test **9.2.6** for measuring static coefficient of friction and foot rail dimensions since the test result is non-quantitative.

**9.2.7 Moving Surface**—The purpose of this test is to evaluate the slip resistance of the moving surface of the treadmill and to verify that the moving surface meets dimensional requirements. Note that the procedure for measurement is essentially the same as outlined in section **9.2.6**.

**9.2.7.1 Apparatus and Set Up**—The treadmill shall be placed adjacent to a test device consisting of a roughened (using 60 to 63 grain size abrasive paper) rubber surfaced block made with standard rubber as defined in clause B.2 of annex B of **ISO 4649**, which will apply a vertical force of 30 N (6.6 lb.), pulled by a rope affixed to a tensile testing apparatus (equivalent to test set up shown in **ISO 5904**) or other appropriate means. Temperature of the test apparatus and test specimen shall be  $20^{\circ} \pm 3^{\circ}\text{C}$  ( $68^{\circ} \pm 6^{\circ}\text{F}$ ). Provide a means of spraying a light mist of water onto the foot rails.

**9.2.7.2 Calibration**—Verify that the test equipment is properly calibrated and accurate to within  $\pm 0.5\text{ N}$  ( $\pm 0.1\text{ lb}$ ). Verify that the distance measuring equipment is calibrated and accurate to within  $\pm 1\text{ mm}$  ( $.040\text{ in}$ ).

**9.2.7.3 Procedure**—Secure the moving surface so that it cannot move. Place the friction block attached to the test apparatus on the moving surface. Slowly apply force to the friction block until it begins to move. Record maximum force applied to the friction block. Repeat this procedure two (2) more times. Apply a light mist of water to the moving surface and repeat test. Measure the length and width of the usable moving surface.

**9.2.7.4 Pass/Fail Criteria**—Divide the average maximum force applied to the friction block by the weight of the friction block for both the dry and wet conditions. This result is the static coefficient of friction. The coefficient of friction for the moving surface shall exceed 0.5 for both wet and dry conditions. The dimensions of an obstructed rectangle of the moving surface shall conform to dimensional requirements of Section 4.3.8.2 of Specification **F2115**.

**9.2.7.5 Precision and Bias**—No information is presented about either the precision or bias of test **9.2.7** for measuring static coefficient of friction and moving surface dimensions since the test result is non-quantitative.

**9.2.8 Handrails**—The purpose of this test is to verify the dimensional compliance of the handrails.

**9.2.8.1 Apparatus and Set Up**—No set up required, dimensional inspection only.

**9.2.8.2 Calibration**—Verify that the distance measuring equipment is calibrated and accurate to within  $\pm 1\text{ mm}$  ( $.040\text{ in}$ ).

**9.2.8.3 Procedure**—Measure the length of all segments of the hand rail. Measure the distance from the moving surface to the top of the grip surface. If so equipped, measure the horizontal distance between the side handrails.

**9.2.8.4 Pass/Fail Criteria**—The dimensions of the handrails shall conform to dimensional requirements of Section 4.3.8 of Specification **F2115**.

**9.2.8.5 Precision and Bias**—No information is presented about either the precision or bias of test **9.2.8** for measuring handrail dimensions since the test result is non-quantitative.

**9.3 Endurance**—These tests are intended to confirm the endurance of the main components of the treadmill.

**9.3.1 Mechanical Frame Endurance**—The stationary moving surface, frame, and structural components of the treadmill are subjected to a repeated load equal to 1.5 times the maximum user weight as specified by the manufacturer.

**9.3.1.1 Apparatus and Set Up**—A pneumatic cylinder or other appropriate load application device shall be fixtured to apply load to the moving surface at the centerline of the treadmill 33 % of the length of the usable moving surface rearward from the front of the usable moving surface. A  $30 \times 30\text{ cm}$  ( $12\text{ in.} \times 12\text{ in.}$ ) load application area shall be used for the test. Timing controls must be supplied to regulate the load application frequency. Provide appropriate instrumentation to assure that the load is consistent throughout the test duration.

**9.3.1.2 Calibration**—Verify that the load and frequency measuring equipment is properly calibrated and that the load accuracy is within  $\pm 5\%$  of the applied load and that the frequency measurement is accurate to within  $\pm 0.2\text{ Hz}$ .

**9.3.1.3 Procedure**—Elevate the treadmill to the incline that will provide the most stress to the frame and incline system components and position the treadmill under the load application device. No power shall be connected to the treadmill. Block the treadmill into position so that the vibrations created by the test do not cause it to move on the floor. Apply power to the load application system. Adjust the applied load to 1.5 times maximum user weight  $\pm 5\%$  at a frequency of 0.5 to 2 Hz. Assure that the moving surface rebounds completely prior to the next cycle. Verify that the counter is recording the number of cycles. Inspect the treadmill and test apparatus approximately every 250,000 cycles or as needed to insure that the test is functioning properly. If the design of the treadmill is such that keeping the moving surface stationary for the duration of the test would abnormally stress the moving surface (i.e. a treadmill that employs moving slats rather than a conventional belt and deck), the moving surface may be repositioned periodically during the test.

**9.3.1.4 Pass/Fail Criteria**—Upon completion of the test, remove the test unit from the fixture and confirm normal operation of all functions. The treadmill must meet life requirements per classification of use per Section 4.4 of Specification **F2115**. The unit must not show structural cracks or other indications of impending failure.