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Standard Test Methods for Evaluating Design and Performance Characteristics of Stationary Upright and Recumbent Exercise Bicycles and Upper and Total Body Ergometers[1]

This standard is issued under the fixed designation F3023; 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

The goal of these test methods is to provide reliable and repeatable methods for the evaluation of stationary upright and recumbent exercise bicycles and ~~upper body~~ ergometers.

The equipment user must recognize, however, that a standard alone will not necessarily prevent injuries. Like other physical activities, exercise involving stationary ~~upright and recumbent exercise bicycles and upper body ergometers~~ this equipment involves the risk of injury, particularly if the equipment is used improperly or is not properly maintained. In addition, users with physical limitations should seek medical advice and instruction from the fitness facility prior to using this equipment. Certain physical conditions or limitations may preclude some persons from using this equipment ~~properly and without increasing~~ as intended by the manufacturer, and using this equipment may increase the risk of ~~serious~~ injury.

1. Scope

1.1 These test methods specify procedures and equipment used for testing and evaluating stationary exercise upright and recumbent bicycles and ~~crank training equipment (machines)~~ergometers for compliance to Specification F1250. 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 the case of a conflict between this document and Specification F1250, Specification F1250 takes precedence.

1.2 *Requirements*—Stationary exercise bicycles and ~~crank training equipment~~ ergometers are to be tested for the parameters specified in Specification F2276 and Test Methods F2571 and the following parameters unique to this equipment:

1.2.1 Seat post construction and loading,

1.2.2 Handlebar construction and loading,

1.2.3 Pedal construction and loading,

1.2.4 Crank ~~Arm~~arm and ~~Enclosure Entrapment~~enclosure entrapment,

1.2.5 Seat back support loading,

1.2.6 Stability,

1.2.7 Direct Drive Exercise Bicycle Pedal Endurance,

1.2.8 ~~Warnings~~Warnings, and

1.2.9 ~~Documentation~~Documentation.

1.3 This test method[2] contains additional requirements to address the accessibility of the equipment for persons with disabilities.

1.4 *Units*—The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

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[1] These test methods are under the jurisdiction of ASTM Committee F08 on Sports Equipment, Playing Surfaces, and Facilities and ~~is~~are the direct responsibility of Subcommittee F08.30 on Fitness Products.

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[2] This work was funded, in part, by the Rehabilitation Engineering Research Center on RecTech through the National Institute on Disability, Independent Living, and Rehabilitation Research grant #90RE5009-01-00.

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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *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:*[3]

F1250 Specification for Stationary Upright and Recumbent Exercise Bicycles and Upper and Total Body Ergometers
F1749 Specification for Fitness Equipment and Fitness Facility Safety Signage and Labels
F2276 Specification for Fitness Equipment
F2277 Test Methods for Evaluating Design and Performance Characteristics of Selectorized Strength Equipment
F2571 Test Methods for Evaluating Design and Performance Characteristics of Fitness Equipment
F3021 Specification for Universal Design of Fitness Equipment for Inclusive Use by Persons with Functional Limitations and Impairments
F3022 Test Method for Evaluating the Universal Design of Fitness Equipment for Inclusive Use by Persons with Functional Limitations and Impairments

~~2.2 *European Standards:*[3]~~

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

3. Terminology

~~3.1 *Definitions:* For definitions applicable to this standard see Specification F1250.~~

3.1 *Definitions*—For definitions applicable to this standard, see Specifications F1250 and F3021.

4. Significance and Use

4.1 The purpose of these test methods is to provide reliable and repeatable test methods for the evaluation of stationary exercise bicycles and ~~crank training equipment~~ ergometers assembled and maintained according to the manufacturer's specifications. Use of these test methods in conjunction ~~Specification~~ with Specifications F1250 and F3021 is intended to ensure appropriate performance and reliability of said equipment and reduce the risk of serious injury from design deficiencies.

~~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 test procedures and methodologies conform and comply with these test methods and Specification F1250.~~

5. Sample Preparations

5.1 Assemble and adjust the machine on a horizontal surface according to the manufacturer's instructions. For machines that are fully assembled, verify according to the manufacturer's instructions that all components are functioning and that they have been adjusted and aligned properly. Unless otherwise stated, the machine must pass the following tests without adjustment from this initial condition. Apply power to, if required, or use the machine and verify that the unit functions properly.

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

5.3 Unless noted, the machine shall function as intended by the manufacturer after the completion of ~~the tests.~~each test.

6. Test Methods and Procedures

6.1 In addition to the tests specified in Test Methods F2571, stationary exercise bicycles and ergometers shall be evaluated with the following test methods and procedures. These test methods align with the design and construction requirements specified in Specification F1250 (Section 5).

6.2 *Seat Post*—The purpose of this test is to evaluate the construction and retention of the seat post.

6.2.1 *Apparatus and Set Up*—The sample shall be set up as described in Section 5.

6.2.2 *Calibration*—Verify that the measurement device is properly calibrated and has a resolution of 1 mm (0.04 in.).

6.2.3 *Procedure*—The following steps should be followed to test the specifications for the seat post.

[3] 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.

6.2.3.1 *Insertion Depth*—If the seat post is adjustable and removable, remove the seat post from the machine. Measure the largest cross-sectional dimension of the seat post. Multiply this number by 1.5. Inspect the seat post and verify that there is a mark on the seat post indicating the minimum insertion depth at the dimension calculated above. Verify that the mark defined above is even with the top of or below the top of the seat adjustment sleeve tube when the seat is adjusted into its uppermost position. If the minimum insertion depth is provided by design, verify that the design is such that the seat post cannot be removed from the machine without the use of tools or that the seat post cannot be removed without the retention means seating and attaining the minimum insertion depth.

6.2.3.2 Verify that the seat post is adjustable and that the seat post is retained in any of its adjustment positions by a clamp, pin, or similar means.

6.2.3.3 Verify that there is a seat support plate or structure present between the underside of the seat and the top end of the seat post.

6.2.3.4 Refer to Test Methods F2571 Subsection 7.11.1 and follow the procedure for intrinsic load testing of the seat.

6.2.4 *Pass/Fail Criteria*—The seat post shall conform to dimensional and component requirements of Subsection 5.1 of Specification F1250, as well as the loading requirements of Specifications F1250 and F2276. If the above criteria are not met the sample shall fail the test.

6.2.5 *Precision and Bias*—No information is presented about either the precision or bias of this test since the test result is non-quantitative.

6.2.5.1 *Precision*—The precision of this test method has not been determined.

6.2.5.2 *Bias*—The bias of this test method includes quantitative estimates of the uncertainties of the measuring devices, the calibrations of testing equipment, and the skill of the operators. At this time, the statements on bias should be limited to documented performance of particular laboratories.

6.3 *Seat Deflection or Tilt*—The purpose of this test is to evaluate the tilt requirements of the seat assembly.

6.3.1 *Apparatus and Set Up*—The sample shall be set up as described in Section 5 with the seat adjusted into its uppermost adjustment position. Possible methods of providing the force for this test include, but are not limited to, pneumatic cylinder(s) or dead weights. If necessary, the machine may be restrained from movement provided the restraint does not aid the structure or otherwise interfere in the test. Clamp a load receiving plate 50 by 50 mm (1.97 by 1.97 in.) flush with the front (and then the rear) of the seat in such a way that a vertical load can be applied to the seat in an upward vertical direction and then a downward vertical direction. Zero and measure the angle of the loading plate as referenced to the floor.

6.3.2 *Calibration*—Verify the load application system is calibrated and is accurate to within ±2 % of applied load. Verify that the measurement device is properly calibrated and has a resolution of ½ ° or less.

6.3.3 *Procedure*—Apply an upward vertical load to the loading plate. Maintain the load for 5 min then remove. Re-measure the angle of the loading plate with respect to the floor. Repeat the test with a downward load applied to the loading plate. Repeat both tests but apply the vertical loading in both the upward and downward directions to the rear of the seat.

6.3.4 *Pass/Fail Criteria*—The seat deflection or tilt evaluation shall conform to the tilt requirements of Subsection 5.2 of Specification F1250. If the seat tilt exceeds the criteria for any of the above tests, the sample shall fail the test.

6.3.5 *Precision and Bias:*

6.3.5.1 *Precision*—The precision of this test method has not been determined.

6.3.5.2 *Bias*—The bias of this test method includes quantitative estimates of the uncertainties of the measuring devices, the calibrations of testing equipment, and the skill of the operators. At this time, the statements on bias should be limited to documented performance of particular laboratories.

6.4 *Seat Back Support*—The purpose of this test is to evaluate the static structural integrity of the seat back supports.

6.4.1 *Apparatus and Set Up*—The sample shall be set up as described in Section 5. Supply a means of providing a steady state load to the back support. Possible methods of providing the load for this test include, but are not limited to, pneumatic cylinder(s) or dead weights. Load is to be applied on a 300 by 300 mm (11.8 by 11.8 in.) square area with its center located 500 mm (19.7 in.) above the seating surface or 50 mm (1.98 in.) below the upper edge of the seat back if the seat is less than 560 mm (22 in.) tall. Determine and record the vertical dimension, h, to the point of application of the load.

6.4.2 *Calibration*—Verify the load application system is calibrated and is accurate to within ±2 % of the applied load.

6.4.3 *Procedure*—The test load requirements are specified in Subsection 5.3 of Specification F1250. With the back support set up as described above, apply the load horizontally to the center point of the plate and maintain it for 5 min (see Fig. 1).

6.4.4 *Pass/Fail Criteria*—The seat back shall conform to the load requirements of Subsection 5.3 of Specification F1250. The seat back support and supporting structures shall not break and shall function as intended by the manufacturer.

6.4.5 *Precision and Bias:*

6.4.5.1 *Precision*—The precision of this test method has not been determined.

6.4.5.2 *Bias*—The bias of this test method includes quantitative estimates of the uncertainties of the measuring devices, the calibrations of testing equipment, and the skill of the operators. At this time, the statements on bias should be limited to documented performance of particular laboratories.

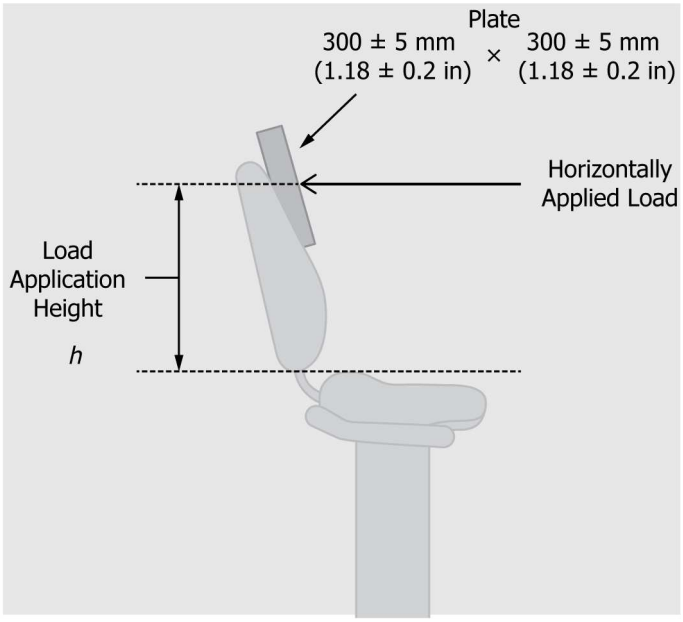

FIG. 1 Seat Back Support Test

6.5 *Handlebar Stem Insertion*—The purpose of this test is to verify the existence of a mark on the handlebar post indicating the minimum insertion depth.

6.5.1 *Apparatus and Set Up*—The sample shall be set up as described in Section 5.

6.5.2 *Calibration*—Verify that the measurement device is properly calibrated and has a resolution of 1 mm (0.04 in.).

6.5.3 *Procedure*—If the handlebar stem is adjustable and removable, remove the handlebar stem from the machine. Measure the largest cross-sectional dimension of the handlebar stem. Multiply this number by 1.5. Inspect the handlebar stem and verify the presence of a mark on the handlebar stem indicating the minimum insertion depth. Verify that this mark is at least at the dimension calculated above, from the end of the handlebar stem. Verify that the mark defined above is even with or below the top of the handlebar adjustment sleeve tube when the handlebar assembly is adjusted into its uppermost position. If the minimum insertion depth is provided by design, verify that the design is such that the handlebar stem cannot be removed from the machine without the use of tools.

6.5.4 *Pass/Fail Criteria*—The dimensions that pertain to the handlebar stem insertion shall conform to dimensional requirements of Subsection 5.4 of Specification F1250. If the above criteria are not met the sample shall fail the test.

6.5.5 *Precision and Bias:*

6.5.5.1 *Precision*—The precision of this test method has not been determined.

6.5.5.2 *Bias*—The bias of this test method includes quantitative estimates of the uncertainties of the measuring devices, the calibrations of testing equipment, and the skill of the operators. At this time, the statements on bias should be limited to documented performance of particular laboratories.

6.6 *Handlebar Static Loading*—The purpose of this test is to evaluate the static structural integrity of the handlebars as set forth in Subsection 5.5 of Specification F1250 and in Specification F2276.

6.6.1 *Apparatus and Set Up*—The sample shall be set up as described in Section 5 with the handlebars adjusted into their uppermost adjustment position. Possible methods of providing the force for this test include, but are not limited to, pneumatic cylinder(s) or dead weights. If necessary, the machine may be restrained from movement as long as that restraint does not aid the structure of the structure being tested. Clamp a 150 mm (5.9 in.) long reference bar to the handlebar to be used for measurements from the handlebar to a fixed reference, such as the floor or a wall for the horizontal axis and vertical axis tests, respectively. Note, the position and orientation of the of the clamped reference bar may need to be moved or repositioned depending on the reference plane used for the specific test, that is, a horizontal or vertical reference plane.

6.6.2 *Calibration*—Verify the torque application system is calibrated and is accurate to within ±5 % of applied torque and the force load application system is calibrated and is accurate to within ±2 % of the applied load. Verify that the measurement device is properly calibrated and has a resolution of 1 mm (0.04 in.).

6.6.3 *Procedure*—The following steps should be followed to test the specifications for handlebar static loading.

6.6.3.1 *Horizontal Axis Torque Evaluation*—The referenced horizontal axis is longitudinal to the body of the bicycle, that is, along the apparent direction of travel of the bicycle. Measure and record the distance from the clamped reference bar to the floor. To confirm the horizontal torque integrity of the handlebars, apply the torque as defined in Subsection 5.5.1 of Specification F1250 about the horizontal axis of the handlebar. Maintain the load for 5 min, and then remove. Re-measure and record the height from

the reference bar to the floor. Note: the torque can be applied by applying an equivalent vertical load downward on one of the handlebar ends at an appropriately calculated distance.

6.6.3.2 *Vertical Axis Torque Evaluation*—Measure and record the distance from the clamped reference bar to a vertical reference surface such as a wall. To confirm the vertical torque integrity of the handlebars, apply the torque as defined in Subsection 5.5.2 of Specification F1250 about the vertical axis of the handlebar. Maintain the load for 5 min, and then remove. Re-measure and record the height from the reference bar to the reference surface.

6.6.3.3 Refer to Test Methods F2571 Subsection 7.11.4 for test procedures for the handlebars.

6.6.3.4 *Recumbent Seat Support Handlebars*—Apply the static load to the weakest structural point of the handlebars in the vertical direction. Maintain the load for 5 min, and then remove. Visually inspect for indications of breakage. If applying the load to only one handlebar (as allowed in Specification F1250), apply ½ the load stated in Specification F1250 vertically for 5 min, and then remove. If two handlebars are provided, then the test load shall be distributed over each handlebar or ½ of the test load shall be applied to one handlebar.

6.6.4 *Pass/Fail Criteria*—The handlebar shall conform to the torque and load requirements of Subsection 5.5 of Specification F1250, as well as the loading requirements of Specification F2276. For the torque evaluations, the reference bar shall not have moved by more than the resolution of the measuring device. For the recumbent handlebar loading evaluation, the handlebars shall not break. If the above criteria are not met the sample shall fail the test.

6.6.5 *Precision and Bias:*

6.6.5.1 *Precision*—The precision of this test method has not been determined.

6.6.5.2 *Bias*—The bias of this test method includes quantitative estimates of the uncertainties of the measuring devices, the calibrations of testing equipment, and the skill of the operators. At this time, the statements on bias should be limited to documented performance of particular laboratories.

6.7 *Pedals*—The purpose of this test is to evaluate the pedal construction.

6.7.1 *Apparatus and Set Up*—The sample shall be set up as described in Section 5.

6.7.2 *Calibration*—Verify that the measurement device is properly calibrated and has a resolution of 1 mm (0.04 in.).

6.7.3 *Procedure*—The following steps should be followed to test the specifications for pedals.

6.7.3.1 Inspect each pedal and verify that the pedals contain a mark indicating right and left as referenced from the user position.

6.7.3.2 Verify that there is a slip resistant gripping surface or structure (such as ribs or teeth) on the surface of the pedal contacted by the user during use.

6.7.3.3 Position the foot pedal into its lowest travel position relative to the floor. Measure the gap between the pedal and the floor.

6.7.3.4 Refer Test Methods F2571 Subsection 7.11.1 for test procedures for the pedals. The load shall be applied vertically at the midpoint of the pedal.

6.7.4 *Pass/Fail Criteria*—The pedal design shall conform to marking, dimensional and textural requirements of Subsection 5.6 of Specification F1250. Upon completion of the loading test the pedal assembly shall not break and shall function as intended by the manufacturer.

6.7.5 *Precision and Bias:*

6.7.5.1 *Precision*—The precision of this test method has not been determined.

6.7.5.2 *Bias*—The bias of this test method includes quantitative estimates of the uncertainties of the measuring devices, the calibrations of testing equipment, and the skill of the operators. At this time, the statements on bias should be limited to documented performance of particular laboratories.

6.8 *Pedal and Crank Endurance*—The purpose of this test is to evaluate the endurance of the pedal or crank handle.

6.8.1 *Apparatus and Set Up*—The sample shall be set up as described in Section 5 with the pedal/crank arm assemblies "blocked" to prevent rotation and set at the 12 o'clock / 6 o'clock positions or the pedal/crank arm assembly may be removed from the exercise bicycle and set up in a test stand. The load to the pedal shall be applied at the center of the pedal vertically. For loading onto the pedal of a bicycle, the load shall be applied against a 50 mm by 50 mm (1.98 in by 1.98 in.) plate that is affixed to the pedal. Possible methods of providing the force for this test include, but are not limited to, pneumatic cylinder(s) or dead weights. Verify that the applied load returns to zero after each loading cycle.

6.8.2 *Calibration*—Verify the load application system is calibrated and is accurate to within ±2 % of the applied load. Verify the accuracy of the counting device to ±0.05 % of the full cycle range of the device.

6.8.3 *Procedure*—With the pedal/crank arm assembly set up as described above, apply the load as described in Subsection 5.7 of Specification F1250 cyclically for the required number of cycles for either institutional or consumer equipment as defined in the same section of that specification.

6.8.4 *Pass/Fail Criteria*—Per the requirements of Subsection 5.7 of Specification F1250, the pedal or crank arm assembly shall not fail as a result of this test.

6.8.5 *Precision and Bias*—No information is presented about either the precision or bias of this test since the test result is non-quantitative.

6.9 *Crank Arm and Shroud Entrapment*—The purpose of this test is to evaluate entrapment at the interface/margins of the crank arm and the center shroud.

6.9.1 *Apparatus and Set Up*—The sample shall be set up as described in Section 5. This test requires probe as specified in Test Methods F2277 Fig. 2. Alternatively, a test probe with the following parameters can be used: a cylindrical test probe of diameter 9.5 mm ± 0.1 mm (0.37 in) and length 75 mm ± 1.5 mm (2.95 in) with surface hardness of HRC 40 or greater. Verify that all guards are properly positioned and secured. An apparatus capable of measuring 4.4 N (1 lb) of pulling force shall be provided.

6.9.2 *Calibration*—Calibrate the load measurement apparatus to confirm accuracy to within ±0.5 N (0.1 lb). Verify that the probe conforms to the dimensions of Test Methods F2277 Fig. 2 or the alternative dimensions provided above.

6.9.3 *Procedure*—Insert the test finger probe parallel to the axis of rotation (within ±5°) of the crank arm along the surface of the crank arm until it contacts the center shroud. Rotate the crank arm completely (in both directions) and ensure that the finger probe does not become entrapped. If the rotation of the crank arm pushes the probe out of the way then entrapment does not occur.

6.9.4 *Pass/Fail Criteria*—Per Subsection 5.8 of Specification F1250, there shall not be an entrapment hazard and the test probe shall not become entrapped.

6.9.5 *Precision and Bias:*

6.9.5.1 *Precision*—The precision of this test method has not been determined.

6.9.5.2 *Bias*—The bias of this test method includes quantitative estimates of the uncertainties of the measuring devices, the calibrations of testing equipment, and the skill of the operators. At this time, the statements on bias should be limited to documented performance of particular laboratories.

6.10 *Drive Train*—The purpose of this test is to evaluate the drive train elements per the Guarding and Entrapment portions of Specification F2276.

6.10.1 *Apparatus and Set Up*—The sample shall be set up as described in Section 5.

6.10.2 *Calibration*—Refer to Specification F2276 and Test Methods F2571 for calibration requirements.

6.10.3 *Procedure*—Refer to Specification F2276 and Test Methods F2571 for procedures to test drive train Guarding and Entrapment.

6.10.4 *Pass/Fail Criteria*—The drive train shall conform to the Guarding and Entrapment requirements of Specification F2276.

6.10.5 *Precision and Bias*—No information is presented about either the precision or bias of this test since the test result is non-quantitative.

6.11 *Institutional Bicycle/Ergometer Endurance Testing*—The purpose of this test is to evaluate the endurance of the exercise bicycle or ergometer.

6.11.1 *Apparatus and Set Up*—The sample shall be set up as described in Section 5 with a mechanism to pedal or actuate the machine through complete cycles similar to how the equipment would be used by a human user. Possible methods of providing the force for this test include, but are not limited to, pneumatic cylinder(s) or electric motors. Verify that the applied load achieves the required magnitude and moves the equipment through complete cycles.

6.11.2 *Calibration*—Verify the load application system is calibrated and is accurate to within ±5 % of the applied load. Verify the accuracy of the counting device to ±0.05 % of the full cycle range of the device.

6.11.3 *Procedure*—With the bicycle or ergometer set up as described above, actuate the equipment through complete cycles of 360° of rotation with the load and speed as described in Subsection 5.10 of Specification F1250. Different loads for direct drive exercise bicycles, upright bicycles, recumbent bicycles, upper body ergometers, and total body ergometers are provided in Subsection 5.10 of Specification F1250. Actuate the bicycles or ergometer cyclically for the required number of cycles as defined in the same section of that specification.

6.11.4 *Pass/Fail Criteria*—Per the requirements of Subsection 5.10 of Specification F1250, the bicycle or ergometer shall not fail as a result of this test.

6.11.5 *Precision and Bias*—No information is presented about either the precision or bias of this test since the test result is non-quantitative.

6.12 *Consumer Bicycle/Ergometer Endurance Testing*—The purpose of this test is to evaluate the endurance of the exercise bicycle or ergometer.

6.12.1 *Apparatus and Set Up*—The sample shall be set up as described in Section 5 with a mechanism to pedal or actuate the machine through complete cycles similar to how the equipment would be used by a human user. Possible methods of providing the force for this test include, but are not limited to, pneumatic cylinder(s) or electric motors. Verify that the applied load achieves the required magnitude and moves the equipment through complete cycles.

6.12.2 *Calibration*—Verify the load application system is calibrated and is accurate to within ±5 % of the applied load.. Verify the accuracy of the counting device to ±0.05 % of the full cycle range of the device.

6.12.3 *Procedure*—With the bicycle or ergometer set up as described above, actuate the equipment through complete cycles of 360° of rotation with the load and speed as described in Subsection 5.11 of Specification F1250. Different loads for direct drive exercise bicycles, upright bicycles, recumbent bicycles, upper body ergometers, and total body ergometers are provided in Subsection 5.11 of the Specification F1250. Actuate the bicycles or ergometer cyclically for the required number of cycles as defined in the same section of that specification.