



Designation: F3104 – 21

Standard Test Methods for Evaluating Design and Performance Characteristics of Externally Loaded Strength Training Equipment, Strength Training Benches and External Weight Storage Equipment¹

This standard is issued under the fixed designation F3104; 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 Externally Loaded Strength Training Equipment, Strength Training Benches and External Weight Storage Equipment. Users of these machines must recognize, however, that conformance to a standard will not necessarily prevent injuries. Like other physical activities, exercise involving this equipment involves the risk of injury, particularly if the equipment is not maintained or used properly.

1. Scope

1.1 These test methods specify procedures and apparatus used for testing and evaluating Externally Loaded Strength Training Equipment, Strength Training Benches and External Weight Storage Equipment for compliance to Specification **F3105**. Both design and operational parameters will be evaluated. Where possible and applicable, accepted test methods from other recognized bodies will be used and referenced.

1.2 *Requirements*—This equipment is to be tested in accordance with this test method or Test Methods **F2571** for all of the following parameters:

- 1.2.1 Stability,
- 1.2.2 Edge and corner sharpness,
- 1.2.3 Tube ends,
- 1.2.4 Entrapment and pinch points,
- 1.2.5 Weight disc retention,
- 1.2.6 Function of adjustments and locking mechanisms,
- 1.2.7 Training weight post loading,
- 1.2.8 Storage weight post loading,
- 1.2.9 Stop height verification,
- 1.2.10 Stop load drop test,
- 1.2.11 Barbell hook dimensions,
- 1.2.12 Catch hook load drop test,
- 1.2.13 Barbell support/frame impact test,
- 1.2.14 Intrinsic loading,
- 1.2.15 Extrinsic loading,

1.2.16 Endurance loading, and

1.2.17 Documentation and warnings verification.

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.*

1.4 *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

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

F2216 Specification for Selectorized Strength Equipment

F2571 Test Methods for Evaluating Design and Performance Characteristics of Fitness Equipment

F3105 Specification for Externally Loaded Strength Training Equipment, Strength Training Benches and External Weight Storage Equipment

2.2 *European Standards:*³

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

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

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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 European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, <http://www.cen.eu>.

EN 957–2 Stationary Training Equipment—Part 2: Strength Training Equipment, Additional Specific Safety Requirements and Test Methods

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *normal operation, n*—the operation of the equipment as defined by the manufacturer.

4. Significance and Use

4.1 The purpose of this document is to provide valid and repeatable test methods for the evaluation of Externally Loaded Strength Training Equipment, Strength Training Benches and External Weight Storage Equipment assembled and maintained according to the manufacturer's specifications. Use of these test methods in conjunction with Specification **F3105** is intended to maximize the reliability of the equipment's design and reduce the risk of serious injury resulting 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 designs and test procedures conform to and comply with these test methods and Specification **F3105**.

6. Units of Measure

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

7. Sample Preparation

7.1 Assemble and adjust the equipment according to the manufacturer's instructions. Remove upholstered pads from the sample. On 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 tests without adjustment from this initial condition. The equipment shall be provided with the largest amount of weight intended to be used with the equipment as stated by the manufacturer for the model to be tested.

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

8. Test Methods and Procedures

8.1 Stability:

8.1.1 This equipment shall be tested with and without the simulated user load in the orientation that is most obviously unstable. For Type 1 and Type 2 equipment as defined in Specification **F3105** the equipment is to be tested with the maximum rated load as stated by the manufacturer applied to the training weight posts with no additional weight stored on the weight storage posts (if so equipped). For Type 3 and 4 equipment the equipment is to be tested with a simulated user load and an applied load equal to the rated lifting load applied to the bench as defined below. Multiple tests will be performed as defined below.

8.1.2 *Apparatus and Set-Up*—Place sample on a non-skid surface inclined at 10° in the orientation that is least stable. The sample shall rest on the supporting surface without anchoring. Determine how the user is placed oriented relative to the machine to perform the exercise (that is, seating, standing, or prone) and then determine how the user's body weight is distributed onto the user support surfaces. For the tests that require a user load, apply a load equal to 100 kg (220 lb) simulating the user's weight and its distribution in the vertical direction at the point(s) of user contact. The load shall be applied in the most onerous condition for the machine type being evaluated. As an example, for a seated user, the user support surface shall be adjusted to the uppermost position (if adjustable) and the center of gravity of the 100 kg (220 lb) load shall be positioned approximately 150 mm (5.9 in.) above the user support surface. Possible methods of providing this load include, but are not limited to, pneumatic cylinder(s) or dead weights. Stability is to be evaluated with weight discs applied to one side and both sides of the machine. Determine most onerous condition and test the equipment in that orientation.

8.1.3 *Calibration*—Using an angle measuring instrument accurate to within 0.1°, verify the non-skid surface is 10 ± 0.5°. Calibrate the load measurement apparatus to confirm accuracy to within ±20 N (4.5 lb) over entire loading range.

8.1.4 *Procedure*—Test the sample as follows:

8.1.4.1 With the sample machine (no user load applied) positioned on the tilt surface, verify that the sample does not tip over with the resistance means in the rest position and no weight load on the training weight posts.

8.1.4.2 Using the aforementioned load apparatus, distribute a vertical load equal to 100 kg (220 lb) ± 5 % in a non-impact manner to the specimen where the user contacts the machine during normal operation. (If only a portion of the user's body is supported by the machine during operation, the 100 kg (220 lb) simulated user weight shall be reduced by the appropriate amount.) Load the maximum rated weight (as stated by the manufacturer) onto the lifting arm, bar or weight support structure and retain the weights from sliding. Raise and support the lifting arms and weights to simulate the furthest point in the range of travel as encountered during normal operation of the machine by a user of 1.8 m (74 in.) stature. Verify that the sample does not tip over.

8.1.4.3 Repeat 8.1.4.1 and 8.1.4.2 with the maximum amount of weight only on one side of the lifting arm or weight structure.

8.1.4.4 Repeat 8.1.4.1 and 8.1.4.2 with the sample oriented in any other directions of potential instability and with weights only on one side of the lifting arm or weight structure.

8.1.4.5 For Type 3 and 4 equipment load the bench vertically at the point(s) of user contact. The equipment is positioned on the tilt table in its most unstable orientation. If a seat is present then the seat shall be loaded with 45.5 kg (100 lb) simulating the 100 kg (220 lb) user's lower body. The applied load to the remainder of the bench is based on the maximal loads experienced by the bench [for example: 225 kg (495 lb) of lifting load] plus the upper body weight of the user [54.5 kg (119.9 lb)]. Apply this load to the bench, without inducing a torque to the bench, at the point of user contact with the bench.

The load shall be applied to the bench along its centerline using a 300 mm (11.8 in.) square plate.

8.1.5 *Pass/Fail Criteria*—In any of the above test conditions, or in any other weight configuration that will be unstable, the sample shall not tip over.

8.1.6 *Precision and Bias*—No information is presented about either the precision or bias of test 8.1 for measuring stability since the test result is non-quantitative.

8.2 *Adjustable Stops:*

8.2.1 This test is a visual inspection of the sample to ensure that adjustable stops (if required) are present and functional.

8.2.2 *Apparatus and Set Up*—The sample shall be set up as described in 7.1.

8.2.3 *Calibration*—Verify that the measuring device is accurate to 1.5 mm (0.06 in.).

8.2.4 *Procedure*—Visually confirm that adjustable stops are present on both sides of the machine and that they adjust with minimal effort. Verify on sled leg press machines that a dead stop is present that stops the lower edge of the carriage at least 266 mm (10.5 in.) from the front edge of the seat pad. Verify on Smith, Squat and Lifting Cage apparatus that one set of stop positions sets the lifting bar at least 711 mm (28 in.) above the floor when the lifting bar is resting on the adjustable stops. Verify the presence of a warning label instructing to not place the stops lower than this position when doing squat exercises.

8.2.5 *Pass/Fail Criteria*—Adjustable stops must be present and function on all Type 2 equipment. Sled leg press machines must have a dead stop that stops the carriage at least 266 mm (10.5 in.) from the edge of the seat. Smith, Squat, and Lifting Cage apparatus must have one set of stop position that stops the lifting arm at least 711 mm (28 in.) from the floor and a warning label must be present on both sides of the machine.

8.2.6 *Precision and Bias*—No information is presented about either the precision or bias of test in 8.2 for adjustable stops since the test result is non-quantitative.

8.3 *Weight Disc Retention:*

8.3.1 This test is a visual inspection of the sample to ensure that the weight discs are retained onto the lifting arms, bar or weight structure.

8.3.2 *Apparatus and Set Up*—The sample shall be set up as described in 7.1.

8.3.3 *Calibration*—Verify that angle measuring instrument is accurate to within 0.1°.

8.3.4 *Procedure*—Visually confirm that the weight plates are retained on the lifting structure by the presence of bar clamps, collars, pins or similar means. If angular placement of the weight posts is the method of retention, then verify that the angle of the weight post with respect to horizontal is at least 2° throughout the entire range of movement of the lifting structure.

8.3.5 *Pass/Fail Criteria*—The weight discs shall be retained. The presence of clamps or similar means or angulation of 2° or greater must be present.

8.3.6 *Precision and Bias*—No information is presented about either the precision or bias of test in 8.3 for evaluating weight disc retention since the test result is non-quantitative.

8.4 *Weight Disc Spacing – Storage Posts:*

8.4.1 This test is a visual inspection of the sample to ensure that the weight storage posts are spaced adequately.

8.4.2 *Apparatus and Set Up*—The sample shall be set up as described in 7.1.

8.4.3 *Calibration*—Verify that the measuring device is accurate to 1 mm (0.04 in.).

8.4.4 *Procedure*—Place the maximum weight plate size (as recommended by the manufacturer) onto each weight storage post. Measure the spacing between the weight discs. The spacing shall be 25 mm (0.98 in.) or greater.

8.4.5 *Pass/Fail Criteria*—The weight stack must begin and end the test in the same rest position and must not move unless it is displaced intentionally by a lifting force applied to the lifting arm.

8.4.6 *Precision and Bias*—No information is presented about either the precision or bias of test in 8.4 for evaluating weight disc spacing since the test result is non-quantitative.

8.5 *Training Weight Post Loading:*

8.5.1 This test is a visual, physical, and functional inspection of the weight posts used to support the training load on the equipment to ensure that they meet the loading parameters of Specification F3105.

8.5.2 *Apparatus and Set Up*—The sample shall be set up as described in 7.1. Determine whether the sample is designed for consumer or institutional use. Obtain from the manufacturer the maximum load rating for each weight training post. Provide a means (pneumatic, hydraulic, or similar) for providing the specified test load vertically downward to the training post.

8.5.3 *Calibration*—Calibrate the load measurement apparatus to confirm accuracy to within ± 50 N (± 11 lb).

8.5.4 *Procedure*—Obtain and record from the manufacturer the maximum load amount that the weight support post is subjected to during operation of the sample machine. Secure a load application device to the center of the weight support post. The post may either be pushed or pulled downward with the loading device. Apply the specified load to the weight post with an 80 mm (3.15 in.) belt. Maintain this load for 5 min. Repeat the test for each of the weight support posts.

8.5.5 *Pass/Fail Criteria*—If the weight post fails to support the load for 5 minutes or if the weight support post fails structurally then the weight support post shall fail the test.

8.5.6 *Precision and Bias*—No information is presented about either the precision or bias of test in 8.4 for evaluating training weight post loading since the test result is non-quantitative.

8.6 *Storage Weight Post Loading:*

8.6.1 This test is a visual, physical, and functional inspection of the weight posts used for storage on the equipment to ensure that they meet the loading parameters of Specification F3105.

8.6.2 *Apparatus and Set Up*—The sample shall be set up as described in 7.1. Determine whether the sample is designed for consumer or institutional use. Obtain from the manufacturer the maximum load rating for each weight storage post. Provide a means (pneumatic, hydraulic, or similar) for providing the specified test load vertically downward to the center of the storage post.

8.6.3 *Calibration*—Calibrate the load measurement apparatus to confirm accuracy to within ± 50 N (± 11 lb).

8.6.4 *Procedure*—Obtain and record from the manufacturer the maximum load amount that the weight storage post is subjected to. Secure a load application device to the center of the weight storage post. The post may either be pushed or pulled vertically downward with the loading device. Apply the specified test load to the center of the weight post with an 80 mm (3.15 in.) belt. Maintain this load for 5 min. Repeat the test for each of the weight support posts.

8.6.5 *Pass/Fail Criteria*—If the weight storage post fails to support the load for 5 minutes or if the weight storage post fails structurally then the weight storage post shall fail the test.

8.6.6 *Precision and Bias*—No information is presented about either the precision or bias of test in 8.5 for evaluating weight storage post loading since the test result is non-quantitative.

8.7 *Type 5 Equipment Loading:*

8.7.1 This is a functional test of the weight posts or trays used for storage on Type 5 equipment to ensure that they meet the loading requirements of Specification **F3105**.

8.7.2 *Apparatus and Set Up*—The sample shall be set up as described in 7.1. Provide means (pneumatic, hydraulic, or similar) for applying a load vertically downward to the center of the weight support or centerline of the unsupported span of a weight support. The load to the tray or rails shall be applied by a loading plate 300 mm (11.8 in.) wide and spanning the complete depth of the tray or rail structure. The load to the storage posts shall be applied at the middle of each post with a 80 mm (3.15 in.) belt.

8.7.3 *Calibration*—Calibrate the load measurement apparatus to confirm accuracy to within ± 50 N (± 11 lb).

8.7.4 *Procedure*—Obtain and record from the manufacturer the maximum load that each weight storage post or tray is to be subjected to. For storage trays, find the most onerous location (point which induces the largest stress within the structure) for a downward force on the tray. Apply the specified test load to the tray at this point. Each tray shall be tested separately. For storage posts, measure the length of the storage post and determine the midpoint of the post and apply the specified test load. Each post shall be tested separately. Secure a load application device to each of the load application points. The post or tray may either be pushed or pulled vertically downward with the loading device. Apply the calculated load for 1 min, using the means from 8.7.2.

8.7.5 *Pass/Fail Criteria*—If the weight storage post or tray fails to support the load for 1 min or if the weight storage post or tray fails structurally then the equipment shall fail the test.

8.7.6 *Precision and Bias*—No information is presented about either the precision or bias of the test described in 8.7 for evaluating weight storage post loading since the test result is non-quantitative.

8.8 *Drop Load Test – Stops:*

8.8.1 This test is a drop load test onto the adjustable and fixed stops of the sample. The purpose is to ensure the integrity of the stops.

8.8.2 *Apparatus and Set Up*—The sample shall be set up as described in 7.1. A system or apparatus shall be employed that

drops the maximum training load onto the stops, along the direction of travel of the machine through a distance of 457 mm (18 in.).

8.8.3 *Calibration*—Verify that the measuring device is accurate to 1.5 mm (0.06 in.).

8.8.4 *Procedure*—Load the lifting arm or carriage with the maximum training weight as stated by the manufacturer and retain with collars or other appropriate means. Raise the bar or carriage, in the direction of machine travel, to a distance of 457 mm (18 in.) above the fixed or adjustable stop to be tested. Release the load allowing the bar or carriage to free fall, along the travel direction, and strike the stops. Raise the bar or carriage and repeat the drop for 10 cycles for institutional equipment or 1 cycle for consumer equipment.

8.8.5 *Pass/Fail Criteria*—The stops shall not break and the bar or carriage assembly shall still support the load.

8.8.6 *Precision and Bias*—No information is presented about either the precision or bias of test in 8.6 for evaluating stop drop load test since the test result is non-quantitative.

8.9 *Drop Load Test – Catch Hook:*

8.9.1 This test is a drop load test onto the barbell support hooks of the sample. The purpose is to ensure the integrity of the hooks.

8.9.2 *Apparatus and Set Up*—The sample shall be set up as described in 7.1. A system or apparatus shall be employed that drops the maximum training load onto the support hooks from a height of 150 mm (5.9 in.).

8.9.3 *Calibration*—Verify that the measuring device is accurate to 1.5 mm (0.06 in.).

8.9.4 *Procedure*—Load the lifting bar with the maximum training weight as stated by the manufacturer and retain with collars or other appropriate means. Raise the bar to a height of 150 mm (5.9 in.) above the rest surface of the bar support hook. Release the load allowing the bar or carriage to free fall and strike the hook. Raise the bar or carriage and repeat the drop for 10 cycles for institutional equipment or 1 cycle for consumer equipment.

8.9.5 *Pass/Fail Criteria*—The support hooks shall not break.

8.9.6 *Precision and Bias*—No information is presented about either the precision or bias of test in 8.8 for evaluating support hook drop load test since the test result is non-quantitative.

8.10 *Catch/Frame Impact Testing:*

8.10.1 This test is an impact load test onto the side frame structure of Type 3 equipment as defined in Specification **F3105**. The purpose is to ensure the integrity of the frame structure.

8.10.2 *Apparatus and Set Up*—The sample shall be set up as described in 7.1. A system or apparatus shall be employed that dynamically impacts the maximum training load onto the barbell support frames. This load shall strike both side frames at a vertical location measured down 38 mm (1.5 in.) from the uppermost end of the side frames. The load shall be positioned horizontally 300 mm (11.8 in.) in front of the side frames. An acceptable construction of the test apparatus would be a pendulum structure that supports the training bar above the bench or seat and is designed and configured so that when